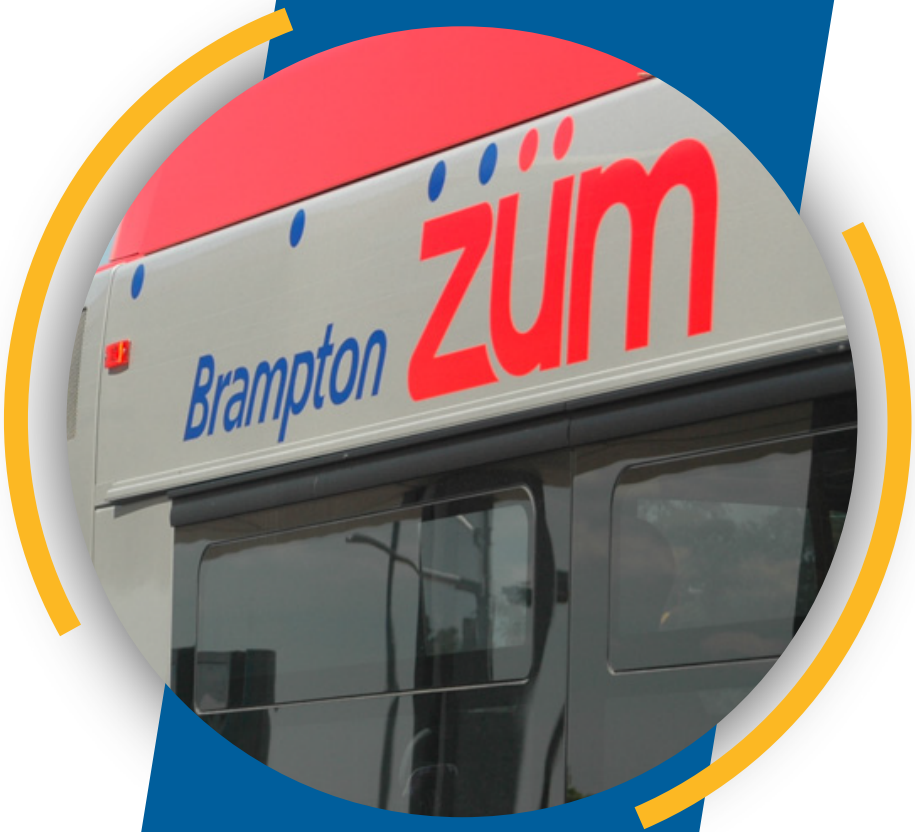
Brampton Transit

BUS MAINTENANCE & STORAGE FACILITY

Appendix L

Stormwater Management

March 18, 2021



Prepared for

BRAMPTON Flower City
brampton.ca

Prepared by

IBI GROUP

Stormwater Management Report

Brampton Transit Satellite Yard

Prepared for City of Brampton
by IBI Group

July 28, 2020

Document Control Page

CLIENT:	City of Brampton
PROJECT NAME:	Environmental Assessment Study for a New Transit Maintenance Facility
REPORT TITLE:	Brampton Transit Satellite Yard
IBI REFERENCE:	121785
VERSION:	1
DIGITAL MASTER:	J:\121785_BramptonTPAP\7.0_Production\7.3_Design\04_Civil\Drainage\SWM Report
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AUTHORIZATION:	
CIRCULATION LIST:	
HISTORY:	

Table of Contents

Table of Contents (continued)

LIST OF TABLES

1 Introduction

IBI Group has been retained by the City of Brampton to complete an Environmental Assessment (EA) study for a new satellite yard in the northeast quadrant of the city in accordance with Ontario's Transit Project Assessment Process (TPAP). The proposed satellite yard will achieve the required expansion of Brampton Transit's storage and maintenance facilities' capacity to accommodate the future acquisition of new vehicles. The study area consists of a 16.7 hectare (ha) parcel of land located southwest of the Cadetta Road / Highway 50 intersection near the border of the City of Vaughan and the City of Brampton (refer to **Figure 1** in **APPENDIX A**). The Project limits are bounded by Highway 50 to the east, Cadetta Road to the north, West Rainbow Creek to the west, and the Johnson Family Farm complex at 10192 Highway 50 to the south. The proposed works for the new satellite yard include a maintenance and storage facility (MSF), associated parking, and an on-site SWM Pond to address stormwater quantity and quality control, as well as erosion control requirements.

This Stormwater Management (SWM) Report is a supporting document to the EA study for the proposed satellite yard. The purpose of this SWM Report is to document the existing drainage conditions on site and describe the proposed drainage and approach to stormwater management as a result of the new satellite yard construction.

2 SWM & Drainage Design Criteria

The proposed site for the new Brampton Transit satellite yard is located within the City of Brampton and Toronto and Region Conservation Authority (TRCA) jurisdiction, with the western portion of the study area falling within TRCA regulation limits. As such, any proposed development, interference or alteration on site near the western Project limit will require a permit from the TRCA. The proposed study area is located within the Humber River watershed, specifically within the Rainbow Creek subwatershed which ultimately drains into the Main Humber River. West Rainbow Creek, which meanders along the western site boundary, has headwaters originating just north of Mayfield Road. The section of West Rainbow Creek located adjacent to the study area has been classified as a warmwater watercourse with intermittent flow by the Ontario Ministry of Natural Resources and Forestry (MNRF), and as a small riverine warmwater habitat by the TRCA. Despite the proximity of West Rainbow Creek, the proposed works on site do not result in any watercourse crossings. TRCA and City of Brampton SWM guidelines govern the proposed SWM and drainage design for the new satellite yard. A list of applicable SWM guidelines and reference documents for the proposed work on site is summarized below.

- City of Brampton Subdivision Design Manual (SDM, December 2008);
- Standard Drawing No. 343 (City of Brampton, 1992);
- TRCA Stormwater Management Criteria (SMC, August 2012);
- Ministry of the Environment, Conservation and Parks (MECP) Stormwater Management Planning and Design Manual (SMPDM, March 2003);
- Works & Transportation Satellite Yards Municipal Class Environmental Assessment Environmental Study Report (ESR, June 2012) prepared by AECOM;
- Appendix H of the ESR: Preliminary Storm Water Management Report - EA Study for Development of Works and Transportation Satellite Yards - Northeast Site (ESR SWM Report, March 2012) prepared by AECOM;

- Appendix K of the ESR: Geotechnical Investigation - Proposed Operations Facility - Site NE2 - 10192 Highway 50, Brampton, Ontario (ESR Geotechnical Report, November 2011) prepared by Inspec-Sol Engineering Solutions; and
- Fluvial Geomorphological Assessment – Rainbow Creek (GeoMorphix, January 2020).

The following **Table 1** outlines the general SWM and drainage design criteria for the proposed Brampton Transit satellite yard.

Table 1: General SWM & Drainage Design Criteria

DESIGN CRITERIA	REQUIREMENT	REFERENCE
Minor Drainage System	The minor storm drainage system will be sized to convey runoff from a 2-year storm event.	City of Brampton SDM III (3) (c)
Major Drainage System	The major storm drainage system will be designed to convey runoff from storms in excess of a 2-year event up to and including the 100-year event by means of overland flow.	City of Brampton SDM III (18) (a)
Water Quantity (Flood) Control	Control post-development peak flows to pre-development levels for all storms up to and including the 100-year storm (i.e., 2, 5, 10, 25, 50, & 100-year storms) using unit flow relationships (Equation F: Sub-Basin 36)	TRCA SMC Table 3-1 & Appendix A
IDF Curve Data	For the hydrological analyses, rainfall intensity will be calculated using the City of Brampton IDF curve parameters.	City of Brampton Standard Drawing No: 343
Water Quality Control	Enhanced Level Protection (80% TSS Removal): Required Unit Storage Volume based on Impervious Level of proposed site.	TRCA SMC 5.2 & City of Brampton SDM IV (2) I. (a) & MECP SMPDM 3.3.2 & Table 3.2
Erosion Control	For sites with SWM pond, extended detention of the 25mm event for a period of 48 hours is required.	TRCA SMC 4.2
Water Balance Control	Minimum on-site retention of all run-off from a 5mm rainfall event through infiltration, evapotranspiration, and/or stormwater reuse.	MECP SMPDM 5.2.2(ii)

3 Existing Drainage Condition

3.1 Existing Land Use, Soils and Physiography

The predominant land use within the Project limits is agricultural, consisting primarily of alfalfa fields that maintain gradual slopes towards the West Rainbow Creek. Directly adjacent to the site, the land use is rural residential and industrial. The proposed satellite yard is situated within the Peel Plain physiographic region which is generally characterized by a gradual and fairly uniform slope towards Lake Ontario. The geology within the study area is dominated by glaciolacustrine silt and clay with Halton clayey silt till. The Halton Till is a dense clayey silt till that underlies the entire site and often contains numerous minor layers of silt and silty fine sand. The bedrock underlying the site is Georgian Bay Formation shale and is estimated to be about 30 meters below ground surface.

3.2 Existing Drainage Elements

The Cadetta Road right-of-way is urbanized with curb and gutters directing runoff to the Highway 50 drainage ditch via asphalt outlet gutters on the north and south side of Cadetta Road. Flows are then conveyed through two existing corrugated steel pipe (CSP) culverts under Cadetta Road (600mm) and Highway 50 (800mm), ultimately draining northeast to another drain. An external drainage area north of the site also drains through the 600 mm diameter CSP culvert under Cadetta Road and is then directed by the Highway 50 drainage ditch through the 800 mm diameter CSP culvert across Highway 50. The existing CSP culverts are in fair to poor condition with signs of moderate corrosion. None of the on-site drainage is conveyed to the existing storm sewer system (**Figure 2** in **APPENDIX B** illustrates the on-site drainage patterns in the existing condition).

3.3 Existing Drainage Patterns

Figure 2, presented in **APPENDIX B**, depicts the existing condition at the satellite yard, including drainage area discretization and the direction of overland flow routes. As stated previously, the site for the Brampton Transit satellite yard is currently a farm field with no existing buildings or built-up areas. As depicted in **Figure 2**, the study area was sub-divided into two catchment areas with a high ridge splitting the site and dictating the direction of overland flow. Catchment 1 provides direct sheet flow into West Rainbow Creek, while Catchment 2 flows towards Highway 50 and drains into the highway drainage ditch. During larger rainfall events, Catchment 2 drains south along the Highway 50 drainage ditch and then flows westerly along a tributary of West Rainbow Creek towards the main channel of the watercourse. The total imperviousness within the site limit is 17% under the existing conditions, with an overall run-off coefficient of 0.36.

The following **Table 2** summarizes the existing catchment areas and uncontrolled peak flows generated for various design storms under the existing condition at the satellite yard using the Rational Method for flow calculation and the City of Brampton IDF curves for determination of rainfall intensity. Area and runoff coefficient calculations, as well as a full peak flow summary for all storm events are provided in **APPENDIX E**.

Table 2: Existing Condition Peak Flows

CATCHMENT ID	AREA (ha)	FLOW (m^3/s)			
		2-YEAR	5-YEAR	10-YEAR	100-YEAR
Catchment 1	10.62	0.592	0.782	0.908	1.306
Catchment 2	6.07	0.740	0.978	1.136	1.634
TOTAL	**16.69**	**1.332**	**1.760**	**2.044**	**2.940**

4 Proposed Drainage Condition

The satellite yard will be constructed in two phases resulting in intermediate and ultimate drainage conditions. In Phase 1 (intermediate condition), West Rainbow Creek follows the same channel alignment as in the existing condition and the proposed site layout is bounded by the creek to the west. In Phase 2 (ultimate condition), West Rainbow Creek will be realigned to the west, providing more space on-site and allowing for the expansion of the MSF building. The proposed site drainage is analyzed for both the intermediate and ultimate conditions.

4.1 Proposed Drainage Elements

In the proposed condition, land use on-site will be industrial, comprising a new satellite yard equipped with an MSF and an associated parking lot. A proposed on-site storm sewer system will collect and convey post-development runoff towards a proposed SWM Pond in the southwest quadrant of the site. The SWM Pond will be equipped with orifice control at the outlet in order to control the rate of outflow before discharging into the receiving watercourse (West Rainbow Creek). All post-development on-site runoff will ultimately discharge into West Rainbow Creek through the SWM Pond. A bypass system to the roof runoff with direct discharge to SWM pond main cell will be implemented. Roof water will help in diluting the pollutants.

4.2 Proposed Drainage Patterns

Figure 3 and **Figure 4,** presented in **APPENDIX C** and **APPENDIX D**, depict the intermediate and ultimate conditions at the satellite yard, including proposed infrastructure and landscaping, drainage area discretization and the direction of overland flow routes. Runoff from the site will continue to be discharged to West Rainbow Creek. Under intermediate conditions, the impervious area on site will be increased to 58%, and the overall run-off coefficient will be increased to 0.63. Under the ultimate condition, the impervious area on site will be increased to 68.5%, and the overall run-off coefficient will be increased to 0.70.

As depicted in **Figure 3** and **Figure 4**, the satellite yard was discretized as one catchment area in the proposed condition (Catchment 3). Runoff from the entire site will be collected by a proposed storm sewer system and conveyed to a proposed SWM Pond in the southwest quadrant of the site. The SWM Pond will be equipped with orifice control at the outlet in order to control the rate of discharge into West Rainbow Creek. The proposed MSF building will be equipped with roof drains to direct roof water towards the pond. All post-development on-site runoff will ultimately discharge into West Rainbow Creek through the SWM Pond.

The following **Table 3** summarizes the uncontrolled peak flows generated for various design storms under intermediate and ultimate conditions at the satellite yard using the same methodology as in the existing condition analysis. Area and runoff coefficient calculations, as well as a full peak flow summary for all storm events are provided in **APPENDIX E**.

Table 3: Proposed Condition Peak Flows

CATCHMENT ID	AREA (ha)	FLOW (m^3/s)			
		2-YEAR	5-YEAR	10-YEAR	100-YEAR
INTERMEDIATE CONDITION					
Catchment 3	16.69	2.312	3.055	3.548	5.103
ULTIMATE CONDITION					
Catchment 3	16.69	2.560	3.384	3.930	5.653

5 Design Features of Proposed SWM System

5.1 Minor and Major System Drainage

In the intermediate and ultimate conditions, runoff from minor system storm events will be collected on-site and conveyed by a proposed storm sewer system towards the proposed SWM Pond. The on-site storm sewer system will be designed according to a 2-year return period. Major system drainage (runoff in excess of a 2-year storm up to an including the 100-

year event) will be conveyed overland as sheet flow towards the SWM Pond. Runoff from both the minor and major systems will ultimately be discharged into West Rainbow Creek.

5.2 Water Quantity (Flood) Control

As a result of the new satellite yard development, water quantity (flood) control is required for the entire site. Since the site is located within the Humber River watershed, unit flow control is required for all design storms (2-100 year). Unit flow equations for each storm event were taken from Table E.1 of Appendix A within the TRCA Stormwater Management Criteria (August 2012) guidelines based on Sub-Basin 36 (Equation F). Unit flow rates were calculated by substituting total site area into the unit flow equations, and controlled flow rates were established by multiplying the unit flow rates by total site area to determine the controlled/allowable release rates leaving the proposed site for each return period. Refer to **APPENDIX E** for a summary of existing condition, intermediate condition, and ultimate condition uncontrolled flows, as well as intermediate and ultimate condition controlled flows (based on the unit flow rates) for the satellite yard.

In order to provide water quantity control for the satellite yard, a SWM Pond is proposed in the southwest quadrant of the site. The flood control storage volume requirement for the satellite yard was calculated to be 4652.77 m^3 and determined by the Modified Rational Method with an inflow rate equal to the 100-year ultimate condition uncontrolled flow for the entire site (5.65 m^3/s) and an outflow rate equal to the 100-year controlled discharge (0.39 m^3/s). Orifice control is proposed at the SWM Pond outlet to control the discharge into West Rainbow Creek. Flood control volume calculations are presented in **APPENDIX E**. The following **Table 4** summarizes the flood control storage volume requirements on site. Sizing calculation for orifice controls will be provided in the detail design.

Table 4: Satellite Yard Flood Control Storage Volume Requirement

FLOW (m^3/s)		FLOOD CONTROL REQUIRED STORAGE VOLUME (m^3)
ULTIMATE CONDITION 100-YEAR UNCONTROLLED RATE	100-YEAR CONTROLLED RELEASE RATE	
5.653	0.390	4652.77

5.3 Water Quality Control

Water quality control is required for the satellite yard as a result of the impervious surface areas in the post-development condition. As stipulated in the TRCA Stormwater Management Criteria (August 2012), quality control requirements for the site must comply with Enhanced Level Protection defined by the MECP as 80% TSS removal. For the satellite yard, water quality control is achieved through implementation of the SWM Pond, specifically through the Permanent Pool volume. Interpolating the data within Table 3.2 of the MECP's SMPDM (March 2003), based on a site imperviousness of 68.5% under ultimate conditions, the water quality unit storage requirement for the proposed SWM Pond is 222 m^3/ha. Subtracting the 40 m^3/ha Extended Detention volume requirement and multiplying by total site area results in a Permanent Pool volume of 3037 m^3 for the proposed SWM Pond to address water quality control for the site. Calculations for water quality control and Permanent Pool volume are provided in **APPENDIX F**.

5.4 Erosion Control

As stipulated in the TRCA Stormwater Management Criteria (August 2012), to address erosion control for sites with a SWM Pond, extended detention of the 25 mm storm event is required for a period of 48 hours. The erosion control storage volume for the satellite yard was determined by multiplying a 25 mm rainfall depth across the entire site area, then multiplying by the ultimate condition site runoff coefficient (0.70). The resulting erosion control storage volume for the site is 2921 m^3. Erosion control calculations are provided in **APPENDIX F**.

5.5 SWM Pond

A SWM Pond is proposed in the southwest quadrant of the satellite yard to address water quantity, quality, and erosion control requirements for the site. Total pond volume is considered the sum of the Permanent Pool volume and the Active Storage volume, with Active Storage being the sum of the flood control and erosion control volumes. As such, the total required storage volume for the SWM Pond is 10,658 m^3. Refer to **Table 5** for a summary of SWM Pond storage volume requirements.

Table 5: SWM Pond Storage Volume Requirements

PERMANENT POOL VOLUME (m^3)	ACTIVE STORAGE VOLUME (m^3)			TOTAL SWM POND STORAGE VOLUME (m^3)
QUALITY CONTROL	*FLOOD CONTROL	EROSION CONTROL	TOTAL	
3037	4700	2921	7621	10,658

** Flood Control Volume rounded up from 4652.77 m^3 to 4700 m^3 for a more conservative approach.*

Using a groundwater elevation of 206.49 m (measured at BH14-11 on 07/18/2011, from the ESR Geotechnical Report), the bottom of pond elevation was set 1.0 m above the groundwater table at an elevation of 207.49 m. With an internal slope of 5:1 and a 0.3 m freeboard, the SWM Pond was designed to achieve the required storage volume within the allotted footprint. Furthermore, a reverse slope/bottom draw pipe will be used to collect cooler water from the pond bottom and discharge it through the orifice control to provide thermal mitigation. Refer to **APPENDIX G** for SWM Pond design calculations.

Surface flow from snowmelt will be directed to forebay first (which will be installed with a liner). Salt up-taking vegetation will be planted in the forebay and main cell to reduce the salt concentration in the pond. Landscape details will be provided in the detail design.

In addition to the above, the mitigation of salt-impacted runoff effects will be achieved by adherence to salt management practices as recommended by the Transportation Association of Canada (TAC), Ministry of Transportation (MTO), and the City of Brampton's Salt Water Management Plan and to the use of meltwater management facilities to store salt-impacted runoff for potential re-use as brine. In general, salt storage and handling will follow Best Management Practices and this will not pose a groundwater problem. The details of site specific Salt Water Management Plan will be provided at the detailed design phase.

5.6 Watercourse Buffer

A 10 m buffer is provided for the site from the Regional flood line. The Regional flood line governs as it is wider than the mender belt width established in the Fluvial Geomorphological Assessment for Rainbow Creek (GeoMorphix, January 2020). **Figure 3** and **Figure 4** (**APPENDIX C** and **APPENDIX D**, respectively) depict the 10 m buffer from the Regional flood line.

5.7 Water Balance Control

Water balance control is required for the proposed site. As stipulated by the MECP, the proposed design for the satellite yard must provide, at a minimum, on-site retention of all run-off from the first 5 mm of each rainfall event through infiltration, evapotranspiration, and/or stormwater reuse. As part of the proposed design, water balance control is achieved through ditch infiltration. Water balance calculations yielded a required infiltration volume of 834.65 m^3 for the proposed satellite yard (determined by multiplying 5 mm of rainfall across the entire site area). Based on the ditch infiltration area, the infiltration rate of the underlying soil (calculated using borehole data from the ESR Geotechnical Report), and a 48-hour detention time (as per

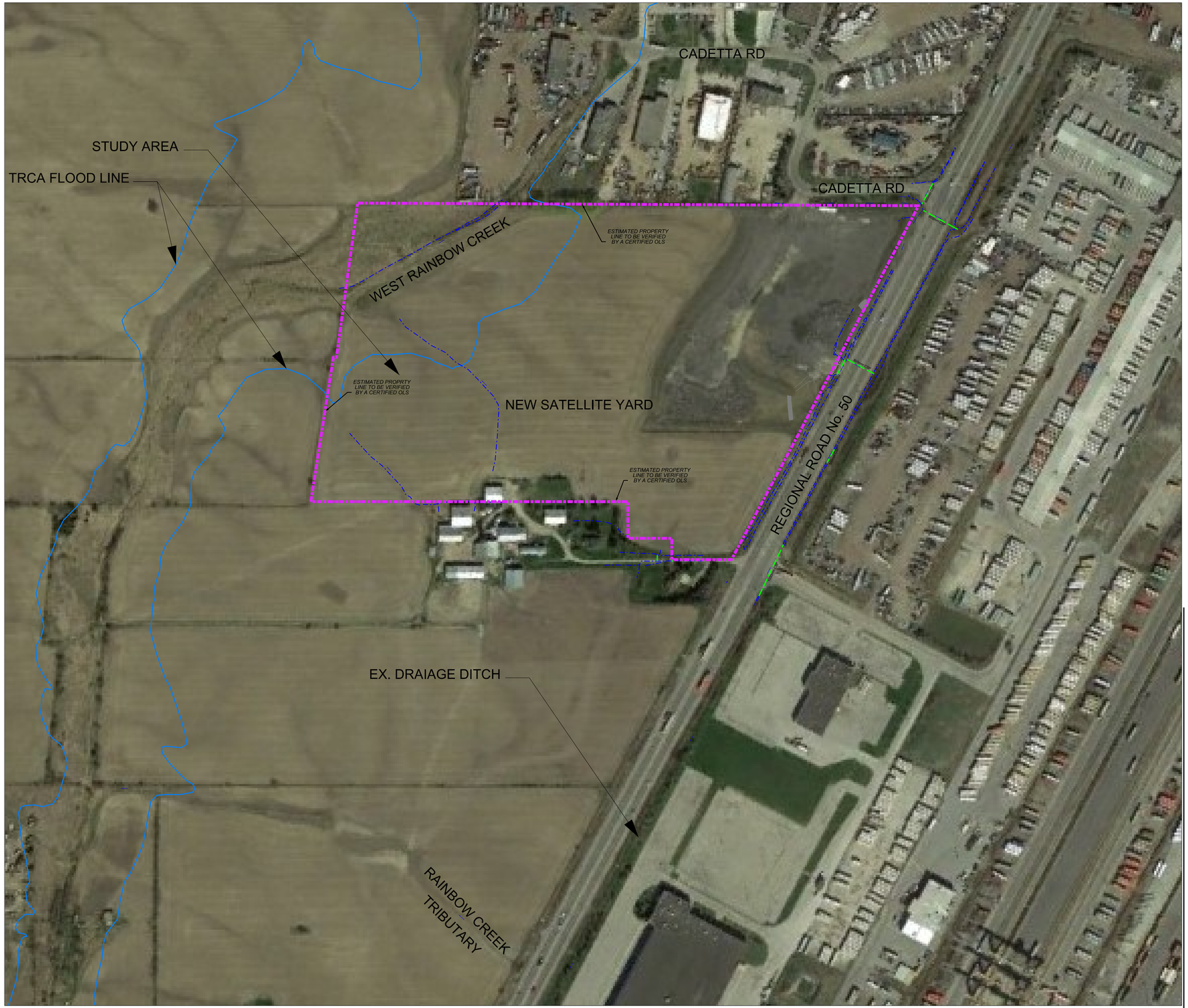
TRCA guidelines), the proposed ditches will be capable of infiltrating 855.88 m^3 of runoff which is equivalent to a rainfall depth of 5.13 mm spread across the entire site, thereby meeting the MECP's 5 mm water balance requirement. Calculations for water balance control are provided in **APPENDIX H**.

6 Conclusion

This report has documented the existing drainage conditions on-site and described the proposed drainage and approach to stormwater management for the new satellite yard. The findings of this report are summarized as follows:

- The satellite yard will be constructed in two phases resulting in intermediate and ultimate drainage conditions. In Phase 1 (intermediate condition), West Rainbow Creek follows the same channel alignment as in the existing condition and the proposed site layout is bounded by the creek to the west. In Phase 2 (ultimate condition), West Rainbow Creek will be realigned to the west, providing more space on-site and allowing for the expansion of the MSF building.
- A 10 m buffer is provided for the site from the Regional flood line.
- A storm sewer system is proposed to convey post-development runoff to a proposed SWM Pond in the southwest quadrant of the site.
- The proposed SWM pond will be equipped with orifice control at the outlet in order to control the rate of discharge into the receiving watercourse (West Rainbow Creek). A reverse slope/bottom draw pipe will be used to collect cooler water from the pond bottom and discharge it through the orifice control to provide thermal mitigation.
- Since the satellite yard is located within the Humber River watershed, unit flow control is required for all design storms (2-100 year) using the unit flow equations outlined in Table E.1, Appendix A of the TRCA Stormwater Management Criteria guidelines based on Sub-Basin 36 (Equation F).
- The proposed SWM Pond will achieve water quantity, water quality, and erosion control requirements for the satellite yard through Permanent Pool and Active Storage Volume.
- The SWM Pond has been designed to achieve Enhanced Level Protection (80% TSS removal) water quality control in accordance with the MECP's requirements for habitat protection.
- The SWM Pond has been designed to provide extended detention of the 25 mm storm event for a period of 48 hours in compliance with TRCA erosion control requirements.
- Sizing calculation for orifice controls will be provided in the detail design.
- The forebay of the SWM Pond will be installed with a liner. Salt up-taking vegetation will be planted in the forebay and main cell to reduce the salt concentration in the pond. Landscape details will be provided in the detail design.
- The details of site specific Salt Water Management Plan will be provided at the detailed design phase.
- Water balance control for the satellite yard will be achieved through ditch infiltration. The proposed ditches will be capable of infiltrating a volume of runoff equivalent to a rainfall depth of 5.13 mm spread across the entire site, thereby meeting the MECP's 5 mm water balance requirement.

APPENDIX A: SITE OVERVIEW



NO.	BY	DATE	REVISIONS	CHECKED

BRAMPTON Flower City
brampton.ca

Public Works & Engineering

Capital Works

PROJECT DWG. NO.

SITE PLAN

TRANSIT FACILITY

STORMWATER MANAGEMENT PLAN

PROPOSED RECONSTRUCTION

SURVEYED BY:	--------	DATE: SEPTEMBER 30, 2019		FILE NO.	--------
DRAWN BY:	N.M	CHECKED BY:	R.P	DRAWING NO.	SHEET NO.
DESIGNED BY:	K.H	CHECKED BY:	--------	**FIGURE 1**	**1**
SCALE:	1:2000	DATE:	14 JULY 2020		

LAST UPDATED 23 JAN 17 – PWZ

APPENDIX B: EXISTING DRAINAGE CONFIGURATION

TRCA FLOOD LINE

ESTIMATED PROPERTY LINE TO BE VERIFIED BY A CERTIFIED OLS

WEST RAINBOW CREEK

CADETTA RD

800mm CSP

800mm CSP

2 | 0.55
6.07 ha.

1 | 0.25
10.62 ha.

CATCHMENT ID
RUNOFF COEFFICIENT
CATCHMENT AREA
CATCHMENT BOUNDARY
RUNOFF FLOW

ESTIMATED PROPRTY LINE TO BE VERIFIED BY A CERTIFIED OLS

EX. DRAIAGE DITCH

ESTIMATED PROPERTY LINE TO BE VERIFIED BY A CERTIFIED OLS

REGIONAL ROAD No. 50

800mm CSP

800mm CSP

1800mm CSP

NO.	BY	DATE	REVISIONS	CHECKED

BRAMPTON Flower City
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Public Works & Engineering
Capital Works

PROJECT | DWG. NO.

SITE PLAN
TRANSIT FACILITY
STORMWATER MANAGEMENT PLAN

PROPOSED RECONSTRUCTION

SURVEYED BY: ----------	DATE: SEPTEMBER 30, 2019	FILE NO. ----------	
DRAWN BY: N.M	CHECKED BY: R.P	DRAWING NO. FIGURE 2	SHEET NO. 2
DESIGNED BY: K.H	CHECKED BY: ----------		
SCALE: 1:1000	DATE: 14 JULY 2020		

LAST UPDATED 23 JAN 17 – PMZ

APPENDIX C: INTERMEDIATE DRAINAGE CONFIGURATION

1m FLAT BOTTOM DITCH

ESTIMATED PROPERTY LINE TO BE VERIFIED BY A CERTIFIED OLS

CADETTA RD

3 — 6 — 3

WEST RAINBOW CREEK

3 | 0.63
16.69 ha.

REVISED LOCATION OF EXTENDED FLOOD PLAIN (CONFIRMED BY GIS 2019)

HW

ESTIMATED PROPERTY LINE TO BE VERIFIED BY A CERTIFIED OLS

OLD LOCATION OF EXTENDED FLOOD PLAIN (ESR 2012)

STM PIPE

10

BUS GARAGE EXPANSION

PARKING STRUCTURE
±680 PARKING SPOTS
1

1
BUS GARAGE
- 246 SBE'S
18,500 sm

ADMIN. OFFICE
2,400 sm

MAIN ELEC. SUBSTATION
225 sm

FIRE ROUTE

6
8

FUTURE LOCATION OF CADETTA ROAD
WITH A SIGNALIZED, FULL TURNS INTERSECTION IN APPROXIMATELY YEAR 2041 WHEN THE A2/HWY.50 GRADE SEPARATION IS CONSTRUCTED

POTENTIAL WIDENING OF REGIONAL ROAD NO. 50

MAIN BUS ENTRANCE

1 | 0.25
10.62 ha.

RUNOFF COEFFICIENT
CATCHMENT ID
CATCHMENT AREA
CATCHMENT BOUNDARY
RUNOFF FLOW

FOREBAY

STM POND
1

1

MAINTENANCE EXPANSION

1
10 STANDARD BAYS
MAINTENANCE - 20 BAYS
11,400 sm
LUNCHROOM
10 ARTIC. BAYS
TEMP. ACCESS
STORES
1,000 sm

SERVICE LANES
2,500 sm

BYPASS LANE

BACKUP POWER GENERATORS

TANK FARM
360 sm

SHIPPING/ RECEIVING

PAINTED LINES

STOP BAR

SCREENING/ FENCING

OUTDOOR BUS STAGING/LAYBY AREA

3 — 6 — 3

DEDICATED BUS EXITING LANE

EARTH BERM / TREE BUFFER

SOUND WALL

ESTIMATED PROPERTY LINES TO BE VERIFIED BY A CERTIFIED OLS

SOUND WALL

1m FLAT BOTTOM DITCH

ESTIMATED PROPERTY LINES TO BE VERIFIED BY A CERTIFIED OLS

EX. DRAIAGE DITCH

REGIONAL ROAD No. 50

NO.	BY	DATE	REVISIONS	CHECKED

BRAMPTON Flower City
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Public Works & Engineering
Capital Works

PROJECT | DWG. NO.

SITE PLAN
TRANSIT FACILITY
STORMWATER MANAGEMENT PLAN

PROPOSED RECONSTRUCTION

SURVEYED BY:	---------	DATE: SEPTEMBER 30, 2019		FILE NO.	--------
DRAWN BY:	N.M	CHECKED BY:	R.P	DRAWING NO.	SHEET NO.
DESIGNED BY:	K.H	CHECKED BY:	---------	FIGURE 3	3
SCALE:	1:1000	DATE:	14 JULY 2020		

LAST UPDATED 23 JAN 17 – PWZ

APPENDIX D: ULTIMATE DRAINAGE CONFIGURATION

NEW LOCATION OF EXTENDED FLOOD PLAIN (ADDENDUM TO MESP 2018)

PROPOSED RE-ALIGNMENT OF RAINBOW CREEK (ADDENDUM TO MESP 2018)

1m FLAT BOTTOM DITCH

ESTIMATED PROPERTY LINE TO BE VERIFIED BY A CERTIFIED OLS

CADETTA RD

WEST RAINBOW CREEK

10

10

10

FENCED-IN MATERIALS STORAGE ±1800sm

3 | 0.70

16.69 ha.

FUTURE ENERGY STORAGE ± 4,600 sm

RIP RAP

HW

STM PIPE

STM OUTLET (ABOVE 2-YEAR LEVEL)

2

STM POND

1

FOREBAY

1

PHASE 2A:

CONSTRUCT THE NORTH SIDE ADDITION FIRST AND GET INTO FULL OPERATION

PHASE 2B:

CLOSE OUT THIS SECTION OF BUSES BY MOVING IT TO THE NORTH SIDE, AND CONSTRUCT SECOND ADDITION TO GARAGE

PROPOSED HOARDING DURING PHASE 2B

PHASE 2B:

CONSTRUCT SECOND ADDITION TO GARAGE

TOTAL BUS STORAGE DURING PHASE 2B = 294 SBE'S

3 6 3

2

PARKING STRUCTURE

±680 PARKING SPOTS

BUS GARAGE - 438 SBE'S 31,800 sm

ADMIN. OFFICE 2,400 sm

MAIN ELEC. SUBSTATION 225 sm

FIRE ROUTE

6

8

FUTURE LOCATION OF CADETTA ROAD

WITH A SIGNALIZED, FULL TURNS INTERSECTION IN APPROXIMATELY YEAR 2041 WHEN THE A2/HWY.50 GRADE SEPARATION IS CONSTRUCTED

POTENTIAL WIDENING OF REGIONAL ROAD NO. 50

OUTDOOR GASOLINE CAR FUELING STATION

MAIN BUS ENTRANCE

STORES 1,000 sm

2

8 STANDARD BAYS

10 STANDARD BAYS

8 ARTIC. BAYS

MAINTENANCE - 36 BAYS 14,900 sm

LUNCHROOM

10 ARTIC. BAYS

SERVICE LANES 2,500 sm

BYPASS LANE

BACKUP POWER GENERATORS

TANK FARM 360 sm

STORES 1,000 sm

SHIPPING/ RECEIVING

PAINTED LINES

ESTIMATED PROPERTY LINE TO BE VERIFIED BY A CERTIFIED OLS

STOP BAR

SCREENING/ FENCING

OUTDOOR BUS STAGING/LAYBY AREA

3 6 3

DEDICATED BUS EXITING LANE

EARTH BERM / TREE BUFFER

SOUND WALL

TEMPORARY ACCESS TO MAINTENANCE AREA DURING PHASE 2 CONSTRUCTION

ESTIMATED PROPERTY LINES TO BE VERIFIED BY A CERTIFIED OLS

SOUND WALL

1m FLAT BOTTOM DITCH

ESTIMATED PROPERTY LINES TO BE VERIFIED BY A CERTIFIED OLS

EX. DRAIAGE DITCH

REGIONAL ROAD No. 50

1 | 0.25

10.62 ha.

RUNOFF COEFFICIENT

CATCHMENT ID

CATCHMENT AREA

CATCHMENT BOUNDARY

RUNOFF FLOW

NO.	BY	DATE	REVISIONS	CHECKED

BRAMPTON Flower City

brampton.ca

Public Works & Engineering

Capital Works

PROJECT

DWG. NO.

SITE PLAN

TRANSIT FACILITY

STORMWATER MANAGEMENT PLAN

PROPOSED RECONSTRUCTION

SURVEYED BY:	---------	DATE: SEPTEMBER 30, 2019	FILE NO. ---------
DRAWN BY:	N.M	CHECKED BY: R.P	DRAWING NO. FIGURE 4
DESIGNED BY:	K.H	CHECKED BY: ---------	SHEET NO. 4
SCALE:	1:1000	DATE: 14 JULY 2020	

LAST UPDATED 23 JAN 17 – PWZ

APPENDIX E: WATER QUANTITY CONTROL CALCULATIONS

APPENDIX E

Drainage Area Summary

EXISTING CONDITION										
Location	Catchment ID	Area (m^2)				Runoff Coefficient	Area (ha)			
		TOTAL	GREEN AREA	GRAVEL	HARD SURFACE		TOTAL	GREEN AREA	GRAVEL	HARD SURFACE
Brampton Transit NE Satellite Yard	C1	106215.51	105599.49	285.12	330.90	0.25	10.62	10.56	0.03	0.03
	C2	60714.26	32031.88	550.42	28131.96	0.55	6.07	3.20	0.06	2.81
	Total	166929.77	137631.37	835.54	28462.86	0.36	16.69	13.76	0.08	2.85

INTERMEDIATE CONDITION (PHASE 1)										
Location	Catchment ID	Area (m^2)				Runoff Coefficient	Area (ha)			
		TOTAL	GREEN AREA	GRAVEL	HARD SURFACE		TOTAL	GREEN AREA	GRAVEL	HARD SURFACE
Brampton Transit NE Satellite Yard	C3	166929.77	69959.08	0.00	96970.69	0.63	16.69	7.00	0.00	9.70
	Total	166929.77	69959.08	0.00	96970.69	0.63	16.69	7.00	0.00	9.70

ULTIMATE CONDITION (PHASE 2)										
Location	Catchment ID	Area (m^2)				Runoff Coefficient	Area (ha)			
		TOTAL	GREEN AREA	GRAVEL	HARD SURFACE		TOTAL	GREEN AREA	GRAVEL	HARD SURFACE
Brampton Transit NE Satellite Yard	C3	166929.77	52604.11	0.00	114325.66	0.70	16.69	5.26	0.00	11.43
	Total	166929.77	52604.11	0.00	114325.66	0.70	16.69	5.26	0.00	11.43

Runoff Coefficients	
Material	C Value
GREEN AREA	0.25
GRAVEL	0.40
HARD SURFACE	0.90

APPENDIX E

IDF Curve Data

Brampton T_c (min) 10

Return Period	A	B	C	i (mm/hr)
City of Brampton				
2	22.1	-	-0.714	79.43
5	29.9	-	-0.701	104.99
10	35.1	-	-0.695	121.93
25	41.6	-	-0.691	143.48
50	46.5	-	-0.688	159.52
100	51.3	-	-0.686	175.36

Storage Calculation for 100-Year Storm

Location: Brampton Transit NE Satellite Yard
Catchment ID: C3
Option #: 3.2
Phase: Intermediate (Phase 1)

Post-Development (C3):	100-year storm (uncontrolled)	Q_{100} (m^3/s) = 5.103
Pre-Development (C1+C2):	100-year storm (uncontrolled)	Q_{100} (m^3/s) = 2.940
Unit Flow Release Rate:	100-year storm: Q = 29.912 - 2.316*ln(A)	Q_{100} (m^3/s) = 0.390

$Q_{control}$ (m^3/s) = 0.390

Inflow Parameters (Post-Development - C3)		
Area =	16.69	ha
R.C =	0.63	

IDF Curve Data (City of Brampton 100-Year)		
	A =	51.3
	B =	-
	C =	-0.686

Time (min)	Intensity (mm/hr)	Peak Flow (m^3/s)	Inflow Volume (m^3)	Release Rate (m^3/s)	Outflow Volume (m^3)	Storage (m^3)
75.00	44.02	1.281	5764.43	0.39049	1757.21	4007.23
76.00	43.62	1.269	5788.46	0.39049	1780.64	4007.82
77.00	43.23	1.258	5812.27	0.39049	1804.06	4008.20
78.00	42.85	1.247	5835.86	0.39049	1827.49	4008.37
79.00	42.48	1.236	5859.25	0.39049	1850.92	4008.33
80.00	42.11	1.226	5882.44	0.39049	1874.35	4008.09
81.00	41.75	1.215	5905.43	0.39049	1897.78	4007.65
82.00	41.41	1.205	5928.23	0.39049	1921.21	4007.02
83.00	41.06	1.195	5950.84	0.39049	1944.64	4006.19
84.00	40.73	1.185	5973.26	0.39049	1968.07	4005.18
Storage required to control 100-year post-development peak flow to 100-year unit flow release rate (m^3):						**4008.37**

Storage Calculation for 100-Year Storm

Location: Brampton Transit NE Satellite Yard
Catchment ID: C3
Option #: 3.2
Phase: Ultimate (Phase 2)

Post-Development (C3):	100-year storm (uncontrolled)	Q_{100} (m^3/s) = 5.653
Pre-Development (C1+C2):	100-year storm (uncontrolled)	Q_{100} (m^3/s) = 2.940
Unit Flow Release Rate:	100-year storm: Q = 29.912 - 2.316*ln(A)	Q_{100} (m^3/s) = 0.390

$Q_{control}$ (m^3/s) = 0.390

Inflow Parameters (Post-Development - C3)		
Area =	16.69	ha
R.C =	0.70	

IDF Curve Data (City of Brampton 100-Year)		
	A =	51.3
	B =	-
	C =	-0.686

Time (min)	Intensity (mm/hr)	Peak Flow (m^3/s)	Inflow Volume (m^3)	Release Rate (m^3/s)	Outflow Volume (m^3)	Storage (m^3)
85.00	40.40	1.302	6641.08	0.39049	1991.50	4649.58
86.00	40.07	1.292	6665.51	0.39049	2014.93	4650.58
87.00	39.76	1.282	6689.75	0.39049	2038.36	4651.39
88.00	39.45	1.272	6713.80	0.39049	2061.79	4652.01
89.00	39.14	1.262	6737.67	0.39049	2085.22	4652.45
90.00	38.84	1.252	6761.35	0.39049	2108.65	4652.70
91.00	38.55	1.243	6784.85	0.39049	2132.08	4652.77
92.00	38.26	1.233	6808.17	0.39049	2155.51	4652.66
93.00	37.98	1.224	6831.32	0.39049	2178.94	4652.38
94.00	37.70	1.215	6854.30	0.39049	2202.37	4651.94
Storage required to control 100-year post-development peak flow to 100-year unit flow release rate (m^3):						**4652.77**

APPENDIX E

Brampton Transit Satellite Yard Stormwater Management Summary

EXISTING CONDITION													
Drainage Catchment ID	Area (ha)				% Impervious	Runoff Coefficient	Time of Concentration (min)	Rainfall Intensity (mm/hr)					
	GREEN AREA	GRAVEL	HARD SURFACE	Total				i_2	i_5	i_{10}	i_{25}	i_{50}	i_{100}
C1	10.56	0.03	0.03	10.62	0.31	0.25	10.00	79.43	104.99	121.93	143.48	159.52	175.36
C2	3.20	0.06	2.81	6.07	46.34	0.55	10.00	79.43	104.99	121.93	143.48	159.52	175.36
Total	13.76	0.08	2.85	16.69	17.05	0.36	-	-	-	-	-	-	-

INTERMEDIATE CONDITION (PHASE 1)													
Drainage Catchment ID	Area (ha)				% Impervious	Runoff Coefficient	Time of Concentration (min)	Rainfall Intensity (mm/hr)					
	GREEN AREA	GRAVEL	HARD SURFACE	Total				i_2	i_5	i_{10}	i_{25}	i_{50}	i_{100}
C3	7.00	0.00	9.70	16.69	58.09	0.63	10.00	79.43	104.99	121.93	143.48	159.52	175.36
Total	7.00	0.00	9.70	16.69	58.09	0.63	-	-	-	-	-	-	-

ULTIMATE CONDITION (PHASE 2)													
Drainage Catchment ID	Area (ha)				% Impervious	Runoff Coefficient	Time of Concentration (min)	Rainfall Intensity (mm/hr)					
	GREEN AREA	GRAVEL	HARD SURFACE	Total				i_2	i_5	i_{10}	i_{25}	i_{50}	i_{100}
C3	5.26	0.00	11.43	16.69	68.49	0.70	10.00	79.43	104.99	121.93	143.48	159.52	175.36
Total	5.26	0.00	11.43	16.69	68.49	0.70	-	-	-	-	-	-	-

APPENDIX E

Drainage Catchment ID	EXISTING CONDITION					
	Flow (m^3/s)					
	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
C1	0.592	0.782	0.908	1.069	1.188	1.306
C2	0.740	0.978	1.136	1.337	1.487	1.634
Total	1.332	1.760	2.044	2.406	2.675	2.940

Drainage Catchment ID	INTERMEDIATE CONDITION (PHASE 1)						
	Flow (m^3/s)						Required Storage Volume (m^3)
	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	
C3	2.312	3.055	3.548	4.175	4.642	5.103	4008.37
Total	2.312	3.055	3.548	4.175	4.642	5.103	4008.37

Drainage Catchment ID	ULTIMATE CONDITION (PHASE 2)						
	Flow (m^3/s)						Required Storage Volume (m^3)
	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	
C3	2.560	3.384	3.930	4.625	5.142	5.653	4652.77
Total	2.560	3.384	3.930	4.625	5.142	5.653	4652.77

Existing, Proposed & Controlled Flow Rate Comparison

Unit Flow Relationships for Humber River Watershed (Sub-Basin 36)	
Return Period	**Unit Flow Equation (Q = L/s/ha)**
2-Year	Q = 9.506 - 0.719*ln(A)
5-Year	Q = 14.652 - 1.136*ln(A)
10-Year	Q = 17.957 - 1.373*ln(A)
25-Year	Q = 22.639 - 1.741*ln(A)
50-Year	Q = 26.566 - 2.082*ln(A)
100-Year	Q = 29.912 - 2.316*ln(A)

NOTE: *Unit flow equations taken from Table E.1 of Appendix A in the TRCA Stormwater Management Criteria (August 2012) based on Sub-Basin 36 (Equation F).*

EXISTING CONDITION (Uncontrolled)						
Catchment Area	**Flow (m^3/s)**					
	2-Year	**5-Year**	**10-Year**	**25-Year**	**50-Year**	**100-Year**
C1	0.592	0.782	0.908	1.069	1.188	1.306
C2	0.740	0.978	1.136	1.337	1.487	1.634
TOTAL	1.332	1.760	2.044	2.406	2.675	2.940

INTERMEDIATE CONDITION - PHASE 1 (Uncontrolled)						
Catchment Area	**Flow (m^3/s)**					
	2-Year	**5-Year**	**10-Year**	**25-Year**	**50-Year**	**100-Year**
C3	2.312	3.055	3.548	4.175	4.642	5.103
TOTAL	2.312	3.055	3.548	4.175	4.642	5.103

ULTIMATE CONDITION - PHASE 2 (Uncontrolled)						
Catchment Area	**Flow (m^3/s)**					
	2-Year	**5-Year**	**10-Year**	**25-Year**	**50-Year**	**100-Year**
C3	2.560	3.384	3.930	4.625	5.142	5.653
TOTAL	2.560	3.384	3.930	4.625	5.142	5.653

INTERMEDIATE & ULTIMATE CONDITION (Controlled - Unit Flow)						
Catchment Area	**Flow (m^3/s)**					
	2-Year	**5-Year**	**10-Year**	**25-Year**	**50-Year**	**100-Year**
C3	0.125	0.191	0.235	0.296	0.346	0.390
TOTAL	0.125	0.191	0.235	0.296	0.346	0.390

NOTES:

(1) Existing and proposed uncontrolled flow rates are calculated using the Rational Method and catchment area parameters.

(2) Proposed controlled flow rates are calculated using the unit flow equations taken from Table E.1 of Appendix A in the TRCA Stormwater Management Criteria (August 2012) based on Sub-Basin 36 (Equation F).

(3) Proposed controlled flow rates are calculated using existing condition catchment areas.

APPENDIX F: WATER QUALITY & EROSION CONTROL CALCULATIONS

APPENDIX F

Storage Requirement for Quality & Erosion Control

ULTIMATE CONDITION (PHASE 2)	
Description	**Drainage Area (ha)**
HARD SURFACE	11.43
GREEN AREA	5.26
TOTAL	16.69
Runoff Coefficient (C)	**0.70**
Percent Imperviousness (%)	**68.5**

As per MECP Stormwater Management Manual Table 3.2, for enhanced 80% long-term TSS removal, storage requirement for wet pond with 55% and 70% impervious level is 190 m^3/ha and 225 m^3/ha, respectively.

For 68.5% imperviousness level, the water quality storage requirement is 222 m^3/ha.

Total Storage Requirement for Quality Control (m^3):	222 m^3/ha x A =	3705
Extended Detention Volume Requirement (m^3):	40 m^3/ha x A =	668
Required Permanent Pool Volume (m^3):	**Quality Control - Extended Detention =**	**3037**
Erosion Control Volume Requirement (25 mm storm) (m^3):	C*A*25 mm =	2921
Flood Control Storage Requirement (m^3):	Control 100-Year Post to TRCA's Allowable Release Rate =	4700
Total Storage Volume above Permanent Pool up to HWL (m^3):	**Erosion Control + Flood Control =**	**7621**
Total Required Storage Volume from Bottom of Pond up to HWL (m^3):	**Permanent Pool + Erosion Control + Flood Control =**	**10658**

APPENDIX G: SWM POND SIZING CALCULATIONS

APPENDIX G

BRAMPTON TPAP- SWM POND CAPACITY CALCULATIONS

Component	Water Height (m)	Elevation (m)	Area (m^2)	Storage (m^3)	
				Total	Active
Bottom of Pond	0.000	207.49	4517.92	0.00	0.00
	0.200	207.69	4810.84	932.88	0.00
	0.400	207.89	5110.05	1925.59	0.00
	0.600	208.09	5415.55	2980.04	0.00
Permanent Water Level (PWL) (3037 m^3 required)	0.611	208.10	5430.98	3039.39	2.39
	0.800	208.29	5727.32	4098.10	1061.10
	1.000	208.49	6045.38	5281.65	2244.65
Extended Detention Level (5958 m^3 required)	1.110	208.60	6222.99	5961.21	2924.21
	1.200	208.69	6369.72	6532.58	3495.58
	1.400	208.89	6700.34	7852.78	4815.78
	1.600	209.09	7037.25	9244.14	6207.14
HWL (10658 m^3 required)	1.794	209.28	7370.06	10663.52	7626.52
	1.800	209.29	7380.44	10708.52	7671.52
	2.000	209.49	7729.92	12247.84	9210.84
HWL + 0.30 m	2.100	209.59	7907.01	13046.18	10009.18

STAGE-STORAGE-DISCHARGE

Pond Level	Stage / Elevation (m)	Storage (m^3)	Active Storage (m^3)	Discharge (m^3/s)
Bottom of Pond	207.49	0.00	0.00	0.000
	207.69	932.88	0.00	0.000
	207.89	1925.59	0.00	0.000
	208.09	2980.04	0.00	0.000
Permanent Water Level (PWL)	208.10	3039.39	0.00	0.000
	208.29	4098.10	1059.00	0.018
	208.49	5281.65	2243.00	0.030
Extended Detention Level	208.60	5961.21	2922.00	0.035
	208.69	6532.58	3494.00	0.107
	208.89	7852.78	4814.00	0.120
	209.09	9244.14	6205.00	0.131
HWL	209.28	10663.52	7625.00	0.141
	209.29	10708.52	7670.00	0.142
	209.49	12247.84	9210.00	0.152
Freeboard	209.59	13046.18	10007.00	0.156

APPENDIX H: WATER BALANCE CONTROL CALCULATIONS

APPENDIX H

Water Balance Control Calculations (5 mm)

Ditch Infiltration					
Location	**(1) Required Infiltration Volume (m^3)**	**(2) Infiltration Area (m^2)**	**(3) Infiltration Rate (mm/hr)**	**(4) Detention Time (hr)**	**Provided Infiltration Volume (m^3)**
Brampton Transit NE Satellite Yard	834.65	1350.00	13.21	48	855.88
TOTAL	**834.65**	**1350.00**	**-**	**-**	**855.88**
			(5) EQUIVALENT DEPTH OF RAINFALL (mm):		**5.13**

NOTES:

(1) Required infiltration volume to achieve water balance control determined by multiplying 5mm across entire site area.

(2) Infiltration area is equal to surface area of ditches.

(3) Infiltration rate calculated based on BH 14-11 SS-4 & SS-5 Particle Size Distributions within report titled "Geotechnical Investigation - Proposed Operations Facility - Site NE2 - 10192 Highway 50, Brampton, Ontario" prepared by Inspec-Sol Engineering Solutions (November 3, 2011).

(4) 48-hour detention time as per Section C.2.3, Appendix C of the TRCA's Stormwater Management Criteria (August 2012).

(5) Equivalent Depth of Rainfall determined by dividing provided infiltration volume by total site area (represents equivalent rainfall depth spread across entire site).

(6) Proposed site plan is conceptual and ditch details will be finalized in detailed design.

Infiltration Rate Calculations

Borehole Data												
Location	Borehole ID #	Borehole Location	Actual Soils Breakdown					Adjusted Soils Breakdown (neglecting gravel)				Soil Texture	Infiltration Rate (mm/hr)
			% Gravel	% Sand	% Silt	% Clay	% Total	% Sand	% Silt	% Clay	% Total		
Brampton Transit	BH 14-11 SS-4	SWM Pond	4	26	46	24	100	27.08	47.92	25.00	100	Loam	13.72
NE Satellite Yard	BH 14-11 SS-5	SWM Pond	6	29	47	18	100	30.85	50.00	19.15	100	Silt Loam	12.70
											AVERAGE INFILTRATION RATE (mm/hr):		13.21

NOTES:

(1) % gravel, sand, silt and clay for BH 14-11 SS-4 & SS-5 taken from Particle Size Distributions within report titled "Geotechnical Investigation - Proposed Operations Facility - Site NE2 - 10192 Highway 50, Brampton, Ontario" prepared by Inspec-Sol Engineering Solutions (November 3, 2011).

(2) Soil texture determined based on soil material percentages and the Soil Texture Triangle schematic (shown below).

(3) Infiltration rate of soils (0-4% slope) taken from ***https://qcode.us/codes/sacramentocounty/view.php?topic=14-14_10-14_10_110***