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 comments and the background information compiled for the Highway 7 Corridor & Vaughan North-South Link Public Transit Improvements EA, particularly the Natural Sciences Report prepared by LGL and dated March 2005.

The storm water management criteria are summarized as follows:

- There are four main watersheds – Humber River, Don River, Rouge River and Petticoat Creek - with 64 watercourses within the Highway 7 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 transitway 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. 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 Peel clay and Chinguacousy clay loam with Milliken loam becoming more predominant in the eastern portion of the study area. These soils are not suitable for infiltration type facilities. In addition, due to potential for contamination of the groundwater due to salt and oils from roadway runoff, infiltration basins are not appropriate for the Highway 7 transitway.

Oil/grit separators are appropriate for small commercial and industrial areas 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 $\leq$ 0.5 m/s; depth $\leq$ 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 at maintenance facilities.

5 Storm Water Management Concept Plan

5.1 General Approach

The existing right-of-way widths vary quite substantially along Highway 7 due to property acquisitions for widening and redevelopment. In general, Highway 7 has a ROW varying from 20 m to 60 m wide. Similarly, the number of lanes along Highway 7 also varies from as few as 2 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 transitway would have the following characteristics:

- 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;
- 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 transitway 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.

An existing six lane roadway with a centre turn lane has the following typical geometry:

- 43.5 m right-of-way;
- sidewalks on each side – each 2.0 m wide;
- outside curb and gutter – each 0.5 m wide;
- three traffic lanes in each direction – four at 3.5 m and two at 3.75 m wide;
- centre turning lane – 4.5 m wide; and
- right-of-way is 71% impervious.

The proposed six lane roadway with the transitway would have the following characteristics:

- 43.5 m right-of-way;
- sidewalks on each side – each 2.0 m wide;
- outside curb and gutter – each 0.5 m wide;
- three traffic lanes in each direction – four at 3.5 m and two at 3.75 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 81% impervious.

The typical transitway layout will increase the imperviousness within the right-of-way from 71%

to 81% where the existing roadway has 6 lanes with a centre turn lane.

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

There are no existing storm water management facilities along the Highway 7 corridor that specifically provide treatment for runoff from Highway 7. Currently runoff discharges uncontrolled to trunk sewers and the various watercourses that cross Highway 7.

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 transitway will be developed during the detail design phase.

Many sections of the Highway 7 are urbanized and there are generally limited opportunities to provide storm water management for the Highway 7/transitway runoff. The existing roadway runoff has a greater impact on the downstream watercourses than the potential increase in runoff due to the proposed transitway. 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 transitway. This type of initiative would be separate from the current environmental assessment for the Highway 7 Corridor Public Transit Improvements.

There are sections of Highway 7 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 Highway 7 – both from the existing and transitway 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 transitway are identified in the following sections.

5.2.1 Highway 7 – Highway 50 to Huntington Road (Sta.10+000 to Sta. 10+160)

The road drains from east to west and runoff continues westward along Highway 7 past Highway 50. The area west of Highway 50 is undeveloped and it may be possible to outlet the storm drainage to grassed swales.

5.2.2 Highway 7 – Huntington Road to Highway 27 (Sta. 10+160 to Sta. 12+270)

This stretch of road includes the Highway 427 interchange and 4 crossings of Humber River tributaries. 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.

5.2.3 Highway 7 – Highway 27 to Kipling Avenue (Sta. 12+270 to Sta. 14+325)

This section drains from both the west and east to Rainbow Creek (also known as Plunkett's Creek) located at Sta. 13+920. Grassed swales and rock flow checks, based on available property, are proposed prior to the runoff outletting to Rainbow Creek.

5.2.4 Highway 7 – Kipling Avenue to Islington Avenue (Sta. 14+325 to Sta. 15+000)

Rapid transit in this section is in mixed traffic and only minor widening is required at each end to connect to the transitway. Storm water management is not required for this section.

5.2.5 Highway 7 – Islington Avenue to east of Bruce Street (Sta. 15+000 to Sta. 15+700)

This section drains from east to west and outlets to the Humber River located west of Islington Avenue. The area is primarily urbanized and sections of retaining walls are required along the steep slope just east of Islington Avenue to accommodate the transitway widening. There are no opportunities for a grassed swale or wet pond.

5.2.6 Highway 7 – East of Bruce Street to Colossus Drive (Sta. 15+700 to Sta. 19+020)

This section drains from the west and east with an overall low spot located at Sta. 15+990 – a tributary of the Main Humber River. There Is another crossing at Sta. 17+000 – Emery Creek, a tributary of the Lower Humber River. The Emery Creek crossing is piped with no visual evidence of a watercourse. This section is nearly all urbanized, however, there may be some opportunity to provide grassed swales just east of the tributary at Sta. 15+990.

5.2.7 Highway 7 – Colossus Drive to Millway Avenue (Sta. 19+020 to Sta. 20+200)

This section includes the Highway 400 interchange located at Sta. 19+200. There is a tributary of Black Creek that crosses Highway 7 at Colossus Drive and another tributary that starts just south of Highway 7 on the east side of the interchange. Structure widening and ramp re-alignment is required at the Highway 400 interchange for the transitway. In addition, the interchange is to be reconfigured for Phase 1 of the Vaughan Corporate Centre. It is recommended that storm water management for Highway 7 – both existing and transitway drainage - be included in the reconfiguration of the interchange.

5.2.8 Highway 7 – Millway Avenue to CN MacMillan Yard (Sta. 20+200 to Sta. 21+820)

Black Creek crosses this section of road just east of Jane Street. There is a storm water management facility located at the north end of the crossing. The storm water pond should be enlarged as needed to accommodate the increased runoff from the transitway.

5.2.9 Highway 7 – CN MacMillan Yard to Keele Street (Sta. 21+820 to 22+570)

A tributary of the West Don River parallels the north side of Highway 7 with some open space between the roadway and the tributary. A grassed swale is proposed along the north side of Highway 7.

5.2.10 Jane Street – Highway 7 to Highway 407 (Sta. 220+410 to 221+300)

This section has a low point at Sta. 220+650 with Black Creek parallel to the east side of the road. It may be possible in this location to outlet to a grassed swale just prior to Black Creek.

5.2.11 Jane Street – Highway 407 to Beechwood Cemetery Entrance (Sta. 221+300 to Sta. 221+760)

Black Creek crosses Jane Street at Sta. 221+650 and a tributary crosses south of this section at Sta. 221+900. There are storm water management facilities at these locations as part of a rehabilitation of Black Creek. These facilities can continue to be used for the drainage of the roadway and transitway.

5.2.12 Jane Street – Beechwood Cemeterey Entrance to Proposed West-East Collector Road (Sta. 221+760 to Sta. 222+150)

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

5.2.13 Proposed West-East Collector Road – Jane Street to Street C (Sta. 230+000 to Sta. 230+720)

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

5.2.14 Street C - Proposed West-East Collector Road to Steeles Avenue (Sta. 240 +000 to Sta. 240+220)

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

5.2.15 Steeles Avenue – Street C to Keele Street (Sta. 253+280 to Sta. 254+670)

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

5.2.16 Keele Street - Steeles Avenue to Highway 7 (Sta. 524+760 to 526+900)

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

5.2.17 Highway 7 – Keele Street to GO Bradford (Sta. 22+570 to 23+500)

Drainage in this section is to a tributary of the West Don River that is south of and parallel to Highway 7. The tributary is in the rear yards of properties that front onto Highway 7. The area is completely urbanized and there are no opportunities for grassed swales or wet ponds within or adjacent to the right-of-way.

5.2.18 Highway 7 - GO Bradford to North Rivermede/Centre Street (Sta. 23+500 to Sta. 24+140)

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

5.2.19 Centre Street - Highway 7 to Dufferin Street (Sta. 324+160 to Sta. 324+800)

This section includes the Highway 407 overpass and a hydro corridor. Drainage in this area can continue to discharge to the open space area.

5.2.20 Centre Street - Dufferin Street to Bathurst Street (Sta. 324+800 to Sta. 326+875)

The area is completely urbanized and there are no opportunities for grassed swales or wet ponds within or adjacent to the right-of-way.

5.2.21 Bathurst Street - Centre Street to Worth Boulevard/Flamingo Road (Sta. 326+875 to Sta. 328+170)

The area is completely urbanized and there are no opportunities for grassed swales or wet ponds within or adjacent to the right-of-way.

5.2.22 Bathurst Street and Bathurst Street Connection Road - Worth Boulevard/Flamingo Road to Highway 7 (Sta. 328+170 to Sta. 329+740)

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

5.2.23 Highway 7 - Bathurst Street Connection Road to east of Hunters Point Drive (Sta. 28+230 to Sta. 29+570)

This section drains from the west and east to the East Don River crossing at Sta. 28+940. There is open space on both sides of the road and grassed swales are proposed prior to the runoff discharging to the East Don River.

5.2.24 Highway 7 - East of Hunters Point Drive to Cedar Avenue (Sta. 29+570 to Sta. 32+910)

This section eventually outlets to the large storm water management facility located in the northeast quadrant of Highway 7 and Yonge Street. The existing facility will continue to provide water quality and quantity treatment for the existing and transitway runoff.

5.2.25 Highway 7 - Cedar Avenue to Saddle Creek Drive (Sta. 32+910 to Sta. 34+810)

This section drains from the west and east to the German Mills Creek crossing at Sta. 34+200. There is open space on both sides of the road and grassed swales are proposed prior to the runoff discharging to the East Don River.

5.2.26 Highway 7 - Saddle Creek Drive to Leslie Street (Sta. 34+810 to Sta. 35+900)

This section drains from the west and east to a tributary of German Mills Creek that crosses Highway 7 at Sta. 35+350. While there is some open space near the west end of this section, the highway through the watercourse area is fully urbanized and there are no opportunities for grassed swales or wet ponds within or adjacent to the right-of-way.

5.2.27 Highway 7 - Leslie Street to Highway 404 (Sta. 35+900 to Sta. 36+850)

This section drains from the west to a tributary of German Mills Creek that crosses Highway 7 at Sta. 36+460. The storm sewer currently discharges directly to the concrete culvert crossing. There is some open space within the right-of-way adjacent to the crossing on both sides of the highway and it is proposed that the storm sewer outlet to a grassed swale prior to the crossing.

5.2.28 Highway 7 - Highway 404 to Montgomery Crescent/Fairburn Drive (Sta. 36+850 to Sta. 38+450)

This section drains from the west and east to the Beaver Creek crossing at Sta. 37+780. There is insufficient right-of-way adjacent to the crossing to use a grassed swale. There is an existing storm water management facility located on the south side of Highway 7 just west of the crossing. While this facility was implemented for the adjacent development area, the possibility of discharging the Highway 7 drainage to this facility needs to be investigated during detail design.

5.2.29 Highway 7 - Montgomery Crescent/Fairburn Drive to Apple Creek (Sta. 38+450 to Sta. 38+695)

This section drains from the west and the storm sewer can outlet to a grassed swale on the north side prior to discharging to Apple Creek.

5.2.30 Highway 7 - Apple Creek to west of Town Centre Boulevard (Sta. 38+695 to Sta. 39+330)

This section drains from the east to a low point located east of Apple Creek. There is an existing storm water facility on the north side of Highway 7 that was retrofitted in 1997 as a wetland to provide water quality treatment and erosion for a development area to the northeast. The existing facility is 8% larger than required for the existing drainage area and would have sufficient capacity to provide water quality treatment for the increase in paved area due to the transitway. Use of this pond needs to be investigated further during detail design.

5.2.31 Highway 7 - West of Town Centre Boulevard to Town Centre Boulevard (Sta. 39+300 to Sta. 39+580)

This section drains from the west and outlets to the existing trunk sewer on Warden Avenue that flows southward and discharges to the Rouge River. There is limited space to provide storm water quality control for this section of Highway 7 and the increased runoff from the transitway is only a small portion of the overall flow in the Warden Avenue trunk sewer. Storm water management for the Warden Avenue trunk sewer would require a separate study.

5.2.32 Town Centre Boulevard - Highway 7 to west of Rouge River (Sta. 439+580 to Sta. 440+170)

Drainage for this section was provided as part of a drainage master plan for the Clegg Road/Cedarland Drive area. The existing sewer has a direct discharge to the Rouge River. There is an existing storm water pond to the south of the storm outlet that was built after the storm sewer. Due to differences in elevation, the storm sewer outlet could not be included in the pond. The transitway will continue to discharge to the existing storm sewer on Town Centre Boulevard.

5.2.33 Markham Centre Alignment - Town Centre Boulevard to Warden Avenue (Sta. 540+070 to Sta. 540+450)

This alignment crosses the Rouge River floodplain and consists of a two 3.5 m wide transit lanes with a 0.5 m shoulder. Rather than a storm sewer system, individual outlets to the vegetated area adjacent to the transitway are proposed for this section.

5.2.34 Markham Centre Alignment - Warden Avenue to Future Sciberas Road (Sta. 540+450 to Sta. 541+720)

This section is part of a large development planning area north of Highway 407 between Warden Avenue and Kennedy Road. A number of storm water management ponds will be required for the overall development area. These ponds will provide water quality control for the transitway runoff.

5.2.35 Markham Centre Alignment - Future Sciberas Road to Helen Aveunue (Sta. 541+720 to Sta. 542+235)

This section is an underpass beneath the GO Stouffville tracks and the low point will be up to 7 m below the existing ground elevation. The actual drainage for this section - deep storm sewer or pumping station - will need to be determined during detail design and will be dependent upon the final design for Enterprise Drive which will be adjacent to the transitway. Enterprise Drive is the main west-east roadway within the large development planning area north of Highway 407 between Warden Avenue and Kennedy Road.

5.2.36 Helen Avenue - Markham Centre Alignment to Kennedy Road (Sta. 605+030 to Sta. 605+300)

Drainage for this section will need to be incorporated into the drainage for Helen Avenue which is currently under construction.

5.2.37 Kennedy Road - Helen Avenue to Avoca Drive (Sta. 742+500 to Sta. 743+300)

This section drains from the south and north to a tributary of the Rouge River located at Sta. 742+760. Drainage for this section will need be incorporated into the planned widening of Kennedy Road to six lanes between Highway 407 and Highway 7.

5.2.38 Kennedy Road - Avoca Drive to Highway 7 (Sta. 743+300 to Sta. 743+650)

This section drains from the south and continues northward on Kennedy Road to the Rouge River crossing located north of Highway 7. This section is fully urbanized and there are no opportunities for grassed swales or wet ponds within or adjacent to the right-of-way.

5.2.39 Highway 7 - Kennedy Road to east of McCowan Road (Sta. 42+540 to Sta. 44+370)

This section drains from the west and east to the Lower Rouge River crossing located at Sta. 43+255. There is open space along the north side of Highway 7 particularly west of the crossing and a storm sewer outlet to a grassed swale is proposed prior to discharging to the Lower Rouge River.

5.2.40 Highway 7 - East of McCowan Road to Galsworthy Drive/Gardenview Boulevard (Sta. 44+370 to Sta.45+580)

This section drains from the west and east to a low point at Robinson Street. Drainage will be provided by the existing storm sewer network. This section is fully urbanized and there are no opportunities for grassed swales or wet ponds within or adjacent to the right-of-way.

5.2.41 Highway 7 - Galsworthy Drive/Gardenview Boulevard to Wooten Way (Sta. 45+580 to Sta. 47+690)

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

5.2.42 Highway 7 - Wooten Way to west of Ninth Line (Sta. 47+690 to 48+100)

This section drains from the east and contributes to the storm sewers that continue westward from Wooten Way. This section is fully urbanized and there are no opportunities for grassed swales or wet ponds within or adjacent to the right-of-way.

5.2.43 Highway 7 - West of Ninth Line to east of Ninth Line (Sta. 48+100 to Sta. 49+880)

This section drains from the west and east to storm sewers on Ninth Line. The final outlet has not been defined and needs to be confirmed during detail design.

5.2.44 Highway 7 - East of Ninth Line to Reesor Road (Sta. 49+880 to 50+450)

This section has two low points at Sta. 49+170 and Sta. 50+150 and drainage is provided by two tributaries of the Little Rouge River. It is recommended that storm water management be provided for both Highway 7 and the transitway as the adjacent lands under go development.

5.2.45 Highway 7 - Reesor Road to York-Durham Line/Regional Road 30 (Sta. 50+450 to Sta. 53+200)

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