

# Draft Rezoning Drainage and Stormwater Management Report–Queen/Spadina Station Integrated Transit Oriented Communities

378 Queen Street West  
165-177 Spadina Avenue  
443-455 Queen Street West  
Toronto Ontario M5T 2C4

Contract RFS-2019-NAFC-110

PO 214244

HDR Project 10206938



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TORONTO, ONTARIO

May 21, 2021

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## Abbreviations

BMP	Best Management Practice
DRM	Design Requirements Manual
HGL	Hydraulic Grade Line
HGRA	High Volume Groundwater Recharge Areas
IBC	Initial Business Case
IDF	Intensity-Duration-Frequency
IO	Infrastructure Ontario
mbgs	m below ground surface
MECP	Ministry of the Environment, Conservation and Parks
OGS	Oil and Grit Separator
OL	Ontario Line
RCD	Reference Concept Design
SWM	Stormwater Management
TGS	Toronto Green Standard
TMC681	Toronto Municipal Code Chapter 681
TOC	Transit Oriented Communities
TSS	Total Suspended Solids
TRCA	Toronto and Region Conservation Authority
WWFMG	Wet Weather Flow Management Guidelines

# 1 Introduction

## 1.1 Project Description

The Province of Ontario is planning to build a new 15.5 km rapid transit line serving the City of Toronto. The development of this line is being managed jointly by Metrolinx, the Provincial Transit Agency responsible for the Greater Toronto and Hamilton Area, and Infrastructure Ontario (IO). The work is based on an Initial Business Case (IBC) published in July 2019, including a representative alignment for the Ontario Line. The Proposed Ontario Line (OL) is running between the Ontario Science Centre and Exhibition GO Station. The Ontario Line Technical Advisory Services team have been organized into the following segments, as shown in **Figure 1-1**.

- Operation Maintenance and Storage Facility (OMSF), and
- Four linear geographical segments:
  - Lakeshore (containing both Lakeshore West and Lakeshore East)
  - Downtown
  - Pape
  - Thorncliffe

The Downtown Segment is predominantly underground and begins at the tunnel portal near Strachan Avenue in the west and ends at the tunnel portal within Don Yard in the east. The segment consists of six stations:

- King/Bathurst Station
- Queen/Spadina Station
- Osgoode Station
- Queen Station
- Moss Park Station
- Corktown Station

Transit Oriented Communities (TOC) are proposed at the Ontario Line Stations to integrate high density, mixed-used developments with the transit infrastructure. This Draft Rezoning Drainage and Stormwater Management report summarizes the drainage and stormwater management (SWM) requirements for the proposed Ontario Line TOC at the intersection of Queen Street West and Spadina Avenue in the City of Toronto with respect to drainage conveyance, stormwater quantity control, stormwater quality treatment, and water balance.



Figure 1-1. Ontario Line Segments

## 1.2 Queen and Spadina Station

Queen and Spadina station is located at the intersection of Queen Street West and Spadina Avenue. Two development buildings are proposed at the northeast (Site E) and southwest (Site F) corners of the intersection. The proposed station will run across Queen Street and will be integrated into the two development buildings.

### Background Review

In preparation of the Queen/Spadina TOC Draft Rezoning Drainage and Stormwater Management Report, the following essential documents were obtained and reviewed:

- Drawing OL-S01-C-UT-003, Ontario Line Spadina Station, Composite Utility Plan.
- Drawing OL-S01-C-XS-003, Ontario Line Spadina Station, Composite Utility Cross Sections
- Drawing 203T000E-203T113E, Architectural plan;
- Drawing 203T000F-203T113F, Architectural plan; and
- Ontario Line Downtown Segment Stormwater Management Report, Metrolinx, November 23, 2020.

## 2 Existing Conditions

Currently, the site is occupied by two low-rise buildings at the proposed locations, at the southwest and northeast corners of the intersection. Spadina Avenue slopes from north to south, while Queen Street West slopes from east to west.

### 2.1 Minor and Major Flows

Minor flow within the vicinity of the site is captured via a number of catch basins and conveyed into existing storm sewers, which includes 600 mm sewer and 825mm sewer along Spadina Avenue and 425 mm sewer and 525 mm sewer along Queen Street. In addition to those, there is also a 1050 mm x 1500 mm combined sewer along Spadina Avenue and a 600 mm x 900 mm combined sewer along Queen Street. Please refer to the attached existing conditions drainage plan **Appendix A**.

Spadina Avenue slopes continuously from north to south for more than 5 kms, creating a large drainage area for the major flow at the intersection of Queen Street and Spadina Avenue. The major flow along Spadina Avenue runs from north of Queen Street towards Ontario Lake.

The City is working on the InfoWorks model for this area, and will not be available before the year 2021. With limited information that is currently available, its not possible to further comment on where the existing buildings are draining.

## 3 Stormwater Management Criteria

Stormwater management requirements are specified by the authorities having jurisdiction over the Project. These requirements are applicable to all locations where the proposed design will influence or be influenced by surface water runoff. The stormwater management design criteria are described below and supplemented by the Project Specific Output Specifications (PSOS). Stormwater management criteria for this Project are set by the following documents:

- Stormwater Management Planning and Design Manual (MECP, 2003)
- Design Criteria for Sewers and Watermains (City of Toronto, 2019)
- Wet Weather Flow Management Guidelines (City of Toronto, 2006)
- Stormwater Management Criteria (TRCA, 2012)
- Living City Policies (TRCA, 2014)
- Toronto Green Standard (City of Toronto, 2018)
- Low Impact Development Stormwater Management Planning and Design Guide (Credit Valley Conservation and TRCA, 2010)
- GO Design Requirements Manual (Metrolinx, 2019)
- Design Standard, 'DS-05, Sustainable Design Standard, Version 1.0 (Metrolinx, May 2020)

The Wet Weather Flow Management Guidelines (WWFMG) provide requirements and guidance on stormwater management for developments within the City of Toronto. Table 7 in the WWFMG provides a summary of applicable design criteria based on the type

and size of proposed development. Storm sewer and inlet design requirements for the City of Toronto are provided in the Design Criteria for Sewers and Watermains. The Toronto Green Standard (TGS) provides additional stormwater standards specifically related to sustainable development. The TRCA Stormwater Management Criteria provides design requirements related to stormwater management for developments within the jurisdiction of the Toronto and Region Conservation Authority (TRCA). Requirements vary depending on the watershed in which a proposed development is located. The GO Design Requirements Manual (DRM) supplements the local guidelines and provides guidance to be adhered to in all Metrolinx developments. The Metrolinx Design Standard, 'DS-05, Sustainable Design Standard, Version 1.0, May 2020' provides SWM requirements for Metrolinx sites that are greater than 0.5 ha.

## 3.1 SWM Criteria Summary

The key criteria applicable to this Project are summarized in the following sections. Additional criteria and general guidance can be found in the PSOS and the guideline documents listed at the beginning of **Section 4**.

### 3.1.1 Quality Control

- Provide a long-term average removal of 80% of total suspended solids (TSS) from the storm runoff of additional impervious areas (TRCA Guidelines).
- Provide a long-term average removal of 80% of total suspended solids (TSS) on an annual loading basis from all the storm runoff leaving the site (WWFMG, TGS).
  - OGS devices are credited with a maximum of 50% TSS removal (WWFMG, TRCA).

### 3.1.2 Quantity/Flood Control

- Provide protection against surface flooding from ponding on streets during the 100-year event. Consult Toronto Water – Sewer Asset Planning Section for developments within the City's chronic basement flooding areas (WWFMG).
- Drainage discharged to the municipal storm sewer must be controlled to the peak release rate from the lower of:
  - The existing conditions peak flow from design event with a 2-year return period assuming a runoff coefficient of 0.5, if the existing imperviousness is greater than 50%; and,
  - The existing capacity of the storm sewer (WWFMG).
- In absence of an approved or adequate overland flow route, all flows from the 2-year up to the 100-year return storm events shall be stored on site and released at the allowable release rate as defined above (WWFMG).
- Peak flows should be calculated using the intensity-duration-frequency (IDF) information in the WWFMG.

### 3.1.3 Water Balance

- Retain all runoff from the 5 mm rainfall event on site through infiltration, evaporation, and/or rainwater reuse (WWFMG, TGS - Tier 1).
- Retain all runoff from the 10 mm rainfall event on site through infiltration, evaporation, and/or rainwater reuse (TGS - Tier 2).



- For sites located in high volume groundwater recharge areas (HGRA), pre-development groundwater recharge rates should be maintained (TRCA).

### 3.1.4 Erosion Control

- For infill/redevelopment sites (<2 ha), where the site does not drain to a sensitive watercourse, erosion control should be provided through the retention of a small design rainfall event (typically 5 mm). This is often achieved by satisfying the water balance retention requirement (WWFMG, TRCA).
- For new large development sites (> 5 ha) discharge directly and/or in proximity (within 100 m) of natural watercourses, it is required to complete an Erosion Analysis Report to determine the erosion control criteria for the sites (WWFMG).
- For sites where it is not feasible (this condition must be reviewed and agreed by City staff) to complete an erosion analysis study report, it is typically required that runoff from a 25 mm design storm shall be detained on-site and released over a minimum of 24 hours (WWFMG).

### 3.1.5 Private Water Discharge

Within the City of Toronto, the discharge of water from a private site (Private Water) to a municipal sewer system is regulated under Toronto Municipal Code Chapter 681 (TMC681). TMC681 defines Private Water to include both surface and groundwater. In the case of surface water, compliance with these requirements is generally demonstrated by satisfying the quality and quantity control requirements of the City of Toronto Wet Weather Flow Management Guidelines (WWFMG).

In the case of groundwater or a mixture of surface water and groundwater, if temporary or permanent discharging is permitted, a “Private Water Discharge Approval Application” must be approved by the City of Toronto (Toronto Water, Environmental Monitoring and Protection Unit). A Private Water Discharge Approval Application is required for all structures that are not waterproofed where the foundation is  $\leq 1$  m above the seasonally high groundwater elevation.

The following outlines the general requirements that must be satisfied in order to be granted a permit for long-term or short-term discharge of groundwater to a municipal storm, sanitary, or combined sewer.

#### **Storm Sewer**

##### *Quality Requirements*

- Water quality tests must demonstrate that the water to be discharged meets the quality requirements specified in TMC681, Table 2.
  - If water quality does not meet TMC681, Table 2 requirements, on-site treatment system may be designed to raise the quality enough to allow the water to be discharged to the storm sewer.
- Design must include provision for water quality testing for the duration of the discharge period through grab sampling.
- Design must include backup plan in case water quality changes and no longer meets TMC681, Table 2.

### *Quantity Requirements*

- Design of discharge system must meet quantity control requirements of the WWFMG. As such, the proposed groundwater discharge rate should be removed from the overall allowable site release rate for the site's stormwater management system.
- Design must include provision for water quantity testing for the duration of the discharge period including continuous monitoring of flows.

## **Sanitary or Combined Sewer**

### *Quality Requirements*

- Water quality tests must demonstrate that the water to be discharged meets the quality requirements specified in TMC681, Table 1.
  - If water quality does not meet TMC681, Table 1 requirements, on-site treatment system may be designed to raise the quality enough to allow the water to be discharged to the sanitary or combined sewer.
- Design must include provision for water quality testing for the duration of the discharge period through grab sampling.
- Design must include backup plan in case water quality changes and no longer meets TMC681, Table 1.

### *Quantity Requirements*

- Hydraulic analysis of the downstream system up to a trunk sewer must be conducted. The model must be calibrated based on monitoring data and needs to consider:
  - Average wastewater flow with peaking factor
  - Inflow and Infiltration (based on monitoring done by the applicant)
  - Both wet weather and dry weather flows\*
- Assessment must compare the downstream Hydraulic Grade Line (HGL) vs the City's basement flooding freeboard requirement which is  $HGL \leq 1.8$  m below ground surface (mbgs), not a comparison of proposed HGL vs existing HGL (where the 1.8 mbgs criterion is already violated).

\*In some cases, if the HGL criteria are not met during wet weather, it may be possible to provide on-site storage and automated flow monitoring/control to store the Private Water during the wet weather and release it at a controlled rate during dry weather (referred to as a Discharge Management Plan). These plans are evaluated on a case-by-case basis and approved based on an analysis of the modelling sensitivity, risk, and adequacy of contingencies presented.

If the requirements noted above cannot be met, the Private Water must be hauled off site and treated/disposed elsewhere. It should be noted that the process for obtaining approval to discharge Private Water to a municipal sewer is often lengthy as it involves field investigations, coordination between multiple design disciplines, and review by multiple City departments.

## 3.2 Erosion & Sediment Control Guidelines during Construction

On-site temporary erosion and sediment control should be provided during construction as per the Erosion & Sediment Control Guidelines for Urban Construction (TRCA, 2019).

## 4 Proposed Conditions

Two multi-story development buildings are proposed at the northeast (Site E) and southwest (Site F) corners of the intersection as shown on Proposed Drainage Area Plans (**Appendix A**). The proposed station will run across Queen Street and proposed buildings will be integrated into the station building. As such, the station building will not have a separate roof and will not receive direct precipitation.

Ontario Line Queen-Spadina TOC site developments are as follows:

- A proposed building at the northeast intersection of Queen Street and Spadina Avenue (Site E) with a total area of 0.0975 ha; and
- A proposed building at the southwest intersection of Queen Street and Spadina Avenue (Site F) with a total area of 0.1588 ha.

## 5 Stormwater Management Plan

As per the applicable SWM criteria summarized in **Section 3.1**, it is required to provide water balance, as well as quantity, quality and erosion control for the proposed Queen/Spadina sites. The stormwater best management practices (BMP) considered for the site include a green roof, underground detention/retention tanks, and oil/grit separator (OGS) units. The Proposed Conditions Drainage Plan is presented in **Appendix A**.

All building openings should be protected from flooding. During detail design, depth of overland flow at these locations should be calculated using dual drainage models to confirm that all openings to the buildings will have sufficient freeboard above the maximum water elevation during the 100-year storm event.

### 5.1 Quantity Control

Drainage discharged to a municipal storm sewer must be controlled to the allowable peak release rate as stated in **Section 3.1.2** of this report. In absence of an adequate overland flow route, all site runoff from the 2-year up to the 100-year return storm events will be stored on site and released at the allowable release rate (2-yr pre-development rate). The capacity of the receiving sewer systems will need to be calculated during detail design to confirm the allowable release rate. The quantity control storage volumes were calculated as 31 m<sup>3</sup> and 51 m<sup>3</sup> for the northeast and southwest buildings, respectively, as shown in **Table 5-1**. Detailed calculations are included in **Appendix B**. In concept, a storage tank with orifice control can be installed in the first underground level to provide the required storage volume. Controlled runoff from the northeast building can discharge to the existing 600 mm storm sewer running along Spadina Avenue, and controlled runoff

from the southwest building can discharge to the existing 850 mm storm sewer running along Spadina Avenue.

**Table 5-1. Quantity Control Storage**

ID	Area (ha)		Runoff Coefficient			Allowable Release Rate <sup>2</sup> (L/s)	Required Storage Volume (m <sup>3</sup> )
	Exist.	Prop.	Exist.	Exist. <sup>1</sup> (City Criteria)	Prop.		
Site E	0.10	0.10	0.9	0.5	0.9	12.0	31
Site F	0.16	0.16	0.9	0.5	0.9	19.0	51

Note:

<sup>1</sup> Assuming a runoff coefficient of 0.5, if the existing imperviousness is greater than 50%.

<sup>2</sup> Based on the 2-yr pre-development flow rate

## 5.2 Water Balance and Erosion Control

The water balance criterion of TGS Tier 2 requires the retention of 10 mm of runoff over the proposed area, which is equivalent to the retention of 451 m<sup>3</sup>/year for Site E and 735 m<sup>3</sup>/year for Site F. Total proposed green roof for site E is 236 m<sup>2</sup> and for site F is 568 m<sup>2</sup>. In concept, the proposed green roof will achieve retention of 87 m<sup>3</sup>/year and 210 m<sup>3</sup>/year for Site E and Site F, respectively, equivalent to 19% and 29% of the annual target. To meet the TGS Tier 2 criterion, the remaining runoff to meet the water balance target up to 100% retention for each site will be stored in the storage tank for reuse. The required tank storage is 8.5 m<sup>3</sup> for Site E and 13.7 m<sup>3</sup> for Site F. By satisfying the water balance retention criterion, the erosion control criterion will be achieved for the sites, since they have a drainage area less than 2 ha. Refer to **Table 5-2** for water balance storage summary and **Appendix B** for detailed calculations.

**Table 5-2. Water Balance Storage**

ID	Land-Cover Type	Area (ha)	Initial Abstraction (mm)	% of Annual Rain	Total Annual Volume (m <sup>3</sup> )	% of Target	Required Storage Tank Volume (m <sup>3</sup> )
Site E	Impervious Area	0.0698	1	14	68	15	8.5
Site E	Green Roof -Intensive	0.0236	7	56	87	19	
Site F	Impervious Area	0.0935	1	14	94	13	13.7
Site F	Green Roof -Intensive	0.0568	7	56	210	29	

## 5.3 Quality Control

Quality control will be required to provide long-term average removal of 80% of total suspended solids (TSS) from all runoff leaving the site as per WWFMG. In concept, combination of OGS units and green roof will provide the required quality control to the runoff leaving the site as shown in **Table 5-3**. Detailed calculations are provided in **Appendix B**.

**Table 5-3. Quality Control Storage**

ID	Area (ha)	Paved Area (ha)	% Impervious <sup>1</sup>	Req. Volume <sup>2</sup> (m <sup>3</sup> )	Mitigation Measures	Prop. Green Roof Area (m <sup>2</sup> )	Prop. Green roof Storage Volume (m <sup>3</sup> )
Site E	0.10	0.10	0.9	3.61	Green Roof (Infiltration)	236	14
Site F	0.16	0.16	0.9	5.88	Green Roof (Infiltration)	568	34

Notes:

<sup>1</sup> Based on RC value

<sup>2</sup> From Table 3.2 of MOE SWM Planning and Design Manual (2003)

## 6 Conclusions and Recommendations

This Stormwater Application is prepared in support of the Rezoning Application for the proposed Queen/Spadina TOC Development Sites. The Reference Concept Design (RCD) satisfies SWM and drainage requirements for the Proposed Queen/Spadina Sites as follows:

- **Quantity Control:**

Storage tank units with orifice control are proposed in the first underground level to provide quantity control.

- **Quality Control:**

Quality control for each site will be provided via the proposed green roof and an Oil Grit Separator unit.

- **Water Balance:**

Green roof and water reuse are proposed to satisfy the 10 mm retention requirement.

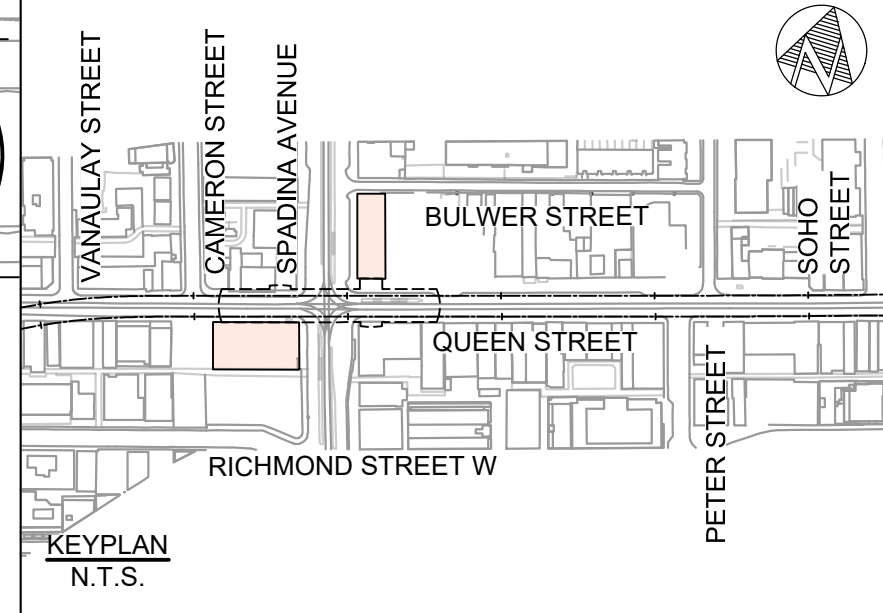
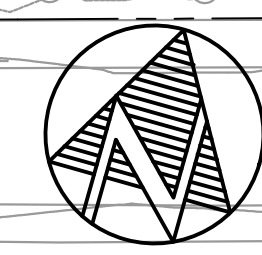
- **Minor Drainage System:**

Water captured from the roofs of the building will be discharged into the existing storm sewer systems after receiving quality and quantity treatment.

- **Major Drainage System:**

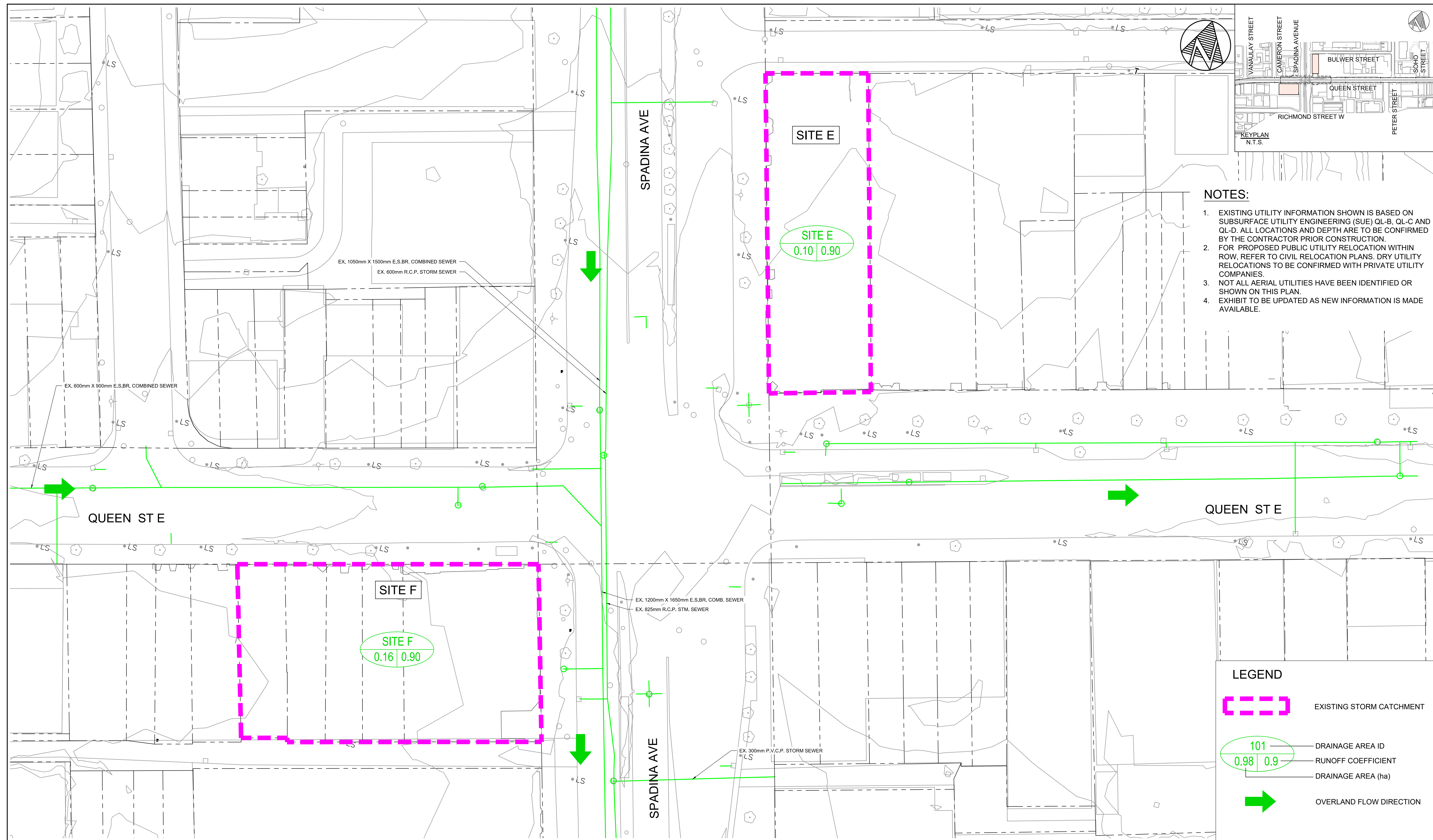
Major system drainage patterns will be generally maintained under proposed conditions. For the proposed aboveground structures, major system flows will be captured and controlled using underground storage.

# Appendix A. Drainage Plans



**NOTES:**

1. EXISTING UTILITY INFORMATION SHOWN IS BASED ON SUBSURFACE UTILITY ENGINEERING (SUE) QL-B, QL-C AND QL-D. ALL LOCATIONS AND DEPTH ARE TO BE CONFIRMED BY THE CONTRACTOR PRIOR CONSTRUCTION.
2. FOR PROPOSED PUBLIC UTILITY RELOCATION WITHIN ROW, REFER TO CIVIL RELOCATION PLANS. DRY UTILITY RELOCATIONS TO BE CONFIRMED WITH PRIVATE UTILITY COMPANIES.
3. NOT ALL AERIAL UTILITIES HAVE BEEN IDENTIFIED OR SHOWN ON THIS PLAN.
4. EXHIBIT TO BE UPDATED AS NEW INFORMATION IS MADE AVAILABLE.



**LEGEND**

- EXISTING STORM CATCHMENT
- DRAINAGE AREA ID
- RUNOFF COEFFICIENT
- DRAINAGE AREA (ha)
- OVERLAND FLOW DIRECTION

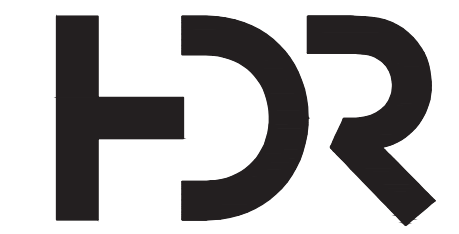
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3		6	

**RCD**  
NOT FOR CONSTRUCTION

SCALE(S) 0 3 6 9 12m  
1:300

STATUS



DESIGNED S. KHORSHID 2020/09/09  
 DRAWN H. WANG 2020/09/09  
 CHECKED M. LI 2020/12/08  
 APPROVED APPROVED 2020/12/08

**ONTARIO LINE SUBWAY**

TITLE  
**TOC QUEEN-SPADINA STATION**  
EXISTING DRAINAGE PLAN

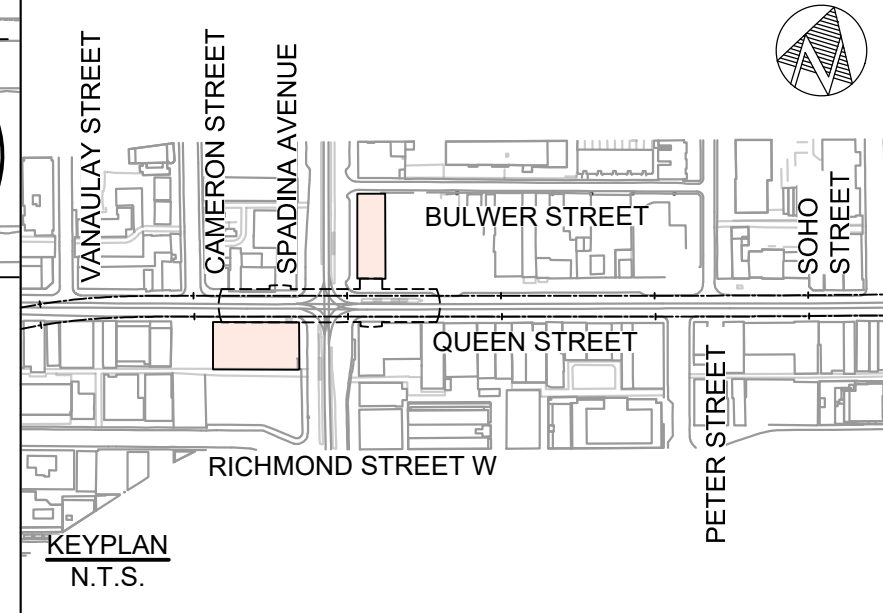
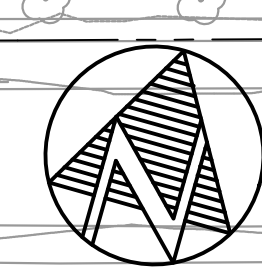
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**METROLINX**  
Infrastructure Ontario

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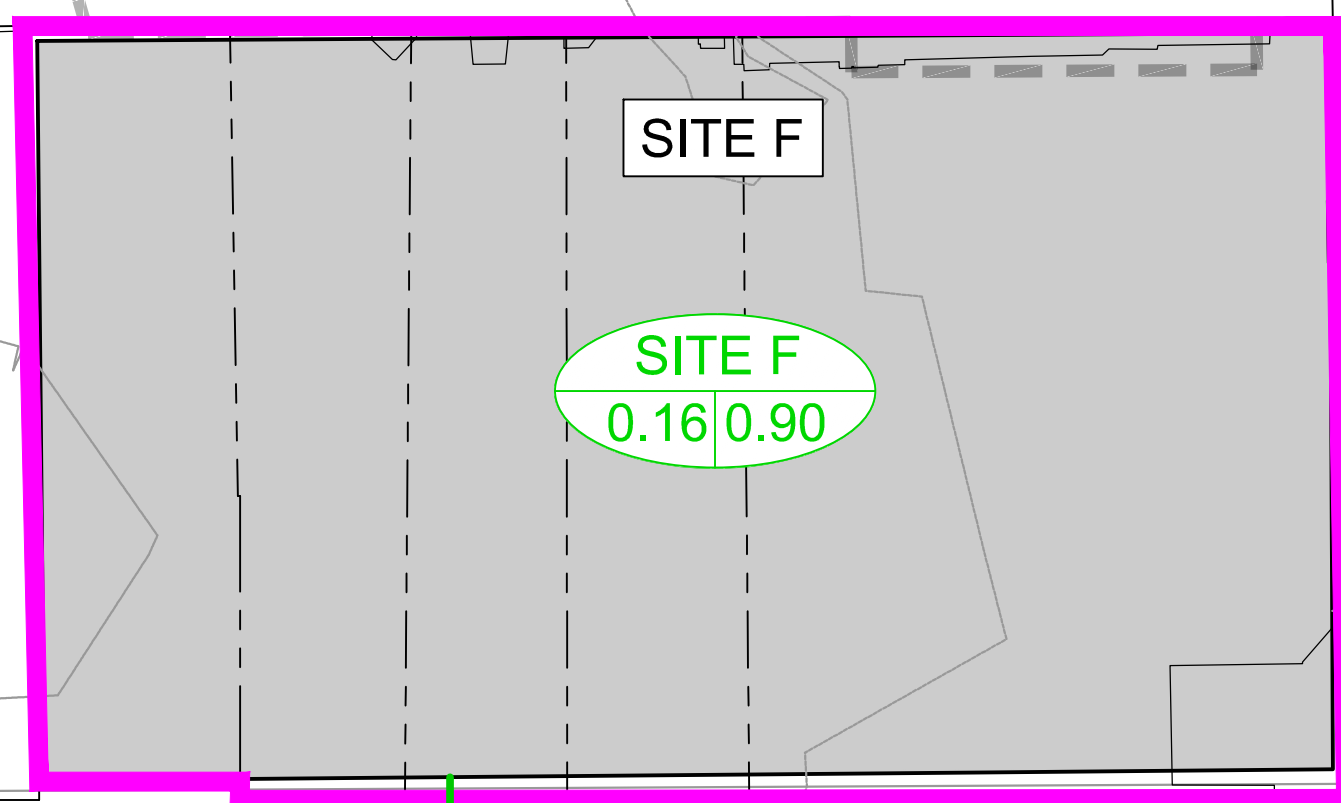
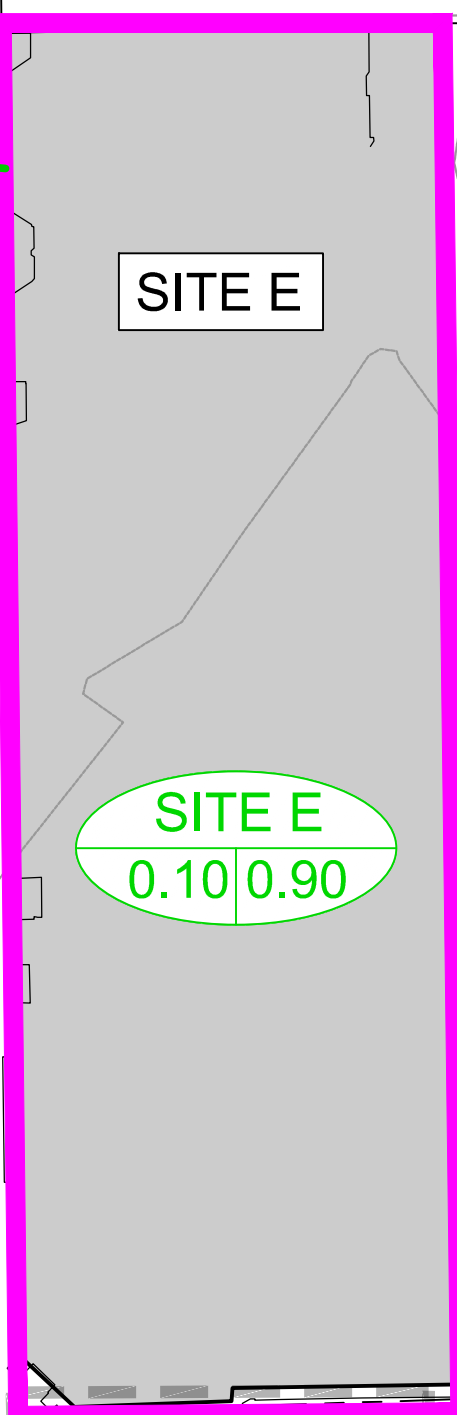
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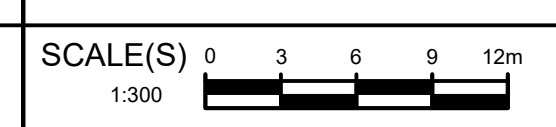
**LEGEND**

- PROPOSED STORM CATCHMENT
- DRAINAGE AREA ID  
RUNOFF COEFFICIENT  
DRAINAGE AREA (ha)
- OVERLAND FLOW DIRECTION
- PROPOSED UNDERGROUND CONCOURSE LEVEL

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3		6	

**RCD**  
NOT FOR CONSTRUCTION



STATUS




DESIGNED S. KHORSHID 2020/12/08  
 DRAWN H. WANG 2020/09/09  
 CHECKED M. LI 2020/12/08  
 APPROVED APPROVED 2020/12/08

**ONTARIO LINE SUBWAY**  
**TOC**  
**QUEEN-SPADINA STATION**  
**PROPOSED DRAINAGE PLAN**

Plot Date: \_\_\_\_\_  
  
 Dwg. No. DR0300-02-SF141 Sheet No. \_\_\_\_\_

## Appendix B. Stormwater Management Calculations

	Project	OLTA	No.10206938	
	By	S. Khorshid	Date	11-May-2021
	Checked	S. Sadek	Checked	11-May-2021

**Stormwater Management Calculations**

**Pre-Development Runoff Coefficients & Uncontrolled Peak Flows -Site E**

Catchment ID	Area, A (ha)	2-10-yr		25-yr			50-yr			100-yr		
		C	A x C	C <sub>f</sub>	C	A x C	C <sub>f</sub>	C	A x C	C <sub>f</sub>	C	A x C
Site E-Queen/Spadina (Paved)	0.0975	0.9	0.0878	1.1	0.95	0.0926	1.2	0.95	0.0926	1.3	0.95	0.0926
Site E-Queen/Spadina (Green)	0	0.2	0.0000	1.1	0.22	0.0000	1.2	0.24	0.0000	1.3	0.25	0.0000
0.0975		0.0878		0.0926			0.0926			0.0926		

Total Drainage Area		0.0975 ha
Weighted C	2-yr	0.50
	5-10-yr	0.90
	25-yr	0.95
	50-yr	0.95
	100-yr	0.95

- NOTE:**
- C<sub>f</sub> = Runoff Coefficient Factor
  - Reference of C<sub>f</sub>: MTO
  - Use 'C' value as 0.5 if the existing weighted 'C' value is greater than 0.5 for 2-yr return period

Run off Calculation (using Rational Method):

Q = C \* i \* A / 360 cms

C = Runoff Coefficient

i = Rainfall Intensity (mm/[City of Toronto IDF Curve])

A = Watershed Area (ha)

IDF Eqn : i = A \* T ^ B

A & B parameter for IDF Curve

Year	A =	B =
2	21.800	-0.780
5	32.000	-0.790
10	38.700	-0.800
25	45.200	-0.800
50	53.500	-0.800
100	59.700	-0.800

T <sub>c</sub> (min)	10
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Peak Flows

Year	Rainfall	Peak Flow	
	mm/hr	m <sup>3</sup> /s	(L/s)
2	88.189	0.012	12
5	131.792	0.032	32
10	162.268	0.040	40
25	189.522	0.049	49
50	224.324	0.058	58
100	250.320	0.064	64



<b>HDR</b>	Project	OLTA	No.10206938	
	By	S. Khorshid	Date	11-May-2021
	Checked	S. Sadek	Checked	11-May-2021
<b>Stormwater Management Calculations</b>				

**REQUIRED STORAGE (POST - PRE) 2 yr**

**Site E**

Watershed Area, A	0.0975	ha
Weighted Post Development Runoff Coefficient, C	0.900	

Using Modified Rational Method

$Q = C * i * A / 360 \text{ cms}$

C = Runoff Coefficient

i = Rainfall intensity (mm/hr) [ From IDF Curve ]

A = Watershed Area (ha)

Allowable Release rate [2 yr Pre-development Flow]	0.012	m <sup>3</sup> /s
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Storm Duration (min)	Storm Runoff Rate (cms)	Storm Runoff Volume (m <sup>3</sup> )	Release Flow Volume (m <sup>3</sup> )	Required Storage Volume (m <sup>3</sup> )	Rainfall 2 Yr mm/hr
0	0.000	0.00	0.00	0.00	0.00
10	0.021	12.90	7.17	5.73	88.189
20	0.013	15.02	14.33	0.69	51.358
30	0.009	16.42	16.42	0.00	37.433
60	0.005	19.13	19.13	0.00	21.800
120	0.003	22.28	22.28	0.00	12.696
360	0.001	28.37	28.37	0.00	5.389
720	0.001	33.05	33.05	0.00	3.138
1440	0.000	38.49	38.49	0.00	1.828

**Maximum Storage (Post - Pre) 6 m<sup>3</sup>**

<b>HLR</b>	Project	OLTA		No.10206938	
	By	S. Khorshid		Date	11-May-2021
	Checked	S. Sadek		Checked	11-May-2021
<b>Stormwater Management Calculations</b>					

**REQUIRED STORAGE (POST - PRE) 100**yr  
**Site E**

Watershed Area, A	0.0975	ha
Weighted Post Development Runoff Coefficient, C	0.950	

Using Modified Rational Method

$Q = C * i * A / 360$  cms

C = Runoff Coefficient

i = Rainfall intensity (mm/hr) [ From IDF Curve ]

A = Watershed Area (ha)

Allowable Release rate [2 yr Pre-development Flow]	0.012	m <sup>3</sup> /s
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Storm Duration (min)	Storm Runoff Rate (cms)	Storm Runoff Volume (m <sup>3</sup> )	Release Flow Volume (m <sup>3</sup> )	Required Storage Volume (m <sup>3</sup> )	Rainfall 100 Yr mm/hr
0	0.000	0.00	0.00	0.00	0.00
10	0.064	38.64	7.17	31.48	250.320
20	0.037	44.39	14.33	30.06	143.771
30	0.027	48.14	21.50	26.64	103.944
60	0.015	55.30	42.99	12.30	59.700
120	0.009	63.52	63.52	0.00	34.289
360	0.004	79.13	79.13	0.00	14.238
720	0.002	90.89	90.89	0.00	8.178
1440	0.001	104.41	104.41	0.00	4.697

**Maximum Storage (Post - Pre) 31**m<sup>3</sup>

<b>FDR</b>	Project	OLTA	No.10206938	
	By	S. Khorshid	Date	11-May-2021
	Checked	S. Sadek	Checked	11-May-2021
<b>Stormwater Management Calculations</b>				

**Pre-Development Runoff Coefficients & Uncontrolled Peak Flows -Site F**

Catchment	Area, A (ha)	2-10-yr		25-yr			50-yr			100-yr		
		C	A x C	C <sub>f</sub>	C	A x C	C <sub>f</sub>	C	A x C	C <sub>f</sub>	C	A x C
Site F-Queen/Spadina (Paved)	0.1588	0.9	0.1429	1.1	0.95	0.1509	1.2	0.95	0.1509	1.25	0.95	0.1509
Site F-Queen/Spadina(Green)	0	0.2	0.0000	1.1	0.22	0.0000	1.2	0.24	0.0000	1.25	0.25	0.0000
	<b>0.1588</b>		<b>0.1429</b>			<b>0.1509</b>			<b>0.1509</b>			<b>0.1509</b>

Total Drainage Area		0.1588 ha
Weighted C	2-yr	0.50
	5-10-yr	0.90
	25-yr	0.95
	50-yr	0.95
	100-yr	0.95

- NOTE:**
- C<sub>f</sub> = Runoff Coefficient Factor
  - Reference of C<sub>f</sub>: MTO
  - Use 'C' value as 0.5 if the existing weighted 'C' value is greater than 0.5 for 2-yr return period

Run off Calculation (using Rational Method):

$$Q = C * i * A / 360 \text{ cms}$$

C = Runoff Coefficient  
 i = Rainfall Intensity (r [City of Toronto IDF Curve])  
 A = Watershed Area (ha)

$$\text{IDF Eqn } i = A * T ^ B$$

A & B parameter for IDF Curve

Year	A =	B =
2	21.800	-0.780
5	32.000	-0.790
10	38.700	-0.800
25	45.200	-0.800
50	53.500	-0.800
100	59.700	-0.800

T <sub>c</sub> (min)	10
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Peak Flows

Year	Rainfall	Peak Flow	
	mm/hr	m <sup>3</sup> /s	(L/s)
2	88.189	0.019	19
5	131.792	0.052	52
10	162.268	0.064	64
25	189.522	0.079	79
50	224.324	0.094	94
100	250.320	0.105	105

<b>HTDR</b>	Project	OLTA	No.10206938	
	By	S. Khorshid	Date	11-May-2021
	Checked	S. Sadek	Checked	11-May-2021

**Stormwater Management Calculations**

**Post-development Runoff Coefficients & Uncontrolled Peak Flows -Site F**

Catchment ID	Area, A (ha)	2-10-yr		25-yr			50-yr			100-yr		
		C	A x C	C <sub>f</sub>	C	A x C	C <sub>f</sub>	C	A x C	C <sub>f</sub>	C	A x C
Site F-Queen/Spadina (Paved)	0.1588	0.9	0.1429	1.1	0.95	0.1509	1.2	0.95	0.1509	1.25	0.95	0.1509
Site F-Queen/Spadina(Green)	0	0.2	0.0000	1.1	0.22	0.0000	1.2	0.24	0.0000	1.25	0.25	0.0000
	<b>0.1588</b>		<b>0.1429</b>			<b>0.1509</b>			<b>0.1509</b>			<b>0.1509</b>

Total Drainage Area	0.1588	ha
Weighted C	2-10-yr	0.90
	25-yr	0.95
	50-yr	0.95
	100-yr	0.95

- NOTE:**
1. C<sub>f</sub> = Runoff Coefficient Factor
  2. Reference of C<sub>f</sub>: MTO

Run off Calculation (using Rational Method):

$$Q = C * i * A / 360 \text{ cms}$$

C = Runoff Coefficient

i = Rainfall Intensity (mm/ [City of Toronto IDF Curve])

A = Watershed Area (ha)

$$\text{IDF Eqn : } i = A * T ^ B$$

A & B parameter for IDF Curve

Year	A =	B =
2	21.800	-0.780
5	32.000	-0.790
10	38.700	-0.800
25	45.200	-0.800
50	53.500	-0.800
100	59.700	-0.800

T <sub>c</sub> (min)	10
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**Peak Flows**

Year	Rainfall	Peak Flow	
	mm/hr	m <sup>3</sup> /s	(L/s)
2	88.189	0.035	35
5	131.792	0.052	52
10	162.268	0.064	64
25	189.522	0.079	79
50	224.324	0.094	94
100	250.320	0.105	105



<b>OLTA</b>	Project	OLTA	No.10206938	
	By	S. Khorshid	Date	11-May-2021
	Checked	S. Sadek	Checked	11-May-2021
<b>Stormwater Management Calculations</b>				

**REQUIRED STORAGE (POST - PRE)**      2      yr

**Site F**

Watershed Area, A	0.1588	ha
Weighted Post Development Runoff Coefficient, C	0.900	

Using Modified Rational Method

$$Q = C * i * A / 360 \text{ cms}$$

C = Runoff Coefficient

i = Rainfall intensity (mm/hr) [ From IDF Curve ]

A = Watershed Area (ha)

Allowable Release rate [2 yr Pre-development Flow]      0.019      m<sup>3</sup>/s

Storm Duration (min)	Storm Runoff Rate (cms)	Storm Runoff Volume (m <sup>3</sup> )	Release Flow Volume (m <sup>3</sup> )	Required Storage Volume (m <sup>3</sup> )	Rainfall 2 Yr mm/hr
0	0.000	0.00	0.00	0.00	0.00
10	0.035	21.01	11.67	9.34	88.189
20	0.020	24.47	23.34	1.13	51.358
30	0.015	26.75	26.75	0.00	37.433
60	0.009	31.16	31.16	0.00	21.800
120	0.005	36.29	36.29	0.00	12.696
360	0.002	46.21	46.21	0.00	5.389
720	0.001	53.82	53.82	0.00	3.138
1440	0.001	62.69	62.69	0.00	1.828

**Maximum Storage (Post - Pre)**      9      m<sup>3</sup>

<b>OTR</b>	Project	OLTA	No.10206938	
	By	S. Khorshid	Date	11-May-2021
	Checked	S. Sadek	Checked	11-May-2021
<b>Stormwater Management Calculations</b>				

**REQUIRED STORAGE (POST - PRE) 100 yr**  
**Site F**

Watershed Area, A	0.1588	ha
Weighted Post Development Runoff Coefficient, C	0.950	

Using Modified Rational Method

$$Q = C * i * A / 360 \text{ cms}$$

C = Runoff Coefficient

i = Rainfall intensity (mm/hr) [ From IDF Curve ]

A = Watershed Area (ha)

Allowable Release rate [2yr Pre-development Flow]	0.019	m <sup>3</sup> /s
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Storm Duration (min)	Storm Runoff Rate (cms)	Storm Runoff Volume (m <sup>3</sup> )	Release Flow Volume (m <sup>3</sup> )	Required Storage Volume (m <sup>3</sup> )	Rainfall Yr mm/hr
0	0.000	0.00	0.00	0.00	0.00
10	0.105	62.94	11.67	51.27	250.320
20	0.060	72.30	23.34	48.96	143.771
30	0.044	78.40	35.01	43.39	103.944
60	0.025	90.06	70.02	20.04	59.700
120	0.014	103.46	103.46	0.00	34.289
360	0.006	128.88	128.88	0.00	14.238
720	0.003	148.04	148.04	0.00	8.178
1440	0.002	170.06	170.06	0.00	4.697

**Maximum Storage (Post - Pre) 51 m<sup>3</sup>**

<b>OTR</b>	Project	OLTA		No.10206938	
	By	S. Khorshid	Date	11-May-2021	
	Checked	S. Sadek	Checked	11-May-2021	

**Stormwater Management Calculations**

**WATER BALANCE CALCULATIONS - Site E**

<b>Site Characteristics</b>		
Site Area	0.0975	ha

<b>Retention Requirements</b>		
rainfall/year (source: Canadian Climate Normals 1971-2000 Lester B. Pearson)	661.6	mm/yr
Retain depth of	10	mm/yr
% annual rain	70%	
Site requirement	451.5	m <sup>3</sup> /yr

Tabular Format of WWFMG - Figure 1A

**% of Total Average Annual Rainfall Depth**

Rainfall (mm)	% Annual
0	0
2.5	30
5	47
10	70
15	82
20	90
25	94
30	97
35	99
40	100

Catchment Area characteristics		Capture Event Characteristics			Source Characteristics					Tank Characteristics for water reuse					Totals		
Area (ha)		Capture Event (mm)	% of Annual Rain	Total Annual Volume (m <sup>3</sup> )	Initial Abstraction (mm)	% of Annual Rain	Source Volume (m <sup>3</sup> )	Source Annual Volume (m <sup>3</sup> )	% of Target	Overflow to Tank	Overflow Depth to Tank (mm)	% of Annual Rain	Tank Volume (m <sup>3</sup> )	Tank Annual Volume (m <sup>3</sup> )	% of Target	Total Annual Volume (m <sup>3</sup> )	% of Target
0.0739	Impervious Roof	10	70%	342	1	14%	0.74	68	15%	Yes	9	56%	6.65	274	61%	342	76%
0.0236	Proposed Green Roof	15	82%	128	7	56%	1.65	87	19%	Yes	8	26%	1.89	41	9%	128	28%
Total																470	104%

<b>OTR</b>	Project	OLTA		No.10206938	
	By	S. Khorshid	Date	11-May-2021	
	Checked	S. Sadek	Checked	11-May-2021	

**Stormwater Management Calculations**

**WATER BALANCE CALCULATIONS - Site F**

<b>Site Characteristics</b>		
Site Area	0.1588	ha

<b>Retention Requirements</b>		
rainfall/year (source: Canadian Climate Normals 1971-2000 Lester B. Pearson)	661.6	mm/yr
Retain depth of	10	mm/yr
% annual rain	70%	
Site requirement	735.4	m <sup>3</sup> /yr

**Tabular Format of WWFMG - Figure 1A**

**% of Total Average Annual Rainfall Depth**

Rainfall (mm)	% Annual
0	0
2.5	30
5	47
10	70
15	82
20	90
25	94
30	97
35	99
40	100

Catchment Area characteristics		Capture Event Characteristics			Source Characteristics					Tank Characteristics for water reuse					Totals		
Area (ha)		Capture Event (mm)	% of Annual Rain	Total Annual Volume (m <sup>3</sup> )	Initial Abstraction (mm)	% of Annual Rain	Source Volume (m <sup>3</sup> )	Source Annual Volume (m <sup>3</sup> )	% of Target	Overflow to Tank	Overflow Depth to Tank (mm)	% of Annual Rain	Tank Volume (m <sup>3</sup> )	Tank Annual Volume (m <sup>3</sup> )	% of Target	Total Annual Volume (m <sup>3</sup> )	% of Target
0.102	Impervious Roof	10	70%	472	1	14%	1.02	94	13%	Yes	9	56%	9.18	378	51%	472	64%
0.0568	Proposed Green Roof	15	82%	308	7	56%	3.98	210	29%	Yes	8	26%	4.54	98	13%	308	42%
<b>Total</b>																<b>781</b>	<b>106%</b>

<b>HDR</b>	Project	OLTA	No.10206938		
	By	S. Khorshid	Date	11-May-2021	
	Checked	S. Sadek	Checked	11-May-2021	
<b>Stormwater Management Calculations</b>					

**QUALITY CONTROL CALCULATIONS**

Drainage Area ID [1]	Proposed			Req. Volume for Quality Control <sup>1</sup> (m <sup>3</sup> ) [5]	Mitigation Measures [6]	Proposed Water Quality/ Balance Storage Volume (m <sup>3</sup> ) [7]
	Drainage Area (ha) [2]	Paved Area (ha) [3]	% Impervious <sup>2</sup> [4]			
<b>Site E</b>	0.10	0.10	90.0%	3.61	Infiltration (Green roof)	14
<b>Site F</b>	0.16	0.16	90.0%	5.88	Infiltration (Green roof)	34

<sup>1</sup> From Table 3.2 of MOE SWM Planning and Design Manual (2003)

<sup>2</sup> Based on RC value

**MOE Table 3.2**

Impervious Level (%)	W.Q. Storage Volume* (m <sup>3</sup> /ha)
35%	25
55%	30
70%	35
85%	40

Green Roof (infiltration)			
	Area (ha)	Depth (m)	Void Space, n
Site B	0.0236	0.15	0.4
Site D	0.0568	0.15	0.4