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Appendix B-2

Stormwater Management Report

Toronto Transit Commission

Stormwater Management Report
Scarborough Subway Extension

Prepared by:
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August, 2017

Project Number: 60347355

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AECOM: 2015-04-13

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SWM RPT-SSE-60347355.Docx

1. Introduction

The Toronto Transit Commission (TTC) retained AECOM Canada Ltd. (AECOM) to complete an Environment Assessment (EA) study of the proposed extension of Line 2 (Bloor-Danforth Subway). The proposed express subway extension will replace the aging Line 3 (Scarborough Rapid Transit) to provide an 'express' subway service from Kennedy Station to its new terminus – Scarborough Centre Station. The purpose of the EA study is to identify the preferred alignment, station location and associated construction strategy.

A stormwater management report was completed as part of the EA study to present the results of the preliminary drainage impact assessment completed for the preferred alignment located within the McCowan corridor. The impact assessment is based on a desktop review and engineering assumptions that would require further refinement during the Detailed Design Phase of the Project.

The objectives of the subject stormwater management study include:

- Identify design opportunities and constraints related to drainage and stormwater management;
- Identify existing and proposed drainage condition;
- Develop a general Stormwater Management Strategy for the proposed subway, stations and ancillary structures;
- Develop a conceptual Stormwater Management (SWM) Plan for the proposed Scarborough Centre Station and provide recommendations regarding integration of SWM practices into the station site plan;
- Identify the construction impacts and provide high level recommendations; and
- Identify the future considerations in the Detailed Design Phase of the Project.

1.1 Study Area

Figure 1 shows the general location of the proposed subway extension**.** The preferred subway alignment begins at Kennedy Station, runs easterly under Eglinton Avenue East then turns northerly at McCowan Road then offsets to the west at Ellesmere Road through Borough Drive to Scarborough Centre. The proposed Scarborough Centre Station is located just to the east of the existing Scarborough LRT (Line 3) Town Centre Station and to the south east of the Scarborough Town Centre shopping mall. The proposed subway is located within the Highland Creek Watershed in the City of Toronto, which is under the jurisdiction of the Toronto and Region Conservation Authority (TRCA).

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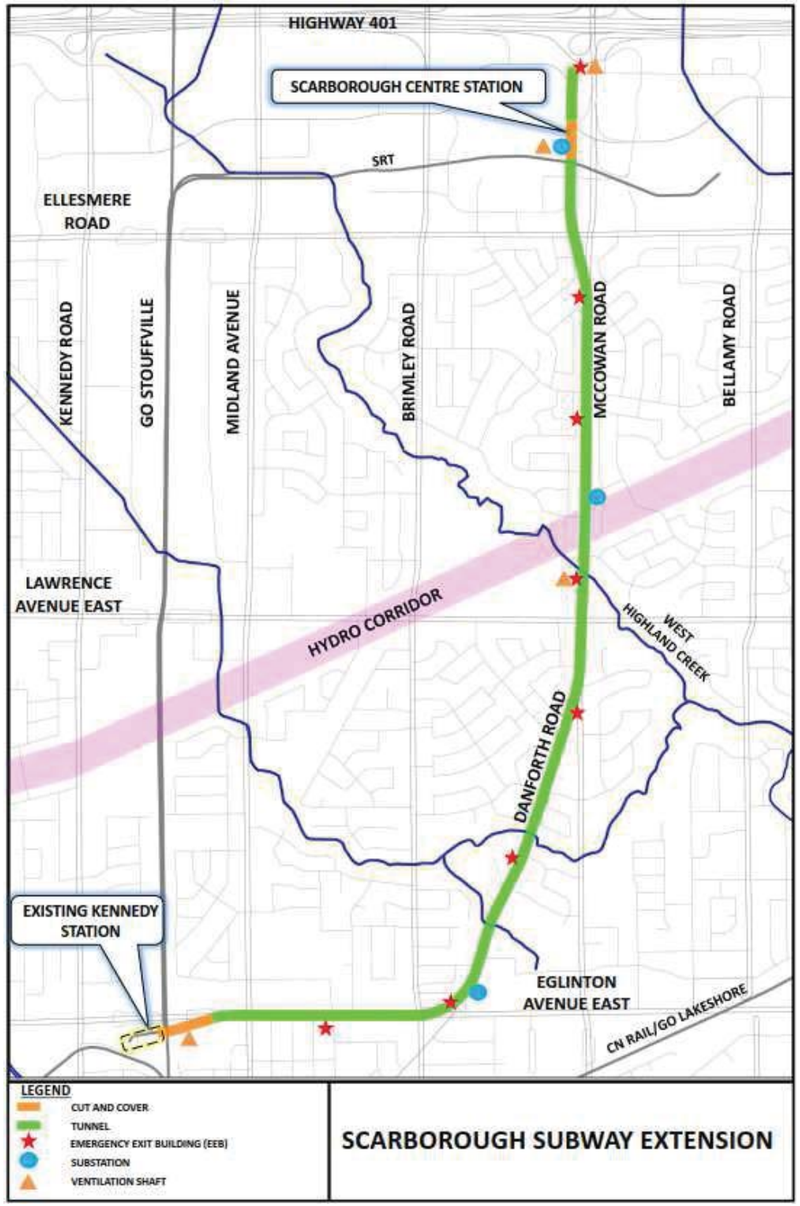

Figure 1: Study Area

1.2 Background Review

To have a better understanding of the existing site and the proposed development, reviews of the following have been completed:

- Reference Drawings of the Town Centre Station, Scarbrough Town Centre Light Rail Transit, Toronto Transit Commission, February 1983;
- Plan of the Scarborough Town Centre, Storm Sewers (6378-01-U29A) by M.M. Dillon Limited, May 1969;
- General Plan, Storm and Sanitary Sewers, Scarborough Town Centre (83-78-03) by M.M. Dillon Limited, 1971;
- Construction Drawing, Sewers and Watermains, Scarborough Town Centre Regional Shopping Centre by Dillon Consulting Engineers and Planners and Bregman & Hamann Architect's and Engineer's, December 1971;
- As Built Drawings, Storm and Sanitary Sewers (6378-03), Scarborough Town Centre (83-78-03) by M.M. Dillon Limited, 1971;
- As Built Drawing, Grading and Storm Sewers and Underground Services (K-97A and K-86-A), Scarborough Town Centre Regional Shopping Centre by M.M. Dillon Limited and Bregman & Hamann Architect's and Engineer's, July 1973;
- TRCA Regulation Limits (GIS Layer); and
- TRCA Highland Creek Floodplain Mapping.

The following associated Policies and Design Standards were also reviewed in developing the proposed stormwater management concept:

- Toronto Transit Commission (TTC) Design Manual, April 2016;
- Wet Weather Flow Management Guidelines (City of Toronto, November 2006);
- Toronto and Region Conservation Stormwater Management Criteria (TRCA, August 2012);
- Design Criteria for Sewers and Watermains (City of Toronto, 2007); and
- Ministry of Environment and Climate Change (MOECC) Stormwater Management Planning and Design Manual, March 2003.

1.3 Stormwater Management Standard Review

1.3.1 City of Toronto

The *City's Wet Weather Flow Management Guidelines (WWFMG)* is the governing document with respect to drainage and stormwater management in the City. The WWFMG outlines requirements for quantity control, quality control, water balance and erosion control, as well as discharge criteria to municipal infrastructure. These requirements are typically translated into a need to either detain (i.e. attenuate and gradually release flows) or retain (i.e. reduce volume of) stormwater runoff. Refer to **Appendix A.1** for a copy of *Table 7 Summary of Stormwater Management Requirements for Various Types of Development* in WWFMG.

- *Water Balance*. Retain Stormwater on-site to the extent practicable to achieve the same level of annual volume of overland runoff allowable from the development site under pre-development conditions. The minimum on-site runoff retention requires the proponent to retain all runoff from a design rainfall event - typically 5 mm through infiltration, evapotranspiration and rainwater reuse;

- *Water Quality*. Water quality target is the long-term average of removal of 80% Total Suspended Solids (TSS) on an annual loading basis;
- *Water Quantity*.
  (1) Flood Flow Management Criteria: The TRCA Flood Flow Criteria shall be applied to any new development site contributing flow to a specific watercourse at the point of discharge. The TRCA Flood Flow Criteria Map indicates that quantity control should ensure post to pre-development peak flows for 2 to 100-year return period events. For redevelopment sites < 5 ha, peak flows can be computed using simplified approach such as the Rational Method and IDF curves;
  (2) Discharge Criteria to Municipal Infrastructure: the allowable release rate to the municipal storm sewer system from the site during a 2 year design storm even must not exceed the peak runoff rate from the site under pre-development condition or existing capacity of the receiving storm sewer whichever is less;
  (3) When there is no approved or adequate overland flow route and if the proposed changes result in increased flows entering the sewer system, then all flow from the 2-year up to the 100-year return period storms shall be stored on site and released at the allowable rate.

1.3.2 Toronto Transit Commission (TTC)

TTC's Design Standards, Volume 1, DM-0208-00 Civil – Storm Drainage provides design criteria for the storm drainage facilities which are located on, or cross, the transit system property or required location or modification as a result of transit system construction. The following is a summary:

- The design of the storm drainage system shall be in accordance with the standards and stormwater management policies of the local municipality, the Regional Conservation Authority, the Ontario Ministry of Environment Climate Change (MOECC), the Ontario Ministry of Natural Resources and Forestry (MNRF), and the Ministry of Transportation of Ontario (MTO). (Clause 1.4);
- The Modified Rational Method may be used to develop hydrographs for the design of detention storage systems, for rainfalls lasting longer than the time of concentration. (Clause 2.2);
- Runoff detention can be achieved by various techniques such as: roof storage (control flow roof drains), surface storage (parking lots and landscaped areas), subsurface storage tanks, in-line storage in storm sewers and maintenance holes, inlet control devices (orifice plates or tubes) in catchbasins and maintenance holes. (Clause 3.1);
- Roof storage maximum controlled run-off 42 l/s per hectare of roof area, maximum ponding depth 150 mm; surface storage maximum ponding depth of 0 mm for 1:2 year storm and 250 mm for 1: 100-Year storm. (Clause 3.2); and
- Overland flow gradients for parking lots shall be a minimum of 2% and a maximum of 4%. (Clause 5.2.1).

1.3.3 Toronto and Region Conservation Authority (TRCA)

In accordance with TRCA's requirements, lot level conveyance controls (parking and roof-top storage) are to be designed to reduce post development peak flows for 2:100 year return periods to pre-development flows. Furthermore, the Toronto and Region Conservation Authority (TRCA) encourages that the treatment train approach using source, conveyance, and end-of-pipe facilities, in combination with low impact development practices, should be considered to meet the design criteria associated with water quantity, quality, erosion, and water balance.

The *Erosion and Sediment Control Guideline for Urban Construction (Greater Golden Horseshoe Conservation Authorities, 2006),* provides guidance on the suitable SWM approaches and criteria to be applied during construction.

2. Proposed Project Description

The proposed Scarborough Subway Extension (SSE) includes:

- 6.2 kilometre extension of the Bloor-Danforth subway (Line 2) from Kennedy Station express to Scarborough Centre;
- A new station – Scarborough Centre Station – at the terminus; and
- Ancillary features – which are supporting elements that are required for the operation of the subway, including Emergency Exit Buildings (EEBs) and Traction Power Substations (TPSSs).

Subway Horizontal and Vertical Alignment

With reference to **Figure 2**, the preferred alignment travels east along Eglinton Avenue East within the road right-of-way (ROW) from Kennedy Station to Danforth Road. The alignment then travels north along Danforth Road / McCowan Road in the centre of the road ROW until Lawrence Avenue East. North of Lawrence, the alignment runs west of the road ROW to north of the Highland Creek and Gatineau Hydro Corridor, after which it returns to the centre of the McCowan Road ROW. South of Ellesmere Road it will divert to the west side of the road, continue under several residential properties, a gas station, and the Frank Faubert Woodlot, allowing the new Scarborough Centre Station to be located under the planned extension of Borough Drive.

The entire SSE will be underground. Except for a very short section east of Kennedy Station, there will typically be at least 10 metres of ground cover above the tunnel structure.

Scarborough Centre Station

The preferred subway station is located west of McCowan Road, under an extension of Borough Drive, in a north-south orientation between Triton and Progress Road. The new Scarborough Centre Station consists of subway station (platform, concourse, entrances and associated facilities) and bus terminal. The construction of the Station will also include associated road improvements.

Ancillary Features

Emergency Exit Buildings (EEBs) extend from the underground tunnel to grade and are designed to provide an emergency exit for passengers and an emergency access for firefighting crews. Eight EEBs are required as shown in **Figure 2**. The at-grade footprint of each EEB is approximately 30 square metres.

Electrical power is required to power the trains (referred to as traction power) as well as to operate lights, equipment and safety systems associated with the SSE. There are three Traction Power Substations (TPSSs) proposed along the SSE. Substation # 3 is to be located at Scarborough Centre Station. The approximate surface footprint of traction power substations #1 and #2 are 1,000 square metres.

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Toronto Transit Commission
Stormwater Management Report
Scarborough Subway Extension

Construction

The SSE will be constructed via tunnelling and cut-and-cover construction. Most of the alignment will be constructed via tunnelling – from Eglinton Avenue, east of Kennedy Station to Town Centre Court and from the north end of the subway box to the north limit of the alignment, located immediately south of Highway 401. The key elements which will be constructed via cut-and-cover construction include:

- Construction of the tunnel boring machine launch and extraction shafts;
- Demolition and reconstruction of the existing Kennedy tail track structure (located below the Don Montgomery Community Centre parking lot); and
- Construction of Scarborough Centre Station, the mid-tunnel ventilation structure, EEBs and traction power substations.

As shown in **Figure 2**, tunnelling would start from a launch site located immediately south of Highway 401 (Launch Shaft). The entire site would be roughly 10,000 square metres. A second construction shaft is just north of Town Centre Court with roughly 10,000 square metres.

3. Drainage Impact Assessment

3.1 Existing Condition

3.1.1 Macro Drainage System

The study area is located within the Highland Creek watershed as shown in **Figure 2**. The Highland Creek watershed is approximately 102 km^2 in area, with over 75 km of watercourses. The watershed is almost completely (85%) urbanized, and represents the most developed watershed in the jurisdiction of the Toronto and Region Conservation Authority (TRCA). Most of the development had occurred before stormwater management controls became a requirement, resulting in high peak flows associated with urban watercourses, as well as poor water quality. The watercourses have been significantly altered as a result of the development occurring in the past. This approach also resulted in severe erosion affecting a number of reaches, and requiring frequent stabilization efforts. As a result, a significant percentage of the channel network has been either buried underground or lined with concrete or gabion baskets to reduce erosion and prevent flooding. The watershed is also characterized with a number of fish barriers (like dams and weirs) and a lack of riparian vegetation.

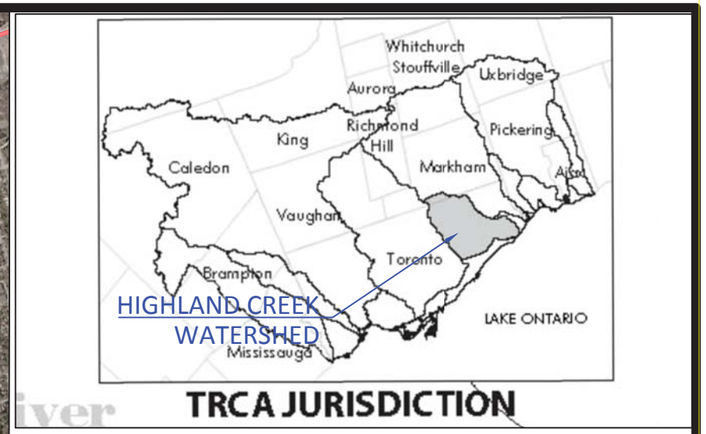
3.1.2 Micro Drainage System

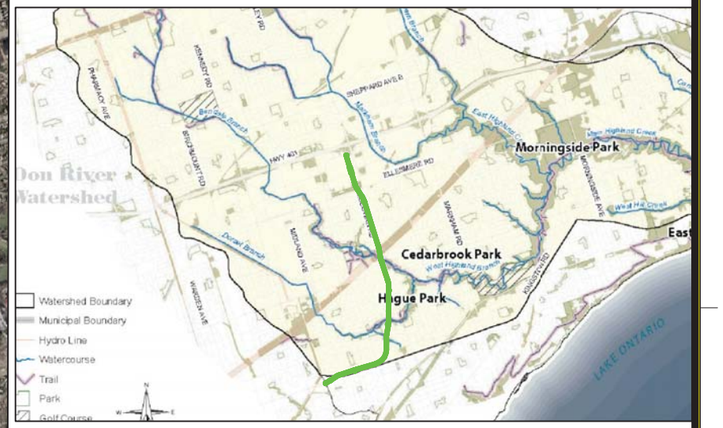
Local drainage from the Scarborough Centre Subway Station and related facilities will be required to tie in to existing sewers. Existing sewer systems are generally designed to accommodate only minor runoff events for the existing level of development. The subway station and related facilities, although being constructed in already built-up areas, would potentially be required to over control the peak flows as required by the discharged criteria to municipal sewers.

3.1.3 Surface Water Quality

Majority of the existing stormwater system was built before current Ministry of the Environment Climate Change (MOECC) guidelines were in place and there are no quality treatment facilities found within the macro drainage system.

The *City of Toronto's Wet Weather Flow Management Master Plan (WWFMMP)* and *Wet Weather Flow Management Guidelines (WWFMG)* provide direction on various methods for improving the quality of stormwater runoff. Any proposed works to be considered by this undertaking must be consistent with the approach and recommendations of these governing documents.





CADD FILE NAME: T:\Projects\3-33017665-ScarbSubwayExt\09 Drainage\07 Drawings\Figure 2 Alignment with TRCA.dwg

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Figure 2 Alignment with TRCA.dwg

LEGEND

🟩	PREFERRED SSE ALIGNMENT
━	TRCA REGULATED FLOODLINE
━	TRCA REGULATION LIMITS
★	EMERGENCY EXIT BUILDING (EEB)
●	TRACTION POWER SUBSTATION (TPSS)

TRCA JURISDICTION

HIGHLAND CREEK WATERSHED

REVISIONS		REVISIONS	
△ ADDENDUM No. OR CONTRACT CHANGE No. DESCRIPTION OF CHANGE	YYYY-MM-DD	△ ADDENDUM No. OR CONTRACT CHANGE No. DESCRIPTION OF CHANGE	YYYY-MM-DD
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AECOM

DRAWN A.I. 5/1/2017
CHECKED J.D./S.R.
CORRECT
SCALE
NOT TO SCALE

SCARBOROUGH SUBWAY EXTENSION

EXISTING DRAINAGE CONDITION ALONG PREFERRED ALIGNMENT

Plot Date: 08/12/2015

TORONTO TRANSIT COMMISSION
ENGINEERING DEPARTMENT

Dwg. No.
FIGURE 2

Sheet No.

SHEET No.

DRAWING No.

3.2 Proposed Drainage Condition

3.2.1 Watercourses

Figure 2 demonstrates the existing drainage features including watercourses and TRCA Regulation Limits along the preferred subway alignment. As shown in **Figure 2**, the tunnel for the preferred alignment will be crossing under tributaries of the West Highland Creek. Since the running structure will be underground and advanced tunnelling technologies will be utilized in its construction, the SSE is anticipated to have insignificant impacts to the watercourses above the subway tunnel. Advanced waterproofing measures should, however, be considered in these areas to mitigate potential water leakage under the crossing. As also noted in **Figure 2**, an Emergency Entrance Building (EEB 5) is proposed adjacent to the Bendale Branch of West Highland Creek and is within the TRCA Regulation Limits. The extent of the potential impact and possible relocation of EEB 5 will be investigated in the Detailed Design Phase of the Project.

3.2.2 Storm Sewers

The proposed SSE might impact existing storm sewers potentially requiring relocation or replacement. Relocation or realignment of existing storm sewers is anticipated at subway terminals such as the existing Kennedy Station and the proposed Scarborough Center Station due to the proposed cut and cover construction and other potential station improvements.

A high level preliminary assessment of potential impact to existing storm sewers at the Scarborough Center Station was completed. Result of the preliminary assessment identified the following existing storm sewers that will potentially require relocation and new connections:

- The existing 1500 mm storm sewer, identified in **Figures 3 and 4** as North Outlet;
- The existing 1950 mm storm sewer at Progress Avenue;
- The existing 1350 mm storm sewer Triton Road crossing the new subway;
- The existing 900 mm storm sewer at Borough Drive; and
- The existing storm sewer connections from the Scarborough Town Centre Mall.

Figure 4 shows the potential relocation or realignment of existing storm sewers and conceptual layout of proposed station storm sewers. The extent of the potential impact and details of the required relocation/replacement will be identified in the Detailed Design Phase of the Project.

The proposed relocation/replacement of and re-connection to existing storm sewers will be required to comply with the City's discharge criteria to municipal infrastructure discussed in **Sections 1.3.1** and **3.2.3**.

3.2.3 Bus Terminal, Station and Tunnel Facilities

As the proposed SSE is anticipated to be primarily sub-surface, the areas with cut-and-cover construction, namely the Bus Terminal, Station and ancillary tunnel facilities (EEBs, TPSSs) will be the primary locations where the SSE will interact with surface drainage and storm sewers.

Figure 2 identifies the locations of EEBs and TPSSs, and the major cut-and-cover construction areas at the existing Kennedy Station and the proposed Scarborough Centre Station. **Figure 4** shows the outline of the limit of the proposed development including the proposed drainage condition at the proposed Scarborough Centre Station.

The proposed Scarborough Centre Station, Bus Terminal and associated facilities will discharge to existing McCowan Road and Progress Avenue storm sewers which ultimately discharge to the East Highland Creek.

The proposed Scarborough Centre Station and Bus Terminal facilities will be constructed in areas that have already been developed resulting in a minor increase in impervious areas. **Table 1** shows a summary of the potential increase in impervious areas, assuming the proposed facility block will be all impervious. As noted, a slight increase in imperviousness of 0.33 hectares is anticipated; however, discharge criteria to municipal sewer limit the allowable flow to the predevelopment flow or existing capacity of the receiving storm sewer, whichever is less. In addition, when the percent-imperviousness of a development site under pre-development condition is higher than 50 % (regardless of what the post-development condition is), the maximum value of the Runoff Coefficient used in calculating the pre-development peak runoff rate is limited to 0.50, thus over-controlling the proposed condition peak flow.

Table 1: Imperviousness Impact of the Proposed Stations and Associated Facilities

Location	Facility	Approx. Area (ha)	Existing Condition			Proposed Condition			New Imp. Area (ha)
			Impervious Area	Pervious Area	% Imp.	Impervious Area	Pervious Area	% Imp.	
Scarborough Centre Station	Station, Bus Terminal, Roads / Entrances	4.3	3.95	0.33	92%	4.3	0.00	100%	0.33

To mitigate the impact of the proposed development in the surface run-off rates, flow attenuation with detention storage will be required as mandated the City, TRCA and MOECC.

The construction of the EEBs, TPSSs and other associated tunnel facilities are not expected to have a significant impact on the stormwater run-off due to their small above-ground footprint. This will be confirmed during the Detailed Design Phase of the Project.

4. Stormwater Management Strategy

The drainage impact assessment completed in **Section 3** indicates that the proposed subway, stations and ancillary structures such as EEBs, TPSSs and other associated tunnel facilities will impact existing storm sewers, existing drainage pattern, and stormwater quality and quantity discharging to existing watercourses. In addition, requirement for water balance and erosion control will be mandated by regulatory agencies. This section discusses the stormwater management strategy proposed for the proposed SSE to mitigate impact of the proposed development and compliance with regulatory agency requirements. A specific consideration was given to the proposed Scarborough Center Station which has larger above-ground footprint and results more significant impacts to the surface drainage and storm sewers.

4.1 General Stormwater Management Strategy

To address impacts to surface water quality, quality, water balance and erosion control, lot level controls will be implemented for the proposed SSE and its associated facilities. The recommended approach to Stormwater Management is summarized in **Table 2**.

Lot level controls will be implemented for the proposed SSE stations, bus terminal, tunnel and associated ancillary facilities to address potential impacts to surface water quality, quantity, water balance and erosion. The recommended approach to stormwater management is summarized in **Table 2**. Details of the Stormwater Management Strategy will be further developed during the Detailed Design Phase of the Project.

Table 2: Recommended Stormwater Management Strategy

Location	Facility	Potential Outlet	Water Balance	Water Quality	Water Quantity
Scarborough Centre	Station, Bus Terminal, Roads / Entrances	McCowan Road and Progress Avenue Storm Sewers	Rooftop garden; Landscape areas with absorbent soil.	Oil / grit separators (OGS) as part of a "treatment train" approach to stormwater management	Roof Control Drains on all above ground buildings; Lot level conveyance controls such as underground storage and parking lot storage.
Tunnel Alignment	Tunnel Running/ Ancillary Structures	Various storm sewers along the alignment	N/A	OGS	N/A
Various along Alignment	EEBs	Various storm sewers along the alignment	Low Impact Development (LID) including permeable pavement, perforated pipe, infiltration trenches, enhanced swale, etc., according to the site condition.	OGS and/or other LIDs	Roof Control Drains on all above ground buildings
Two along Alignment	Traction Power Substation	Various storm sewers along the alignment	LID including permeable pavement, perforated pipe, infiltration trenches, enhanced swale, etc., according to the site condition.	OGS and/or other LIDs	Roof Control Drains on all above ground buildings

4.2 Scarborough Centre Station

To mitigate potential impact of the proposed Scarborough Centre Station, a conceptual stormwater management strategy was prepared in advance of the detail design. The preferred approach to developing the SWM Strategy will be to rely on the application of a treatment train and Low Impact Development (LID) practices. The focus will remain on lot level controls such as underground stormwater detention, oil/grit separator, green roofs and infiltration/bio-retention features. In order to develop a stormwater management plan that addresses the criteria in **Section 1.3**, the constraints and opportunities that exist were identified and given due consideration. In summary, the key issues that must be addressed by the stormwater management strategy include erosion control, quantity control, quality control, water balance and conveyance.

4.2.1 Existing Drainage Condition

The existing drainage condition at the proposed Scarborough Centre Station is shown in **Figure 3**. As noted in **Figure 3**, two drainage outlets are identified within the limit of the proposed station namely, the North Outlet and East Outlet.

Minor and major flows from the existing station currently drains to the East Outlet, which is an existing 1350 mm storm sewer discharging to the McCowan Storm Sewer. The East Outlet also conveys drainage from an existing development south of Triton Road and existing SRT Line 3. The North Outlet conveys drainage from portion of Scarborough Town Centre Shopping Mall and existing parking lots located east of the mall. The North Outlet is an existing 1500 mm storm sewer discharging to the Progress Avenue Storm Sewer which combines with the McCowan Storm Sewer at Progress Avenue Road and McCowan Road Junction which ultimately discharges to the East Highland Creek. The external drainage areas surrounding the proposed station are highly developed areas generally constructed in the early 1970's with some redevelopment in recent years. The existing Scarborough Centre Station was been constructed in the 1980's and it is unknown whether stormwater management has been in place during its development.

Table 3 shows the estimated drainage areas conveyed to the two drainage outlets. The catchment boundaries were estimated based on contours and interpretation of available as-built drawings of the existing surrounding development. The boundaries maybe modified upon availability of the existing servicing information of the more recent developments. The capacity of the existing storm sewers receiving outflows from the proposed station will be further investigated in the Detailed Design Phase of the Project.

Table 3: Summary of Estimated Drainage Catchment Areas

Outlet Name	Drainage Area			Recipient Storm Sewer/ Watercourse
	Scarborough Centre Station	External Area	Total	
North Outlet	1.7 ha	7.2 ha	8.9 ha	Progress Avenue Storm Sewer
East Outlet	2.6 ha	8.7 ha	11.3 ha	McCowan Road Storm Sewers
Total	4.3 ha	15.9 ha	20.2 ha	Progress Avenue Storm Sewers to East Highland Creek

CADD FILE NAME: T:\Projects\3-33017665-ScarbSubwayExt\09 Drainage\07 Drawings\Figure 3 – Scar Centre STA Existing Condition.dwg

anrboro3.dgn (BORDER) JULY 2, 2013

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Figure 3 – Scar Centre STA Existing Condition.dwg

SHEET No.

DRAWING No.

PROGRESS AVE

BOROUGH DR

TRITON RD

MCCOWAN RD

SCARBOROUGH TOWN CENTRE SHOPPING MALL

Existing Scarborough Centre Station

North External
7.2 ha | 0.90

Overland Flow Route to Progress Road at Borough Drive Intersection Blocked During Construction

1500mmØ STM@0.30%

1350mmØ Conc.STM at 0.52%

North Outlet
(1500 mm Ø STM)

Progress Avenue Storm Sewers

Mccowan Road Storm Sewer

1650mmSTM@0.52%
(see Dwg U-181-6)

North(100)
1.7 ha | 0.50

East (200)
2.6 ha | 0.50

900mmØ@0.68%

975mmØ CONC.STM.@0.5%

1350mmØ CONC.STM.@0.42%
(see Dwg J15-22-U-10)

East Outlet
(1350 mm Ø STM)

Existing SRT
(Line 3)

SERVICE CANADA CENTRE

East External
8.7 ha | 0.90

Proposed Scarborough Subway Extension Property Limit

TOWN CENTRE CRT

BUSHBY DR

SCARBOROUGH CIVIC CENTRE

LEGEND

- Overland Flow Route
- Existing Storm Sewer
- Proposed Subway Limit
- Catchment Boundary
- Approx. Development Limit
- Existing Station
- Catchment Identifier (e.g. North(100) 1.7 ha | 0.50) / Drainage Area / Modified "C"
- Contours

REVISIONS	REVISIONS

AECOM

DRAWN A.I. 13/06/2016
CHECKED J.D.
CORRECT S.R.
SCALE 25 m 0m 12.5 m 25 m

SCARBOROUGH SUBWAY EXTENSION

STORMWATER MANAGEMENT REPORT
SCARBOROUGH CENTRE STATION
EXISTING DRAINAGE CONDITION

Plot Date: 08/12/2015

TORONTO TRANSIT COMMISSION
ENGINEERING DEPARTMENT

Dwg. No. FIGURE 3

Sheet No.

4.2.2 Proposed Drainage Condition and SWM Strategy

The proposed drainage condition and conceptual SWM plan at the proposed Scarborough Centre Station is shown in **Figure 4**. As noted in **Figure 3**, the two existing drainage outlets identified as the North and East Outlets will be relocated due to potential conflict with the proposed underground facilities. Although the existing drainage pattern will be altered due to the construction of new road connections and access roads, the existing minor and overland flow route will be maintained to the extent possible.

The recommended SWM Strategy is described in **Table 4**. Lot level controls will be implemented to address potential impacts to surface water quality, quantity, water balance and erosion. The SWM strategy relies on the effectiveness of treatment train that would include but not limited to rooftop gardens and roof control drains, landscaping, oil/grit separators, underground storage and parking lot storage.

Table 4: Scarborough Centre Station Recommended Stormwater Management Strategy

Facility	Potential Outlet	Water Balance	Water Quality	Water Quantity
Bus Terminal/ Roads/ Entrances	McCowan Road and Progress Road Storm Sewers	Rooftop garden; Landscape areas with absorbent soil.	Oil / Grit Separators (OGS) as part of a "treatment train" approach to stormwater management.	Roof Control Drains on all above ground buildings; Lot level conveyance controls such as underground storage and parking lot storage.

Water Balance

Water balance for the station may be achieved by incorporating LID practices such as green-roof, rainwater harvesting, vegetated filter strip and open landscape areas. Recommendation from a geotechnical specialist will be required to determine soil permeability and if permeable pavers, infiltration basins/ bioretention can be incorporated in the design of potential landscaping. Further consideration to the water balance assessment will be provided in the Detailed Design Phase of the Project.

Water Quality

The level of fishery sensitivity of the receiving watercourse shall dictate the required stormwater quality control standard to be applied for the station. As noted on **Table 4**, oil / grit separators (OGS) will be installed as part of a "treatment train" approach to stormwater management. As shown in **Figure 4**, one OGS will be installed at each outlet. Vegetable filter strip can also be incorporated as part of the landscaping. Additional water quality measures will be explored during the Detailed Design Phase of the Project when additional details of the station become available.

Water Quantity

The required control for water quantity is dictated by the discharged criteria to municipal infrastructure summarized in **Section 1.3.1**. As noted in **Sections 1.3.1** and **3.2.3**, discharge criteria to municipal sewer limit the allowable

flow to the predevelopment flow or existing capacity of the receiving storm sewer, whichever is less. When the percent-imperviousness of a development site under pre-development condition is higher than 50 % (regardless of what the post-development condition is), the maximum value of the Runoff Coefficient used in calculating the pre-development peak runoff rate is limited to 0.50, thus over-controlling the proposed condition peak flow. Based on this criteria and assuming no approved overland route under the proposed condition, the 100-year post development flow will be attenuated to the 2-year pre-development flow modified using a run-off coefficient of 0.50.

Table 5, summarizes the modified existing condition peak flows as well as the proposed condition uncontrolled flow for the North and East Outlets. The required storage to attenuate to the 100-year post development flow to the modified 2-year predevelopment flow is in order of 585 m^3 for the North Outlet and 894 m^3 for the East Outlet. It is noted that providing attenuation and storage for the modified 2-year pre-development rates is over controlling the actual existing condition flow rates. The capacity of the existing storm sewers will be further investigated in the Detailed Design Phase of the Project to minimize the required storage and attenuation requirement. Quantity control will be achieved by means of roof drain control, underground and parking lot storage. The feasibility of the recommended quantity control strategy will be further investigated in the Detailed Design Phase of the Project.

Table 5: Water Quantity Control Requirement

Drainage Outlet	Drainage Area (ha)	Existing Condition						Proposed Condition (Uncontrolled)						Conceptual Storage Requirement
		Drainage ID	Modified C[1]	Peak Flow, m^3/s				Drainage ID	C[1]	Peak Flow, m^3/s				
				2-yr	5-yr	25-yr[2]	100-yr[2]			2-yr	5-yr	25-yr	100-yr	m^3
North Outlet Progress Storm Sewer	1.7	100	0.50	0.208	0.311	0.493	0.739	1000	0.90	0.375	0.561	0.884	1.183	585
East Outlet McCowan Storm Sewer	2.6	200	0.50	0.319	0.476	0.753	1.131	2000	0.90	0.574	0.857	1.356	1.809	894

[1] - Run-off Coefficient.

[2] - Estimated by increasing the run-off coefficient "C" by 10% for 25-year event and 25% for the 100-year event.

The Rational Method outputs for the existing and proposed conditions are provided in **Appendix B**.

Storm Sewer System

Figure 4, shows the conceptual layout of the proposed storm sewer system for the proposed station. It is noted that the existing 1500 mm storm sewer and part of the existing 1950 mm storm sewers at Progress Avenue (North Outlet) and the existing 1350 mm storm sewer at Triton Road connecting to the McCowan Storm Sewers (East Outlet) will require relocation. The extent, alignment and details of the proposed storm sewer relocation including the proposed storm service connections within the station will be further investigated in the Detailed Design Phase of the Project.

Rationale and Limitations

The drainage impact assessment and the stormwater management plan were prepared in advance of the detail design and thus based on preliminary assumptions and will be modified in the subsequence design phase. The Conceptual SWM Plan as shown in **Figure 4** identifies the approximate limit of development and storm sewer layouts. The actual footprint, shape and characteristic of the proposed station, limit of development and the extent

and alignment of potential storm sewer relocation and storm sewers will be refined in the Detailed Design Phase of the Project. The conceptual SWM plan may be utilized to guide in preparing specific details such as grading plan and storm sewer connection of the proposed development. Specific details of the stormwater management plan addressing water balance, erosion, water quality and quantity will be provided in the Detailed Design Phase of the Project.

CADD FILE NAME: T:\Projects\3-33017665-ScarbSubwayExt\09 Drainage\07 Drawings\Figure 4 – Scar Centre STA Proposed Condition.dwg

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Figure 4 – Scar Centre STA Proposed Condition.dwg

SHEET No.

DRAWING No.

PROGRESS AVE

BOROUGH DR

TRITON RD

MCCOWAN RD

SCARBOROUGH TOWN CENTRE SHOPPING MALL

Existing Scarborough Centre Station

New North Outlet (1500 mm Ø STM)

Potential Storm Sewer Realignment/ Relocation

Progress Avenue Storm Sewer

Potential Location of Oil Grit Separator

Potential New Storm Sewer with Stormwater Detension

North External 7.2 ha 0.90

North(1000) 1.7 ha 0.90

East(2000) 2.6 ha 0.90

East External 8.7 ha 0.90

Mccowan Road Storm Sewer

East Outlet (1350 mm Ø STM)

Existing SRT (Line 3) to be Decommissioned

SERVICE CANADA CENTRE

Potential Storm Sewer Realignment/ Relocation

Potential Location of Oil Grit Separator

Proposed Scarborough Subway Extension Property Limit

TOWN CENTRE CRT

BUSHBY DR

SCARBOROUGH CIVIC CENTRE

LEGEND

- Overland Flow Route
- Existing Storm Sewer
- Proposed Storm Sewer
- Proposed Subway Limit
- Catchment Boundary
- Approx. Development Limit
- Existing Station
- North(1000) 1.7 ha 0.90 — Catchment Identifier / Drainage Area / Run-off Coeff.
- Contours

REVISIONS	REVISIONS

AECOM

DRAWN A.I. 14/06/2016

CHECKED J.D./S.R.

CORRECT

SCALE 25 m 0m 12.5 m 25 m

SCARBOROUGH SUBWAY EXTENSION

STORMWATER MANAGEMENT REPORT

SCARBOROUGH CENTRE STATION PROPOSED DRAINAGE CONDITION

Plot Date: 08/12/2015

TORONTO TRANSIT COMMISSION ENGINEERING DEPARTMENT

Dwg. No. FIGURE 4

Sheet No.

5. Construction Impacts and Mitigation

5.1 Impacts to Existing Drainage System and Environment

Since the majority of the SSE will be constructed using advanced tunnelling technology, construction impact to existing drainage would be minimal and can be mitigated. Significant impact is anticipated on SSE segments requiring the cut-and-cover construction method. Open cut construction could potentially interfere with existing drainage including, but not limited to, storm sewers and major flow overland flow routes. A detailed assessment of these potential conflicts should be further investigated during the Detailed Design Phase of the Project.

As described in **Section 2**, the major cut-and-cover construction will be located at the north end and south end of the study area. In general, the locations of cut-and-cover construction are not in close proximity to and are not expected to have a significant impact on watercourses. The EEB location (EEB 5) proposed on the north side of the Scarborough and Rouge Hospital is within TRCA Regulation Limits and adjacent to the Regulatory Floodline, as shown in **Figure 2**. TRCA Floodplain Map of Highland Creek (Sheet #13) is attached in **Appendix A.2**. The construction of EEB 5 may have temporary impacts to the Bendale Branch of West Highland Creek. A Flood Risk Assessment might be required during the Detailed Design Phase of the Project. Further impacts resulting from construction activities are the potential for sediment and stormwater pollutants to enter nearby watercourses. Temporary erosion and sediment control measures during construction will be required to prevent migration of sediment off-site. Finally, no drainage or hydrology impacts to the Hyrdo Corridor are anticipated as a result of construction.

5.2 Mitigation

Drainage impacts resulting from the cut-and-cover construction method should be further investigated when addition details become available and a comprehensive water management plan will be developed during the Detailed Design Phase of the Project to make sure that the adequate drainage is to be maintained during the actual period of construction.

Documents related to erosion and sediment control measures have been produced in the form of legislation, guidelines and by-laws. These documents shall be reviewed and consulted in preparation of an Erosion and Sediment Control Plan to be completed during the Detailed Design Phase of the Project and prior to construction. Guidelines used within TRCA's jurisdiction include, but are not limited to, the following:

- Ministry of Natural Resources and Forestry (MNRF) Technical Guideline: Erosion and Sediment Control (ESC);
- The Greater Golden Horseshoe Area Conservation Authorities Erosion and Sediment Control Guidelines for Urban construction;
- City of Toronto Sewer Use By-Law; and
- Ministry of Transportation (MTO) Drainage Management Manual (1995-1997).

Mitigation measures shall be addressed in contract documents according to TRCA's Erosion and Sedimentation guidelines which explain the design function, installation procedure, maintenance procedure and removal of temporary ESC measures. Measures to be considered may include, but are not limited to, check dams, erosion control blankets, grassed swales, sediment traps and silt fence.

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Stormwater Management Report
Scarborough Subway Extension

In addition to the ESC Plan, an Environmental Management Plan (EMP) will be needed specifically for the excavation and construction associated with EEB 5. This EMP will assist in addressing dewatering impacts on surface features such as fish and fish habitat, nearby terrestrial features etc. This EMP will need to be reviewed and approved by the TRCA prior to project construction.

6. Summary and Recommendations

Results of the drainage impact study are summarized below:

- The proposed Scarborough Subway Extension would impact existing storm sewers and result to an increase in surface water quantity, reduced run-off quality impacting the receiving watercourse downstream of the site as well as increased erosion and impact to groundwater;
- The Stormwater Management Strategy as discussed in **Section 4** and summarized presented in **Tables 2** and **4** is recommended to be integrated in the proposed Scarborough Subway Extension to mitigate potential negative impact to stormwater;
- The Stormwater Management Strategy for the Scarborough Centre Station Development as presented in **Figure 4** are also recommended to be integrated in the station development to address stormwater impact.

The proposed stormwater management strategy as presented in this report can be utilized to develop a Detailed Stormwater Management Plan to satisfy regulatory agency criteria for water balance, quality and quantity controls.

The recommended future design considerations include:

- Conduct Hydraulic Analysis and Modelling to define the level of impact on flow rates, runoff volumes, and water levels and velocities as a result of Project ancillary facilities during the Detailed Design Phase of the Project.
- Complete a storm sewers impact assessment during the Detailed Design Phase of the Project.
- Provide details of stormwater management plan during the Detailed Design Phase of the Project.
- The extent of potential impact and details of relocation / replacement of existing storm sewers to be identified during the Detailed Design Phase of the Project;
- During the Detailed Design Phase of the Project, utilize the following lot level controls as appropriate, to mitigate surface water quality, quantity, water balance and erosion:
  - Rooftop garden;
  - Roof Control Drains on above-ground buildings;
  - Landscape areas with absorbent soil;
  - LID including permeable pavement, perforated pipe, infiltration trenches, enhanced swale etc. based on site conditions;
  - Oil/Grit Separator; and,
  - Lot level conveyance controls such as underground storage and parking lot storage.
- Advanced waterproofing measures for running structure at watercourse crossing to mitigate potential water leakage;
- Complete a detailed drainage impacts assessment resulting from the cut-and-cover construction method and a comprehensive water management plan shall be developed to ensure adequate drainage is maintained during the construction; and

- Complete a detailed erosion and sediment control plan (ESC Plan) for the Project and an Environmental Management Plan (EMP) for EEB5 in coordination with other design disciplines and regulatory agencies.

It should be noted that the drainage impact assessment and water quantity control requirement for Scarborough Center Station were based on the recent Station Layout dated on April 26, 2017**. Tables1, 3, 5** and **Figures 3, 4** generally represent the current design.

Appendix A

Background Information

Appendix A.1: Copy of WWFMG Table 7 Summary of Stormwater Management Requirements for Various Types of Development WWFMG
Appendix A.2: TRCA Floodplain Map Highland Creek (Sheet #13)

Appendix A.1
Copy of WWFMG Table 7 Summary of Stormwater Management Requirements for Various Types of Development

Table 7 Summary of Stormwater Management Requirements for Various Types of Development (November 2006)

Types of Development	Water Balance	Water Quality		Water Quantity		Erosion & Sediment Control During Construction	Discharge Criteria to Municipal Infrastructure	Sewer Connections
		TSS Removal	Disinfection	Flood Flow Management	Erosion Control			
References to WWFM (interim) Guidelines	**Sections 2.2.1.1 & 2.2.1.2**	**Sections 2.2.2.1& 2.2.2.2**	**Sections 2.2.2.3 & 2.2.2.4**	**Sections 2.2.3.1 & 2.2.3.2**	**Sections 2.2.3.3 & 2.2.3.4**	**Sections 2.2.3.5 & 2.2.3.6**	**Sections 2.2.3.7, 2.2.3.8 & 3.1**	**Sections 3.2.1, 3.2.2 & 3.2.3**
1. Large new developments (residential & non-residential) - total site area > 5.0 ha	▪ Retain stormwater on-site, to the extent practicable, to achieve the same level of annual volume of overland runoff allowable from the development site under pre-development conditions (see Table 3 & Figure 2). ▪ If the allowable annual runoff volume (see Table 3 & Figure 2) from the development site under post-development conditions is less than the pre-development conditions, then the more stringent runoff control requirement becomes the governing target for the development site. The maximum allowable annual runoff volume from any development site is 50% of the total average annual rainfall depth. ▪ In all cases, the minimum on-site runoff retention requires the proponent to retain all runoff from a small design rainfall event - typically 5 mm (In Toronto, storms with 24-hour volumes of 5 mm or less contribute about 50% of the total average annual rainfall volume) through infiltration, evapotranspiration & rainwater reuse.	▪ Require long-term average removal of 80% of TSS on an annual loading basis from all runoff leaving the site. (Suspended solids removal efficiency is to be calculated based on 100% of the total runoff volume resulted from all storm events that occur in an average year.) ▪ Overall efficiency in TSS removal can be considered in combination with minimum on-site runoff retention and other conveyance & end-of-pipe controls (i.e. the treatment train approach).	▪ Provide disinfection treatment for storm runoff from the development site, which discharges directly to the Lake or Waterfront areas.	▪ The required level of peak flow control from a development site contributing flow to a specific watercourse at the point of discharge shall follow Toronto and Region Conservation Authority (TRCA) Flood Flow Criteria Map (see Appendix C.1). ▪ For development sites within the City's chronic basement flooding areas (see Basement Flooding Relief Work Program Location Map & Schedule in Appendix D), the proponent shall consult Toronto Water – Sewer Asset Planning Section for details of requirements, where applicable ▪ The City of Toronto has adopted the 100-year storm as the level of protection for properties, where feasible, against surface flooding from ponding on streets, particularly, in areas of the City experiencing chronic basement flooding and/or when a proper major (overland flow) stormwater drainage system does not exist (see Section 2.2.3.8 for overland flow drainage system requirements).	▪ For Rouge River watershed (within City of Toronto), follow TRCA (Toronto and Region Conservation Authority) erosion control criteria for individual sites, which discharge directly to and/or are in proximity of natural watercourses. (a) Detain the post-development rainfall runoff from a 30 mm storm for a minimum of 24 hours for Tributary "B" of the little Rouge Creek (south of Steeles Ave. – see map on Appendix C.4) (b) Detain the post-development rainfall runoff from a 33 mm storm for a minimum of 48 hours for the Morningside Tributary of the Rouge River (south of Steeles Ave. – see map on Appendix C.4) ▪ For all other watersheds where new large development blocks (site area > 5 ha) discharge directly and/or in proximity (within 100 m) of natural watercourses, the proponents are required to complete an Erosion Analysis Report to determine the erosion control criteria for the sites (see Appendix E.2 for the terms of reference for such study analysis – obtained from TRCA). ▪ For sites where it is not feasible ** (this condition must be reviewed and agreed by City staff) to complete an erosion analysis study report, we typically require that runoff	▪ Regardless of size for all development sites, temporary erosion and sediment control for construction must be provided on-site. ▪ All erosion and sediment control BMPs shall be designed, constructed and maintained in all development sites in accordance with the GTA CA's Erosion & Sediment Control Guidelines for Urban Construction (2006) and/or other City of Toronto requirements on a site-by-site basis, where applicable.	▪ The allowable release rate to the municipal storm sewer system from the development site during a 2-year design storm event must not exceed the peak runoff rate from the site under pre-development conditions during the same storm event, or existing capacity of the receiving storm sewer, whichever is less. ▪ Unless directed by City staff, the consultant shall demonstrate that existing downstream system has capacity to accommodate design flows from point of connection of the development site to an existing outfall or municipal trunk sewer (confirm existing capacity and/or original design parameters and contributing drainage areas with local district staff). ▪ When the % imperviousness of a development site under pre-development condition is higher than 50% (regardless of what the post-development condition is), the maximum value of C (Runoff Coefficient) used in calculating the pre-development peak runoff rate is limited to 0.5. ▪ Unless directed by City staff, the minor storm sewer system shall be designed to a 1 in 2 years design storm frequency based on City of Toronto Intensity-Duration-Frequency (IDF) curves and a 10-minute inlet time (or initial time of concentration). The following IDF curve shall be applied to all districts across the City: $I = AT^C$, where **I** = Rainfall Intensity (mm/hr) **T** = Time of Concentration (hour) Parameters of **A** and **C**: Return Period (Year) / A / C 2 / 21.8 / -0.78 5 / 32 / -0.79 10 / 38.7 / -0.80 25 / 45.2 / -0.80 50 / 53.5 / -0.80 100 / 59.7 / -0.80	▪ New Private Sewer Connections The direct connection of any new private storm sewer to the municipal storm sewer system is prohibited for any new or reconstructed residential, industrial, commercial or institutional buildings. Application for an exemption must be supported by a Stormwater Management Report identifying the storm water quantity and quality control measures being proposed for the site, and may be approved for any proposed direct connection to the municipal storm sewer system, where the report successfully demonstrates that there is no practical alternative means of drainage available on site and the proposed method is satisfied by the City staff. ▪ Roof Water Leaders / Downspouts (a) No new connections to sanitary, combined and storm sewers will be permitted for roof water leaders or downspouts. (b) Existing roof/downspout connections to the combined sewer systems shall be eliminated except under exceptional circumstances. If necessary due to site constraints, existing roof/downspout connections to the combined sewer systems may be permitted to reconnect to the storm sewer systems, where road sewer separation from the combined sewer systems has been implemented. (c) Storm water collected from roof water leaders / downspouts shall be directed to pervious areas for infiltration or other areas for re-use on site. Storm water collected by a down-pipe from the eavestrough shall be discharged at grade with provisions to prevent soil erosion and shall be conducted away from the building in such a manner that the storm water will not accumulate at or near the building and will not adversely affect adjacent properties.

Types of Development	Water Balance	Water Quality		Water Quantity		Erosion & Sediment Control During Construction	Discharge Criteria to Municipal Infrastructure	Sewer Connections
		TSS Removal	Disinfection	Flood Flow Management	Erosion Control			
References to WWFM (interim) Guidelines	Sections 2.2.1.1 & 2.2.1.2	Sections 2.2.2.1& 2.2.2.2	Sections 2.2.2.3 & 2.2.2.4	Sections 2.2.3.1 & 2.2.3.2	Sections 2.2.3.3 & 2.2.3.4	Sections 2.2.3.5 & 2.2.3.6	Sections 2.2.3.7, 2.2.3.8 & 3.1	Sections 3.2.1, 3.2.2 & 3.2.3
					from a 25 mm design storm shall be detained on-site and released over a minimum of 24 hours. ▪ New developments shall be designed to minimize the number of new storm outfalls in the valley and all new outfalls shall be designed to minimize potential erosion (see Appendix E.3 for Storm Outfall & Outfall Channel Design Criteria - obtained from TRCA). ** Physical site conditions may be considered "not feasible", such as proposed development is negligible with respect to the total drainage area of the receiving watercourse (e.g., less than 1%) and/or watercourse is not sensitive to development – concrete channel, etc.		▪ Storm runoff, which exceeds the allowable release rate defined above but complies with all other requirements (i.e. water balance, water quality, flood flow and erosion controls) is allowed to discharge off-site via overland flow routes (major system) of sufficient capacities (up to a 100 year design storm). If no approved or adequate overland flow route exists, then all flow from the 2 year up to the 100-year return event storms shall be stored on site and released at the allowable release rate defined above or the capacity of the existing minor system, whichever is less.	▪ Foundation Drains (a) All new foundation drains shall be pumped to the grade, wherever possible, subject to soil conditions with respect to environmental impacts and soil permeability. (b) Weeping tiles / foundation drains shall not be connected to any municipal sewers. If necessary due to site constraints, foundation drains may be permitted by City staff, to reconnect to the storm sewer systems, where road sewer separation from the combined sewer systems has been implemented. (c) Where no practical alternative means of drainage is available; staff would review the application for an exemption on a case-by-case basis and may approve the direct connection to the municipal sewer systems with set conditions on proper safeguard to protect the City from any liability in the event of basement flooding.
2. Small new developments (residential & non-residential) - total site area < 5.0 ha	▪ Same as (1) above ▪ In all cases, the minimum on-site runoff retention requires the proponent to retain all runoff from a small design rainfall event - typically 5 mm (In Toronto, storms with 24-hour volumes of 5 mm or less contribute about 50% of the total average annual rainfall volume) through infiltration, evapotranspiration & rainwater reuse.	▪ Same as (1) above	▪ Same as (1) above	▪ Same as (1) above ▪ For development sites < 2 ha, the proponent may use a simplified approach such as the Rational Method / IDF curves to compute peak flows.	▪ Same as (1) above	▪ Same as (1) above	▪ Same as (1) above	▪ Same as (1) above
3. Residential infill Housing (relatively small isolated development or intensification situations with site areas less than 5 ha and storm/combined sewer infrastructure exists) (a) Site area -	▪ Same as (1) above	▪ Same as (1) above	▪ Not applicable	▪ Same as (1) above	▪ Not applicable unless the	▪ Same as (1) above		▪ Same as (1) above

Types of Development	Water Balance	Water Quality		Water Quantity		Erosion & Sediment Control During Construction	Discharge Criteria to Municipal Infrastructure	Sewer Connections
		TSS Removal	Disinfection	Flood Flow Management	Erosion Control			
References to WWFM (interim) Guidelines	**Sections 2.2.1.1 & 2.2.1.2**	**Sections 2.2.2.1& 2.2.2.2**	**Sections 2.2.2.3 & 2.2.2.4**	**Sections 2.2.3.1 & 2.2.3.2**	**Sections 2.2.3.3 & 2.2.3.4**	**Sections 2.2.3.5 & 2.2.3.6**	**Sections 2.2.3.7, 2.2.3.8 & 3.1**	**Sections 3.2.1, 3.2.2 & 3.2.3**
greater than 0.1 ha but smaller than 5 ha with more than 2 residential units	▪ In all cases, the minimum on-site runoff retention requires the proponent to retain all runoff from a small design rainfall event - typically 5 mm (on average, the total rainfall from all small events with daily rainfall amounts, less than or equal to 5 mm, is equivalent to about 50% volume of the total average annual rainfall in Toronto) through infiltration, evapotranspiration & rainwater reuse.			▪ For development sites < 2 ha, the proponent may use a simplified approach such as the Rational Method / IDF curves to compute peak flows.	infill site is located in close proximity (within 100 m) to natural watercourses (see control requirements on Section 1 above). ▪ For small infill or intensification sites < 2 ha, erosion control in the form of stormwater detention is normally not required, provided the on-site minimum runoff retention from a small design rainfall event (typically 5 mm) is achieved under the Water Balance Criteria.		▪ Same as (1) above	
(b) Site area ≤ 0.1 ha with only one single residential unit	▪ In case the subsoil conditions on-site are not suitable for infiltration, the proponent shall provide a minimum depth of 300 mm absorbent soil for on-site pervious / landscaping areas (see Appendix F for City of Toronto standards for landscaping soil).	▪ Not applicable	▪ Not applicable	▪ For development sites within the City's chronic basement flooding areas (see Basement Flooding Relief Work Program Location Map & Schedule in Appendix D), the proponent shall consult Toronto Water – Sewer Asset Planning Section for details of requirements, where applicable ▪ The City of Toronto has adopted the 100-year storm as the level of protection for properties, where feasible, against surface flooding from ponding on streets, particularly, in areas of the City experiencing chronic basement flooding and/or when a proper major (overland flow) stormwater drainage system does not exist (see Section 2.2.3.8 for overland flow drainage system requirements).	▪ Not applicable	▪ Same as (1) above	▪ Same as (1) above	▪ Same as (1) above
(c) minor additions and/or modifications to residential buildings (total dwelling unit after expansion does not exceed twice the size of the existing dwelling unit and a single	▪ Not applicable	▪ Not applicable	▪ Not applicable	▪ Same as (3b) above	▪ Not applicable	▪ Not applicable	▪ Not applicable	▪ Not applicable

Types of Development	Water Balance	Water Quality		Water Quantity		Erosion & Sediment Control During Construction	Discharge Criteria to Municipal Infrastructure	Sewer Connections
		TSS Removal	Disinfection	Flood Flow Management	Erosion Control			
References to WWFM (interim) Guidelines	**Sections 2.2.1.1 & 2.2.1.2**	**Sections 2.2.2.1& 2.2.2.2**	**Sections 2.2.2.3 & 2.2.2.4**	**Sections 2.2.3.1 & 2.2.3.2**	**Sections 2.2.3.3 & 2.2.3.4**	**Sections 2.2.3.5 & 2.2.3.6**	**Sections 2.2.3.7, 2.2.3.8 & 3.1**	**Sections 3.2.1, 3.2.2 & 3.2.3**
family home may add up to 2 units , and medium/high density residential buildings may add up to 1 additional unit) - no site alteration								
4. Non-residential and mixed uses (e.g., industrial / commercial / institutional infill) - relatively small isolated development or intensification situations with site areas less than 5 ha and storm/combined sewer infrastructure exists								
(a) Site area - greater than 0.3 ha but smaller than 5 ha, including large expansions to non-residential buildings (expansion exceeds 50% of the gross floor area of the existing building)	▪ Same as (3a) above	▪ same as (3a) above ▪ OGSs and/or other BMPs may be required for development that have a higher potential for spills (e.g., automobile service sector, dry cleaning sector, etc.) – see Toronto Municipal Code Chapter 681 – Sewers, Article I, Sewage and Land Drainage (Sewer Use By-Law No. 457-2000) for details.	▪ Not applicable	▪ Same as (3a) above	▪ Same as (3a) above	▪ Same as (1) above	▪ Same as (1) above	▪ Same as (1) above
(b) Small site area ≤ 0.3 ha,	▪ Same as (3b) above	▪ OGSs and/or other BMPs may be required for development that have a higher potential for spills (e.g., automobile service sector, dry cleaning sector, etc.) – see Toronto Municipal Code Chapter 681 – Sewers, Article I, Sewage and Land Drainage (Sewer Use By-Law No. 457-2000) for details.	▪ Not applicable	▪ Same as (3b) above	Not applicable	▪ Same as (1) above	▪ Same as (1) above	▪ Same as (1) above

Types of Development	Water Balance	Water Quality		Water Quantity		Erosion & Sediment Control During Construction	Discharge Criteria to Municipal Infrastructure	Sewer Connections
		TSS Removal	Disinfection	Flood Flow Management	Erosion Control			
References to WWFM (interim) Guidelines	**Sections 2.2.1.1 & 2.2.1.2**	**Sections 2.2.2.1& 2.2.2.2**	**Sections 2.2.2.3 & 2.2.2.4**	**Sections 2.2.3.1 & 2.2.3.2**	**Sections 2.2.3.3 & 2.2.3.4**	**Sections 2.2.3.5 & 2.2.3.6**	**Sections 2.2.3.7, 2.2.3.8 & 3.1**	**Sections 3.2.1, 3.2.2 & 3.2.3**
(c) minor additions and/or modifications to non-residential buildings (expansion does not exceed 50% of the gross floor area of the existing building) - no site alteration	▪ Not applicable	▪ Not applicable	▪ Not applicable	▪ Same as (3b) above	▪ Not applicable	▪ Not applicable	▪ Not applicable	▪ Not applicable

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Appendix A.2
TRCA Floodplain Map Highland Creek (Sheet #13)

REVISIONS			
NO.	DESCRIPTION	BY	DATE
1	CROSS-SECTION ID'S CHANGED	R.A.G.	2013-12-02

LEGEND

Cross-Section Label

Cross-Section Leader Line

Regional Flood Elevation (m)

Cross-Section Number 14.060 172.00

100 Year Existing Flood Elevation (m) 172.00

Cross-Section Length

REGULATORY FLOOD ELEVATION IS THE HIGHER OF THE TWO ELEVATIONS DISPLAYED

LEGEND

Contour Index
Contour Intermediate
Contour Auxiliary
Contour Depression
Contour Text
Spot Height
Road
Parking Lot
Race Track
Wall
Retaining Wall
Rail Line
Runway
Silo, Smoke, Tank
Marsh Symbol
Marsh Boundary
Township Fabric
Hydro Tower
Trail
Bridge
Wooded Area
Tree
Hedge
Fence
Water Feature
Culvert Symbol
Culvert to Scale
Dam
Pool
Building
Pit
Pile
Regulatory Flood Line

This map was compiled photogrammetrically from 1/10000 aerial photography flown in 2002.

The vertical datum is mean sea level as established by the Geographic Survey of Canada.

North American Datum 1983, U.T.M. 6° projection Zone 17. Central Meridian 81° W.

Grid interval 100 metres.

PLEASE NOTE:
FLOODLINE ELEVATIONS ARE SUBJECT TO CHANGE DUE TO REVISED INFORMATION.

J.D.BARNES LIMITED

145 RENFREW DRIVE SUITE 100
MARKHAM, ONTARIO L3R 9R6
TEL (905) 477-3600
FAX (905) 477-3882

DATE ISSUED
SEPT 28 2004

PLEASE NOTE:
THE ONTARIO LAND SURVEYOR STAMP VERIFIES ONLY THE TOPOGRAPHIC AND PLANIMETRIC DATA, NOT THE CADASTRAL DATA, UNLESS OTHERWISE NOTED

EarthTech
A Tyco International Ltd. Company

PLEASE NOTE:
THE PROFESSIONAL ENGINEER'S STAMP VERIFIES THE FLOOD LINE AND ASSOCIATED DATA NOT THE MAP DATA UNLESS OTHERWISE NOTED

B.R. RICHERT

FLOOD PLAIN MAPPING PROGRAM

FLOODLINE APPROVED DATE: 2007-03-27

TORONTO AND REGION Conservation
for The Living City
5 Shoreham Drive Downsview Ontario M3N 1S4 (416) 661-6600

Scale 1:2000

CONTOUR INTERVAL 1.0 METRES

HIGHLAND CREEK

SHEET No. 13

Appendix B

Hydrologic Analysis

Appendix B.1
Rational Method Output – Existing Condition

Project Name : Scarborugh Subway Extension
Scarborugh Centre Station, City of Toronto
Project No. : 33017665

Modified Existing Condition - East Outlet (Basin 200)

2-Year Pre-Development Peak Flow

Rational Method			Rainfall Intensity Coefficients
Area =	2.600	ha	City of Toronto
"C" =	0.50		2 Year Storm
Tc =	10.00	min	
AC =	1.300		a = 21.8
2.78*AC =	3.614		b = 0.00
Rainfall Intensity =	88.19	mm/hr	c = 0.780

Runoff = 318.7 l/s

5-Year Pre-Development Peak Flow

Rational Method			Rainfall Intensity Coefficients
Area =	2.600	ha	City of Toronto
"C" =	0.50		5 Year Storm
Tc =	10.00	min	
AC =	1.300		a = 32.0
2.78*AC =	3.614		b = 0.00
Rainfall Intensity =	131.79	mm/hr	c = 0.790

Runoff = 476.3 l/s

25-Year Pre-Development Peak Flow

Rational Method			Rainfall Intensity Coefficients
Area =	2.600	ha	City of Toronto
"C" =	0.55		25 Year Storm
Tc =	10.00	min	
AC =	1.430		a = 45.2
2.78*AC =	3.975		b = 0.00
Rainfall Intensity =	189.52	mm/hr	c = 0.800

Runoff = 753.4 l/s

100-Year Pre-Development Peak Flow

Rational Method			Rainfall Intensity Coefficients
Area =	2.600	ha	City of Toronto
"C" =	0.63		100 Year Storm
Tc =	10.00	min	
AC =	1.625		a = 59.7
2.78*AC =	4.518		b = 0.00
Rainfall Intensity =	250.32	mm/hr	c = 0.800

Runoff = 1130.8 l/s

Project Name : Scarborugh Subway Extension
Scarborugh Centre Station, City of Toronto
Project No. : 33017665

Modified Existing Condition -North Outlet (Basin 100)

2-Year Pre-Development Peak Flow

Rational Method			Rainfall Intensity Coefficients
Area =	1.700	ha	City of Toronto
"C" =	0.50		2 Year Storm
Tc =	10.00	min	
AC =	0.850		a = 21.8
2.78*AC =	2.363		b = 0.00
Rainfall Intensity =	88.19	mm/hr	c = 0.780

Runoff = 208.4 l/s

5-Year Pre-Development Peak Flow

Rational Method			Rainfall Intensity Coefficients
Area =	1.700	ha	City of Toronto
"C" =	0.50		5 Year Storm
Tc =	10.00	min	
AC =	0.850		a = 32.0
2.78*AC =	2.363		b = 0.00
Rainfall Intensity =	131.79	mm/hr	c = 0.790

Runoff = 311.4 l/s

25-Year Pre-Development Peak Flow

Rational Method			Rainfall Intensity Coefficients
Area =	1.700	ha	City of Toronto
"C" =	0.55		25 Year Storm
Tc =	10.00	min	
AC =	0.935		a = 45.2
2.78*AC =	2.599		b = 0.00
Rainfall Intensity =	189.52	mm/hr	c = 0.800

Runoff = 492.6 l/s

100-Year Pre-Development Peak Flow

Rational Method			Rainfall Intensity Coefficients
Area =	1.700	ha	City of Toronto
"C" =	0.63		100 Year Storm
Tc =	10.00	min	
AC =	1.063		a = 59.7
2.78*AC =	2.954		b = 0.00
Rainfall Intensity =	250.32	mm/hr	c = 0.800

Runoff = 739.4 l/s

Appendix B.2
Rational Method Output – Proposed Condition

Project Name : Scarborugh Subway Extension
Scarborugh Centre Station, City of Toronto
Project No. : 33017665

Proposed Condition - East Outlet (Basin 2000)

2-Year Post-Development Peak Flow

Rational Method		
Area =	2.600	ha
"C" =	0.90	
Tc =	10.00	min
AC =	2.340	
2.78*AC =	6.505	
Rainfall Intensity =	88.19	mm/hr

Rainfall Intensity Coefficients City of Toronto 2 Year Storm	
a =	21.8
b =	0.00
c =	0.780

Runoff = 573.7 l/s

5-Year Pre-Development Peak Flow

Rational Method		
Area =	2.600	ha
"C" =	0.90	
Tc =	10.00	min
AC =	2.340	
2.78*AC =	6.505	
Rainfall Intensity =	131.79	mm/hr

Rainfall Intensity Coefficients City of Toronto 5 Year Storm	
a =	32.0
b =	0.00
c =	0.790

Runoff = 857.3 l/s

25-Year Pre-Development Peak Flow

Rational Method		
Area =	2.600	ha
"C" =	0.99	
Tc =	10.00	min
AC =	2.574	
2.78*AC =	7.156	
Rainfall Intensity =	189.52	mm/hr

Rainfall Intensity Coefficients City of Toronto 25 Year Storm	
a =	45.2
b =	0.00
c =	0.800

Runoff = 1356.2 l/s

100-Year Post-Development Peak Flow

Rational Method		
Area =	2.600	ha
"C" =	1.00	
Tc =	10.00	min
AC =	2.600	
2.78*AC =	7.228	
Rainfall Intensity =	250.32	mm/hr

Rainfall Intensity Coefficients City of Toronto 100 Year Storm	
a =	59.7
b =	0.00
c =	0.800

Runoff = 1809.3 l/s

Project Name : Scarborough Subway Extension
Scarborough Centre Station, City of Toronto
Project No. : 33017665

Proposed Condition - North Outlet (Basin 1000)

2-Year Pre-Development Peak Flow

Rational Method		
Area =	1.700	ha
"C" =	0.90	
Tc =	10.00	min
AC =	1.530	
2.78*AC =	4.253	
Rainfall Intensity =	88.19	mm/hr

Rainfall Intensity Coefficients	
City of Toronto 2 Year Storm	
a =	21.8
b =	0.00
c =	0.780

Runoff = 375.1 l/s

5-Year Pre-Development Peak Flow

Rational Method		
Area =	1.700	ha
"C" =	0.90	
Tc =	10.00	min
AC =	1.530	
2.78*AC =	4.253	
Rainfall Intensity =	131.79	mm/hr

Rainfall Intensity Coefficients	
City of Toronto 5 Year Storm	
a =	32.0
b =	0.00
c =	0.790

Runoff = 560.6 l/s

25-Year Pre-Development Peak Flow

Rational Method		
Area =	1.700	ha
"C" =	0.99	
Tc =	10.00	min
AC =	1.683	
2.78*AC =	4.679	
Rainfall Intensity =	189.52	mm/hr

Rainfall Intensity Coefficients	
City of Toronto 25 Year Storm	
a =	45.2
b =	0.00
c =	0.800

Runoff = 886.7 l/s

100-Year Pre-Development Peak Flow

Rational Method		
Area =	1.700	ha
"C" =	1.00	
Tc =	10.00	min
AC =	1.700	
2.78*AC =	4.726	
Rainfall Intensity =	250.32	mm/hr

Rainfall Intensity Coefficients	
City of Toronto 100 Year Storm	
a =	59.7
b =	0.00
c =	0.800

Runoff = 1183.0 l/s

Modified Rational Method

Project Name : Scarborough Subway Extension
Scarborough Centre Station, City of Toronto
Project No. : 33017665

Area =	1.7	ha
"C" =	1	
AC=	1.7	
Tc =	10.0	min
Time Increment =	5.0	min
Release Rate =	208.4	l/s
Max.Storage =	585	m3

NORTH OUTLET
TO PROGRESS ROAD
BASIN 1000

100-Year	
a=	59.7
b=	0.00
c=	0.800

Constant Inflows

0.0	l/s
0.0	l/s
0.0	l/s
	l/s

Time (min)	Rainfall Intensity (mm/hr)	Storm Runoff (l/s)	Runoff Volume (m3)	Released Volume (m3)	Storage Volume (m3)	
10.0	250.3	1183.01	709.8	125.0	584.8	<<<<
15.0	181.0	855.30	769.8	187.6	582.2	
20.0	143.8	679.46	815.4	250.1	565.3	
25.0	120.3	568.38	852.6	312.6	540.0	
30.0	103.9	491.24	884.2	375.1	509.1	
35.0	91.9	434.24	911.9	437.6	474.3	
40.0	82.6	390.25	936.6	500.2	436.4	
45.0	75.1	355.16	958.9	562.7	396.2	
50.0	69.1	326.45	979.3	625.2	354.1	
55.0	64.0	302.48	998.2	687.7	310.5	
60.0	59.7	282.14	1015.7	750.2	265.5	
65.0	56.0	264.64	1032.1	812.8	219.3	
70.0	52.8	249.41	1047.5	875.3	172.2	
75.0	49.9	236.02	1062.1	937.8	124.3	
80.0	47.4	224.14	1075.9	1000.3	75.5	
85.0	45.2	213.53	1089.0	1062.8	26.2	
90.0	43.2	203.98	1101.5	1125.4	-23.8	
95.0	41.3	195.35	1113.5	1187.9	-74.4	
100.0	39.7	187.49	1125.0	1250.4	-125.4	
105.0	38.2	180.32	1136.0	1312.9	-176.9	
110.0	36.8	173.73	1146.6	1375.4	-228.8	
115.0	35.5	167.66	1156.9	1438.0	-281.1	
120.0	34.3	162.05	1166.7	1500.5	-333.7	
125.0	33.2	156.84	1176.3	1563.0	-386.7	

Modified Rational Method

Project Name : Scarborough Subway Extension
Scarborough Centre Station, City of Toronto
Project No. : 33017665

Area =	**2.6**	ha
"C" =	**1**	
AC=	**2.6**	
Tc =	**10.0**	min
Time Increment =	**5.0**	min
Release Rate =	**318.7**	l/s
Max.Storage =	**894**	m3

EAST OUTLET
TO MCCOWAN ROAD
BASIN 2000

100-Year

a=	59.7
b=	0.00
c=	0.800

Constant Inflows

0.0	l/s
0.0	l/s
0.0	l/s
	l/s

Time (min)	Rainfall Intensity (mm/hr)	Storm Runoff (l/s)	Runoff Volume (m3)	Released Volume (m3)	Storage Volume (m3)	
10.0	250.3	1809.31	1085.6	191.2	894.4	<<<<
15.0	181.0	1308.10	1177.3	286.8	890.5	
20.0	143.8	1039.18	1247.0	382.4	864.6	
25.0	120.3	869.28	1303.9	478.1	825.9	
30.0	103.9	751.31	1352.3	573.7	778.7	
35.0	91.9	664.14	1394.7	669.3	725.4	
40.0	82.6	596.85	1432.4	764.9	667.6	
45.0	75.1	543.18	1466.6	860.5	606.1	
50.0	69.1	499.27	1497.8	956.1	541.7	
55.0	64.0	462.62	1526.6	1051.7	474.9	
60.0	59.7	431.51	1553.4	1147.3	406.1	
65.0	56.0	404.75	1578.5	1242.9	335.6	
70.0	52.8	381.45	1602.1	1338.5	263.5	
75.0	49.9	360.96	1624.3	1434.2	190.2	
80.0	47.4	342.80	1645.4	1529.8	115.7	
85.0	45.2	326.57	1665.5	1625.4	40.1	
90.0	43.2	311.97	1684.7	1721.0	-36.3	
95.0	41.3	298.77	1703.0	1816.6	-113.6	
100.0	39.7	286.76	1720.5	1912.2	-191.7	
105.0	38.2	275.78	1737.4	2007.8	-270.4	
110.0	36.8	265.70	1753.7	2103.4	-349.8	
115.0	35.5	256.42	1769.3	2199.0	-429.7	
120.0	34.3	247.84	1784.4	2294.6	-510.2	
125.0	33.2	239.88	1799.1	2390.3	-591.2	