Draft Rezoning Drainage and Stormwater Management Report – King/Bathurst Integrated Transit Oriented Communities

662-668 King Street West
663-647 King Street West, 69-73 Bathurst Street, 58 Steward Street
Toronto Ontario M5V 1M7

Contract RFS-2019-NAFC-110

PO 214244

HDR Project 10206938

Ontario Line Technical Advisor

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 King Street West and Bathurst Street 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 King and Bathurst Station

King and Bathurst station is located at the intersection of King Street West and Bathurst Street. Two development buildings are proposed at the northeast (North Site) and southeast (South Site) corners of the intersection. The proposed station will run diagonally across King Street West and Bathurst Street intersection and will be integrated into the two development buildings.

Background Review

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

- Drawing OL-S01-C-UT-002, Ontario Line King Station, Composite Utility Plan;
- Drawing OL-S01-C-XS-002, Ontario Line King Station, Composite Utility Cross Sections;
- Drawing PND-03-0810-02, King Bathurst TOC North Site, Architectural plan;
- Drawing PND-03-0810-02, King Bathurst TOC South Site, 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 southeast and northeast corners of the intersection. Bathurst Street slopes from north to south, while King Street slopes from the site towards both east and west.

2.1 Minor and Major Flows

Minor flow within the vicinity of the site is captured via a number of catchbasins and conveyed into existing storm sewers, which includes a 600 mm storm sewer along Bathurst Street discharging to a 1350 mm storm sewer along King Street that ultimately discharges into a 3810 mm storm sewer running north to south along Portland Street. There are also a 750 mm x 1125 mm and a 450 mm combined sewer along Bathurst Street. Refer to the Existing Conditions Drainage Plan in **Appendix A**.

Bathurst Street slopes continuously from north to south for more than 5 km, creating a large drainage area for the major flow at the intersection of Bathurst Street and King Street. The major overland flow along Bathurst runs from north to south and along King Street runs towards the west.

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 Metrolix 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 3**.

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 ≤ 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 ≤ 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 buildings are proposed at the northeast (North Site) and southeast (South Site) corners of the intersection as shown on Proposed Drainage Area Plans **(Appendix A)**. The proposed station will run diagonally across King Street West and Bathurst Street intersection and the 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 King-Bathurst TOC site developments are as follows:

- A proposed building at the northeast intersection of King Street and Bathurst Street (North Site) with a total area of 0.16 ha; and
- A proposed building at the southeast intersection of King Street and Bathurst Street (South Site) with a total area of 0.19 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 King/Bathurst 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 53 m^3 and 63 m^3 for the northeast and southeast 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 1350 mm storm sewer running along King Street, and controlled runoff from the southeast building can discharge to the existing 600 mm combined sewer running along Bathurst Street south of King Street.

Table 5-1. Quantity Control Storage

ID	Area (ha)		Runoff Coefficient			Allowable Release Rate[2] (L/s)	Required Storage Volume (m^3)
	Exist.	Prop.	Exist.	Exist.[1] (City Criteria)	Prop.		
North Site	0.16	0.16	0.9	0.5	0.9	20	53
South Site	0.19	0.19	0.9	0.5	0.9	24	63

Note:

[1] Assuming a runoff coefficient of 0.5, if the existing imperviousness is greater than 50%.

[2] 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 761 m^3/year for North Site and 906 m^3/year for South Site. Total proposed green roof for North Site is 711 m^2 and for South Site is 993 m^2. In concept, the proposed green roof will achieve retention of 263 m^3/year and 368 m^3/year for North Site and South Site, respectively, equivalent to 35% and 41% 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 14.1 m^3 for North Site and 16.6 m^3 for South Site. 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 5 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^3)	% of Target	Required Storage Tank Volume (m^3)
North Site	Impervious Area	0.093	1	14	86	11	14.1
North Site	Green Roof -Intensive	0.071	7	56	263	35	
South Site	Impervious Area	0.096	1	14	89	10	16.6
South Site	Green Roof -Intensive	0.099	7	56	368	41	

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[1]	Req. Volume[2] (m^3)	Mitigation Measures	Prop. Green Roof Area (m^2)	Prop. Green roof Storage Volume (m^3)
North Site	0.16	0.16	0.9	6.09	Green Roof (Infiltration)	711	43
South Site	0.19	0.19	0.9	7.25	Green Roof (Infiltration)	993	60

Notes:
[1] Based on RC value
[2] 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 King/Bathurst TOC Development Sites. The Reference Concept Design (RCD) satisfies SWM and drainage requirements for the Proposed King/Bathurst 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.

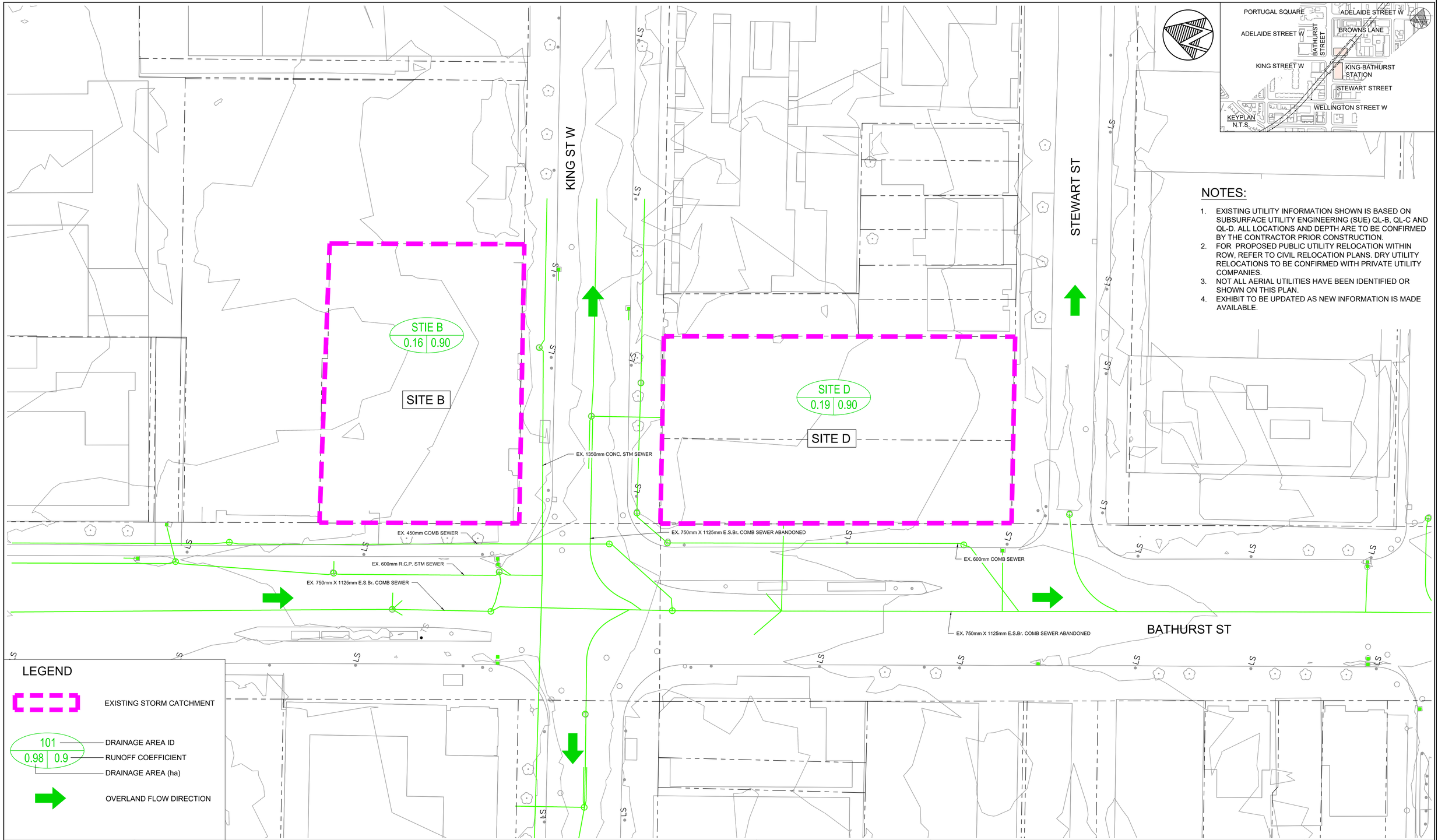
- **Minor Drainage System:**

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 Area 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.

REVISIONS		REVISIONS	
1		4	
2		5	
3		6	

RCD
NOT FOR CONSTRUCTION

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

STATUS

HDR

ONE TEAM
ONTARIO LINE TECHNICAL ADVISOR

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

TITLE
TOC
KING-BATHURST STATION
EXISTING DRAINAGE PLAN

Plot Date:

METROLINX
Infrastructure Ontario

Dwg. No. DR0300-02-SF130

Sheet No.

FILE: 10206938-dr0300-02-sf130.dwg
PLOTTED BY: USER

PROPOSED WESTBOUND TRACK CENTRELINE

PROPOSED EASTBOUND TRACK CENTRELINE

KING ST W

STEWART ST

BATHURST ST

SITE B
0.16 | 0.90

SITE B

SITE D
0.19 | 0.90

SITE D

PROPOSED STORM SERVICE CONNECTION

PROPOSED STORM SERVICE CONNECTION

EX. 1350mm CONC. STM SEWER

EX. 450mm COMB SEWER

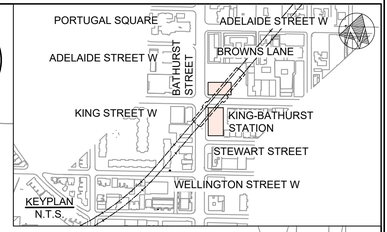
EX. 600mm R.C.P. STM SEWER

EX. 750mm X 1125mm E.S.Br. COMB SEWER

EX. 750mm X 1125mm E.S.Br. COMB SEWER ABANDONED

EX. 600mm COMB SEWER

EX. 750mm X 1125mm E.S.Br. COMB SEWER ABANDONED



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.
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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

- PROPOSED STORM CATCHMENT
- 101 — DRAINAGE AREA ID
- 0.98 | 0.9 — RUNOFF COEFFICIENT / DRAINAGE AREA (ha)
- OVERLAND FLOW DIRECTION
- PROPOSED UNDERGROUND CONCOURSE LEVEL

REVISIONS		REVISIONS	
1		4	
2		5	
3		6	

RCD
NOT FOR CONSTRUCTION

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

STATUS

ONETEAM
ONTARIO LINE TECHNICAL ADVISOR

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

TITLE
TOC
KING-BATHURST STATION
PROPOSED DRAINAGE PLAN

Plot Date:

METROLINX
Infrastructure Ontario

Dwg. No. DR0300-02-SF131

Sheet No.

FILE: 10206938-dr0300-02-sf130.dwg
PLOTTED BY: USER

Appendix B. Stormwater Management Calculations

ONE TEAM
ONTARIO LINE TECHNICAL ADVISOR

HDR	Project	OLTA	No.10206938	
	By	S. Khorshid	Date	20-May-2021
	Checked	S. Sadek	Checked	20-May-2021

Stormwater Management Calculations

Pre-Development Runoff Coefficients & Uncontrolled Peak Flows -Site B

Catchment	Area, A	2-10-yr		25-yr			50-yr			100-yr		
ID	(ha)	C	A x C	C_f	C	A x C	C_f	C	A x C	C_f	C	A x C
Site B-King/Bathurst (Paved)	0.1643	0.9	0.1479	1.1	0.95	0.1561	1.2	0.95	0.1561	1.3	0.95	0.1561
Site B-King/Bathurst (Green)	0	0.2	0.0000	1.1	0.22	0.0000	1.2	0.24	0.0000	1.3	0.25	0.0000
	0.1643		**0.1479**			**0.1561**			**0.1561**			**0.1561**

Total Drainage Area		0.1643	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:

1. C_f = Runoff Coefficient Factor
2. Reference of C_f : MTO
3. 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_c (min)	10

Peak Flows

Year	Rainfall mm/hr	Peak Flow m^3/s	Peak Flow (L/s)
2	88.189	0.020	20
5	131.792	0.030	30
10	162.268	0.037	37
25	189.522	0.078	78
50	224.324	0.097	97
100	250.320	0.109	109

Project	OLTA	No.10206938		
By	S. Khorshid	Date	20-May-2021	
Checked	S. Sadek	Checked	20-May-2021	

Stormwater Management Calculations

Post-Development Runoff Coefficients & Uncontrolled Peak Flows -Site B

Catchment	Area, A	2-10-yr		25-yr			50-yr			100-yr		
ID	(ha)	C	A x C	C_f	C	A x C	C_f	C	A x C	C_f	C	A x C
Site B-King/Bathurst (Paved)	0.1643	0.9	0.1479	1.1	0.95	0.1561	1.2	0.95	0.1561	1.3	0.95	0.1561
Site B-King/Bathurst (Green)	0	0.2	0.0000	1.1	0.22	0.0000	1.2	0.24	0.0000	1.3	0.25	0.0000
	0.1643		**0.1479**			**0.1561**			**0.1561**			**0.1561**

Total Drainage Area		0.1643	ha
Weighted C	2-10-yr	0.90	
	25-yr	0.95	
	50-yr	0.95	
	100-yr	0.95	

NOTE:

1. C_f = Runoff Coefficient Factor
2. Reference of C_f: MTO

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_c (min)	10

Peak Flows

	Rainfall	Peak Flow	
Year	mm/hr	m^3/s	(L/s)
2	88.189	0.036	36
5	131.792	0.054	54
10	162.268	0.067	67
25	189.522	0.082	82
50	224.324	0.097	97
100	250.320	0.109	109

	Project	OLTA	No.10206938	
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	Checked	S. Sadek	Checked	20-May-2021

Stormwater Management Calculations

REQUIRED STORAGE (POST - PRE) 2 yr

Site B

Watershed Area, A	0.1643	ha
Weighted Post Development Runoff Coefficient, C	0.900	

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]	0.020	m^3/s

Storm Duration (min)	Storm Runoff Rate (cms)	Storm Runoff Volume (m^3)	Release Flow Volume (m^3)	Required Storage Volume (m^3)	Rainfall 2 Yr mm/hr
0	0.000	0.00	0.00	0.00	0.00
10	0.036	21.73	12.07	9.66	88.189
20	0.021	25.31	24.15	1.17	51.358
30	0.015	27.68	27.68	0.00	37.433
60	0.009	32.24	32.24	0.00	21.800
120	0.005	37.55	37.55	0.00	12.696
360	0.002	47.81	47.81	0.00	5.389
720	0.001	55.69	55.69	0.00	3.138
1440	0.001	64.86	64.86	0.00	1.828

Maximum Storage (Post - Pre)	10	m^3

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	Project	OLTA	No.10206938	
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Stormwater Management Calculations

REQUIRED STORAGE (POST - PRE) 100 yr

Site B

Watershed Area, A	0.1643	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]	0.020	m^3/s

Storm Duration (min)	Storm Runoff Rate (cms)	Storm Runoff Volume (m^3)	Release Flow Volume (m^3)	Required Storage Volume (m^3)	Rainfall 100 Yr mm/hr
0	0.000	0.00	0.00	0.00	0.00
10	0.109	65.12	12.07	53.04	250.320
20	0.062	74.80	24.15	50.65	143.771
30	0.045	81.12	36.22	44.90	103.944
60	0.026	93.18	72.45	20.74	59.700
120	0.015	107.04	107.04	0.00	34.289
360	0.006	133.34	133.34	0.00	14.238
720	0.004	153.17	153.17	0.00	8.178
1440	0.002	175.95	175.95	0.00	4.697

Maximum Storage (Post - Pre)	53	m^3

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Stormwater Management Calculations

Pre-Development Runoff Coefficients & Uncontrolled Peak Flows -Site D

Catchment ID	Area, A (ha)	2-10-yr C	2-10-yr A x C	25-yr C_f	25-yr C	25-yr A x C	50-yr C_f	50-yr C	50-yr A x C	100-yr C_f	100-yr C	100-yr A x C
Site D-King/Bathurst (Paved)	0.1957	0.9	0.1761	1.1	0.95	0.1859	1.2	0.95	0.1859	1.25	0.95	0.1859
Site D-King/Bathurst (Green)	0	0.2	0.0000	1.1	0.22	0.0000	1.2	0.24	0.0000	1.25	0.25	0.0000
	0.1957		**0.1761**			**0.1859**			**0.1859**			**0.1859**

Total Drainage Area		0.1957	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:

1. C_f = Runoff Coefficient Factor
2. Reference of C_f: MTO
3. 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 (r [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_c (min)	10

Peak Flows

Year	Rainfall mm/hr	Peak Flow m^3/s	Peak Flow (L/s)
2	88.189	0.024	24
5	131.792	0.036	36
10	162.268	0.044	44
25	189.522	0.093	93
50	224.324	0.116	116
100	250.320	0.129	129

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Stormwater Management Calculations

Post-development Runoff Coefficients & Uncontrolled Peak Flows -Site D

Catchment ID	Area, A (ha)	2-10-yr C	2-10-yr A x C	25-yr C_f	25-yr C	25-yr A x C	50-yr C_f	50-yr C	50-yr A x C	100-yr C_f	100-yr C	100-yr A x C
Site D-King/Bathurst (Paved)	0.1957	0.9	0.1761	1.1	0.95	0.1859	1.2	0.95	0.1859	1.25	0.95	0.1859
Site D-King/Bathurst (Green)	0	0.2	0.0000	1.1	0.22	0.0000	1.2	0.24	0.0000	1.25	0.25	0.0000
	0.1957		**0.1761**			**0.1859**			**0.1859**			**0.1859**

Total Drainage Area		0.1957	ha
Weighted C	2-10-yr	0.90	
	25-yr	0.95	
	50-yr	0.95	
	100-yr	0.95	

NOTE:

1. C_f = Runoff Coefficient Factor
2. Reference of C_f: MTO

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_c (min)	10

Peak Flows

Year	Rainfall mm/hr	Peak Flow m^3/s	Peak Flow (L/s)
2	88.189	0.043	43
5	131.792	0.064	64
10	162.268	0.079	79
25	189.522	0.098	98
50	224.324	0.116	116
100	250.320	0.129	129

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Stormwater Management Calculations

REQUIRED STORAGE (POST - PRE)	2	yr

Site D

Watershed Area, A	0.1957	ha
Weighted Post Development Runoff Coefficient, C	0.900	

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]	0.024	m^3/s

Storm Duration (min)	Storm Runoff Rate (cms)	Storm Runoff Volume (m^3)	Release Flow Volume (m^3)	Required Storage Volume (m^3)	Rainfall 2 Yr mm/hr
0	0.000	0.00	0.00	0.00	0.00
10	0.043	25.89	14.38	11.51	88.189
20	0.025	30.15	28.76	1.39	51.358
30	0.018	32.97	32.97	0.00	37.433
60	0.011	38.40	38.40	0.00	21.800
120	0.006	44.72	44.72	0.00	12.696
360	0.003	56.95	56.95	0.00	5.389
720	0.002	66.33	66.33	0.00	3.138
1440	0.001	77.26	77.26	0.00	1.828

Maximum Storage (Post - Pre)	12	m^3

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Stormwater Management Calculations

REQUIRED STORAGE (POST - PRE) 100 yr

Site D

Watershed Area, A	0.1957	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 [2yr Pre-development Flow]	0.024	m^3/s

Storm Duration (min)	Storm Runoff Rate (cms)	Storm Runoff Volume (m^3)	Release Flow Volume (m^3)	Required Storage Volume (m^3)	Rainfall Yr mm/hr
0	0.000	0.00	0.00	0.00	0.00
10	0.129	77.56	14.38	63.18	250.320
20	0.074	89.10	28.76	60.33	143.771
30	0.054	96.62	43.15	53.48	103.944
60	0.031	110.99	86.29	24.70	59.700
120	0.018	127.50	127.50	0.00	34.289
360	0.007	158.83	158.83	0.00	14.238
720	0.004	182.44	182.44	0.00	8.178
1440	0.002	209.57	209.57	0.00	4.697

Maximum Storage (Post - Pre)	63	m^3

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Stormwater Management Calculations

WATER BALANCE CALCULATIONS - Site B		

Site Characteristics		
Site Area	0.1643	ha

Retention Requirements		
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	760.9	m^3/yr

Tabular Format of WWFMG - Figure 1A

% of Total Average Annual Rainfall Deptl

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^3)**	**Initial Abstraction (mm)**	**% of Annual Rain**	**Source Volume (m^3)**	**Source Annual Volume (m^3)**	**% of Target**	**Overflow to Tank**	**Overflow Depth to Tank (mm)**	**% of Annual Rain**	**Tank Volume (m^3)**	**Tank Annual Volume (m^3)**	**% of Target**	**Total Annual Volume (m^3)**	**% of Target**
0.0932	Impervious Roof	10	70%	432	1	14%	0.93	86	11%	Yes	9	56%	8.39	345	45%	432	57%
0.0711	Proposed Green Roof	15	82%	386	7	56%	4.98	263	35%	Yes	8	26%	5.69	122	16%	386	51%
															Total	817	107%

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Stormwater Management Calculations

WATER BALANCE CALCULATIONS - Site D		

Site Characteristics		
Site Area	0.1957	ha

Retention Requirements		
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	906.3	m^3/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^3)**	**Initial Abstraction (mm)**	**% of Annual Rain**	**Source Volume (m^3)**	**Source Annual Volume (m^3)**	**% of Target**	**Overflow to Tank**	**Overflow Depth to Tank (mm)**	**% of Annual Rain**	**Tank Volume (m^3)**	**Tank Annual Volume (m^3)**	**% of Target**	**Total Annual Volume (m^3)**	**% of Target**
0.0964	Impervious Roof	10	70%	446	1	14%	0.96	89	10%	Yes	9	56%	8.68	357	39%	446	49%
0.0993	Proposed Green Roof	15	82%	539	7	56%	6.95	368	41%	Yes	8	26%	7.94	171	19%	539	59%
															Total	985	109%

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Stormwater Management Calculations					

QUALITY CONTROL CALCULATIONS

Drainage Area ID [1]	Proposed			Req. Volume for Quality Control[1] (m^3) [5]	Mitigation Measures [6]	Proposed Water Quality/ Balance Storage Volume (m^3) [7]
	Drainage Area (ha) [2]	Paved Area (ha) [3]	% Impervious[2] [4]			
Site B	0.16	0.16	90.0%	6.09	Infiltration (Green roof)	43
Site D	0.20	0.20	90.0%	7.25	Infiltration (Green roof)	60

[1] From Table 3.2 of MOE SWM Planning and Design Manual (2003)

[2] Based on RC value

MOE Table 3.2

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

Green Roof (infiltration)			
	Area (ha)	Depth (m)	Void Space, n
Site B	0.0711	0.15	0.4
Site D	0.0993	0.15	0.4