KPMB Architects
Report Number: 221-05528-00

Westminster United Church (4094 Tomken Road)

Stormwater Management Report

August 10, 2023 Revision 3

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Stormwater Management Report

KPMB Architects
Revision 3

Project No.: 221-05528-00
Date: August 10, 2023

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Revision History

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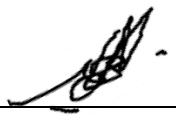

August 10th, 2023

Fatima Elkhier, P.Eng.
Project Engineer, Land Development

Date

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Senior Project Manager, Water Resources

Date

[1] Approval of this document is an administrative function indicating readiness for release and does not impart legal liability on to the Approver for any technical content contained herein. Technical accuracy and fit-for-purpose of this content is obtained through the review process. The Approver shall ensure the applicable review process has occurred prior to signing the document.

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1 INTRODUCTION

1.1 Scope

WSP has been retained by KPMB Architects to prepare a Stormwater Management (SWM) Report to support the rezoning application for the proposed development at Westminster United Church, located at municipal address 4094 Tomken Road, in the City of Mississauga. This SWM report examines the potential water quality, quantity, balance, and erosion impacts of the proposed development and summarizes how each will be addressed in accordance with the City of Mississauga's Development Requirements (2020), and the 2012 Toronto and Region Conservation Authority (TRCA) Stormwater Management Criteria

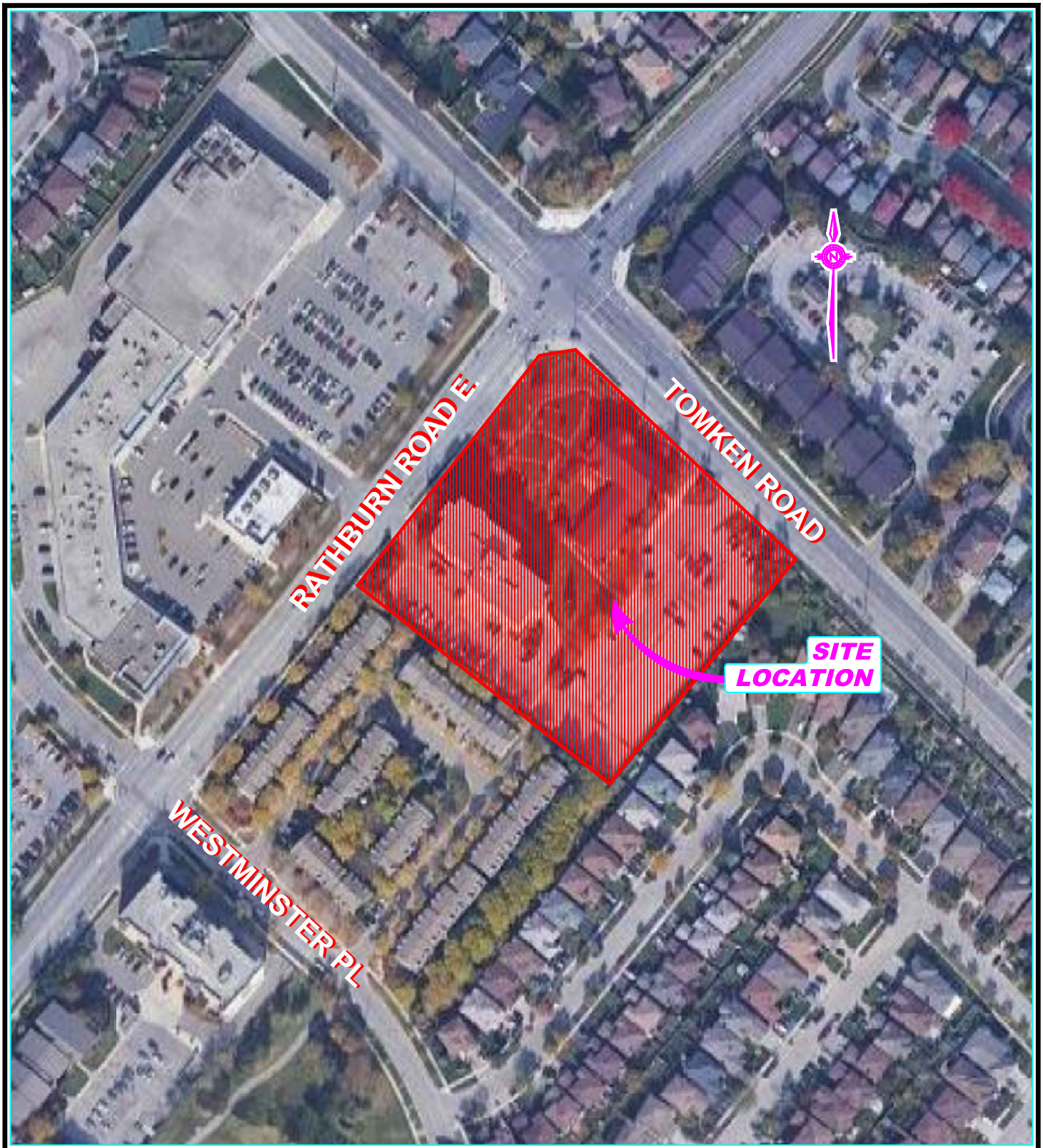
1.2 Site Location

The site occupies an area of approximately 1.43 ha. It is located on the south corner of the intersection of Tomken Road West and Rathburn Road East. The site is located in the Etobicoke Creek Watershed, under the jurisdiction of the Toronto and Region Conservation Authority (TRCA). The location of the proposed re-development is illustrated in **Figure 1.**

1.3 Stormwater Management Plan Objectives

The objectives of the stormwater management plan are as follows:

- Determine the site-specific stormwater management requirements to ensure that the development is in conformance with the City of Mississauga and TRCA SWM criteria.
- Evaluate various stormwater management practices that meet the requirements of the City and the conservation authority and recommend a preferred strategy; and
- Prepare a stormwater management report documenting the strategy along with the technical information necessary for the justification and preliminary sizing of the proposed stormwater management facilities.



CLIENT

KPMB ARCHITECTS

TITLE

WESTMINSTER UNITED CHURCH

4094 TOMKEN ROAD

SITE LOCATION

wsp

Checked A.M.B.	Drawn M.S.L.
Date OCTOBER 2022	Proj. No. 221-05528-00
Scale N.T.S.	Figure No. 1 / Gr.No. 00

1.4 Design Criteria

The City of Mississauga issued a Development Requirements Manual in 2020 to provide direction on the management of rainfall and runoff inside the City's jurisdiction.

A summary of the stormwater management criteria applicable to this project follows:

- **Water Balance** (Stormwater Runoff Volume Reduction): The City of Mississauga's Development Requirements Manual states that the first 5 mm runoff shall be retained on-site and managed by way of infiltration, evapotranspiration, re-use or filtration.
- **Water Quality**: The City of Mississauga Design Requirements specify that at site level, applicants are required to provide a minimum treatment of 80% total suspended solids removal (TSS removal).
- **Erosion Control**: The City of Mississauga has a minimum stormwater runoff volume reduction from developing sites to reduce erosive forces during frequent storms in streams and watercourses. It is required that the first 5 mm of runoff shall be retained on-site and managed by way of infiltration, evapotranspiration, or re-use.
- **Water Quantity Control and Discharge to Municipal Infrastructure:** The City of Mississauga's Development Requirements is to reduce the stormwater peak flow runoff from developing sites. The requirements vary depending on the watershed. This requirement echoes the Conservation Authority's flood control requirements.
    - City's storm sewer system is required to accommodate a 10-year storm (Development Requirements Manual, November 2020, City of Mississauga), all post-development flows up to the 100-year storm from the site to the municipal storm sewer shall not exceed the 10-year pre-development flow at a runoff coefficient of C=0.50 *or* the receiving capacity of the storm sewer, whichever is less.
    - **Little Etobicoke Creek Unit Flow Rates (UFR):** The site is located in the Etobicoke Creek Watershed, under the jurisdiction of the Toronto and Region Conservation Authority (TRCA), thus the allowable flow rate for Little Etobicoke Creek is governed by UFR identified under Section 8 of the City of Mississauga Design Guidelines.

2 PRE-DEVELOPMENT CONDITIONS

2.1 General

The 1.43 ha site is currently occupied by the existing 0.1 ha church building, a 7-storey apartment building, a surface parking area, with the remainder of the site a mixture of soft and hard landscaping.

The area of the existing buildings and adjacent unchanged areas (approximately 0.48 ha) will be excluded from this stormwater management calculations as there will be no changes to their post development drainage conditions. Approximately 0.95 ha will contribute to the drainage area of the new development, which will be taken as the "Project Area" approach for analysis and providing SWM controls. The existing runoff coefficient for the Project Area is estimated at 0.58. The existing condition of the site is shown in **Figure 2.**

2.2 Rainfall Information

The rainfall intensity for the site was calculated using the following equation:

$$I = A/(B + T)^C$$

Where:

I = rainfall intensity in mm/hour

T = time of concentration in hours

A, B, and C = constant parameters (see below)

The parameters (A, B, C) for use in the City of Mississauga are summarized in **Table 2.1.**

Table 2-1: Rainfall Parameters

Return Period (Years)	2	5	10	25	50	100
A	610	820	1010	1160	1300	1450
B	4.60	4.60	4.60	4.60	4.60	4.60
C	0.78	0.78	0.78	0.78	0.78	0.78

Source: City of Mississauga's Development Requirements (2020)

RATHBURN ROAD EAST

LEGEND

- PROPERTY BOUNDARY
- DEVELOPMENT BOUNDARY

102 — SUB-CATCHMENT ID.
1.089 — DRAINAGE AREA (ha)
0.82 — RUNOFF COEFFICIENT (2- YEAR AND 10- YEAR)

CLIENT: KPMB ARCHITECTS

TITLE: WESTMINSTER UNITED CHURCH
(4094 TOMKEN ROAD

EXISTING CONDITIONS

wsp
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Checked	A.M.B.	Drawn	G.M.C. & F.E.
Date	JUL 2023	Proj. No.	221-05528
Scale	1:750	Figure No.	2

FILENAME: C:\Users\CAFE077272\ACCDocs\WSP Canada projects (AMER)\LDO\Files\221-05528 Westminster Mississauga\SWM\FIGURES\FIGURE 2-3.dwg
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2.3 Allowable Flow Rates

The site location is within the Little Etobicoke Creek watershed, a sub-watershed to Etobicoke Creek. In Accordance with the City of Mississauga Design Requirements the stormwater quantity control requirements are governed by watershed controls.

As the City's storm sewer system is required to accommodate a 10-year storm, all post-development flows up to the 100-year storm discharged to the municipal storm sewer shall be the lesser of:

- The 10-year pre-development flow at a runoff coefficient of C=0.50;
- The receiving capacity of the storm sewer, or
- Little Etobicoke Creek UFR, whichever is less.

As no capacity constraints were identified for the storm sewer, the 10-year pre-development flow was determined to be 129.9 L/s, however the UFR for Little Etobicoke Creek are lower and shall define the control rate allowed for discharge. The calculated peak flow rates for the site under pre-development conditions are summarized below in **Table 2.2.** Detailed calculations are contained within **Appendix A.**

Table 2-2: Pre-Development Peak Discharge Rates

Return Period (Years)	Runoff Coefficient, C	Rainfall Intensity (mm/hr)	Existing Uncontrolled Peak Flow Rate, Q (L/s)*	TRCA Etobicoke Creek UFR (L/s)	City Allowable Release Rate, Q_A, (L/s)
2	0.58	59.9	91.3	**29.3**	78.5
5	0.58	80.5	122.7	**42.6**	105.5
10	0.58	99.2	151.1	**52.8**	129.9
25**	0.64	113.9	191.0	**65.3**	
50**	0.69	127.1	232.5	**77.4**	
100**	0.72	140.7	268.0	**87.7**	

*Area of 0.95 ha and time of concentration of 15 minutes

** Adjustment factors applied as per the City's Development Requirement Manual (2020) adjustment factors for 25-, 50-, and 100-year runoff coefficients.

3 POST-DEVELOPMENT CONDITIONS

3.1 General

The proposed development within the 0.95 ha project area consists of two new residential buildings and related at-grade landscaping. The new buildings provide below ground/basement parking, with the parking structure underlying the full footprint of the two new buildings and part of their surrounding areas. There will be two vehicular access to the site, one through Rathburn Road East and the other via Tomken Road. An area breakdown for the new site is provided below in **Table 3.1.** Please refer to **Figure 3** for details of the post-development conditions, land-uses, and stormwater catchment.

The areas of the existing buildings are not altered under proposed conditions; thus, they are excluded from the stormwater management calculations and analysis as there are not changes to drainage conditions related to these areas.

Table 3-1: Proposed Land-Use Area Breakdown

Proposed Land-use	Area (m^2)	%-Coverage	Runoff Coefficient, C*
Impervious Roof Area	715	8%	0.90
Green Roof Area	1,272	13%	0.50
Soft Landscaping	3,296	35%	0.25
Asphalt Vehicular Surfaces	3,095	33%	0.90
At Grade Impervious	1,047	11%	0.90
Total Project Area	**9,425**	**100%**	**0.62**

*2-year through 10-year runoff coefficient

3.2 Water Balance

The 5 mm water balance (stormwater retention) will be implemented for this project area. The development proposes 3,296 m^2 of soft landscaping and 1,272 m^2 of green roof area. A summary of the calculated water balance required for retention is provided in **Table 3.2**, determined to be 24.29 m^3. A reuse volume within the SWM cistern is used for retaining the required water balance within the project area of the site for reuse purposes.

RATHBURN ROAD EAST

TOMKEN ROAD

201
0.942
0.62

LEGEND

- PROPERTY BOUNDARY
- DEVELOPMENT BOUNDARY
- IMPERVIOUS ROOF AREA
- PERVIOUS AREA
- GREEN ROOF
- OVERLAND FLOW ROUTE
- 102 — SUB-CATCHMENT ID.
- 1.089 — DRAINAGE AREA (ha)
- 0.82 — RUNOFF COEFFICIENT (2- YEAR AND 10- YEAR)

CLIENT
KPMB ARCHITECTS

TITLE
WESTMINSTER UNITED CHURCH
(4094 TOMKEN ROAD

PROPOSED CONDITIONS

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Checked	A.M.B.	Drawn	G.M.C. & F.E.
Date	JUL 2023	Proj. No.	221-05528
Scale	1:750	Figure No.	3

FILENAME: C:\Users\caj\c078443\ACCDocs\WSP Canada projects (AMER)\LDO\Files\221-05528 Westminster Mississauga\SWM\FIGURES\FIGURE 2-3.dwg
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Table 3-2: Water Balance

Proposed Land-use	Area (m^2)	IA (m)	5 mm Retention Volume (m^3)	Volume Abstracted (m^3)	Required Water Balance Volume (m^3)
Impervious Roof Area	715	0	3.58	-	3.58
Green Roof Area	1,272	0.005	6.36	6.36	-
Soft Landscaping	3,296	0.005	16.48	16.48	-
At-Grade Vehicular Surfaces	3,095	0	15.48	-	15.48
At Grade Impervious	1,047	0	5.24	-	5.24
Total Project Area	**9,425**	**-**	**47.13**	**22.84**	**24.29**

Options for stormwater reuse proposed include volume for irrigation of soft landscaped area, flushing greywater toilets, and other non-potable reuses. The retention volume within the SWM cistern will provide a volume of 24.5 m^3 for reuse. A pump system is to be designed for pumping water from the sump area of the cistern. Please refer to **Appendix A** for calculations.

3.3 Water Quality Control

The 0.95 ha area proposes approximately 4,142 m^2 of new impervious at-grade which represent 44% of the proposed land use. Soft landscaping areas and runoff originating from new roof areas are considered clean in terms of stormwater quality. City of Mississauga requires 80% TSS removal on an average annual basis from all imperviousness and sediment-generating surfaces. Stormwater runoff is collected from all vehicular and impervious surface areas and is treated by an Imbrium Jellyfish water quality unit to achieve 80% TSS removal. The unit is a JF6-3-1 and in proposed in an offline configuration. Details regarding sizing and treatment flow rate, treatment area for the quality control unit are included in **Appendix B**.

3.4 Erosion Control

The City of Mississauga Design Guidelines states that the first 5 mm of runoff shall be retained and managed on site as a minimum requirement for developing sites to assist in mitigating erosion and water balance. Erosion control during construction is outlined in the Erosion and Sediment Control Plan provided in the WSP Functional Service Report (FSR), issued under separate cover, and will conform to the City of Mississauga's Development Requirements.

3.5 Water Quantity Control

A HydroCAD model for the project was constructed and utilized to determine the required storage volume in the proposed stormwater cistern, and to provide outlet discharge control rates to the required flows under all storm events. The Modified Rational Method (an inherent subroutine of the HydroCAD software) has been used for the modelling exercise. The adjustment factors to runoff coefficient are applied to the 25-year through 100-year storms. The UFR for the Etobicoke Creek (zone 216) are considered in sizing the storage system and as a constraint in the design of the outlet flows.

The cistern is located within the proposed southernmost building. The outlet from the SWM cistern shall discharge to a connection to the Tomken Road municipal storm sewer; Please Refer to Civil Site Servicing Plan Drawing C 102. The cistern provides a storage volume of 337.5 m^3 (150 m^2 x a 2.25 m H). A 24.5 m^3 volume is provided for reuse, yielding a total a cistern volume of 358 m^3. A 150 mm orifice plate, 0.10 m from the internal base of the cistern, controls outflow. The baffle, set at 2.1 m, allows overflow to spill to the main cistern portion should the reuse portion become full, or the reuse mechanism to draw volume fail. An emergency overflow is provided at the top of the cistern, discharging to street level and the adjacent right of way. This will prevent flow backing up into the building pipework if the primary outlet is blocked, or if a storm event in excess of the 100-year return period occurs.

A summary of the modelling results is provided below. Full HydroCAD modelling output is provided in **Appendix C**.

Table 3-3: Summary of Modelling Results

Return Period (Years)	Modelled Peak Cistern Outflow (L/s)	TRCA Etobicoke Creek UFR (L/s)	City Release Rate (L/s)	Utilized Cistern Storage (m^3)	Peak Elevation in Cistern (m)
2	27.6	**29.3**	78.5	78.0	0.53
5	34.3	**42.6**	105.5	106.1	0.71
10	39.6	**52.8**	129.9	132.9	0.87
25	46.3	**65.3**		172.1	1.15
50	52.7	**77.4**		215.0	1.43
100	58.3	**87.7**		257.8	1.72

3.6 Groundwater, Hydrogeology and Groundwater Characterization

A Hydrogeological investigation was conducted in August 2022 by Grounded Engineering Inc. to assess groundwater conditions and quality for the proposed redevelopment of 4094 Tomken Road. According to the hydrogeological report, the finished floor elevation of the two new buildings will extend below the groundwater table level. As the foundation for the development will be designed as watertight (bathtub system), there will be no long-term groundwater discharge to the municipal system. Please refer to the 2023 WSP FSR under section 3.6 for full details.

4 CONCLUSIONS

A stormwater management plan has been prepared in support the rezoning and site plan application for the proposed development at Westminster United Church at municipal address 4094 Tomken Road in the City of Mississauga. The key points are summarized below.

Water Balance and Erosions Control: The 5 mm retention target requires 19.43 m3 of volume to be retained on site. A 24.29 m^3 reuse volume within the SWM cistern will retain the 5 mm runoff from the site to be reused for irrigation and non-potable reuse volume.

Erosion control during construction is outlined in the Erosion and Sediment Control Plan (provided in the FSR under separate cover) and will conform to the City of Mississauga's Development Requirements.

Water Quality Control: An Imbrium Jellyfish filter, model JF6-3-1, installed in an offline configuration, is sized to provide the required 80% TSS removal for the development.

Water Quantity Control

Runoff from all developed areas within the 0.95 ha project area will be directed to a quantity control cistern, fitted with a 150 mm orifice plate at the base of the cistern. The cistern will provide 337.5 m^3 of active control volume to control to the allowable release rate defined by the Little Etobicoke Creek Unit Flow Rates.

BIBLIOGRAPHY

- City of Mississauga, City of Mississauga Development Requirements, section 8 (2020).
- Toronto and Region Conservation Authority, *Stormwater Management Criteria* (2012). Retrieved December 10, 2022

APPENDIX

A SWM Calculations

	Project:	Westmister Mississauga	No.:	221-05528-00
	By:	Fatima Elkhier	Date: 2023-08-10	Page: 1
	Checked:	AMB	Checked:	

Subject: Stormwater Management Calculations - Exisitng Conditions

Calculation of existing runoff rate is undertaken using the Rational Method: **Q = 2.78 CIA**

Where: Q = Peak flow rate (litres/second)
C = Runoff coefficient
I = Rainfall intensity (mm/hour)
A = Catchment area (hectares)

Total Development Area 1.435 hectares
Project Area, A **0.95** hectares

The area measurements and land use types for the site in pre-development are as follows:
External drainage from softlandscape = 0

Land Use	Area (m^2)	Runoff C	Impervious
Impervious Roof Area	0	0.90	100%
Soft/Pervious Landscaping	4620	0.25	0%
Asphalt Vehicular Surfaces	3850	0.90	100%
At Grade Impervious	616	0.90	100%
At Grade Gravel Surface	339	0.80	75%
Total Site Area:	**9425**	0.58	50%

Pre-Dev. Runoff Coefficient, C **0.58**

Rainfall intensity is calculated based on City of Mississauga Intensity-Duration-Frequency (IDF) Equation:

Where: A, B and C = Parameters used by City of Mississauga
I = Rainfall intensity (mm/hour)
T = Time of concentration (hours)

Rainfall intensity calculated in accordance with Municiaplity.

Pre-Development Runoff Rates:

Return Period (Years)	2	5	10	25	50	100
A	610	820	1010	1160	1300	1450
B	4.6	4.6	4.6	4.6	4.7	4.9
C	0.78	0.78	0.78	0.78	0.78	0.78
Runoff Coefficent C*	0.58	0.58	0.58	0.64	0.69	0.72
T (mins) **	15	15	15	15	15	15
T (hrs)	0.250	0.250	0.250	0.250	0.250	0.250
I (mm/hr)	59.9	80.5	99.2	113.9	127.1	140.7
Q (litres/sec)	91.3	122.7	151.1	191.0	232.5	268.0
Q (m3/sec)	0.091	0.123	0.151	0.191	0.233	0.268

* Note that adjustment factors are appiled to the runoff coefficent for larger, less frequent storms for 10 to 100 year events as per 2020 City of Mississauga Development Requirements Manual

** Note recommended minimum value for time of concentration is 15 minutes

	Project:	Westmister Mississauga	No.: 221-05528-00	
	By:	Fatima Elkhier	Date: 2023-08-10	Page:
	Checked:	AMB	Checked:	2

Subject: **Stormwater Management Calculations - Allowable Offsite Discharge Rate**

Calculation of existing runoff rate is undertaken using the Rational Method: **Q = 2.78 CIA**

Where: Q = Peak flow rate (litres/second)
C = Runoff coefficient
I = Rainfall intensity (mm/hour)
A = Catchment area (hectares)

Total Development Area 1.435 hectares
Proposed Area, A **0.95** hectares

The area measurements and land use types for the site in pre-development are as follows:
External drainage from softlandscape = 0

Land Use	Area (m^2)	Runoff C*	Impervious
Impervious Roof Area	0	0.90	100%
Soft/Pervious Landscaping	4620	0.25	0%
Asphalt Vehicular Surfaces	3850	0.90	100%
At Grade Impervious	616	0.90	100%
At Grade Gravel Surface	339	0.80	75%
Total Site Area:	**9425**	**0.58**	50%

*2-year through 10-year

Allowable Runoff Coefficient, C	0.50
Allowable 2-year Flow, Q_A, (L/s)	**78.5**
Allowable 5-year Flow, Q_A, (L/s)	**105.5**
Allowable 10-year Flow, Q_A, (L/s)	**129.9**

Rainfall intensity is calculated based on City of Mississauga Intensity-Duration-Frequency (IDF) Equation:

Where: A, B and C = Parameters used by City of Mississauga
I = Rainfall intensity (mm/hour)
T = Time of concentration (hours)

Rainfall intensity calculated in accordance with Municiaplity.

Uncontrolled Post-Development Runoff Rates:

Return Period (Years)	2	5	10	25	50	100
A	610	820	1010	1160	1300	1450
B	4.6	4.6	4.6	4.6	4.7	4.9
C	0.78	0.78	0.78	0.78	0.78	0.78
Runoff Coefficent C*	0.62	0.62	0.62	0.68	0.74	0.78
T (mins) **	15	15	15	15	15	15
T (hrs)	0.250	0.250	0.250	0.250	0.250	0.250
I (mm/hr)	59.9	80.5	99.2	113.9	127.1	140.7
Q (litres/sec)	98.0	131.7	162.2	204.9	249.5	287.6
Q (m3/sec)	0.0980	0.1317	0.1622	0.2049	0.2495	0.2876

* Note that adjustment factors are appiled to the runoff coefficent for larger, less frequent storms for 10 to 100 year events as per City of Mississauga Development Requirements Manual
** Note recommended minimum value for time of concentration is 15 minutes

Unit Runoff Etobicoke Creek (216)

Land Use	Area (m^2)	2yrs	5 yrs	10 yr	25 yr	50 yr	100yrs
Unit Runoff Rates l/s/ha	9,425	31.10	45.20	56.00	69.30	82.10	93
Total Runoff l/s		**29.3**	**42.6**	**52.8**	**65.3**	**77.4**	**87.7**

Subject: **Stormwater Management Calculations - Water Balance**

The current area measurements and land use types for the site are as follows:

Land Use	Area (m^2)	Runoff C	Impervious	CN
Impervious Roof Area	-	0.90	100%	98
Soft/Pervious Landscaping	4,620	0.25	0%	81
Asphalt Vehicular Surfaces	3,850	0.90	0%	74
At Grade Impervious	616	0.90	100%	98
At Grade Gravel Surface	339	0.80	100%	89
Total Site Area:	9,425	0.58	10%	80

Surface Type	Area (m^2)	IA (m)	Volume Abstracted (m^3)	5 mm Volume (m^3)	Water Balance (m^3)
Impervious Roof Area	715	0.000	0.00	3.58	3.58
Green Roof Area	1,272	0.005	6.36	6.36	0.00
Soft/Pervious Landscaping	3,296	0.005	16.48	16.48	0.00
Asphalt Surfaces/At Grade Impv.	3,095	0.000	0.00	15.48	15.48
At Grade Impervious	1,047	0.000	0.0	5.24	5.24
Total Site Area:	9,425	-	22.84	47.13	24.29

It is assumed that the remaining hard surfaces on the site can abstract 1 mm of rainfall, and that all soft landscaped areas can absorb 5 mm

Therefore, volume of runoff during a 5 mm storm event: 24.29 m^3

APPENDIX

B Water Quality Unit

STANDARD OFFLINE
Jellyfish Filter Sizing Report

Project Information

Date	Monday, October 17, 2022
Project Name	Westminster United Church
Project Number	
Location	Mississauga

Jellyfish Filter Design Overview

This report provides information for the sizing and specification of the Jellyfish Filter. When designed properly in accordance to the guidelines detailed in the Jellyfish Filter Technical Manual, the Jellyfish Filter will exceed the performance and longevity of conventional horizontal bed and granular media filters.

Please see ***www.ImbriumSystems.com*** *for more information.*

Jellyfish Filter System Recommendation

The Jellyfish Filter model JF6-3-1 is recommended to meet the water quality objective by treating a flow of 17.7 L/s, which meets or exceeds 90% of the average annual rainfall runoff volume based on 18 years of TORONTO CENTRAL rainfall data for this site. This model has a sediment capacity of 199 kg, which meets or exceeds the estimated average annual sediment load.

Jellyfish Model	Number of High-Flo Cartridges	Number of Draindown Cartridges	Manhole Diameter (m)	Treatment Flow Rate (L/s)	Sediment Capacity (kg)
JF6-3-1	3	1	1.8	17.7	199

The Jellyfish Filter System

The patented Jellyfish Filter is an engineered stormwater quality treatment technology featuring unique membrane filtration in a compact stand-alone treatment system that removes a high level and wide variety of stormwater pollutants. Exceptional pollutant removal is achieved at high treatment flow rates with minimal head loss and low maintenance costs. Each lightweight Jellyfish Filter cartridge contains an extraordinarily large amount of membrane surface area, resulting in superior flow capacity and pollutant removal capacity.

Maintenance

Regular scheduled inspections and maintenance is necessary to assure proper functioning of the Jellyfish Filter. The maintenance interval is designed to be a minimum of 12 months, but this will vary depending on site loading conditions and upstream pretreatment measures. Quarterly inspections and inspections after all storms beyond the 5-year event are recommended until enough historical performance data has been logged to comfortably initiate an alternative inspection interval.

Please see ***www.ImbriumSystems.com*** *for more information.*

Thank you for the opportunity to present this information to you and your client.

Performance

Jellyfish efficiently captures a high level of Stormwater pollutants, including:

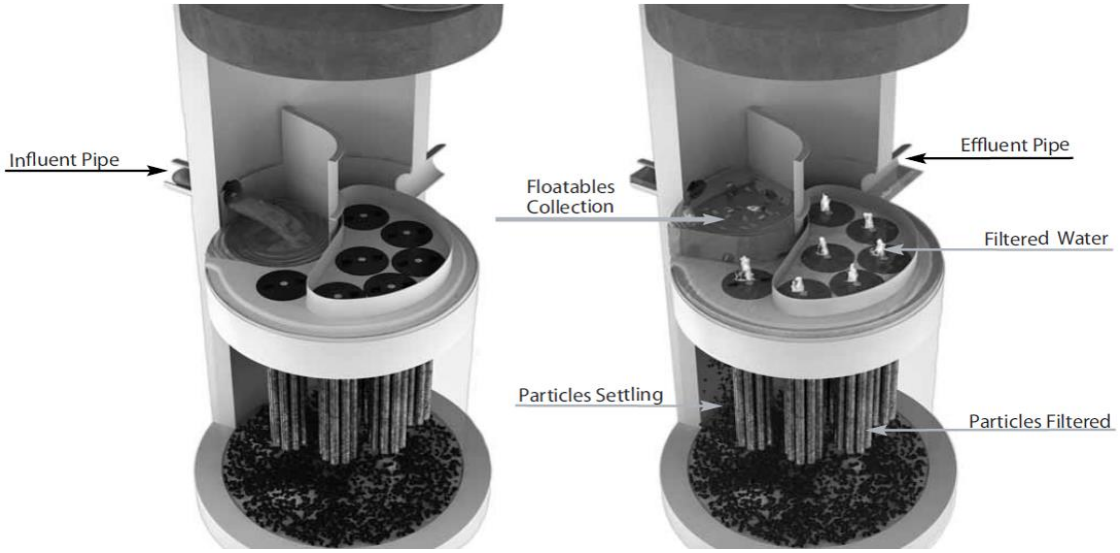
- ☑ 89% of the total suspended solids (TSS) load, including particles less than 5 microns
- ☑ 77% TP removal & 51% TN removal
- ☑ 90% Total Copper, 81% Total Lead, 70% Total Zinc
- ☑ Particulate-bound pollutants such as nutrients, toxic metals, hydrocarbons and bacteria
- ☑ Free oil, Floatable trash and debris

Field Proven Peformance

The Jellyfish filter has been field-tested on an urban site with 25 TARP qualifying rain events and field monitored according to the TARP field test protocol, demonstrating:

- A median TSS removal efficiency of 89%, and a median SSC removal of 99%;
- The ability to capture fine particles as indicated by an effluent d50 median of 3 microns for all monitotred storm events, and a median effluent turbidity of 5 NTUs;
- A median Total Phosphorus removal of 77%, and a median Total Nitrogen removal of 51%.

Jellyfish Filter Treatment Functions



Pre-treatment and Membrane Filtration

Jellyfish® Filter

Project Information

Date:	Monday, October 17, 2022
Project Name:	Westminster United Church
Project Number:	
Location:	Mississauga

Designer Information

Company:	WSP Canada Group Ltd.
Contact:	Fatima Elkhier
Phone #:	(289) 982-4448

Notes

Rainfall

Name:	TORONTO CENTRAL
State:	ON
ID:	100
Record:	1982 to 1999
Co-ords:	45°30'N, 90°30'W

Drainage Area

Total Area:	0.95 ha
Imperviousness:	55%

Upstream Detention

Peak Release Rate:	n/a
Pretreatment Credit:	n/a

Design System Requirements

Flow Loading	90% of the Average Annual Runoff based on 18 years of TORONTO CENTRAL rainfall data:	**15.2 L/s**
Sediment Loading	Treating 90% of the average annual runoff volume, 3143 m³, with a suspended sediment concentration of 60 mg/L.	**189 kg**

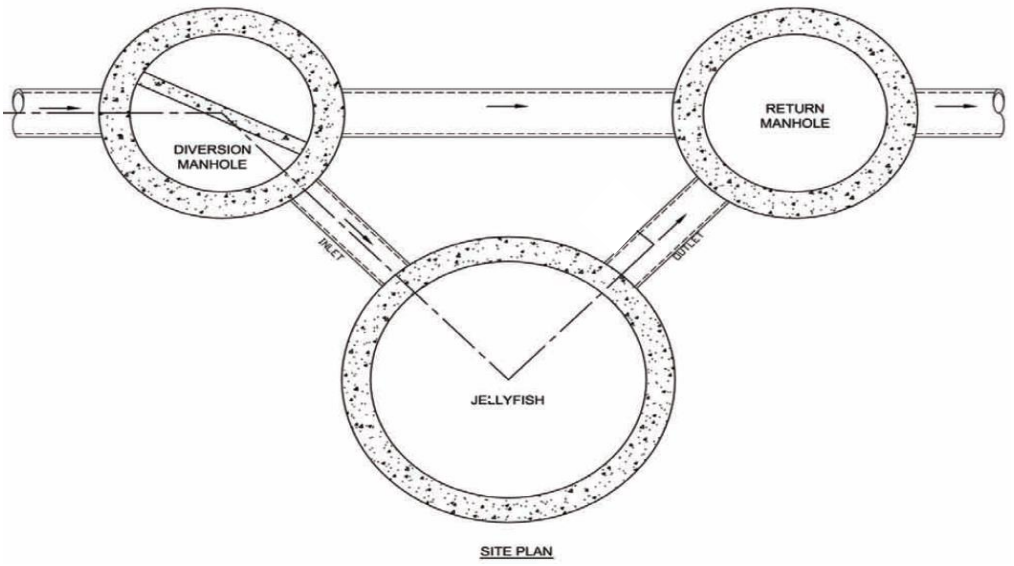
Recommendation

The Jellyfish Filter model JF6-3-1 is recommended to meet the water quality objective by treating a flow of 17.7 L/s, which meets or exceeds 90% of the average annual rainfall runoff volume based on 18 years of TORONTO CENTRAL rainfall data for this site. This model has a sediment capacity of 199 kg, which meets or exceeds the estimated average annual sediment load.

Jellyfish Model	Number of High-Flo Cartridges	Number of Draindown Cartridges	Manhole Diameter (m)	Wet Vol Below Deck (L)	Sump Storage (m³)	Oil Capacity (L)	Treatment Flow Rate (L/s)	Sediment Capacity (kg)
JF4-1-1	1	1	1.2	2313	0.34	379	7.6	85
JF4-2-1	2	1	1.2	2313	0.34	379	12.6	142
JF6-3-1	**3**	**1**	**1.8**	**5205**	**0.79**	**848**	**17.7**	**199**
JF6-4-1	4	1	1.8	5205	0.79	848	22.7	256
JF6-5-1	5	1	1.8	5205	0.79	848	27.8	313
JF6-6-1	6	1	1.8	5205	0.79	848	28.6	370
JF8-6-2	6	2	2.4	9252	1.42	1469	35.3	398
JF8-7-2	7	2	2.4	9252	1.42	1469	40.4	455
JF8-8-2	8	2	2.4	9252	1.42	1469	45.4	512
JF8-9-2	9	2	2.4	9252	1.42	1469	50.5	569
JF8-10-2	10	2	2.4	9252	1.42	1469	50.5	626
JF10-11-3	11	3	3.0	14456	2.21	2302	63.1	711
JF10-12-3	12	3	3.0	14456	2.21	2302	68.2	768
JF10-12-4	12	4	3.0	14456	2.21	2302	70.7	796
JF10-13-4	13	4	3.0	14456	2.21	2302	75.7	853
JF10-14-4	14	4	3.0	14456	2.21	2302	78.9	910
JF10-15-4	15	4	3.0	14456	2.21	2302	78.9	967
JF10-16-4	16	4	3.0	14456	2.21	2302	78.9	1024
JF10-17-4	17	4	3.0	14456	2.21	2302	78.9	1081
JF10-18-4	18	4	3.0	14456	2.21	2302	78.9	1138
JF10-19-4	19	4	3.0	14456	2.21	2302	78.9	1195
JF12-20-5	20	5	3.6	20820	3.2	2771	113.6	1280
JF12-21-5	21	5	3.6	20820	3.2	2771	113.7	1337
JF12-22-5	22	5	3.6	20820	3.2	2771	113.7	1394
JF12-23-5	23	5	3.6	20820	3.2	2771	113.7	1451
JF12-24-5	24	5	3.6	20820	3.2	2771	113.7	1508
JF12-25-5	25	5	3.6	20820	3.2	2771	113.7	1565
JF12-26-5	26	5	3.6	20820	3.2	2771	113.7	1622
JF12-27-5	27	5	3.6	20820	3.2	2771	113.7	1679

Jellyfish Filter Design Notes

- Typically the Jellyfish Filter is designed in an offline configuration, as all stormwater filter systems will perform for a longer duration between required maintenance services when designed and applied in off-line configurations. Depending on the design parameters, an optional internal bypass may be incorporated into the Jellyfish Filter, however note the inspection and maintenance frequency should be expected to increase above that of an off-line system. Speak to your local representative for more information.



Jellyfish Filter Typical Layout

- Typically, 18 inches (457 mm) of driving head is designed into the system, calculated as the difference in elevation between the top of the diversion structure weir and the invert of the Jellyfish Filter outlet pipe. Alternative driving head values can be designed as 12 to 24 inches (305 to 610mm) depending on specific site requirements, requiring additional sizing and design assistance.
- Typically, the Jellyfish Filter is designed with the inlet pipe configured 6 inches (150 mm) above the outlet invert elevation. However, depending on site parameters this can vary to an optional configuration of the inlet pipe entering the unit below the outlet invert elevation.
- The Jellyfish Filter can accommodate multiple inlet pipes within certain restrictions.
- While the optional inlet below deck configuration offers 0 to 360 degree flexibility between the inlet and outlet pipe, typical systems conform to the following:

Model Diameter (m)	Minimum Angle Inlet / Outlet Pipes	Minimum Inlet Pipe Diameter (mm)	Minimum Outlet Pipe Diameter (mm)
1.2	62º	150	200
1.8	**59º**	**200**	**250**
2.4	52º	250	300
3.0	48º	300	450
3.6	40º	300	450

- The Jellyfish Filter can be built at all depths of cover generally associated with conventional stormwater conveyance systems. For sites that require minimal depth of cover for the stormwater infrastructure, the Jellyfish Filter can be applied in a shallow application using a hatch cover. The general minimum depth of cover is 36 inches (915 mm) from top of the underslab to outlet invert.
- If driving head caclulations account for water elevation during submerged conditions the Jellyfish Filter will function effectively under submerged condtions.
- Jellyfish Filter systems may incorporate grated inlets depending on system configuration.
- For sites with water quality treatment flow rates or mass loadings that exceed the design flow rate of the largest standard Jellyfish Filter manhole models, systems can be designed that hydraulically connect multiple Jellyfish Filters in series or alternatively Jellyfish Vault units can be designed.

STANDARD SPECIFICATION
STORMWATER QUALITY – MEMBRANE FILTRATION TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

Specifies requirements for construction and performance of an underground stormwater quality membrane filtration treatment device that removes pollutants from stormwater runoff through the unit operations of sedimentation, floatation, and membrane filtration.

1.2 REFERENCE STANDARDS

ASTM C 891: Specification for Installation of Underground Precast Concrete Utility Structures
ASTM C 478: Specification for Precast Reinforced Concrete Manhole Sections
ASTM C 443: Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM D 4101: Specification for Copolymer steps construction

CAN/CSA-A257.4-M92
Joints for Circular Concrete Sewer and Culvert Pipe, Manhole Sections and Fittings Using Rubber Gaskets

CAN/CSA-A257.4-M92
Precast Reinforced Circular Concrete Manhole Sections, Catch Basins and Fittings

Canadian Highway Bridge Design Code

1.3 SHOP DRAWINGS

Shop drawings for the structure and performance are to be submitted with each order to the contractor. Contractor shall forward shop drawing submittal to the consulting engineer for approval. Shop drawings are to detail the structure's precast concrete and call out or note the fiberglass (FRP) internals/components.

1.4 PRODUCT SUBSTITUTIONS

No product substitutions shall be accepted unless submitted 10 days prior to project bid date, or as directed by the engineer of record. Submissions for substitutions require review and approval by the Engineer of Record, for hydraulic performance, impact to project designs, equivalent treatment performance, and any required project plan and report (hydrology/hydraulic, water quality, stormwater pollution) modifications that would be required by the approving jurisdictions/agencies. Contractor to coordinate with the Engineer of Record any applicable modifications to the project estimates of cost, bonding amount determinations, plan check fees for changes to approved documents, and/or any other regulatory requirements resulting from the product substitution.

1.5 HANDLING AND STORAGE

Prevent damage to materials during storage and handling.

PART 2 – PRODUCTS

2.1 GENERAL

2.1.1 The device shall be a cylindrical or rectangular, all concrete structure (including risers), constructed from precast concrete riser and slab components or monolithic precast structure(s), installed to conform to ASTM C 891 and to any required state highway, municipal or local specifications; whichever is more stringent. The device shall be watertight.

2.1.2 Cartridge Deck The cylindrical concrete device shall include a fiberglass deck. The rectangular concrete device shall include a coated aluminum deck. In either instance, the insert shall be bolted and sealed watertight inside the precast concrete chamber. The deck shall serve as: (a) a horizontal divider between the lower treatment zone and the upper treated effluent zone; (b) a deck for attachment of filter cartridges such that the membrane filter elements of each cartridge extend into the lower treatment zone; (c) a platform for maintenance workers to service the filter cartridges (maximum manned weight = 450 pounds (204 kg)); (d) a conduit for conveyance of treated water to the effluent pipe.

2.1.3 Membrane Filter Cartridges Filter cartridges shall be comprised of reusable cylindrical membrane filter elements connected to a perforated head plate. The number of membrane filter elements per cartridge shall be a minimum of eleven 2.75-inch (70-mm) diameter elements. The length of each filter element shall be a minimum 15 inches (381 mm). Each cartridge shall be fitted into the cartridge deck by insertion into a cartridge receptacle that is permanently mounted into the cartridge deck. Each cartridge shall be secured by a cartridge lid that is threaded onto the receptacle, or similar mechanism to secure the cartridge into the deck. The maximum treatment flow rate of a filter cartridge shall be controlled by an orifice in the cartridge lid, or on the individual cartridge itself, and based on a design flux rate (surface loading rate) determined by the maximum treatment flow rate per unit of filtration membrane surface area. The maximum design flux rate shall be 0.21 gpm/ft² (0.142 lps/m²).

Each membrane filter cartridge shall allow for manual installation and removal. Each filter cartridge shall have filtration membrane surface area and dry installation weight as follows (if length of filter cartridge is between those listed below, the surface area and weight shall be proportionate to the next length shorter and next length longer as shown below):

Filter Cartridge Length (in / mm)	Minimum Filtration Membrane Surface Area (ft2 / m2)	Maximum Filter Cartridge Dry Weight (lbs / kg)
15	106 / 9.8	10.5 / 4.8
27	190 / 17.7	15.0 / 6.8
40	282 / 26.2	20.5 / 9.3
54	381 / 35.4	25.5 / 11.6

2.1.4 Backwashing Cartridges The filter device shall have a weir extending above the cartridge deck, or other mechanism, that encloses the high flow rate filter cartridges when placed in their respective cartridge receptacles within the cartridge deck. The weir, or other mechanism, shall collect a pool of filtered water during inflow events that backwashes the high flow rate cartridges when the inflow

event subsides. All filter cartridges and membranes shall be reusable and allow for the use of filtration membrane rinsing procedures to restore flow capacity and sediment capacity; extending cartridge service life.

2.1.5 Maintenance Access to Captured Pollutants The filter device shall contain an opening(s) that provides maintenance access for removal of accumulated floatable pollutants and sediment, removal of and replacement of filter cartridges, cleaning of the sump, and rinsing of the deck. Access shall have a minimum clear vertical clear space over all of the filter cartridges. Filter cartridges shall be able to be lifted straight vertically out of the receptacles and deck for the entire length of the cartridge.

2.1.6 Bend Structure The device shall be able to be used as a bend structure with minimum angles between inlet and outlet pipes of 90-degrees or less in the stormwater conveyance system.

2.1.7 Double-Wall Containment of Hydrocarbons The cylindrical precast concrete device shall provide double-wall containment for hydrocarbon spill capture by a combined means of an inner wall of fiberglass, to a minimum depth of 12 inches (305 mm) below the cartridge deck, and the precast vessel wall.

2.1.8 Baffle The filter device shall provide a baffle that extends from the underside of the cartridge deck to a minimum length equal to the length of the membrane filter elements. The baffle shall serve to protect the membrane filter elements from contamination by floatables and coarse sediment. The baffle shall be flexible and continuous in cylindrical configurations, and shall be a straight concrete or aluminum wall in rectangular configurations.

2.1.9 Sump The device shall include a minimum 24 inches (610 mm) of sump below the bottom of the cartridges for sediment accumulation, unless otherwise specified by the design engineer. Depths less than 24 inches may have an impact on the total performance and/or longevity between cartridge maintenance/replacement of the device.

2.2 PRECAST CONCRETE SECTIONS

All precast concrete components shall be manufactured to a minimum live load of HS-20 truck loading or greater based on local regulatory specifications, unless otherwise modified or specified by the design engineer, and shall be watertight.

2.3 JOINTS All precast concrete manhole configuration joints shall use nitrile rubber gaskets and shall meet the requirements of ASTM C443, Specification C1619, Class D or engineer approved equal to ensure oil resistance. Mastic sealants or butyl tape are not an acceptable alternative.

2.4 GASKETS Only profile neoprene or nitrile rubber gaskets in accordance to CSA A257.3-M92 will be accepted. Mastic sealants, butyl tape or Conseal CS-101 are not acceptable gasket materials.

2.5 FRAME AND COVER Frame and covers must be manufactured from cast-iron or other composite material tested to withstand H-20 or greater design loads, and as approved by the

local regulatory body. Frames and covers must be embossed with the name of the device manufacturer or the device brand name.

2.6 DOORS AND HATCHES If provided shall meet designated loading requirements or at a minimum for incidental vehicular traffic.

2.7 CONCRETE All concrete components shall be manufactured according to local specifications and shall meet the requirements of ASTM C 478.

2.8 FIBERGLASS The fiberglass portion of the filter device shall be constructed in accordance with the following standard: ASTM D-4097: Contact Molded Glass Fiber Reinforced Chemical Resistant Tanks.

2.9 STEPS Steps shall be constructed according to ASTM D4101 of copolymer polypropylene, and be driven into preformed or pre-drilled holes after the concrete has cured, installed to conform to applicable sections of state, provincial and municipal building codes, highway, municipal or local specifications for the construction of such devices.

2.10 INSPECTION All precast concrete sections shall be inspected to ensure that dimensions, appearance and quality of the product meet local municipal specifications and ASTM C 478.

PART 3 – PERFORMANCE

3.1 GENERAL

3.1.1 Verification – The stormwater quality filter must be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV).

3.1.2 Function - The stormwater quality filter treatment device shall function to remove pollutants by the following unit treatment processes; sedimentation, floatation, and membrane filtration.

3.1.3 Pollutants - The stormwater quality filter treatment device shall remove oil, debris, trash, coarse and fine particulates, particulate-bound pollutants, metals and nutrients from stormwater during runoff events.

3.1.4 Bypass - The stormwater quality filter treatment device shall typically utilize an external bypass to divert excessive flows. Internal bypass systems shall be equipped with a floatables baffle, and must avoid passage through the sump and/or cartridge filtration zone.

3.1.5 Treatment Flux Rate (Surface Loading Rate) – The stormwater quality filter treatment device shall treat 100% of the required water quality treatment flow based on a maximum design treatment flux rate (surface loading rate) across the membrane filter cartridges of 0.21 gpm/ft² (0.142 lps/m²).

3.2 FIELD TEST PERFORMANCE

At a minimum, the stormwater quality filter device shall have been field tested and verified with a minimum 25 TARP qualifying storm events and field monitoring shall have been conducted according to the TARP 2009 NJDEP TARP field test protocol, and have received NJCAT verification.

3.2.1 Suspended Solids Removal - The stormwater quality filter treatment device shall have demonstrated a minimum median TSS removal efficiency of 85% and a minimum median SSC removal efficiency of 95%.

3.2.2 Runoff Volume – The stormwater quality filter treatment device shall be engineered, designed, and sized to treat a minimum of 90 percent of the annual runoff volume determined from use of a minimum 15-year rainfall data set.

3.2.3 Fine Particle Removal - The stormwater quality filter treatment device shall have demonstrated the ability to capture fine particles as indicated by a minimum median removal efficiency of 75% for the particle fraction less than 25 microns, an effluent d_{50} of 15 microns or lower for all monitored storm events.

3.2.4 Turbidity Reduction - The stormwater quality filter treatment device shall have demonstrated the ability to reduce the turbidity from influent from a range of 5 to 171 NTU to an effluent turbidity of 15 NTU or lower.

3.2.5 Nutrient (Total Phosphorus & Total Nitrogen) Removal - The stormwater quality filter treatment device shall have demonstrated a minimum median Total Phosphorus removal of 55%, and a minimum median Total Nitrogen removal of 50%.

3.2.6 Metals (Total Zinc & Total Copper) Removal - The stormwater quality filter treatment device shall have demonstrated a minimum median Total Zinc removal of 55%, and a minimum median Total Copper removal of 85%.

3.3 INSPECTION and MAINTENANCE

The stormwater quality filter device shall have the following features:

3.3.1 Durability of membranes are subject to good handling practices during inspection and maintenance (removal, rinsing, and reinsertion) events, and site specific conditions that may have heavier or lighter loading onto the cartridges, and pollutant variability that may impact the membrane structural integrity. Membrane maintenance and replacement shall be in accordance with manufacturer's recommendations.

3.3.2 Inspection which includes trash and floatables collection, sediment depth determination, and visible determination of backwash pool depth shall be easily conducted from grade (outside the structure).

3.3.3 Manual rinsing of the reusable filter cartridges shall promote restoration of the flow capacity and sediment capacity of the filter cartridges, extending cartridge service life.

3.3.4 The filter device shall have a minimum 12 inches (305 mm) of sediment storage depth, and a minimum of 12 inches between the top of the sediment storage and bottom of the filter cartridge tentacles, unless otherwise specified by the design engineer. Variances may have an impact on the total performance and/or longevity between cartridge maintenance/replacement of the device.

3.3.5 Sediment removal from the filter treatment device shall be able to be conducted using a standard maintenance truck and vacuum apparatus, and a minimum one point of entry to the sump that is unobstructed by filter cartridges.

3.3.6 Maintenance access shall have a minimum clear height that provides suitable vertical clear space over all of the filter cartridges. Filter cartridges shall be able to be lifted straight vertically out of the receptacles and deck for the entire length of the cartridge.

3.3.7 Filter cartridges shall be able to be maintained without the requirement of additional lifting equipment.

PART 4 – EXECUTION

4.1 INSTALLATION

4.1.1 PRECAST DEVICE CONSTRUCTION SEQUENCE

The installation of a watertight precast concrete device should conform to ASTM C 891 and to any state highway, municipal or local specifications for the construction of manholes, whichever is more stringent. Selected sections of a general specification that are applicable are summarized below.

4.1.1.1 The watertight precast concrete device is installed in sections in the following sequence:

- aggregate base
- base slab
- treatment chamber and cartridge deck riser section(s)
- bypass section
- connect inlet and outlet pipes
- concrete riser section(s) and/or transition slab (if required)
- maintenance riser section(s) (if required)
- frame and access cover

4.1.2 The precast base should be placed level at the specified grade. The entire base should be in contact with the underlying compacted granular material. Subsequent sections, complete with joint seals, should be installed in accordance with the precast concrete manufacturer's recommendations.

4.1.3 Adjustment of the stormwater quality treatment device can be performed by lifting the upper sections free of the excavated area, re-leveling the base, and re-installing the sections. Damaged sections and gaskets should be repaired or replaced as necessary to restore original condition and watertight seals. Once the stormwater quality treatment device has been constructed, any/all lift holes must be plugged watertight with mortar or non-shrink grout.

4.1.4 Inlet and Outlet Pipes Inlet and outlet pipes should be securely set into the device using approved pipe seals (flexible boot connections, where applicable) so that the structure is watertight, and such that any pipe intrusion into the device does not impact the device functionality.

4.1.5 Frame and Cover Installation Adjustment units (e.g. grade rings) should be installed to set the frame and cover at the required elevation. The adjustment units should be laid in a full bed of mortar with successive units being joined using sealant recommended by the manufacturer. Frames for the cover should be set in a full bed of mortar at the elevation specified.

4.2 MAINTENANCE ACCESS WALL
In some instances the Maintenance Access Wall, if provided, shall require an extension attachment and sealing to the precast wall and cartridge deck at the job site, rather than at the precast facility. In this instance, installation of these components shall be performed according to instructions provided by the manufacturer.

4.3 FILTER CARTRIDGE INSTALLATION Filter cartridges shall be installed in the cartridge deck only after the construction site is fully stabilized and in accordance with the manufacturer's guidelines and recommendations. Contractor to contact the manufacturer to schedule cartridge delivery and review procedures/requirements to be completed to the device prior to installation of the cartridges and activation of the system.

PART 5 – QUALITY ASSURANCE

5.1 FILTER CARTRIDGE INSTALLATION Manufacturer shall coordinate delivery of filter cartridges and other internal components with contractor. Filter cartridges shall be delivered and installed complete after site is stabilized and unit is ready to accept cartridges. Unit is ready to accept cartridges after is has been cleaned out and any standing water, debris, and other materials have been removed. Contractor shall take appropriate action to protect the filter cartridge receptacles and filter cartridges from damage during construction, and in accordance with the manufacturer's recommendations and guidance. For systems with cartridges installed prior to full site stabilization and prior to system activation, the contractor can plug inlet and outlet pipes to prevent stormwater and other influent from entering the device. Plugs must be removed during the activation process.

5.2 INSPECTION AND MAINTENANCE

5.2.1 The manufacturer shall provide an Owner's Manual upon request.

5.2.2 After construction and installation, and during operation, the device shall be inspected and cleaned as necessary based on the manufacturer's recommended inspection and maintenance guidelines and the local regulatory agency/body.

5.3 REPLACEMENT FILTER CARTRIDGES When replacement membrane filter elements and/or other parts are required, only membrane filter elements and parts approved by the manufacturer for use with the stormwater quality filter device shall be installed.

END OF SECTION

STANDARD PERFORMANCE SPECIFICATION
STORMWATER QUALITY – MEMBRANE FILTRATION TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground stormwater quality membrane filtration treatment device that removes pollutants from stormwater runoff through the unit operations of sedimentation, floatation, and membrane filtration.

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental Management – Environmental Technology Verification (ETV)

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: filtration surface area, treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, filtration treatment device product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 GENERAL

2.1.1 Maintenance Access to Captured Pollutants The filter device shall contain an opening(s) that provides maintenance access for removal of accumulated floatable pollutants and sediment, removal of and replacement of filter cartridges, cleaning of the sump, and rinsing of the internal components. Access shall have a minimum clear vertical clear space over all of the filter cartridges. Filter cartridges shall be able to be lifted straight vertically out of their installed placement for the entire length of the cartridge.

2.1.2 Pollutant Storage: The Filter device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants.

PART 3 – PERFORMANCE

3.1 GENERAL

3.1.1 Verification – The stormwater quality filter treatment device shall have been field tested in accordance with either TARP Tier II Protocol (TARP, 2003) and New Jersey Tier II Stormwater Test Requirements – Amendments to TARP Tier II Protocol (NJDEP, 2009) or Washington State Technology Assessment Protocol – Ecology (TAPE), 2011 or later version. The field test shall have been verified in accordance with ISO 14034:2016 Environmental Management – Environmental Technology Verification (ETV). See Section 3.2 of this specification for field test performance requirements.

3.2 FIELD TEST PERFORMANCE

The field test (as specified in section 3.1.1)shall have monitored a minimum of twenty (20) TARP or TAPE qualifying storm events, and report at **minimum** the following results:

3.2.1 Suspended Solids Removal - The stormwater quality filter treatment device shall have ISO 14034 ETV verified load based median TSS removal efficiency of at least 85% and load based median SSC removal efficiency of at least 98%.

3.2.2 Runoff Volume – The stormwater quality filter treatment device shall be engineered, designed, and sized to treat a minimum of 90 percent of the annual runoff volume determined from use of a minimum 15-year rainfall data set.

3.2.3 Fine Particle Removal - The stormwater quality filter treatment device shall have demonstrated the ability to capture fine particles as indicated by a minimum median removal efficiency of 75% for the particle fraction less than 25 microns, and an effluent d_{50} of 15 microns or lower for all monitored storm events.

3.2.4 Turbidity Reduction - The stormwater quality filter treatment device shall have demonstrated the ability to reduce turbidity such that effluent turbidity is 15 NTU or lower.

3.2.5 Nutrients & Metals – The stormwater quality filter treatment device shall have ISO 14034 ETV Verified minimum load based removal efficiencies for the following:

3.2.5.1 Total Phosphorus (TP) Removal - Median TP removal efficiency of at least 49%.

3.2.5.2 Total Nitrogen (TN) Removal - Median TN removal efficiency of at least 39%.

3.2.5.3 Total Zinc (Zn) Removal - Median Zn removal efficiency of at least 69%.

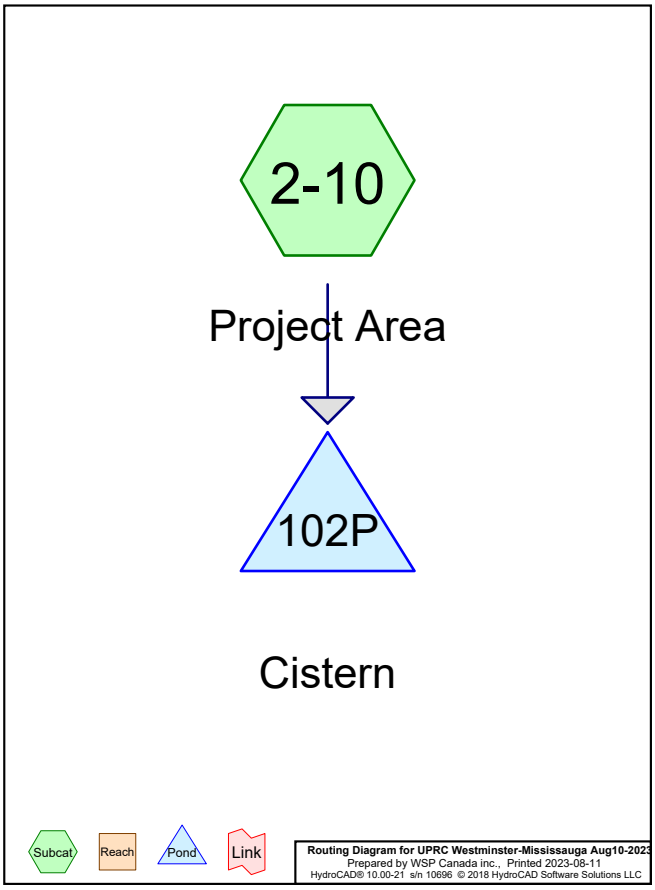
3.2.5.4 Total Copper (Cu) Removal - Median Cu removal efficiency of at least 91%.

END OF SECTION

APPENDIX

C

HydroCAD Output Files



Area Listing (selected nodes)

Area (hectares)	C	Description (subcatchment-numbers)
0.9425	0.62	(2-10)
0.9425	**0.62**	**TOTAL AREA**

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment2-10: Project Area Runoff Area=9,425.0 m² 0.00% Impervious Runoff Depth=13 mm
Tc=15.0 min C=0.62 Runoff=0.0531 m³/s 0.121 Ml

Pond 102P: Cistern Peak Elev=0.520 m Storage=78.0 m³ Inflow=0.0531 m³/s 0.121 Ml
Outflow=0.0276 m³/s 0.106 Ml

Total Runoff Area = 0.9425 ha Runoff Volume = 0.121 Ml Average Runoff Depth = 13 mm
100.00% Pervious = 0.9425 ha 0.00% Impervious = 0.0000 ha

Summary for Subcatchment 2-10: Project Area

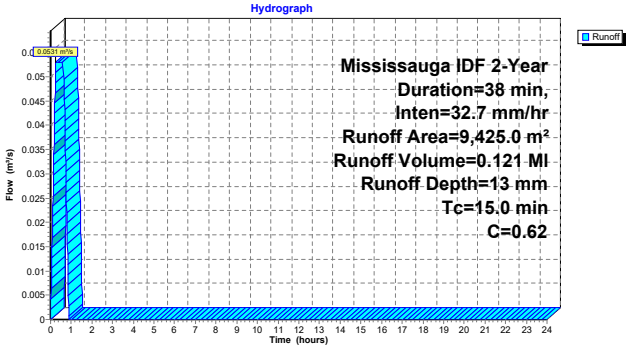
Runoff = 0.0531 m³/s @ 0.25 hrs, Volume= 0.121 Ml, Depth= 13 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Mississauga IDF 2-Year Duration=38 min, Inten=32.7 mm/hr

Area (m²)	C	Description
9,425.0	0.62	
9,425.0		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
15.0					**Direct Entry, Direct Entry**

Subcatchment 2-10: Project Area



Summary for Pond 102P: Cistern

Inflow Area = 0.9425 ha, 0.00% Impervious, Inflow Depth = 13 mm for 2-Year event
Inflow = 0.0531 m³/s @ 0.25 hrs, Volume= 0.121 Ml
Outflow = 0.0276 m³/s @ 0.75 hrs, Volume= 0.106 Ml, Atten= 48%, Lag= 30.2 min
Primary = 0.0276 m³/s @ 0.75 hrs, Volume= 0.106 Ml

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 0.520 m @ 0.75 hrs Surf.Area= 150.0 m² Storage= 78.0 m³

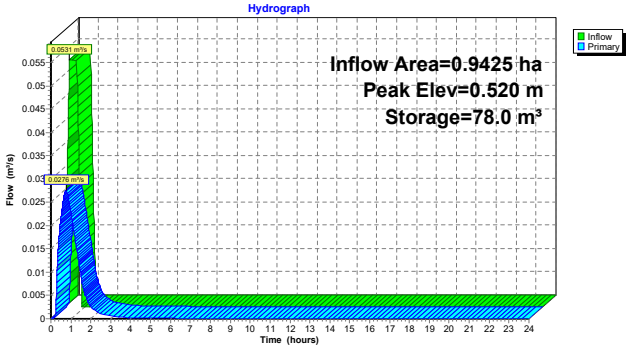
Plug-Flow detention time= 45.8 min calculated for 0.106 Ml (88% of inflow)
Center-of-Mass det. time= 43.2 min (69.7 - 26.5)

Volume	Invert	Avail.Storage	Storage Description
#1	0.000 m	337.5 m³	**150.00 mW x 1.00 mL x 2.25 mH Prismatoid**

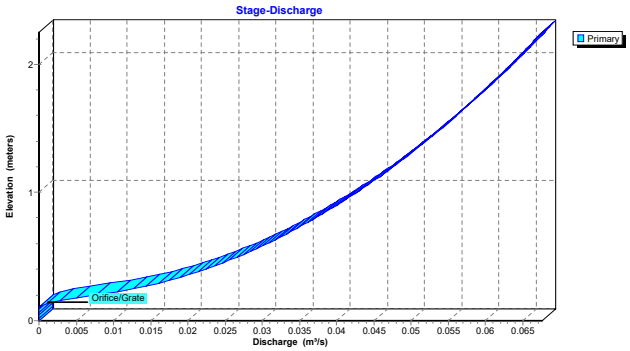
Device	Routing	Invert	Outlet Devices
#1	Primary	0.100 m	**150 mm Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.0276 m³/s @ 0.75 hrs HW=0.520 m (Free Discharge)
1=Orifice/Grate (Orifice Controls 0.0276 m³/s @ 1.56 m/s)

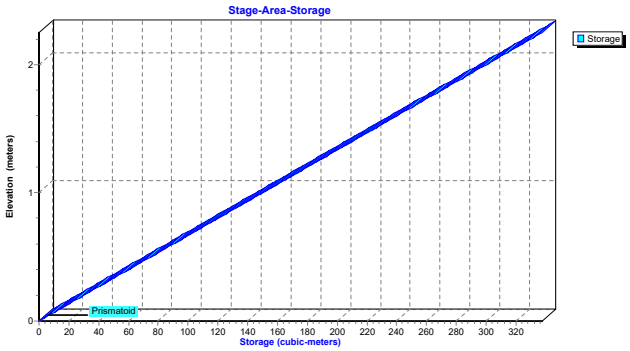
Pond 102P: Cistern



Pond 102P: Cistern



Pond 102P: Cistern



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment2-10: Project Area Runoff Area=9,425.0 m² 0.00% Impervious Runoff Depth=17 mm
Tc=15.0 min C=0.62 Runoff=0.0713 m³/s 0.163 Ml

Pond 102P: Cistern Peak Elev=0.708 m Storage=106.1 m³ Inflow=0.0713 m³/s 0.163 Ml
Outflow=0.0343 m³/s 0.148 Ml

Total Runoff Area = 0.9425 ha Runoff Volume = 0.163 Ml Average Runoff Depth = 17 mm
100.00% Pervious = 0.9425 ha 0.00% Impervious = 0.0000 ha

Summary for Subcatchment 2-10: Project Area

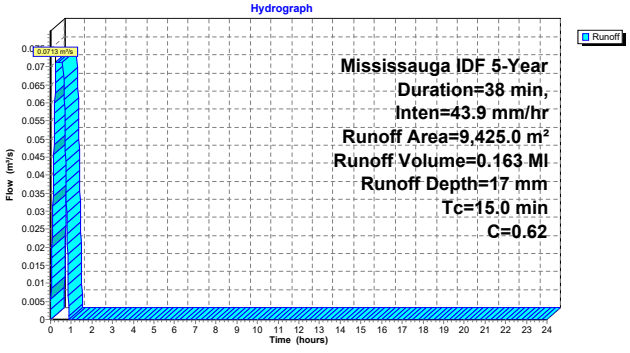
Runoff = 0.0713 m³/s @ 0.25 hrs, Volume= 0.163 Ml, Depth= 17 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Mississauga IDF 5-Year Duration=38 min, Inten=43.9 mm/hr

Area (m²)	C	Description
9,425.0	0.62	
9,425.0		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
15.0					**Direct Entry, Direct Entry**

Subcatchment 2-10: Project Area



Summary for Pond 102P: Cistern

Inflow Area = 0.9425 ha, 0.00% Impervious, Inflow Depth = 17 mm for 5-Year event
Inflow = 0.0713 m³/s @ 0.25 hrs, Volume= 0.163 Ml
Outflow = 0.0343 m³/s @ 0.76 hrs, Volume= 0.148 Ml, Atten= 52%, Lag= 30.8 min
Primary = 0.0343 m³/s @ 0.76 hrs, Volume= 0.148 Ml

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 0.708 m @ 0.76 hrs Surf.Area= 150.0 m² Storage= 106.1 m³

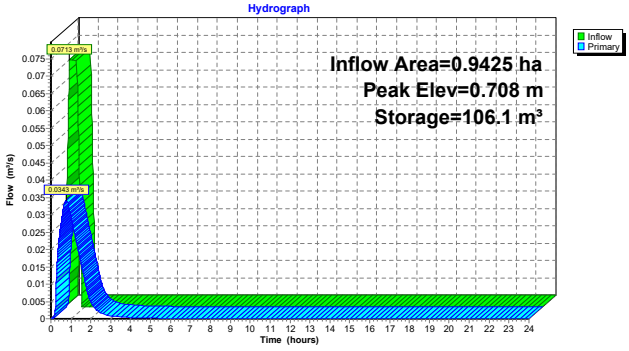
Plug-Flow detention time= 45.9 min calculated for 0.148 Ml (91% of inflow)
Center-of-Mass det. time= 43.9 min (70.4 - 26.5)

Volume	Invert	Avail.Storage	Storage Description
#1	0.000 m	337.5 m³	**150.00 mW x 1.00 mL x 2.25 mH Prismatoid**

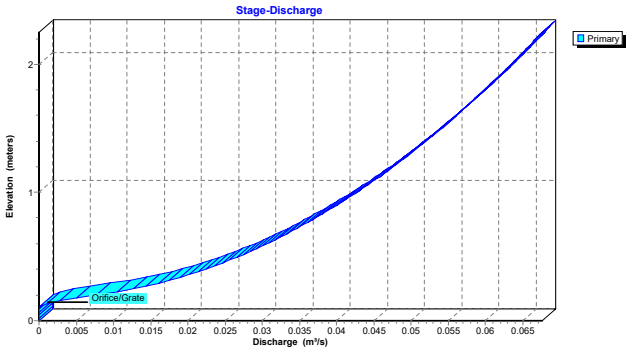
Device	Routing	Invert	Outlet Devices
#1	Primary	0.100 m	**150 mm Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.0343 m³/s @ 0.76 hrs HW=0.707 m (Free Discharge)
1=Orifice/Grate (Orifice Controls 0.0343 m³/s @ 1.94 m/s)

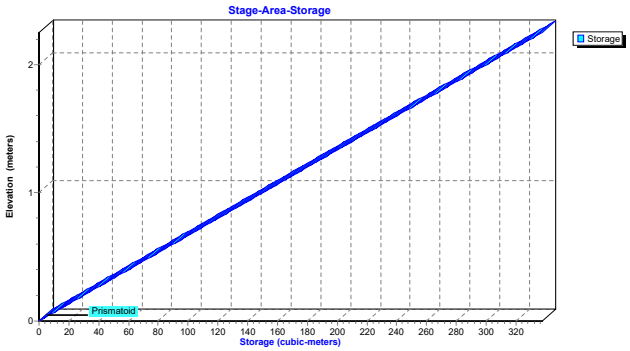
Pond 102P: Cistern



Pond 102P: Cistern



Pond 102P: Cistern



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment2-10: Project Area Runoff Area=9,425.0 m² 0.00% Impervious Runoff Depth=21 mm
Tc=15.0 min C=0.62 Runoff=0.0879 m³/s 0.200 Ml

Pond 102P: Cistern Peak Elev=0.886 m Storage=132.9 m³ Inflow=0.0879 m³/s 0.200 Ml
Outflow=0.0396 m³/s 0.185 Ml

Total Runoff Area = 0.9425 ha Runoff Volume = 0.200 Ml Average Runoff Depth = 21 mm
100.00% Pervious = 0.9425 ha 0.00% Impervious = 0.0000 ha

Summary for Subcatchment 2-10: Project Area

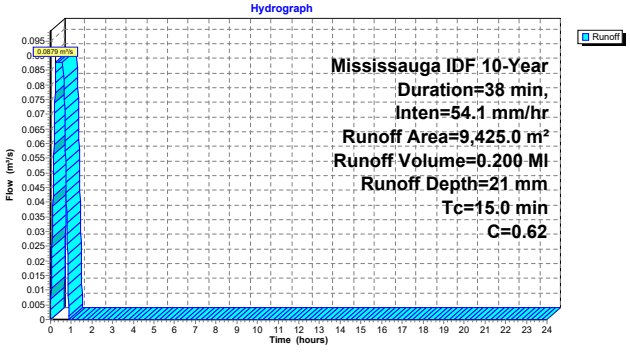
Runoff = 0.0879 m³/s @ 0.25 hrs, Volume= 0.200 Ml, Depth= 21 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Mississauga IDF 10-Year Duration=38 min, Inten=54.1 mm/hr

Area (m²)	C	Description
9,425.0	0.62	
9,425.0		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
15.0					**Direct Entry, Direct Entry**

Subcatchment 2-10: Project Area



Summary for Pond 102P: Cistern

Inflow Area = 0.9425 ha, 0.00% Impervious, Inflow Depth = 21 mm for 10-Year event
Inflow = 0.0879 m³/s @ 0.25 hrs, Volume= 0.200 Ml
Outflow = 0.0396 m³/s @ 0.77 hrs, Volume= 0.185 Ml, Atten= 55%, Lag= 31.2 min
Primary = 0.0396 m³/s @ 0.77 hrs, Volume= 0.185 Ml

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 0.886 m @ 0.77 hrs Surf.Area= 150.0 m² Storage= 132.9 m³

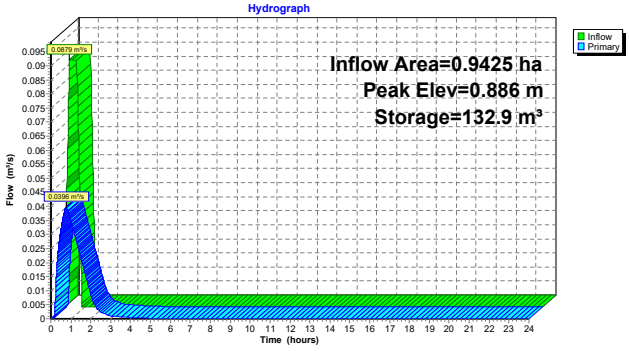
Plug-Flow detention time= 46.8 min calculated for 0.185 Ml (92% of inflow)
Center-of-Mass det. time= 45.5 min (72.0 - 26.5)

Volume	Invert	Avail.Storage	Storage Description
#1	0.000 m	337.5 m³	**150.00 mW x 1.00 mL x 2.25 mH Prismatoid**

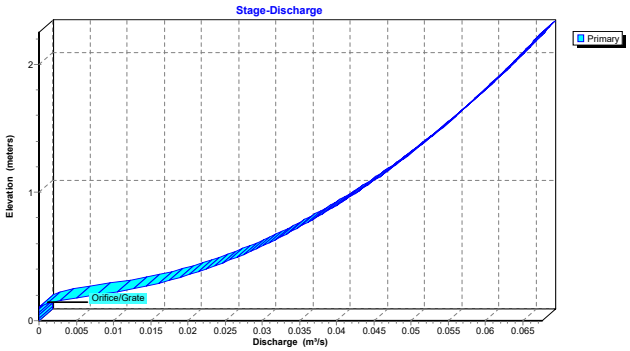
Device	Routing	Invert	Outlet Devices
#1	Primary	0.100 m	**150 mm Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.0396 m³/s @ 0.77 hrs HW=0.886 m (Free Discharge)
1=Orifice/Grate (Orifice Controls 0.0396 m³/s @ 2.24 m/s)

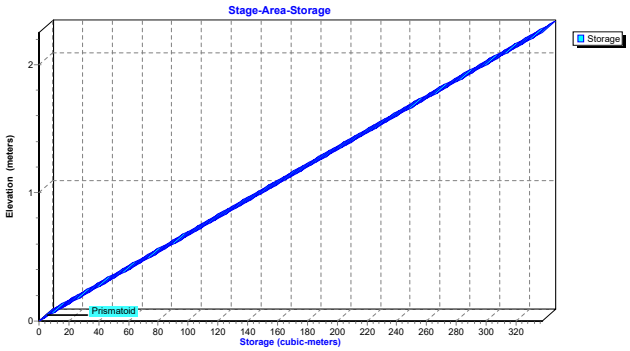
Pond 102P: Cistern

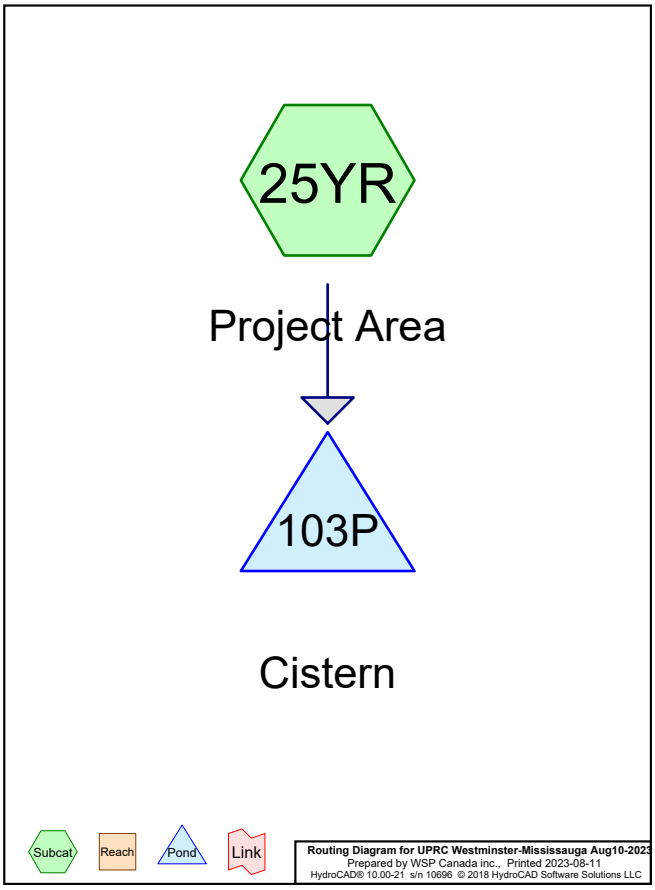


Pond 102P: Cistern



Pond 102P: Cistern





Area Listing (selected nodes)

Area (hectares)	C	Description (subcatchment-numbers)
0.9425	0.68	(25YR)
0.9425	**0.68**	**TOTAL AREA**

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment25YR: Project Area Runoff Area=9,425.0 m² 0.00% Impervious Runoff Depth=28 mm
Tc=15.0 min C=0.68 Runoff=0.0999 m³/s 0.264 Ml

Pond 103P: Cistern Peak Elev=1.147 m Storage=172.1 m³ Inflow=0.0999 m³/s 0.264 Ml
Outflow=0.0463 m³/s 0.249 Ml

Total Runoff Area = 0.9425 ha Runoff Volume = 0.264 Ml Average Runoff Depth = 28 mm
100.00% Pervious = 0.9425 ha 0.00% Impervious = 0.0000 ha

Summary for Subcatchment 25YR: Project Area

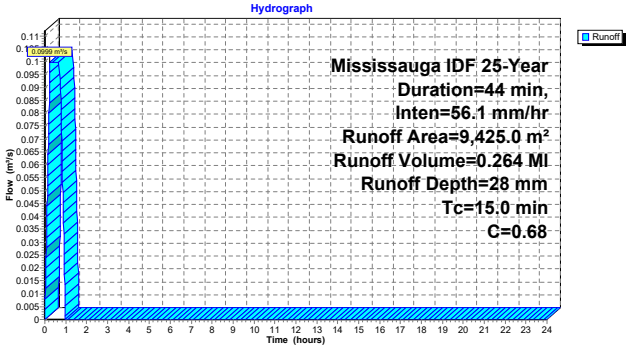
Runoff = 0.0999 m³/s @ 0.25 hrs, Volume= 0.264 Ml, Depth= 28 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Mississauga IDF 25-Year Duration=44 min, Inten=56.1 mm/hr

Area (m²)	C	Description
9,425.0	0.68	
9,425.0		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
15.0					**Direct Entry, Direct Entry**

Subcatchment 25YR: Project Area



Summary for Pond 103P: Cistern

Inflow Area = 0.9425 ha, 0.00% Impervious, Inflow Depth = 28 mm for 25-Year event
Inflow = 0.0999 m³/s @ 0.25 hrs, Volume= 0.264 Ml
Outflow = 0.0463 m³/s @ 0.87 hrs, Volume= 0.249 Ml, Atten= 54%, Lag= 37.0 min
Primary = 0.0463 m³/s @ 0.87 hrs, Volume= 0.249 Ml

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1.147 m @ 0.87 hrs Surf.Area= 150.0 m² Storage= 172.1 m³

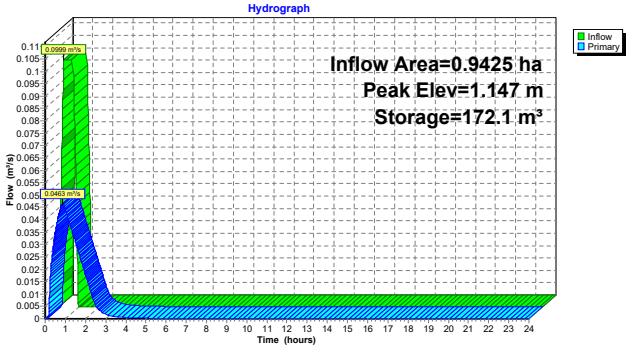
Plug-Flow detention time= 50.1 min calculated for 0.249 Ml (94% of inflow)
Center-of-Mass det. time= 48.6 min (78.1 - 29.5)

Volume	Invert	Avail.Storage	Storage Description
#1	0.000 m	337.5 m³	**1.50 mW x 100.00 mL x 2.25 mH Prismatoid**

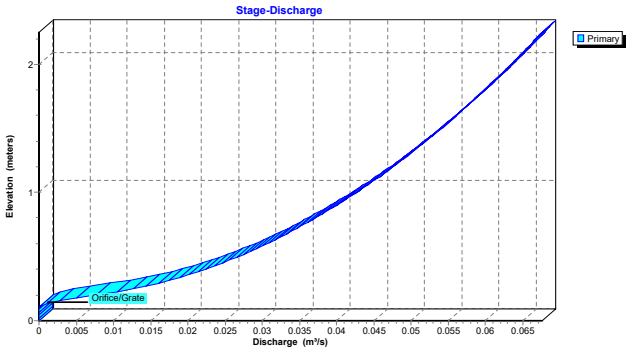
Device	Routing	Invert	Outlet Devices
#1	Primary	0.100 m	**150 mm Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.0463 m³/s @ 0.87 hrs HW=1.147 m (Free Discharge)
└**1=Orifice/Grate** (Orifice Controls 0.0463 m³/s @ 2.62 m/s)

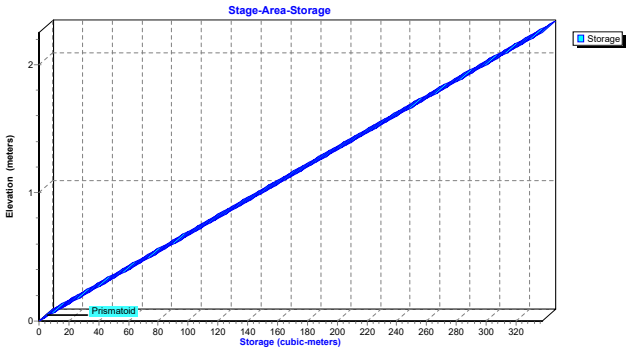
Pond 103P: Cistern

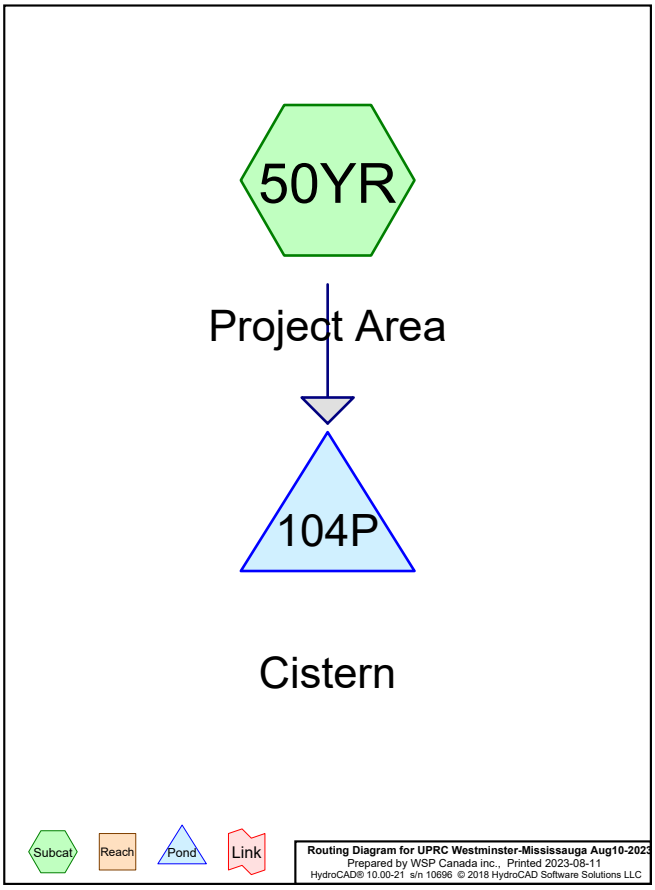


Pond 103P: Cistern



Pond 103P: Cistern





Area Listing (selected nodes)

Area (hectares)	C	Description (subcatchment-numbers)
0.9425	0.74	(50YR)
0.9425	**0.74**	**TOTAL AREA**

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment50YR: Project Area Runoff Area=9,425.0 m² 0.00% Impervious Runoff Depth=35 mm
Tc=15.0 min C=0.74 Runoff=0.1178 m³/s 0.325 Ml

Pond 104P: Cistern Peak Elev=1.433 m Storage=215.0 m³ Inflow=0.1178 m³/s 0.325 Ml
Outflow=0.0527 m³/s 0.310 Ml

Total Runoff Area = 0.9425 ha Runoff Volume = 0.325 Ml Average Runoff Depth = 35 mm
100.00% Pervious = 0.9425 ha 0.00% Impervious = 0.0000 ha

Summary for Subcatchment 50YR: Project Area

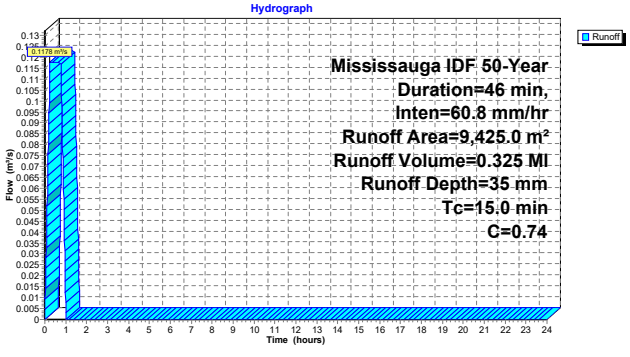
Runoff = 0.1178 m³/s @ 0.25 hrs, Volume= 0.325 Ml, Depth= 35 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Mississauga IDF 50-Year Duration=46 min, Inten=60.8 mm/hr

Area (m²)	C	Description
9,425.0	0.74	
9,425.0		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
15.0					**Direct Entry, Direct Entry**

Subcatchment 50YR: Project Area



Summary for Pond 104P: Cistern

Inflow Area = 0.9425 ha, 0.00% Impervious, Inflow Depth = 35 mm for 50-Year event
Inflow = 0.1178 m³/s @ 0.25 hrs, Volume= 0.325 Ml
Outflow = 0.0527 m³/s @ 0.90 hrs, Volume= 0.310 Ml, Atten= 55%, Lag= 39.3 min
Primary = 0.0527 m³/s @ 0.90 hrs, Volume= 0.310 Ml

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1.433 m @ 0.90 hrs Surf.Area= 150.0 m² Storage= 215.0 m³

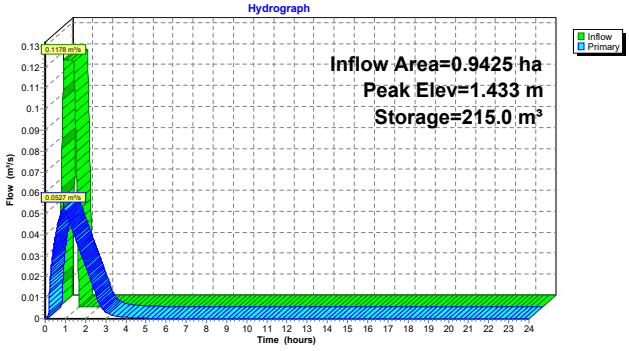
Plug-Flow detention time= 52.9 min calculated for 0.310 Ml (95% of inflow)
Center-of-Mass det. time= 52.0 min (82.5 - 30.5)

Volume	Invert	Avail.Storage	Storage Description
#1	0.000 m	337.5 m³	**150.00 mW x 1.00 mL x 2.25 mH Prismatoid**

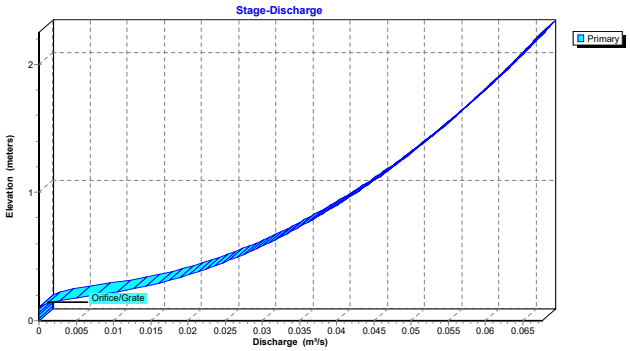
Device	Routing	Invert	Outlet Devices
#1	Primary	0.100 m	**150 mm Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.0527 m³/s @ 0.90 hrs HW=1.433 m (Free Discharge)
1=Orifice/Grate (Orifice Controls 0.0527 m³/s @ 2.98 m/s)

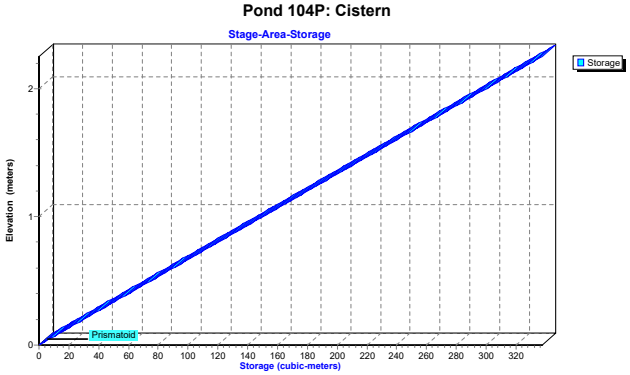
Pond 104P: Cistern

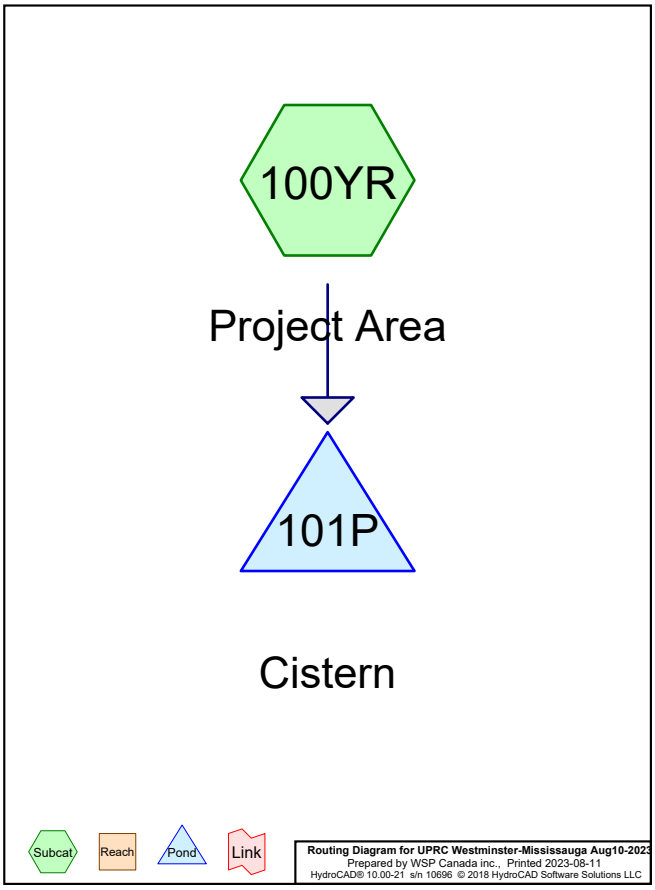


Pond 104P: Cistern



Pond 104P: Cistern





Area Listing (selected nodes)

Area (hectares)	C	Description (subcatchment-numbers)
0.9425	0.78	(100YR)
0.9425	**0.78**	**TOTAL AREA**

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment100YR: Project Area Runoff Area=9,425.0 m² 0.00% Impervious Runoff Depth=41 mm
Tc=15.0 min C=0.78 Runoff=0.1321 m³/s 0.388 Ml

Pond 101P: Cistern Peak Elev=1.719 m Storage=257.8 m³ Inflow=0.1321 m³/s 0.388 Ml
Outflow=0.0583 m³/s 0.373 Ml

Total Runoff Area = 0.9425 ha Runoff Volume = 0.388 Ml Average Runoff Depth = 41 mm
100.00% Pervious = 0.9425 ha 0.00% Impervious = 0.0000 ha

Summary for Subcatchment 100YR: Project Area

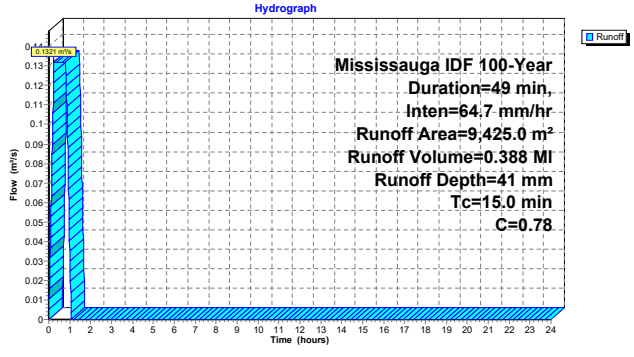
Runoff = 0.1321 m³/s @ 0.25 hrs, Volume= 0.388 Ml, Depth= 41 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Mississauga IDF 100-Year Duration=49 min, Inten=64.7 mm/hr

Area (m²)	C	Description
9,425.0	0.78	
9,425.0		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
15.0					**Direct Entry, Direct Entry**

Subcatchment 100YR: Project Area



Summary for Pond 101P: Cistern

Inflow Area = 0.9425 ha, 0.00% Impervious, Inflow Depth = 41 mm for 100-Year event
Inflow = 0.1321 m³/s @ 0.25 hrs, Volume= 0.388 Ml
Outflow = 0.0583 m³/s @ 0.96 hrs, Volume= 0.373 Ml, Atten= 56%, Lag= 42.4 min
Primary = 0.0583 m³/s @ 0.96 hrs, Volume= 0.373 Ml

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1.719 m @ 0.96 hrs Surf.Area= 150.0 m² Storage= 257.8 m³

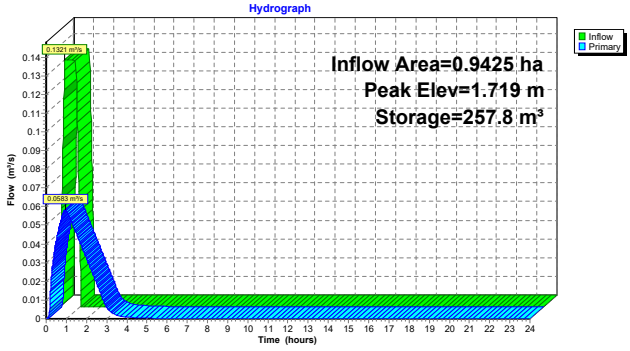
Plug-Flow detention time= 56.6 min calculated for 0.373 Ml (96% of inflow)
Center-of-Mass det. time= 55.4 min (87.4 - 32.0)

Volume	Invert	Avail.Storage	Storage Description
#1	0.000 m	337.5 m³	**150.00 mW x 1.00 mL x 2.25 mH Prismatoid**

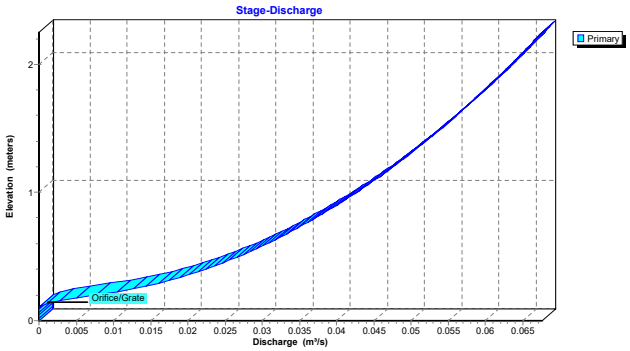
Device	Routing	Invert	Outlet Devices
#1	Primary	0.100 m	**150 mm Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.0583 m³/s @ 0.96 hrs HW=1.718 m (Free Discharge)
1=Orifice/Grate (Orifice Controls 0.0583 m³/s @ 3.30 m/s)

Pond 101P: Cistern



Pond 101P: Cistern



Pond 101P: Cistern