Stormwater Management Report & Servicing Brief

Cadillac Dealership

Mapleview Drive & Reid Drive

City of Barrie

Pearson Engineering Ltd.

Pearsoneng.com

May 2019

18009

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Stormwater Management Report & Servicing Brief
Cadillac Dealership, Barrie

1. Introduction

PEARSON Engineering Ltd. (PEARSON) has been retained by Paul Sadlon Motors (Client) to prepare a Stormwater Management Report & Servicing Brief for the proposed Cadillac Dealership (Project) located at the southeast corner of Mapleview Drive and Reid Drive within the Mapleview Industrial Developments Inc. Industrial subdivision in the City of Barrie (City). The subject lands can be seen on Figure 1.

The subject site includes the development of the 1.25 hectare property including the construction of a one storey car dealership building with a servicing bay and a covered car display area. Asphalt parking areas will be constructed around the proposed building.

1.1. Terms of Reference

The intent of this SWM Brief is to:

- Identify the existing site characteristics including any external drainage conditions;
- Illustrate the design of the stormwater conveyance, capable of accommodating both minor and major storm flows from the site;
- Incorporate the appropriate Best Management Practices for controlling on-site erosion and sedimentation during construction while ultimately ensuring that the post-development release of stormwater is of adequate quality;
- Assess the existing municipal infrastructure in the vicinity of the project and the internal services required to service the proposed Project; and
- Summarize this design in a technically comprehensive and concise manner.

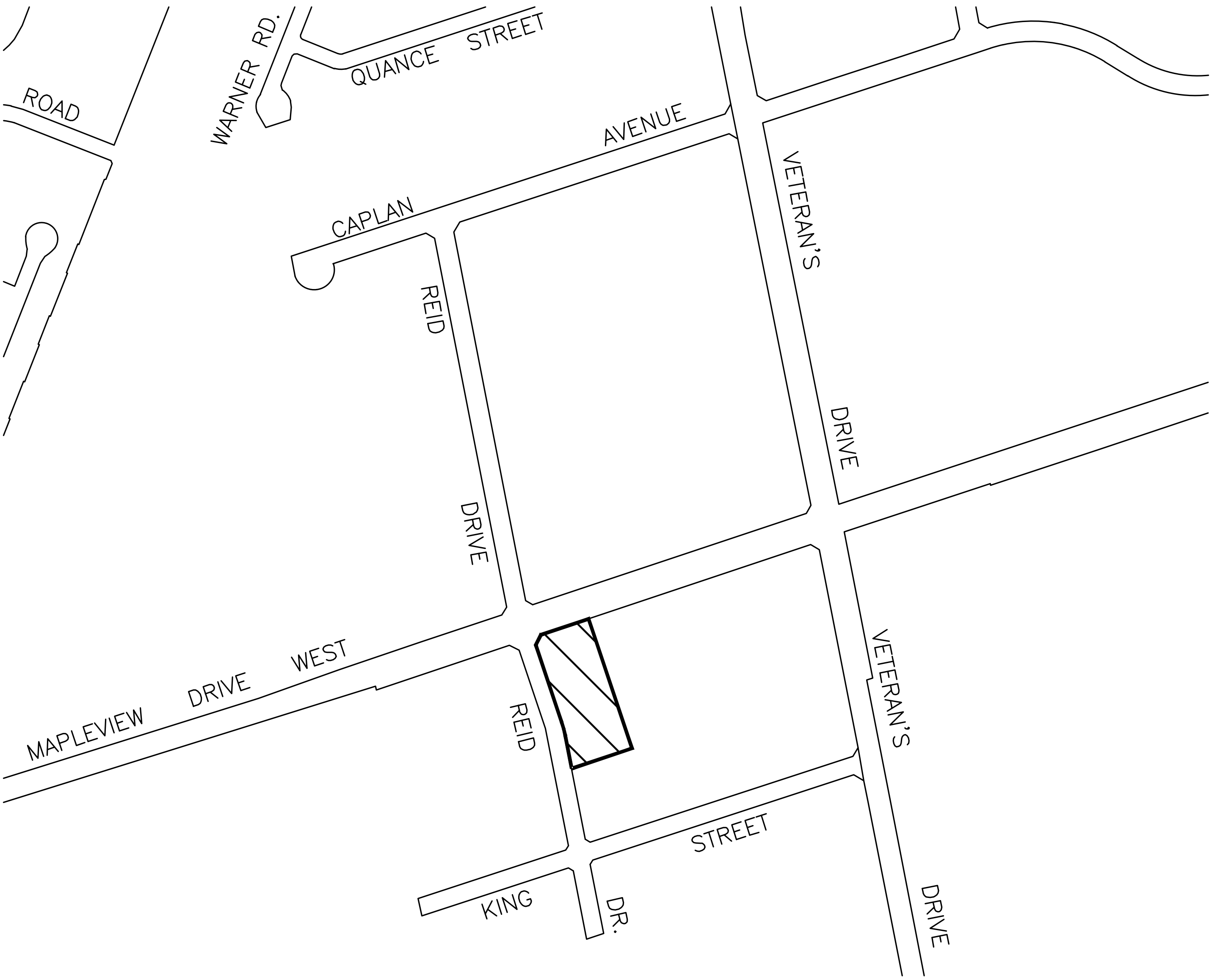
2. Water Supply and Distribution

2.1. Water Servicing Design Criteria

The proposed commercial development has a total area of 1.25 hectares. Utilizing the City of Barrie minimum flow value for commercial use of 28,000 L/ha/day, an Average Daily Flow (ADF) of 0.40 L/s was calculated. Using a Commercial Peaking Factor of 2.0 for this project, a peak flow of 0.81 L/sec was calculated. Calculations for the domestic water requirements for the site can be found in Appendix A.

2.2. Water Distribution System

To service the project, a 50 mm diameter domestic water service and 150 mm diameter fire service will be extended into the project to the proposed building's mechanical room located in the southeast corner of the building. The internal water distribution will connect into the existing 200 mm diameter municipal watermain on the west side of Reid Drive. Refer to drawing SS-1 for the water servicing layout.



CADILLAC DEALERSHIP
MAPLEVIEW DRIVE AND REID DRIVE
BARRIE, ONTARIO

SITE LOCATION PLAN

PEARSON ENGINEERING LTD.
PEARSONENG.COM PH. 705.719.4785

DESIGNED BY	ZZ	HORIZ SCALE	NTS	PROJECT #	18009
DRAWN BY	ZZ	VERT SCALE	NTS	DRAWING #	FIG-1
CHECKED BY	MWD	DATE	OCTOBER 2018	REVISION #	0

3. Sanitary Servicing

3.1. Sanitary Design Criteria

The proposed commercial development has a total area of 1.25 hectares. Utilizing the City of Barrie minimum flow value for commercial use of 28,000 L/ha/day, an Average Daily Flow (ADF) of 0.40 L/s was calculated. Using a Commercial Peaking Factor of 2.0 and an infiltration allowance of 0.10 L/s/ha for this project, a peak flow of 0.93 L/sec was calculated. The proposed 200 mm diameter sanitary sewer has a capacity of 57 L/sec at 3.0% and is sufficient to convey the sanitary design flows. Sanitary design flow calculations can be found in Appendix B.

3.2. Sanitary Sewer System

A sanitary service will be constructed to the southwest corner of the building which will drain to the southwest by gravity to Reid Drive. The proposed 200 mm diameter sanitary sewer from the site will connect into the existing sanitary manhole on Reid Drive. The proposed sanitary sewer system for the site can be seen on drawing SS-1.

4. Stormwater Management

A key component of the Development is the need to address environmental and related Stormwater Management issues. These are examined in a framework aimed at meeting the City of Barrie and MOE requirements. SWM parameters have evolved from an understanding of the location and sensitivity of the site's natural systems. This Report focuses on the necessary measures to satisfy the approval agency's SWM requirements.

The objectives of the SWM plan are to:

- Protect life and property from flooding and erosion;
- Maintain existing storm drainage and runoff patterns;
- Maintain water quality for ecological integrity, recreational opportunities etc.;
- Protect aquatic and fisheries habitats.
- Incorporate Low Impact Development (LID) practices to promote infiltration and reduce phosphorus levels to downstream watercourses.

4.1. Analysis Methodology

The design of the SWM Facilities for this site has been conducted in accordance with:

- The Ministry of the Environment Stormwater Management Planning and Design Manual, March 2003
- City of Barrie Storm Drainage and Stormwater Management Policies and Design Guidelines, November 2009

In order to design the facilities to meet these requirements, it is essential to select the appropriate modeling methodology for the storm system design. Given the size of the site, the Modified Rational Method is appropriate for the design for the SWM system.

4.2. Existing Drainage Conditions

The project site is approximately 1.25 hectares in size, and is currently vacant pasture land. The majority of the site drains via overland sheet flow from south to north, outletting into an existing storm sewer system which drains to a downstream SWM Pond known as the expanded Mapleview Industrial Park Ltd. (MIPL) Phase 1 & Mapleview Industrial Development Inc. (MIDI) Phase 1 & 2 stormwater management pond. The existing SWM Pond was designed by Richardson Foster Ltd. for the Mapleview Industrial Developments Inc. Industrial Subdivision allowing the project site to have a runoff coefficient of 0.75. An 855 x 1345 mm concrete storm pipe slopes west at 0.2% along the northern boundary of the project site and then slopes south at 0.4% along the western boundary and has been designed to convey the 100 year flow to the downstream SWM pond.

Given the size of the site, the Modified Rational Method will be used to determine the SWM release rates. Allowable peak flows for the site were calculated using a runoff coefficient of 0.75 for the site area and can be seen in Table 1 below. Detailed calculations for the existing drainage conditions can be found in Appendix A.

Table 1: Allowable Peak Flows

	2 Year Storm	5 Year Storm	10 Year Storm	25 Year Storm	50 Year Storm	100 Year Storm
Total Flow (m^3/s)	0.22	0.28	0.33	0.42	0.51	0.59

4.3. Proposed Drainage Conditions

Post development drainage patterns for the site will generally follow pre-development. The proposed development includes construction of a car dealership building surrounded by a curbed asphalt parking area. The Development's parking lot has been graded to capture the majority of the site's stormwater and direct it towards a proposed internal storm sewer system. The grassed area along the northern perimeter of the site and a small portion of the driveway will drain uncontrolled via overland sheet flow towards Mapleview Drive. A portion of the grassed area and driveways on the west side of the site will flow uncontrolled via overland sheet flow towards Reid Drive. Catchbasins located within the site are connected to a proposed storm sewer system which is designed using the Rational Method to convey the 100-year storm event peak flows. The catchbasins have been sized to have an inlet capacity sufficient to convey the 100-year flow as per the calculations attached in Appendix A. The proposed storm sewer system will be connected to the existing 855 mm x 1345 mm storm sewer which runs through the site and conveys storm runoff to the existing downstream SWM Pond.

In the event of a major storm, defined as storms larger than the 100-year event, the storm sewer will surcharge, forcing stormwater to the site's surface. All major storm flow will be contained within the curbed parking lot and conveyed through one of three overflow locations. Flows from areas north, south, and west of the building will overflow through the emergency overflow routes located within the proposed driveways entrances towards Reid Drive. Flows east of the building will utilize the emergency overflow through the driveway entrance to Mapleview Drive.

The proposed drainage patterns can be seen on the Post Development Storm Catchment Plan DWG STM-1 under Appendix E.

4.4. Stormwater Quantity Control

The downstream stormwater management pond has been designed for the Mapleview Industrial Developments Inc. Industrial Subdivision assuming the Project Site would have a runoff coefficient of 0.75. The calculated post-development runoff coefficient of 0.82 is greater than the allowable runoff coefficient, and so considerations were taken to reduce post development peak flows to allowable values.

Quantity control for the site will be achieved through the use of an orifice tube and underground storage chambers and surface ponding. A 200 mm orifice tube is proposed downstream of CBMH2 to reduce post development peak flows below the allowable flow rate for the site. A total maximum storage volume of 71m^3 is required for the 100-year storm event. Underground storage units will provide 20m^3 of storage with the remaining volume requirements will be provided in surface ponding in the rear parking lot. The underground storage will be provided by 54 Brentwood ST-36 underground storage units located in the southern parking area. The controlled post development peak flows are shown in Table 2 to be equal to or less than the allowable release rate. Detailed calculations can be seen in Appendix A.

Table 2: Post Development Peak Flows

	2 Year Storm	5 Year Storm	10 Year Storm	25 Year Storm	50 Year Storm	100 Year Storm
Controlled Area (Area 2) (m^3/s)	0.09	0.11	0.14	0.17	0.17	0.17
Uncontrolled Area (Areas 1,3-6) (m^3/s)	0.13	0.17	0.19	0.23	0.25	0.28
Total Site (m^3/s)	**0.22**	**0.28**	**0.33**	**0.40**	**0.42**	**0.45**

4.5. Stormwater Quality Control

The Ministry of the Environment (MOE) in March 2003 issued a “Stormwater Management Planning and Design Manual”. This manual has been adopted by a variety of agencies including the City of Barrie. The objective of our Stormwater Quality Control will be to ensure Enhanced Protection quality control as stated in the MOE manual. To achieve enhanced protection, permanent and temporary control of erosion and sediment transport are proposed and are discussed in the following sections.

4.5.1. Permanent Quality Control

The developments active parking facilities pose a risk to stormwater quality through the collection of grit, salt, sand and oils on the paved surfaces. The existing downstream SWM Pond designed by Richardson Foster Ltd. for the Mapleview Industrial Developments Inc. Industrial Subdivision has been sized to provide quality/erosion control for the project site area assuming a runoff coefficient of 0.75. The site has a runoff coefficient of 0.82, therefore the site requires additional quality control measures to make up the difference in the quality control that is not provided by the downstream wet pond in order to have sufficient water quality storage as per Table 3.2 in the MOECC "Stormwater Management Planning and Design Manual", March 2003. The volume required to meet the requirements for the wet pond design is only an additional 2.4 m^3. As per "The Detailed Stormwater Management Report – Mapleview Industrial Park Ltd – Phase 1" By Richardson Foster Ltd. March 2006, the downstream stormwater pond has been designed with permanent pool and extended detention volumes (16,143 m^3 and 9,150 m^3 respectfully) which are significantly greater than the required volumes (7,196 m^3 and 4,876 m^3 respectfully), to meet quality control requirements set by the MOECC. As such, no onsite quality control measures will be implemented as the increase from the site is nominal and can easily be accommodated within the downstream wet pond.

4.5.2. Quality Control during Construction

During construction, earth grading and excavation will create the potential for soil erosion and sedimentation. It is imperative that effective environmental and sedimentation controls are in place and maintained throughout the duration of construction activities to ensure the stormwater runoff's quality.

Therefore, the following recommendations shall be implemented and maintained during construction to achieve acceptable stormwater runoff quality:

- Installation of silt fence along the entire perimeter of the site to reduce sediment migration onto surrounding properties.
- Installation of a construction entrance mat to minimize transportation of sediment onto roadways.
- Restoration of exposed surfaces with vegetative and non-vegetative material as soon as construction schedules permit. The duration in which surfaces are disturbed/exposed shall not exceed 30 days.
- Reduce stormwater drainage velocities where possible.
- Minimize the amount of existing vegetation removed.

5. Phosphorus Budget

Local conservation authorities have determined the importance of reducing phosphorus levels in water courses in this area. The reduction was based on conservative values derived from the Lake Simcoe Region Conservation Authority (LSRCA). Best efforts are to be employed in order to reduce phosphorus levels to pre-development levels or better.

The existing site generates approximately 0.09 kg of phosphorous annually and the proposed Project will generate approximately 2.27 kg of phosphorous annually without treatment. The site will produce more phosphorus than can be reduced using various quality control measures. As such, best efforts will be used in order to reduce the phosphorus loading as much as is reasonably possible.

To minimize the amount of phosphorous being discharged from the site, rooftop runoff from the proposed building will be infiltrated. The remainder of the stormwater runoff will be treated within the downstream SWM pond. According to the NVCA Phosphorus Loading Development Tool, the typical phosphorus reduction is 100% for all runoff that is infiltrated. The proposed underground infiltration tanks will treat rain water collected from the rooftop. Additionally, the downstream SWM pond has a typical phosphorous reduction of 63%.

The following chart details the anticipated phosphorous loadings for the pre and post-development conditions.

Table 3.1: Phosphorus Loadings

	Total P (kg)
Pre-Development	0.09
Uncontrolled Post Development	2.27
Controlled Post Development	0.70

Detailed calculations can be found in Appendix B.

6. Water Balance

Since the post development state will increase the imperviousness of the site, considerations were taken in regards to groundwater recharge. Calculations were completed utilizing pre-development to post development volume requirements as well as the City of Barrie minimum infiltration volume requirements of 5 mm over the total area of the site. The City of Barrie values govern the infiltration requirements and thus 62 m^3 of storage is required. Stormwater runoff from the rooftop of the building will be directed into underground infiltration tanks located on the west side of the proposed building. An emergency overflow stormwater pipe will be installed at the top of the infiltration tanks and will connect into CBMH1 to prevent the back up of storm flows towards the building in the event of a major storm. Detailed calculations can be found in Appendix C.

7. Maintenance

7.1. Brentwood Chamber

The Brentwood Chambers are proposed to provide 62.0 m^3 of underground infiltration volume as well as 20 m^3 of underground quantity control storage. The chambers should be inspected every 6 months and after each major rainfall event during the first year to ensure that the storm tanks are free of any debris. In subsequent years, the chambers should be inspected semi-annually, or more if deemed necessary for this specific site.

If the average depth of sediment exceeds 3 inches throughout the length of the chamber, a cleanout should be performed. Maintenance should be executed using a vacuum pump truck to evacuate sediment and debris from system. The system should be flushed with clean water, with care taken to avoid extreme direct water pressures and is to be performed in dry weather. Material removed from the unit will be disposed of in a similar manner to that of other stormwater management facilities.

The owner should keep a Record of Maintenance Book to log inspection results and cleanout frequency. The maintenance manual from the manufacturer is included in Appendix D.

8. Conclusions

The proposed development will require the connection of sanitary and watermain services to the existing municipal services on Reid Drive.

Quantity control for the development is provided in underground storage units, surface ponding as well as the downstream SWM Pond.

Quality control for the site will be provided within the downstream SWM Pond. Phosphorus levels will be reduced using best efforts with the implementation of rooftop infiltration as within the downstream SWM Pond.

Water balance for the site is achieved by infiltration of runoff from the rooftop.

All of which is respectfully submitted,

Pearson Engineering Ltd.

Meghan Whynot, P. Eng.	Mike Dejean, P.Eng.
Design Engineer	Manager of Engineering Services

Appendix A

Water Servicing Calculations

PEARSON ENGINEERING LTD.

233 Dunlop Street West
Water Flow Calculations

Design Criteria

Demand per capita (Q):	28,000 L/ha/d
Peaking Factor	2.0

Site Data

Description	Area		Flow Rate		Peaking Factor
Commercial Space	1.25	ha	28,000	L/ha/d	2

<u>Calculate Average Day Demand (ADD)</u>

ADD	=	Area	x	Flow Rate
ADD	=	1.25	x	28,000
ADD	=	34,938	L/day	
ADD	=	0.40	L/s	

<u>Calculate Peak Flow</u>

Peak Flow	=	ADD	x	Peaking Factor
Peak Flow	=	0.40	x	2.00
Peak Flow	=	0.81	L/s	

Appendix B

Sanitary Servicing Calculations

Cadillac Dealership, Mapleview Dr. & Reid Dr.
Sanitary Flow Calculations

Design Criteria

Flow per hectare (Q)	28,000 L/ha/d	
Peak Flow	Qp = P * Q * M / 86400 + I * A	
Peaking Factor (Harmon Formula)	M = 1 + (14 / (4 + (P / 1000) ^ 0.5))	Where: 2 <= "M" <= 4
Extraneous Flows (I)	0.1 L/s/ha	

Site Data

Description	Area		Flow Rate		Peaking Factor
Commercial Space	1.25	ha	28,000	L/ha/d	2

<u>Calculate Average Daily Flows</u>

ADF (L/s)	=	Area	x	Flow Rate
ADF (L/s)	=	1.25	x	28,000
ADF (L/s)	=	34,938	L/day	
ADF (L/s)	=	0.40	L/s	

<u>Calculate Peak Flow</u>

Qp	=	ADF	x	Peaking Factor
Qp	=	0.40	x	2.00
Qp	=	0.81	L/s	
Infiltration Allowance	=	Area	x	Extraneous Flows
Infiltration Allowance	=	1.25	x	0.10
Infiltration Allowance	=	0.12	L/s	
Qp (Inc. Infiltration Allowance)	=	0.93	L/s	

Appendix C

Stormwater Management Calculations

PEARSON ENGINEERING LTD.

Cadillac Dealership, Mapleview Dr. & Reid Dr.
Calculation of Runoff Coefficients

Runoff Coefficient	=	0.15	0.95	0.95	0.60	0.95		Weighted
Surface Cover	=	Grass	Asphalt	Building	Gravel	Concrete		Runoff Coefficient
PRE DEVELOPMENT	Total Area (m^2)	Area (m^2)	Area (m^2)	Area (m^2)	Area (m^2)	Area (m^2)		
1	12479	12479	0	0	0	0		0.15
Pre Total	12479	12479	0	0	0	0		0.15
POST DEVELOPMENT	Total Area (m^2)	Area (m^2)	Area (m^2)	Area (m^2)	Area (m^2)	Area (m^2)		
1	2905	540	2366	0	0	0		0.80
2	2560	47	2420	0	0	94		0.94
3	2106	132	1479	0	0	495		0.90
4	1763	309	1228	0	0	226		0.81
5	572	530	42	0	0	0		0.21
6	430	407	23	0	0	0		0.19
7	2143	0	0	2143	0	0		0.95
Post Total	12479	1964	7557	2143	0	814		0.82

Cadillac Dealership, Mapleview Dr. & Reid Dr.
Allowable Peak Flows

Storm (yrs)	City of Barrie Coeff A	Coeff B	Coeff C
2	**678.085**	**4.699**	**0.781**
5	**853.608**	**4.699**	**0.766**
10	**975.865**	**4.699**	**0.760**
25	**1146.275**	**4.922**	**0.757**
50	**1236.152**	**4.699**	**0.751**
100	**1426.408**	**5.273**	**0.759**

Modified Rational Method
$Q = C_iCIA / 360$

Where:

Q -	Flow Rate (m^3/s)
Ci -	Peaking Coefficient
C -	Rational Method Runoff Coefficient
I -	Storm Intensity (mm/hr)
A -	Area (ha.)

Area Number	1	
Area	1.25	ha
Runoff Coefficient	0.75	
Time of Concentration	10	min

Return Rate	2	year
Peaking Coefficient (C_i)	1.0	
Rainfall Intensity	83.1	mm/hr
Pre-Development Peak Flow	0.22	m^3/s

Return Rate	5	year
Peaking Coefficient (C_i)	1.0	
Rainfall Intensity	108.9	mm/hr
Pre-Development Peak Flow	0.28	m^3/s

Return Rate	10	year
Peaking Coefficient (C_i)	1.0	
Rainfall Intensity	126.5	mm/hr
Pre-Development Peak Flow	0.33	m^3/s

Return Rate	25	year
Peaking Coefficient (C_i)	1.1	
Rainfall Intensity	148.2	mm/hr
Pre-Development Peak Flow	0.42	m^3/s

Return Rate	50	year
Peaking Coefficient (C_i)	1.2	
Rainfall Intensity	164.2	mm/hr
Pre-Development Peak Flow	0.51	m^3/s

Return Rate	100	year
Peaking Coefficient (C_i)	1.25	
Rainfall Intensity	180.2	mm/hr
Pre-Development Peak Flow	0.59	m^3/s

PEARSON ENGINEERING LTD.

Cadillac Dealership, Mapleview Dr. & Reid Dr.
Post-Development Peak Flows

Storm (yrs)	City of Barrie Coeff A	Coeff B	Coeff C
	678.085	4.699	0.781
5	853.608	4.699	0.766
10	975.865	4.699	0.760
25	1146.275	4.922	0.757
50	1236.152	4.699	0.751
100	1426.408	5.273	0.759

Modified Rational Method
$Q = C_iCIA / 360$

Where:

Q -	Flow Rate (m^3/s)
Ci -	Peaking Coefficient
C -	Rational Method Runoff Coefficient
I -	Storm Intensity (mm/hr)
A -	Area (ha.)

	Area to Quantity Control		Uncontrolled Area	
Area Number	1-2		3-7	
Area	0.55	ha	0.70	ha
Runoff Coefficient	0.86		0.79	
Time of Concentration	10	min	10	min
Return Rate	2	year	2	year
Peaking Coefficient (C_i)	1.00		1.00	
Rainfall Intensity	83.1		83.1	
Post-Development Peak Flow	0.11	m^3/s	0.13	m^3/s
Return Rate	5	year	5	year
Peaking Coefficient (C_i)	1.00		1.00	
Rainfall Intensity	108.9		108.9	
Post-Development Peak Flow	0.14	m^3/s	0.17	m^3/s
Return Rate	10	year	10	year
Peaking Coefficient (C_i)	1.00		1.00	
Rainfall Intensity	126.5		126.5	
Post-Development Peak Flow	0.17	m^3/s	0.20	m^3/s
Return Rate	25	year	25	year
Peaking Coefficient (C_i)	1.10		1.10	
Rainfall Intensity	148.2		148.2	
Post-Development Peak Flow	0.19	m^3/s	0.23	m^3/s
Return Rate	50	year	50	year
Peaking Coefficient (C_i)	1.20		1.20	
Rainfall Intensity	164.2		164.2	
Post-Development Peak Flow	0.22	m^3/s	0.25	m^3/s
Return Rate	100	year	100	year
Peaking Coefficient (C_i)	1.25		1.25	
Rainfall Intensity	180.2		180.2	
Post-Development Peak Flow	0.24	m^3/s	0.28	m^3/s

PEARSON ENGINEERING LTD.

Calculation of Runoff Coefficients
Stage-Storage-Discharge Table

Elevation (m)	Area (m^2)	Volume (m^3)	Cum. Vol. (m^3)	Orifice 1 Head (m)	Orifice 1 Flow (m^3/s)	Weir Head (m)	Weir Flow (m^3/s)	Total Flow (m^3/s)
305.45	0	0	0	0.00	0.000	305.45	0.000	0.000
305.55	0	0	0	0.00	0.000	305.55	0.000	0.000
305.65	0	2.2	2	0.05	0.025	305.65	0.000	0.025
305.75	0	2.2	4	0.15	0.043	305.75	0.000	0.043
305.85	0	2.2	7	0.25	0.056	305.85	0.000	0.056
305.95	0	2.2	9	0.35	0.066	305.95	0.000	0.066
306.05	0	2.2	11	0.45	0.075	306.05	0.000	0.075
306.15	0	2.2	13	0.55	0.083	306.15	0.000	0.083
306.25	0	2.2	15	0.65	0.090	306.25	0.000	0.090
306.35	0	2.2	18	0.75	0.096	306.35	0.000	0.096
306.45	0	2.2	20	0.85	0.103	306.45	0.000	0.103
306.55	0	0	20	0.95	0.109	306.55	0.000	0.109
306.65	0	0	20	1.05	0.114	306.65	0.000	0.114
306.75	0	0	20	1.15	0.119	306.75	0.000	0.119
306.85	0	0	20	1.25	0.124	306.85	0.000	0.124
306.95	0	0	20	1.35	0.129	306.95	0.000	0.129
307.05	0	0	20	1.45	0.134	307.05	0.000	0.134
307.15	0	0	20	1.55	0.139	307.15	0.000	0.139
307.25	0	0	20	1.65	0.143	307.25	0.000	0.143
307.70	0	0	20	2.10	0.161	307.70	0.000	0.161
307.75	33	1	21	2.15	0.163	307.75	0.000	0.163
307.80	114	4	24	2.20	0.165	307.80	0.000	0.165
307.85	245	9	33	2.25	0.167	0.00	0.000	0.167
307.90	424	17	50	2.30	0.169	0.00	0.000	0.169
307.95	652	27	77	2.35	0.171	0.00	0.000	0.171
308.00	917	39	116	2.40	0.172	0.00	0.000	0.172

Orifice 1	
Diameter	200 mm
Invert Elevation	305.50
Orifice Constant	0.80
Orifice Centroid	305.60
Orifice Flow Formula	$0.80\pi(D/2000)^2 x(2x9.81xH)^{0.5}$

PEARSON ENGINEERING LTD.

Cadillac Dealership, Mapleview Dr. & Reid Dr.
Quantity Control Volume Calculations

DATE:	30-Oct-18
FILE:	18009
CONTRACT/PROJECT:	Cadillac Dealership
COMPLETED BY:	MJWP

Modified Rational Method Parameters

Pre Development Area (ha)	Post Development Area (ha)	Time of Concentration (min)	Time Increments (min)	Pre Development Runoff Coefficient	Post Development Runoff Coefficient
1.25	0.55	10	1	0.75	0.86

Note: Refer to page Calculation of Runoff Coefficients for detailed calculations of Modified Rational Method parameters.

Allowable Runoff Rate

	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
C	0.75	0.75	0.75	0.75	0.75	0.75
C_i	1.00	1.00	1.00	1.10	1.20	1.25
I	83.11	108.92	126.55	148.15	164.22	180.15
A	1.25	1.25	1.25	1.25	1.25	1.25
Q	0.22	0.28	0.33	0.42	0.51	0.59

Note: Q= 0.00278CC$_i$IA

Rainfall Station	Barrie

SWM Pond Design Input

Storm (yrs)	Chicago Storm Coefficient A	Chicago Storm Coefficient B	Chicago Storm Coefficient C	Allowable Outflow (m3/s)	Post Development Runoff Coefficient
2	678.085	4.699	0.781	0.09	0.86
5	853.608	4.699	0.766	0.11	0.86
10	975.865	4.699	0.760	0.14	0.86
25	1146.275	4.922	0.757	0.17	0.95
50	1236.152	4.699	0.751	0.17	1
100	1426.408	5.273	0.759	0.17	1

Results

Storm Event	Storage m^3	Time min
2	14	12
5	18	12
10	19	12
25	30	13
50	53	15
100	72	17

Note: Storage volume calculated as per Hydrology Handbook, Second Edition, American Society of Civil Engineers, 1996

Time (min)	2 Year Intensity mm/hr	2 Year Inflow m^3/s	2 Year Outflow m^3/s	2 Year Storage m^3	Difference	5 Year Intensity mm/hr	5 Year Inflow m^3/s	5 Year Outflow m^3/s	5 Year Storage m^3	Difference
1	174.18	0.23	0.09	-15	8	225.07	0.30	0.11	-20	10
2	153.52	0.20	0.09	-7	6	198.85	0.26	0.11	-10	7
3	137.71	0.18	0.09	-1	4	178.75	0.23	0.11	-2	6
4	125.19	0.16	0.09	3	3	162.79	0.21	0.11	3	4
5	114.99	0.15	0.09	7	2	149.77	0.20	0.11	8	3
6	106.50	0.14	0.09	9	2	138.93	0.18	0.11	11	2
7	99.33	0.13	0.09	11	1	129.73	0.17	0.11	13	2
8	93.16	0.12	0.09	12	1	121.83	0.16	0.11	15	1
9	87.81	0.12	0.09	13	1	114.96	0.15	0.11	17	1
10	83.11	0.11	0.09	14	0	108.92	0.14	0.11	17	1
11	78.94	0.10	0.09	14	0	103.57	0.14	0.11	18	0
12	75.23	0.10	0.09	14	0	98.78	0.13	0.11	18	0
13	71.88	0.09	0.09	14	0	94.48	0.12	0.11	18	0
14	68.86	0.09	0.09	14	0	90.58	0.12	0.11	18	0
15	66.12	0.09	0.09	14	-14	87.04	0.11	0.11	17	-17
16	63.61	0.08	0.00	0	0	83.80	0.11	0.00	0	0
17	61.31	0.08	0.00	0	0	80.82	0.11	0.00	0	0
18	59.19	0.08	0.00	0	0	78.08	0.10	0.00	0	0
19	57.23	0.08	0.00	0	0	75.55	0.10	0.00	0	0
20	55.41	0.07	0.00	0	0	73.19	0.10	0.00	0	0
21	53.72	0.07	0.00	0	0	71.00	0.09	0.00	0	0
22	52.14	0.07	0.00	0	0	68.95	0.09	0.00	0	0
23	50.67	0.07	0.00	0	0	67.04	0.09	0.00	0	0
24	49.28	0.06	0.00	0	0	65.24	0.09	0.00	0	0
25	47.98	0.06	0.00	0	0	63.55	0.08	0.00	0	0
26	46.76	0.06	0.00	0	0	61.96	0.08	0.00	0	0
27	45.60	0.06	0.00	0	0	60.46	0.08	0.00	0	0
28	44.51	0.06	0.00	0	0	59.04	0.08	0.00	0	0
29	43.47	0.06	0.00	0	0	57.69	0.08	0.00	0	0
30	42.49	0.06	0.00	0	0	56.41	0.07	0.00	0	0
31	41.56	0.05	0.00	0	0	55.20	0.07	0.00	0	0
32	40.67	0.05	0.00	0	0	54.04	0.07	0.00	0	0
33	39.83	0.05	0.00	0	0	52.94	0.07	0.00	0	0
34	39.02	0.05	0.00	0	0	51.89	0.07	0.00	0	0
35	38.25	0.05	0.00	0	0	50.89	0.07	0.00	0	0
36	37.51	0.05	0.00	0	0	49.92	0.07	0.00	0	0
37	36.81	0.05	0.00	0	0	49.01	0.06	0.00	0	0

Time (min)	10 Year Intensity mm/hr	10 Year Inflow m^3/s	10 Year Outflow m^3/s	10 Year Storage m^3	Difference	25 Year Intensity mm/hr	25 Year Inflow m^3/s	25 Year Outflow m^3/s	25 Year Storage m^3	Difference
1	260.01	0.34	0.14	-24	12	298.22	0.43	0.17	-29	15
2	229.94	0.30	0.14	-13	9	264.99	0.38	0.17	-14	11
3	206.87	0.27	0.14	-4	6	239.26	0.35	0.17	-3	9
4	188.54	0.25	0.14	2	5	218.67	0.32	0.17	6	7
5	173.57	0.23	0.14	7	4	201.77	0.29	0.17	12	5
6	161.10	0.21	0.14	11	3	187.63	0.27	0.17	18	4
7	150.52	0.20	0.14	14	2	175.59	0.25	0.17	22	3
8	141.42	0.19	0.14	16	1	165.20	0.24	0.17	25	2
9	133.51	0.18	0.14	17	1	156.14	0.23	0.17	27	2
10	126.55	0.17	0.14	18	1	148.15	0.21	0.17	28	1
11	120.37	0.16	0.14	19	0	141.05	0.20	0.17	30	1
12	114.85	0.15	0.14	19	0	134.69	0.19	0.17	30	0
13	109.89	0.14	0.14	19	0	128.97	0.19	0.17	30	0
14	105.39	0.14	0.14	18	-18	123.77	0.18	0.17	30	0
15	101.30	0.13	0.00	0	0	119.04	0.17	0.17	30	-30
16	97.56	0.13	0.00	0	0	114.71	0.17	0.00	0	0
17	94.12	0.12	0.00	0	0	110.72	0.16	0.00	0	0
18	90.95	0.12	0.00	0	0	107.05	0.15	0.00	0	0
19	88.02	0.12	0.00	0	0	103.64	0.15	0.00	0	0
20	85.30	0.11	0.00	0	0	100.48	0.14	0.00	0	0
21	82.77	0.11	0.00	0	0	97.53	0.14	0.00	0	0
22	80.40	0.11	0.00	0	0	94.78	0.14	0.00	0	0
23	78.18	0.10	0.00	0	0	92.19	0.13	0.00	0	0
24	76.10	0.10	0.00	0	0	89.77	0.13	0.00	0	0
25	74.15	0.10	0.00	0	0	87.49	0.13	0.00	0	0
26	72.31	0.09	0.00	0	0	85.34	0.12	0.00	0	0
27	70.57	0.09	0.00	0	0	83.31	0.12	0.00	0	0
28	68.92	0.09	0.00	0	0	81.39	0.12	0.00	0	0
29	67.36	0.09	0.00	0	0	79.56	0.11	0.00	0	0
30	65.88	0.09	0.00	0	0	77.83	0.11	0.00	0	0
31	64.47	0.08	0.00	0	0	76.19	0.11	0.00	0	0
32	63.13	0.08	0.00	0	0	74.62	0.11	0.00	0	0
33	61.86	0.08	0.00	0	0	73.13	0.11	0.00	0	0
34	60.64	0.08	0.00	0	0	71.70	0.10	0.00	0	0
35	59.47	0.08	0.00	0	0	70.33	0.10	0.00	0	0
36	58.36	0.08	0.00	0	0	69.03	0.10	0.00	0	0
37	57.29	0.08	0.00	0	0	67.78	0.10	0.00	0	0

Time (min)	50 Year Intensity mm/hr	50 Year Inflow m^3/s	50 Year Outflow m^3/s	50 Year Storage m^3	Difference	100 Year Intensity mm/hr	100 Year Inflow m^3/s	100 Year Outflow m^3/s	100 Year Storage m^3	Difference
1	334.55	0.51	0.17	-25	18	353.96	0.54	0.17	-24	20
2	296.30	0.45	0.17	-7	14	316.38	0.48	0.17	-4	16
3	266.91	0.41	0.17	7	11	286.90	0.44	0.17	12	12
4	243.52	0.37	0.17	18	8	263.10	0.40	0.17	24	10
5	224.41	0.34	0.17	26	7	243.43	0.37	0.17	34	8
6	208.47	0.32	0.17	33	5	226.85	0.34	0.17	42	7
7	194.94	0.30	0.17	38	4	212.68	0.32	0.17	49	5
8	183.29	0.28	0.17	42	3	200.41	0.30	0.17	54	4
9	173.15	0.26	0.17	46	3	189.66	0.29	0.17	58	4
10	164.22	0.25	0.17	48	2	180.15	0.27	0.17	62	3
11	156.30	0.24	0.17	50	1	171.69	0.26	0.17	65	2
12	149.22	0.23	0.17	52	1	164.09	0.25	0.17	67	2
13	142.84	0.22	0.17	52	1	157.23	0.24	0.17	69	1
14	137.07	0.21	0.17	53	0	151.00	0.23	0.17	70	1
15	131.81	0.20	0.17	53	0	145.31	0.22	0.17	71	1
16	127.00	0.19	0.17	53	0	140.09	0.21	0.17	71	0
17	122.58	0.19	0.17	53	-1	135.29	0.21	0.17	72	0
18	118.50	0.18	0.17	52	-1	130.86	0.20	0.17	71	0
19	114.72	0.17	0.17	51	-51	126.75	0.19	0.17	71	-1
20	111.22	0.17	0.00	0	0	122.92	0.19	0.17	71	-1
21	107.95	0.16	0.00	0	0	119.35	0.18	0.17	70	-1
22	104.90	0.16	0.00	0	0	116.02	0.18	0.17	69	-1
23	102.04	0.15	0.00	0	0	112.89	0.17	0.17	68	-68
24	99.36	0.15	0.00	0	0	109.95	0.17	0.00	0	0
25	96.84	0.15	0.00	0	0	107.18	0.16	0.00	0	0
26	94.46	0.14	0.00	0	0	104.57	0.16	0.00	0	0
27	92.21	0.14	0.00	0	0	102.10	0.15	0.00	0	0
28	90.09	0.14	0.00	0	0	99.76	0.15	0.00	0	0
29	88.07	0.13	0.00	0	0	97.55	0.15	0.00	0	0
30	86.16	0.13	0.00	0	0	95.44	0.14	0.00	0	0
31	84.34	0.13	0.00	0	0	93.44	0.14	0.00	0	0
32	82.61	0.13	0.00	0	0	91.53	0.14	0.00	0	0
33	80.96	0.12	0.00	0	0	89.71	0.14	0.00	0	0
34	79.38	0.12	0.00	0	0	87.97	0.13	0.00	0	0
35	77.87	0.12	0.00	0	0	86.31	0.13	0.00	0	0
36	76.43	0.12	0.00	0	0	84.71	0.13	0.00	0	0
37	75.05	0.11	0.00	0	0	83.19	0.13	0.00	0	0

Maximum Storage Volume

PEARSON ENGINEERING LTD.

Q= 0.0028*C*I*A (cms)
C=RUNOFF COEFFICIENT
I-RAINFALL INTENSITY= A/(Time+B)^C
A=AREA (ha)

Cadillac Dealership, Mapleview Dr. & Reid Dr.
Storm Sewer Design
100-year

DATE: 30-Oct-18
FILE: 18009
CONTRACT/PROJECT Cadillac Dealership

Areas	MANHOLE		LENGTH	INCREMENT			TOTAL	FLOW TIME (min)		I	TOTAL Q	S	D	Q FULL	V FULL
	FROM	TO	(m)	C	A	CA	CA	TO	IN	(mm/h)	(cms)	(%)	(mm)	(cms)	(m/s)
4.0	DCB1	MH1	43.5	0.81	0.18	0.14	0.14	10.00	0.65	180.15	0.07	0.5	375	0.12	1.12
	MH1	DCBMH1	24.7	0.00	0.00	0.00	0.14	10.65	0.37	174.58	0.07	0.5	375	0.12	1.12
3.0	DCBMH1	855X1345	2.0	0.90	0.21	0.19	0.33	11.01	0.03	171.59	0.16	0.5	450	0.20	1.27
1.0	DCB2	DCBMH2	30.0	0.80	0.29	0.23	0.23	10.00	0.39	180.15	0.12	0.5	450	0.20	1.27
2.0	DCBMH 2	EX. MH 5	6.0	0.94	0.26	0.24	0.24	10.39	0.08	176.70	0.12	0.5	450	0.20	1.27

PEARSON ENGINEERING LTD.

Cadillac Dealership, Mapleview Dr. & Reid Dr.
Catchbasin Inlet Capacity Calculations

Storm (yrs)	City of Barrie Coeff A	Coeff B	Coeff C
	678.085	4.699	0.781
5	853.608	4.699	0.766
10	975.865	4.699	0.760
25	1146.275	4.922	0.757
50	1236.152	4.699	0.751
100	1426.408	5.273	0.759

Modified Rational Method
$Q = C_iCIA / 360$

Where:
- Q - Flow Rate (m^3/s)
- Ci - Peaking Coefficient
- C - Rational Method Runoff Coefficient
- I - Storm Intensity (mm/hr)
- A - Area (ha.)

Area Number	1	2	3	4
Area	0.29 ha	0.26 ha	0.21 ha	0.18 ha
Runoff Coefficient	0.80	0.94	0.90	0.81
Time of Concentration	10 min	10 min	10 min	10 min
Return Rate	100 year	100 year	100 year	100 year
Peaking Coefficient (C_i)	1.25	1.25	1.25	1.25
Rainfall Intensity	180.2	180.2	180.2	180.2
Post-Development Peak Flow	0.12 m^3/s	0.12 m^3/s	0.09 m^3/s	0.07 m^3/s

Note: CB Inlet capactiy Calculation assumes 50% blockage of CB.

	Area Number	Flow Required (m^3/s)	Max Ponding (m)	CB Inlet Capacity (m^3/s)
STM DCB2	1	0.12	0.30	0.20
STM DCBMH2	2	0.12	0.30	0.20
STM DCBMH1	3	0.09	0.16	0.09
STM DCB1	4	0.07	0.13	0.07

Appendix D

Phosphorus Budget Calculations

Cadillac Dealership, Mapleview Dr. & Reid Dr.
Phosphorus Budget Tool

	Residential	Commercial	Low Intensity	Forest
Phosphorus Export (kg/ha/year)	1.32	1.82	0.07	0.05

Pre-Development Condition

	Residential	Commercial	Low Intensity	Forest
Area (ha):	0.00	0.00	1.25	0.00
Total P (kg):	0.00	0.00	0.09	0.00
Total Pre-Development P (kg):		**0.09**		

Post-Development Condition (Uncontrolled)

Total Area	Residential	Commercial	Low Intensity	Forest
Area (ha):	0.00	1.25	0.00	0.00
Total P (kg):	0.00	2.27	0.00	0.00
Total Post-Development P (kg):		**2.27**		

Post Development Condition (Controlled)

Total Area	Residential	Commercial	Low Intensity	Forest
Area (ha):	0.00	1.25	0.00	0.00
Total P (kg):	0.00	2.27	0.00	0.00
Area Draining to Underground Infiltration				
Area (ha):	0.00	0.21	0.00	0.00
Total P (kg):	0.00	0.39	0.00	0.00

Underground Infiltration Trench Treatment

As per NVCA Guidelines, infiltration removes 100% of phosphorus

The rooftop infiltration has been sized to infiltrate 98% of all rainfall

Underground Infiltation Trench Proficiency (%):	100
Amount of Rainfall being infiltrated (%)	98
P Removed (kg):	0.38
P Remaining (kg):	0.01

Area Draining to Wet Pond	Residential	Commercial	Low Intensity	Forest
Area (ha):	0.00	1.03	0.00	0.00
Total P (kg):	0.00	1.88	0.00	0.00

Wet Pond Treatment

Total P to be Treated (kg):	1.88
Wet Pond Proficiency (%):	63
P Removed (kg):	1.19
P Remaining (kg):	0.70

Total Post-Development P (kg) : 0.02+0.70 = **0.70**

Appendix E

Rooftop Infiltration Details

PEARSON
ENGINEERING LTD.

Cadillac Dealership, Mapleview Dr. & Reid Dr.
Pre Development Water Balance

Catchment Designation	Site			
	Grassed	Paved	Total	
Area	12479	0	12479	
Pervious Area	12479	0	12479	
Impervious Area	0	0	0	
Infiltration Factors				
Topography Infiltration Factor	0.2	0		(From MOE Table 3.1 for Rolling Land)
Soil Infiltration Factor	0.2	0		(From MOE Table 3.1 for Medium combinations of clay and loam)
Land Cover Infiltration Factor	0.1	0		
MOE Infiltration Factor	0.5	0		
Actual Infiltration Factor	0.5	0		
Run-Off Coeffiecient	0.5	1		
Runoff from Impervious Surfaces	0	0.95		
Inputs (per Unit Area)				
Precipitation	932.9	932.9	932.9	(Precipitation values from Environment Canada)
Run-On	0	0	0	
Other Inputs	0	0	0	
Total Inputs	932.9	932.9	932.9	
Outputs (per Unit Area)				
Precipitation Surplus	371.9	886.3	371.9	
Net Surplus	371.9	886.3	371.9	
Evapotranspiration	561.0	46.6	561.0	(Evapotranspiration values for pervious area from Table 5-2 in the City of Barrie Tier Three Recharge Estimation, dated June 2012. Values for impervious areas is the difference between the total precipitation and the net surplus)
			0.0	
Infiltration	186.0	0.0	186.0	
Rooftop Infiltration	0.0	0.0	0.0	
Total Infiltration	186.0	0.0	186.0	
Runoff Pervious Areas	186.0	0.0	186.0	
Runoff Impervious Areas	0.0	886.3	0.0	
Total Runoff	186.0	886.3	186.0	
Total Outputs	932.9	932.9	932.9	
Difference (Inputs - Outputs)	0.0	0.0	0.0	
Inputs (Volumes)				
Precipitation	11641	0	11641	
Run-On	0	0	0	
Other Inputs	0	0	0	
Total Inputs	11641	0	11641	
Outputs (Volumes)				
Precipitation Surplus	4641	0	4641	
Net Surplus	4641	0	4641	
Evapotranspiration	7001	0	7001	
Infiltration	2320	0	2320	
Rooftop Infiltration	0	0	0	
Total Infiltration	2320	0	2320	
Runoff Pervious Areas	2320	0	2320	
Runoff Impervious Areas	0	0	0	
Total Runoff	2320	0	2320	
Total Outputs	11641	0	11641	
Difference (Inputs - Outputs)	0	0	0	

Note: Highlighted cells are input cells.

PEARSON ENGINEERING LTD.

Cadillac Dealership, Mapleview Dr. & Reid Dr.
Post Development Water Balance (No Infiltration)

Catchment Designation	Site			
	Grassed	Paved	Building	Total
Area	1964	8371	2143	12479
Pervious Area	1964	0	0	1964
Impervious Area	0	8371	2143	10514
Infiltration Factors				
Topography Infiltration Factor	0.2	0	0	
Soil Infiltration Factor	0.2	0	0	
Land Cover Infiltration Factor	0.1	0	0	
MOE Infiltration Factor	0.5	0	0	
Actual Infiltration Factor	0.5	0	0	
Run-Off Coeffiecient	0.5	1	1	
Runoff from Impervious Surfaces	0	0.95	0.95	
Inputs (per Unit Area)				
Precipitation	932.9	932.9	932.9	932.9
Run-On	0	0	0	0
Other Inputs	0	0	0	0
Total Inputs	932.9	932.9	932.9	932.9
Outputs (per Unit Area)				
Precipitation Surplus	371.9	886.3	886.3	805.3
Net Surplus	371.9	886.3	886.3	805.3
Evapotranspiration	561.0	46.6	46.6	127.6
Infiltration	186.0	0.0	0.0	29.3
Rooftop Infiltration	0.0	0.0	0.0	0.0
Total Infiltration	186.0	0.0	0.0	29.3
Runoff Pervious Areas	186.0	0.0	0.0	29.3
Runoff Impervious Areas	0.0	886.3	886.3	746.7
Total Runoff	186.0	886.3	886.3	776.0
Total Outputs	932.9	932.9	932.9	932.9
Difference (Inputs - Outputs)	0.0	0.0	0.0	0.0
Inputs (Volumes)				
Precipitation	1833	7810	1999	11641
Run-On	0	0	0	0
Other Inputs	0	0	0	0
Total Inputs	1833	7810	1999	11641
Outputs (Volumes)				
Precipitation Surplus	731	7419	1899	10049
Net Surplus	731	7419	1899	10049
Evapotranspiration	1102	390	100	1592
Infiltration	365	0	0	365
Rooftop Infiltration	0	0	0	0
Total Infiltration	365	0	0	365
Runoff Pervious Areas	365	0	0	365
Runoff Impervious Areas	0	7419	1899	9318
Total Runoff	365	7419	1899	9684
Total Outputs	1833	7810	1999	11641
Difference (Inputs - Outputs)	0	0	0	0

(From MOE Table 3.1 for Rolling Land)

(From MOE Table 3.1 for Medium combinations of clay and loam)

(Precipitation values from Environment Canada)

(Evapotranspiration values for pervious area from Table 5-2 in the City of Barrie Tier Three Recharge Estimation, dated June 2012. Values for impervious areas is the difference between the total precipitation and the net surplus)

Note: Highlighted cells are input cells.

Cadillac Dealership, Mapleview Dr. & Reid Dr.
Post Development Water Balance (With Infiltration)

Catchment Designation	Site				
	Grassed	Paved	Building (with Infiltration)	Total	
Area	1964	8371	2143	12479	
Pervious Area	1964	0	0	1964	
Impervious Area	0	8371	2143	10514	
Infiltration Factors					
Topography Infiltration Factor	0.2	0	0		(From MOE Table 3.1 for Rolling Land)
Soil Infiltration Factor	0.2	0	0		(From MOE Table 3.1 for Medium combinations of clay and loam)
Land Cover Infiltration Factor	0.1	0	0		
MOE Infiltration Factor	0.5	0	0		
Actual Infiltration Factor	0.5	0	0		
Run-Off Coeffiecient	0.5	1	1		
Runoff from Impervious Surfaces	0	0.95	0.95		
Inputs (per Unit Area)					
Precipitation	932.9	932.9	932.9	932.9	(Precipitation values from Environment Canada)
Run-On	0	0	0	0	
Other Inputs	0	0	0	0	
Total Inputs	932.9	932.9	932.9	932.9	
Outputs (per Unit Area)					
Precipitation Surplus	371.9	886.3	886.3	805.3	
Net Surplus	371.9	886.3	886.3	805.3	
Evapotranspiration	561.0	46.6	46.6	127.6	(Evapotranspiration values for pervious area from Table 5-2 in the City of Barrie Tier Three Recharge Estimation, dated June 2012. Values for impervious areas is the difference between the total precipitation and the net surplus)
Infiltration	186.0	0.0	0.0	29.3	
Rooftop Infiltration	0.0	0.0	**912.0**	156.6	Depth of rainfall over the rooftop required to be infiltrated to achieve water balance.
Total Infiltration	186.0	0.0	912.0	185.9	
Runoff Pervious Areas	186.0	0.0	0.0	29.3	
Runoff Impervious Areas	0.0	886.3	-25.7	590.1	
Total Runoff	186.0	886.3	-25.7	619.4	
Total Outputs	932.9	932.9	932.9	932.9	
Difference (Inputs - Outputs)	0.0	0.0	0.0	0.0	
Inputs (Volumes)					
Precipitation	1833	7810	1999	11641	
Run-On	0	0	0	0	
Other Inputs	0	0	0	0	
Total Inputs	1833	7810	1999	11641	
Outputs (Volumes)					
Precipitation Surplus	731	7419	1899	10049	
Net Surplus	731	7419	1899	10049	
Evapotranspiration	1102	390	100	1592	
Infiltration	365	0	0	365	
Rooftop Infiltration	0	0	1954	1954	
Total Infiltration	365	0	1954	2320	
Runoff Pervious Areas	365	0	0	365	
Runoff Impervious Areas	0	7419	-55	7364	
Total Runoff	365	7419	-55	7729	
Total Outputs	1833	7810	1999	11641	
Difference (Inputs - Outputs)	0	0	0	0	

Note: Highlighted cells are input cells.

Cadillac Dealership, Mapleview Dr. & Reid Dr.
Water Balance Calculations

Annual Rainfall Depth Req'd

Req'd Rainfall Depth = 912.0 mm (From Post-Development Water Balance (With Infiltration))

Find Percent of Annual Rainfall that Req'd Rainfall Depth represents

Annual Rainfall for Study Area = 932.9 mm

$$\% \text{ Annual Rainfall} = \frac{912.0 \text{ mm}}{932.9 \text{ mm}} = 98\%$$

From MOE Figure C-2, 98% of annual rainfall occurs for storm events of 27 mm or less.

Find storage volume required for rainfall events of 17 mm to Rooftop Infiltration Gallery

Roof Top Area	=	2143	m^2	
Rainfall Depth	=	27	mm	
Storage Volume Req'd	=	A	x	D
	=	2143	x	27
	=	58	m^3	

Minimum Infiltration Volume as per City of Barrie Storm Drainage and Stormwater Management Policies and Design Guidelines Section 4.1.3 is as follows:

Storage Volume Req'd	=	Site Area	x	5	mm
	=	12479	x	0.005	
	=	62	m^3		

Therefore,City of Barrie guidelines governs over water balance/infiltration requirements.

Roof Top Area	=	2143	m^2	
Storage Volume	=	62	m^3	
Rainfall Depth	=	V	÷	D
	=	62	÷	2143
	=	29	mm	

From MOE Figure C-2, 95% of annual rainfall occurs for storm events of 29 mm or less.

Brentwood chambers required will be based on the roof area of proposed building to provide 62 m^3:

Total Roof Top Area	=	2143	m^2
Storage Required	=	62	m^3
Storage per Chamber	=	0.45	m^3
Chambers Required	=	138.65	
	=	139	Chambers

Appendix F

StormTech Chamber Maintenance Manual

STORMTANK®
A Brentwood Brand

Maintenance Guidelines

General:

The StormTank™ Stormwater Storage Module is a component in a stormwater collection system, providing storage for the detention or infiltration of runoff. No two systems are the same; with varying shapes, sizes and configurations. Some include pre-treatment to remove sediment and/or contaminants prior to entering the storage area and some do not. Systems without pre-treatment require greater attention to system functionality and may require additional maintenance.

In order to sustain system functionality Brentwood offers the following general maintenance guidelines.

Precautions:

1. Prior to & During Construction - Siltation prevention of the stormwater system.
   a. Conform to all local, state and federal regulations for sediment and erosion control during construction.
   b. Install site erosion and sediment BMP's (Best Management Practices) required to prevent siltation of the stormwater system.
   c. Inspect and maintain erosion and sediment BMP's during construction.
2. Post Construction - Prior to commissioning the StormTank™ system.
   a. Remove and properly dispose of construction erosion and sediment BMP's per all local, state and federal regulations. Care should be taken during removal of the BMP's as not to allow collected sediment or debris into the stormwater system.
   b. Flush the StormTank™ system to remove any sediment or construction debris immediately after the BMP's removal. Follow the maintenance procedure outlined.

Inspections:

Follow all local, state, and federal regulations regarding stormwater BMP inspection requirements.

Brentwood Industries makes the following recommendations:

1. Frequency
   a. During the first service year a visual inspection should be completed during and after each major rainfall event, in addition to semi-annually, to establish a pattern of sediment and debris buildup.
      i. Each stormwater system is unique and multiple criteria can affect maintenance frequency such as:

a) System Design: pre-treatment/no-pretreatment, inlet protection, stand alone device.
b) Surface Area Collecting From: hardscape, gravel, soil.
c) Adjacent Area: soil runoff, gravel, trash.
d) Seasonal Changes: fall-leaves, winter-salt/cinders.

b. Second year plus; establish an annual inspection frequency based on the information collected during the first year. At a minimum an inspection should be perform semi-annually.
c. Seasonal change; regional areas affected by seasonal change (spring, summer, fall, winter) may require additional inspections at the change of seasons in addition to semi-annually.

2. Inspect:
    a. Inspection ports.
    b. Inflow and outflow points including the inlet/manhole and pipes.
    c. Discharge area.
3. Identify and Report maintenance required:
    a. Sediment and debris accumulation.
    b. System backing up.
    c. Flow rate change.

Maintenance Procedures:

1. Conform to all local, state and federal regulations.
2. Determine if maintenance is required. If a pre-treatment device is installed, follow manufacturer recommendations.
3. Using a vacuum pump truck evacuate debris from the inflow and outflow points.
4. Flush the system with clean water forcing debris from the system. Take care to avoid extreme direct water pressure when flushing the system.
5. Repeat steps 3 and 4 until no debris is evident.

These maintenance guidelines were written by Brentwood Industries, Inc. with the express purpose of providing helpful hints. These guidelines are no to be construed as the only Brentwood approved methods for StormTank™ system maintenance or the final authority in system maintenance. Check with the stormwater system owner/project engineer for their contract/specification requirements and or recommendations. Contact your local StormTank™ distributor or Brentwood Industries for additional technical support if required.

STORMTANK®
A Brentwood Brand

Sub-Surface Stormwater Storage System

Product: **ST-36**

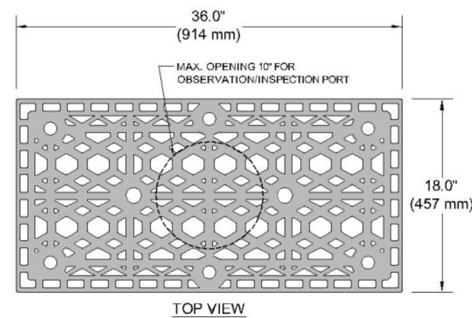
StormTank™ Stormwater Storage System is a high-void, high strength, affordable alternative to crushed stone, concrete structures, or pipe chambers. Use of StormTank™ reclaims valuable surface space for better surface usage such as recreational areas, parking lots or buildings.

StormTank™ module design provides the maximum storage volume while minimizing the installation footprint to reduce construction costs. The open module design, with no partitions or walls between modules, allows for easy inspection and cleaning.

Technical Data

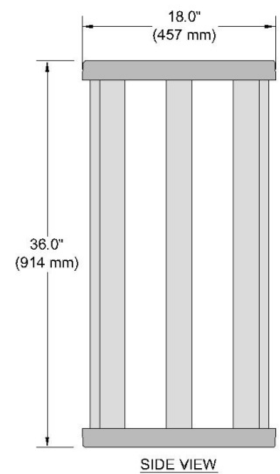
Nominal Specifications	
Size	36”x18”x36” (914x457x914 mm)
Void Space	97.0%
Module Storage	13.10 cf (0.37 m^3)
Installed Storage	15.80 cf (0.45 m^3)
Weight	33.10 lbs. (15 kg)

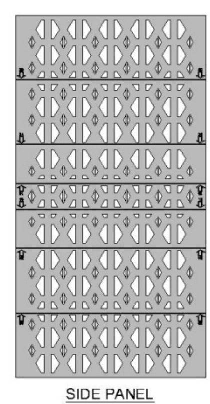
Notes:
- *Installed storage assumes 6” of stone below, 12” stone above and 40% porosity for the stone plus the module volume.*



Shipping Information

Description	Packaged Quantity	Packaged Weight lbs. (kg)
Top/Bottom Platens	84 / skid	568 (258)
	126 / skid	853 (387)
Side Panels (3ft length)	90 / skid	367 (166)
Columns	336 / skid	902 (409)





Manufacturer:
BRENTWOOD

Mailing Address: P.O. Box 605, Reading, PA 19603
Shipping Address 610 Morgantown Road, Reading, PA 19611
Phone: 610-236-1100 Fax: 610-736-1280
Email: stormwater@brentwoodindustries.com
Website: www.Brentwoodindustries.com

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Appendix G

Pearson Engineering Drawings