Stormwater Management Report

45 – 51 Penetang Street

City of Barrie
County of Simcoe

Pearson Engineering Ltd.
Pearsoneng.com

(Revised December 2019)
September 2019
17048

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Stormwater Management Report
45 – 51 Penetang Street - Barrie

1. Introduction

PEARSON Engineering Ltd. has been retained by PIVAG Inc. (Client) to prepare a Stormwater Management (SWM) Report in support of the proposed 5-storey residential building located at 45 and 51 Penetang Street in the City of Barrie (City), County of Simcoe (County).

1.1. Development concept

The subject property is approximately 0.27 ha in size and currently consists of an existing commercial building with parking lot and one vacant residential lot. The existing site drains to the north sloping towards Penetang Street at the front of the property. The location of the site can be seen on Figure 1.

1.2. Terms of Reference

The intent of this SWM Report is to:

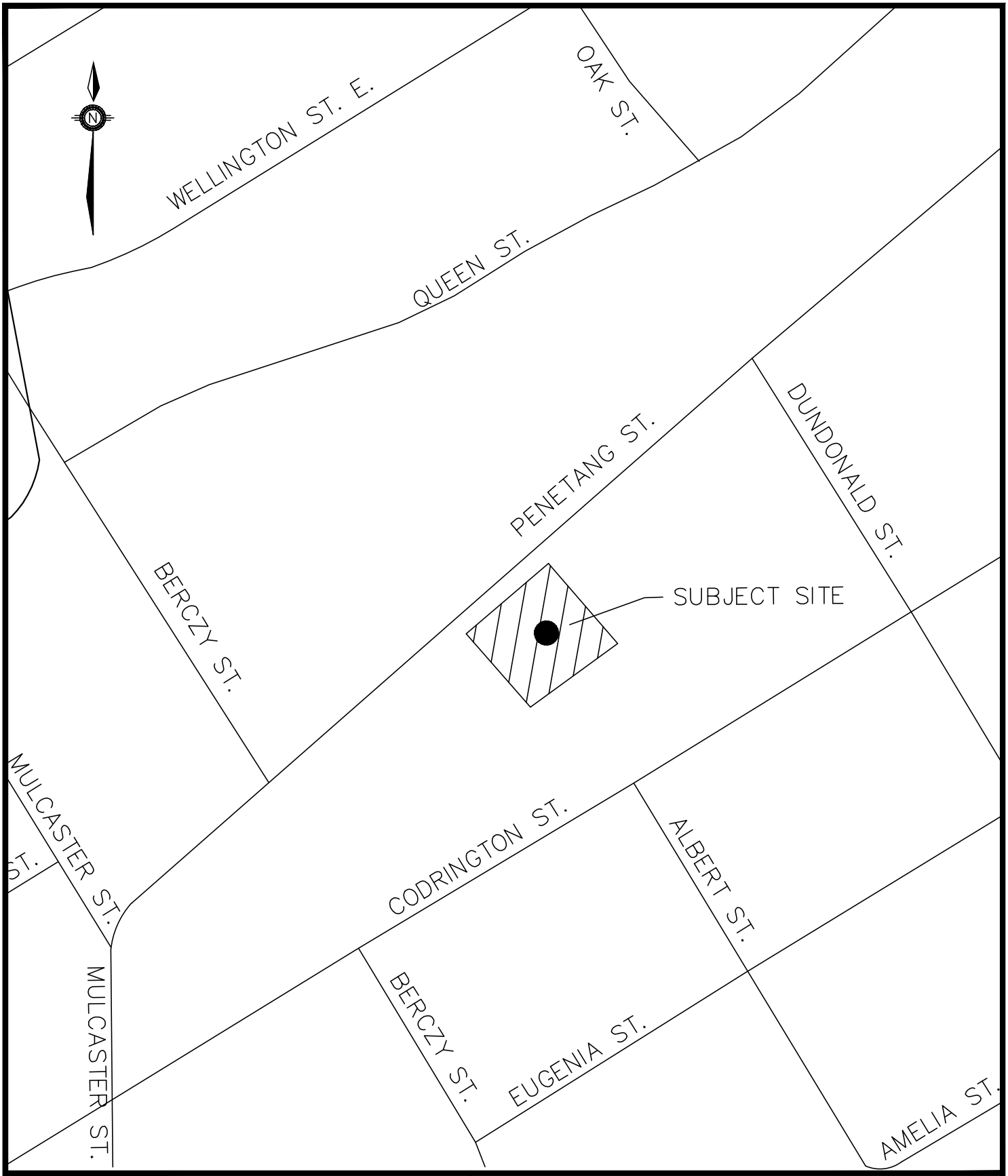
- Identify the existing site characteristics including any external drainage conditions;
- Illustrate the design of the stormwater conveyance system, capable of accommodating both minor and major storm flows from the site;
- Incorporate the appropriate Best Management Practices for controlling on-site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

2. Stormwater Management

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

It is understood the objectives of the SWM plan are to:

- Protect life and property from flooding and erosion
- Maintain water quality for ecological integrity, recreational opportunities etc.
- Protect and maintain groundwater flow regime(s).
- Protect aquatic and fishery communities and habitats.
- Maintain and protect significant natural features.
- Incorporate Low Impact Development (LID) practices to promote infiltration and reduce phosphorus levels to downstream watercourses.



45–51 PENETANG STREET
BARRIE, ONTARIO
COUNTY OF SIMCOE

LOCATION PLAN

PEARSON ENGINEERING LTD.
PEARSONENG.COM PH. 705.719.4785

DESIGNED BY	MWD	HORIZ SCALE	NTS	PROJECT #	17048
DRAWN BY	MJWP	VERT SCALE		DRAWING #	FIG–1
CHECKED BY	MWD	DATE	NOV 2018	REVISION #	0

2.1. 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 – December 2017
- Lake Simcoe Region Conversation Authority Technical Guidelines for Stormwater Management Submissions – September 2016

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.

2.2. Existing Drainage Conditions

The existing project site currently consists of one vacant and one commercial lot. The commercial lot consists of a two-storey commercial building with an adjacent asphalt parking area. The majority of the site's stormwater flows from south to north overland towards Penetang Street at a grade of approximately 1.0% to 2.0%. Storm runoff from the site is captured within the existing 600 mm diameter storm sewer on Penetang Street that runs east to west. The flows that are conveyed overland to Penetang Street ultimately outlet to Kempenfelt Bay. Details of existing storm drainage conditions are shown on Drawing STM-1.

According to the Preliminary Geotechnical Investigation completed by Peto MacCallum Ltd. (PML), dated September 2017, the project site is comprised of topsoil or pavement over fill, over layers of sandy silt and sand, overlying a silt/sand deposit. These characteristics indicate the soil typically has good drainage conditions. Through the completion of each borehole at an average depth of 6.5 m, no water was encountered, although due to moisture content of the soil, a perched water table can be anticipated.

Given the size of the site, the Modified Rational Method will be used to determine the pre-development peak flows. IDF curve parameters were taken from the City of Barrie Stormwater Management Guidelines to determine the storm intensity values and the following pre-development peak flows have been calculated. Pre-development peak flows for the site were calculated using the site's current conditions and can be seen in Table 1 below. Detailed calculations for the existing drainage conditions can be found in Appendix A.

Table 1: Pre-Development Peak Flows

	2 Year Storm	5 Year Storm	10 Year Storm	25 Year Storm	50 Year Storm	100 Year Storm
Total Site (m^3/s)	0.03	0.04	0.05	0.06	0.07	0.08

2.3. Proposed Drainage Conditions

The post-development storm drainage for the project will generally follow pre-development conditions. The proposed rooftop drainage from the building will be conveyed through a 300 mm diameter storm lead to StormTech (Model SC-740) underground storage chambers in the parking lot area at the rear of the proposed building for infiltration. The rear parking lot area will drain via overland flow to proposed permeable pavers in the driveway adjacent to the northeast corner of the parking lot. Underground storage chambers will be provided for quantity control and have been designed as an off-line system. The storm sewer will discharge to the north, conveying flow to Penetang Street through a proposed Oil/Grit Separator (OGS) treatment unit or approved equivalent. The landscaped area at the front of the building will drain uncontrolled to Penetang Street. The proposed post-development storm drainage patterns can be found on Drawing STM-2.

The Project site will be drained via the proposed storm sewer which will be sized for the 5-year storm event while the major system flow will be directed offsite to Penetang Street via the driveway. In the event of a storm greater than the 100-year storm, the stormwater will be conveyed overland through the driveway entrance to Penetang Street.

2.4. Stormwater Quantity Control

The proposed development will increase the imperviousness of the site and as such the post-development peak flows will increase. It is important to quantify the increase in stormwater runoff rates and attenuate these increases. The calculated post-development runoff coefficient of 0.77 is greater than the pre-development runoff coefficient of 0.48.

Considerations were taken to reduce post-development peak flows to pre-development values. Given the size of the site, the Modified Rational Method will be used to determine the SWM release rates. Quantity control on site will be provided through underground storage chambers located in the southeast corner of the project site. A 100 mm diameter orifice tube will be implemented upstream of the OGS-5-C treatment unit to reduce the post-development peak flows leaving the site, causing stormwater to back up into the StormTech underground storage chambers. Calculations in Appendix A demonstrate 51.0 m^3 of storage is required to reduce the 100-year storm peak flow. It is being proposed to provide a total of 54.4 m^3 of quantity control storage through the use of underground storage chambers and surface ponding. In the event of a storm greater than the 100-year storm, an overland flow route will be provided through the driveway entrance to Penetang Street. Post-development peak flows for the site can be seen in Table 2 below.

Table 2: Post-Development Peak Flows

	2 Year Storm	5 Year Storm	10 Year Storm	25 Year Storm	50 Year Storm	100 Year Storm
Area 1 & 2 (Controlled) (m^3/s)	0.02	0.02	0.03	0.03	0.04	0.04
Area 3 (Uncontrolled) (m^3/s)	0.01	0.01	0.01	0.01	0.01	0.02
Total Site (m^3/s)	**0.03**	**0.03**	**0.04**	**0.04**	**0.05**	**0.06**

By comparing Table 1 and Table 2 it can be seen that the project peak flows have been reduced below the pre-development values. Detailed peak flow calculations can be seen in Appendix A.

2.5. Volume Control

Since the project site meets the definition of Major Development as per LSRCA Guidelines, considerations were taken to meet the volume control criteria detailed in section 2.2.2. The LSRCA guidelines state that the 25 mm storm event from the total impervious area of the site is to be retained and treated, with flexible alternatives if this criterion cannot be met.

Due to the project site layout and restrictions such as limited area in the driveway and a limited drainage area, enough on-site storage to achieve infiltration of the 25 mm storm event over the impervious area of the site cannot effectively be infiltrated. Therefore, it is proposed to provide on-site storage to achieve infiltration of the 12.5 mm storm event over the site's impervious areas, resulting in a storage volume of 26.2 m^3. Storage will be provided with 18.0 m^3 of StormTech underground infiltration tanks and 9.6 m^3 of storage of filtration located within the voids of the proposed permeable pavers, resulting in a total of 27.6 m^3 of storage which equates to infiltrating of the 13.2 mm storm event over the site's impervious area. Refer to Appendix A for calculations. The StormTech system information can be found in Appendix F.

2.6. Stormwater Quality Control

The Ministry of the Environment, Conservation, and Parks (MECP) 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 MECP manual. To achieve enhanced protection, permanent and temporary control of erosion and sediment transport are proposed and are discussed in the following sections.

2.6.1. Permanent Quality Control

The development's active parking facilities pose a risk to stormwater quality through the collection of grit, salt, sand and oils on the paved surfaces. Stormwater from the parking lot area will be receive pretreatment from the proposed permeable pavers by filtering through and draining into a perforated pipe located within the pavers. Stormwater flows from the grassed area west of the proposed building and parking lot will flow via grassed swales to the north towards Penetang Street.

Using the LSRCA Guidelines Section 2.2.2. and Table 3.2 Water Quality Storage requirements, a total storage volume of 26.2 m^3 is required in order to provide appropriate quality control. The proposed total volume of the permeable pavers and storage chambers is 27.6 m^3 as per the LSRCA Guidelines. Detailed calculations for the permeable pavers sizing can be seen in Appendix A.

Prior to draining to Penetang Street, stormwater within the storm sewer system will flow through an oil/grit separator unit. A CDS-5-C treatment unit is the proposed OGS to treat the storm water released from this site to the MOE's Enhanced Level Protection standard. This MECP standard stipulates a Total Suspended Solids (TSS) removal of at least 80%. The OGS unit will treat the post development flows to the required MOE quality standard, with a TSS removal rate of approximately 81%. OGS details can be found in Appendix E.

2.6.2. During Construction Activities

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 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.

3. Phosphorus Calculations

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 LSRCA. The existing site generates approximately 0.16 kg of phosphorus annually and the proposed Project will generate approximately 0.36 kg of phosphorus annually if uncontrolled. Best efforts will be used in order to reduce the phosphorus loading as much as is reasonably possible.

To minimize the amount of phosphorus discharged from the site, a treatment train approach is to be utilized. Rooftop runoff from the proposed building will be conveyed to underground storage chambers for infiltration. Stormwater from the parking lot will be conveyed to the permeable pavers via overland flow. The pavers will then drain through the storm sewer into underground storage chambers to be held and conveyed through an OGS treatment unit to further reduce phosphorous levels. The OGS information can be found in Appendix E.

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

Table 3: Phosphorus Loadings

	Total P (kg)
Pre-Development	0.16
Uncontrolled Post-Development	0.36
Total Post-Development	0.18

The post-development site has an increase of total phosphorus. Detailed calculations and a catchment plan for the areas draining to each treatment facility can be found in Appendix B.

4. Water Balance

Since the post-development state will increase the imperviousness of the site, considerations were taken in regard to groundwater recharge. Based on the assumption that the soils are able to accept infiltration, a water budget was completed as per LSRCA guidelines. Under pre-development conditions, the project site had an annual recharge volume of 296 m^3. With the increased imperviousness of the site, this recharge will be reduced to 117 m^3, resulting in a deficit volume of 179 m^3.

In order to infiltrate an additional 179 m^3 annually, a yearly rainfall depth of 256.0 mm from the rooftop is required to be infiltrated. This percentage of annual rainfall occurs for rain events of 3 mm or less resulting in a storage volume of 2.0 m^3. The City of Barrie guidelines outline a requirement to provide retention for the first 5 mm of rainfall over the site area resulting in a required storage volume of 14.0 m^3. Therefore, it is proposed to provide retention for the first 25 mm of rainfall over the rooftop area resulting in a required storage volume of 18.0 m^3 exceeding the City of Barrie minimum criteria. StormTech Chambers (Model# SC-740) are proposed to be used as the underground storage chambers. A water balance calculation summary has been provided below in Table 4 and the detailed calculations have been provided in Appendix C.

Table 4: Water Balance Calculations Summary

Characteristic	Site		
	Pre-Development	Post-Development	Change (Pre to Post)
Inputs (Volumes)			
Precipitation (m^3/yr)	2,538	2,538	0.0%
Run-On (m^3/yr)	0	0	0.0%
Other Inputs (m^3/yr)	0	0	0.0%
Total Inputs (m^3/yr)	2,538	2,538	0.0%
Outputs (Volumes)			
Precipitation Surplus (m^3/yr)	1,593	2,088	31.1%
Net Surplus (m^3/yr)	1,593	2,088	31.1%
Evapotranspiration (m^3/yr)	945	450	-52.4%
Infiltration (m^3/yr)	296	117	-60.5%
Rooftop Infiltration (m^3/yr)	0	0	0.0%
Total Infiltration (m^3/yr)	296	117	-60.5%
Runoff Pervious Areas (m^3/yr)	296	117	-60.5%
Runoff Impervious Areas (m^3/yr)	1,001	1,854	85.3%
Total Runoff (m^3/yr)	1,297	1,971	52.0%
Total Outputs (m^3/yr)	2,538	2,538	0.0%

Note: Tabulated values taken from calculation sheets in Appendix C.

5. Maintenance

5.1. Permeable Pavers

Permeable pavement requires regular inspection and maintenance to ensure that it functions properly. The limiting factor for permeable pavers is clogging within the aggregate layers, filler, or underdrain. The pavers themselves can be reused. Annual inspections of permeable pavement should be conducted in the spring to ensure continued infiltration performance. These inspections should check for spilling or deterioration and investigate whether water is draining between storms. The pavement reservoir should drain completely within 48 hours of the end of the storm event.

5.2. Underground Chambers

The underground storage chambers are proposed to provide underground storage volume for quantity control and for rooftop infiltration. The chambers should be inspected every 6 months during the first year to ensure that the storm tanks are free of any debris. In subsequent years, the chambers should be inspected annually, or more if deemed necessary for this specific site. The maintenance manual from the manufacturer is included in Appendix F.

5.3. Oil/Grit Separator

The OGS unit should be inspected on a monthly basis during the rainy season to ensure that the unit is cleaned out at the appropriate time. Where site conditions may cause a rapid accumulation of pollutants, more frequent inspections should be carried out. It is recommended that the OGS unit be cleaned out at the end of the rainy season. The CDS system should be cleaned when the sump has reached 75% capacity, or the sediment depth has accumulated to a depth of 650 mm. Maintenance is to be performed in dry weather. Material removed from the unit will be disposed of in a similar manner to other stormwater management facilities.

When oils are encountered in the unit, they should be immediately removed upon discovery using a small portable pump and/or adsorbent pads and the remaining water should be decanted to the sanitary sewer system for treatment at the local sewage treatment facility. Contact supplier for a listing of recommended Oil Sorbents. Any sludge or sediment in the bottom of the unit should them be removed and disposed of appropriately. Servicing should be performed immediately after any oil/containment spills in the area. Regular maintenance of the OGS unit will ensure satisfactory and long-term treatment.

5.4. Orifice Tube

The orifice tube controlling flows towards Penetang Street is located just downstream of STM MH2 and should be inspected monthly during the first year of operation and in the spring and fall thereafter. Any standing water observed during inspection of the catchbasin manhole that does not drain away may indicate a blocked orifice tube. The orifice tube should be kept clear of debris and any offending debris should be removed. Access to the orifice tube can be achieved through STM MH2.

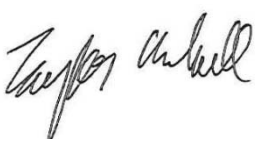
6. Conclusions

Quantity control for the development is provided in underground storage tanks allowing post-development peak flows to be released at pre-development values.

A treatment train approach is implemented consisting of permeable pavers, underground storage chambers and an oil/grit separator to obtain quality control for the site. An OGS treatment unit and permeable pavers are proposed to provide the required quality control to satisfy the MECP Enhanced level requirements.

All of which is respectfully submitted,

Pearson Engineering Ltd.



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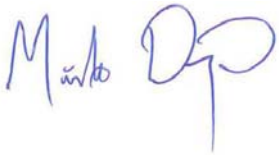
Design Engineer



Mike Dejean, P.Eng.
Manager of Engineering Services

Appendix A

Stormwater Management Calculations

45 - 51 Penetang Street, Barrie
Calculation of Runoff Coefficients

Runoff Coefficient	=	0.15	0.95	0.95	0.60	0.95		Weighted Runoff Coefficient
Surface Cover	=	Grass	Asphalt	Building	Gravel	Concrete		
PRE DEVELOPMENT	Total Area (m^2)	Area (m^2)	Area (m^2)	Area (m^2)	Area (m^2)	Area (m^2)		
1	2721	1591	508	609	0	13		0.48
Pre Total	2721	1591	508	609	0	13		0.48
POST DEVELOPMENT	Total Area (m^2)	Area (m^2)	Area (m^2)	Area (m^2)	Area (m^2)	Area (m^2)		
1	1354	301	939	0	0	114		0.77
2	772	0	71	701	0	0		0.95
3	595	328	154	0	0	113		0.51
Post Total	2721	629	1164	701	0	227		0.77

45 - 51 Penetang Street, Barrie
Pre-Development Peak Flows

Storm Event (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
$Q = C_i CIA / 360$

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	0.27	ha
Runoff Coefficient	0.48	
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	0.03	m^3/s
Return Rate	5	year
Peaking Coefficient (C_i)	1.0	
Rainfall Intensity	108.9	mm/hr
Pre-Development Peak Flow	0.04	m^3/s
Return Rate	10	year
Peaking Coefficient (C_i)	1.0	
Rainfall Intensity	126.5	mm/hr
Pre-Development Peak Flow	0.05	m^3/s
Return Rate	25	year
Peaking Coefficient (C_i)	1.1	
Rainfall Intensity	148.2	mm/hr
Pre-Development Peak Flow	0.06	m^3/s
Return Rate	50	year
Peaking Coefficient (C_i)	1.2	
Rainfall Intensity	164.2	mm/hr
Pre-Development Peak Flow	0.07	m^3/s
Return Rate	100	year
Peaking Coefficient (C_i)	1.25	
Rainfall Intensity	180.2	mm/hr
Pre-Development Peak Flow	0.08	m^3/s

45 - 51 Penetang Street, Barrie
Post-Development Peak Flows

Storm Event (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
$Q = C_i CIA / 360$

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	Controlled Area 1 + 2	Uncontrolled Area 3
Area	0.21 ha	0.06 ha
Runoff Coefficient	0.84	0.51
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	0.04 m^3/s	0.01 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	0.05 m^3/s	0.01 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	0.06 m^3/s	0.01 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	0.07 m^3/s	0.01 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	0.08 m^3/s	0.01 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	0.09 m^3/s	0.02 m^3/s

PEARSON ENGINEERING LTD.

45 - 51 Penetang Street, Barrie
Stage-Storage-Discharge Table

Elevation (m)	Area (m^2)	Incremental Volume (m^3)	Cumulative Volume (m^3)	Orifice Head (m)	Orifice Flow (m^3/s)	Weir Head (m)	Weir Flow (m^3/s)	Total Flow (m^3/s)
252.35	0	0.0	0.0	0.31	0.015	0.000	0.000	0.015
252.40	52	1.3	1.3	0.36	0.017	0.000	0.000	0.017
252.45	52	2.6	3.9	0.41	0.018	0.000	0.000	0.018
252.50	52	2.6	6.5	0.46	0.019	0.000	0.000	0.019
252.55	52	2.6	9.0	0.51	0.020	0.000	0.000	0.020
252.60	52	2.6	11.6	0.56	0.021	0.000	0.000	0.021
252.65	52	2.6	14.2	0.61	0.022	0.000	0.000	0.022
252.70	52	2.6	16.8	0.66	0.023	0.000	0.000	0.023
252.75	52	2.6	19.4	0.71	0.023	0.000	0.000	0.023
252.80	52	2.6	21.9	0.76	0.024	0.000	0.000	0.024
252.85	52	2.6	24.5	0.81	0.025	0.000	0.000	0.025
252.90	52	2.6	27.1	0.86	0.026	0.000	0.000	0.026
252.95	52	2.6	29.7	0.91	0.027	0.000	0.000	0.027
253.00	52	2.6	32.3	0.96	0.027	0.000	0.000	0.027
253.05	52	2.6	34.8	1.01	0.028	0.000	0.000	0.028
253.10	52	2.6	37.4	1.06	0.029	0.000	0.000	0.029
253.15	52	2.6	40.0	1.11	0.029	0.000	0.000	0.029
253.20	0	0.0	40.0	1.16	0.030	0.000	0.000	0.030
253.25	0	0.0	40.0	1.21	0.031	0.000	0.000	0.031
253.30	0	0.0	40.0	1.26	0.031	0.000	0.000	0.031
253.35	0	0.0	40.0	1.31	0.032	0.000	0.000	0.032
253.40	0	0.0	40.0	1.36	0.032	0.000	0.000	0.032
253.45	0	0.0	40.0	1.41	0.033	0.000	0.000	0.033
253.50	0	0.0	40.0	1.46	0.034	0.000	0.000	0.034
253.55	0	0.0	40.0	1.51	0.034	0.000	0.000	0.034
253.60	0	0.0	40.0	1.56	0.035	0.000	0.000	0.035
253.65	0	0.0	40.0	1.61	0.035	0.000	0.000	0.035
253.70	0	0.0	40.0	1.66	0.036	0.000	0.000	0.036
253.75	0	0.0	40.0	1.71	0.036	0.000	0.000	0.036
253.80	0	0.0	40.0	1.76	0.037	0.000	0.000	0.037
253.85	0	0.0	40.0	1.81	0.037	0.000	0.000	0.037
253.90	9	0.2	40.2	1.86	0.038	0.000	0.000	0.038
253.95	36	1.1	41.3	1.91	0.038	0.000	0.000	0.038
254.00	86	3.1	44.4	1.96	0.039	0.000	0.000	0.039
254.05	156	6.1	50.5	2.01	0.039	0.000	0.000	0.039
254.10	0	3.9	54.4	2.06	0.040	0.050	0.114	0.154
254.15	0	0.0	54.4	2.11	0.040	0.100	0.322	0.363
254.20	0	0.0	54.4	2.16	0.041	0.150	0.592	0.633
254.25	0	0.0	54.4	2.21	0.041	0.200	0.911	0.952

Orifice Tube	
Diameter	100 mm
Invert Elevation	251.99
Orifice Constant	0.80
Orifice Centroid	252.04
Orifice Flow Formula	$0.80\pi(D/2000)^2x(2x9.81xH)^{0.5}$

Major Storm Control Driveway Weir	
Width	6.0 m
Invert of Weir	254.05 m
Weir Flow Formula	$1.7WH^{1.5}$

PEARSON ENGINEERING LTD.

45 - 51 Penetang Street, Barrie
Quantity Control Volume Calculations

DATE:	3-Dec-19
FILE:	17048
CONTRACT/PROJECT:	45 - 51 Penetang St., Barrie
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
0.27	0.21	10	1	0.48	0.84

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

Pre-Development Runoff Rate

	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
C	0.48	0.48	0.48	0.48	0.48	0.48
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	0.27	0.27	0.27	0.27	0.27	0.27
Q	0.03	0.04	0.05	0.06	0.07	0.08

Note: Q= 0.00278CCiIA

Rainfall Station	Barrie

SWM Pond Design Input

Storm Event (yrs)	Chicago Storm Coefficient	Chicago Storm Coefficient	Chicago Storm Coefficient	Allowable Outflow	Post Development Runoff Coefficient
	A	B	C	(m^3/s)	
2	678.085	4.699	0.781	0.02	0.84
5	853.608	4.699	0.766	0.02	0.84
10	975.865	4.699	0.760	0.03	0.84
25	1146.275	4.922	0.757	0.03	0.92
50	1236.152	4.699	0.751	0.04	1.00
100	1426.408	5.273	0.759	0.04	1.00

Results

Storm Event (yrs)	Storage (m^3)	Time (min)
2	14	19
5	22	22
10	28	25
25	38	28
50	45	27
100	51	28

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

Time (min)	2 Year					5 Year					10 Year					25 Year					50 Year					100 Year				
	Intensity mm/hr	Inflow m^3/s	Outflow m^3/s	Storage m^3	Difference	Intensity mm/hr	Inflow m^3/s	Outflow m^3/s	Storage m^3	Difference	Intensity mm/hr	Inflow m^3/s	Outflow m^3/s	Storage m^3	Difference	Intensity mm/hr	Inflow m^3/s	Outflow m^3/s	Storage m^3	Difference	Intensity mm/hr	Inflow m^3/s	Outflow m^3/s	Storage m^3	Difference	Intensity mm/hr	Inflow m^3/s	Outflow m^3/s	Storage m^3	Difference
1	174.18	0.09	0.02	-2	3	225.07	0.11	0.02	-1	4	260.01	0.13	0.03	-1	5	298.22	0.16	0.03	-1	7	334.55	0.20	0.04	-1	8	353.96	0.21	0.04	-1	9
2	153.52	0.08	0.02	1	3	198.85	0.10	0.02	3	3	229.94	0.11	0.03	4	4	264.99	0.14	0.03	6	5	296.30	0.17	0.04	7	6	316.38	0.19	0.04	7	7
3	137.71	0.07	0.02	4	2	178.75	0.09	0.02	6	3	206.87	0.10	0.03	8	3	239.26	0.13	0.03	11	4	266.91	0.16	0.04	13	5	286.90	0.17	0.04	14	6
4	125.19	0.06	0.02	6	2	162.79	0.08	0.02	9	2	188.54	0.09	0.03	11	3	218.67	0.12	0.03	15	3	243.52	0.14	0.04	18	4	263.10	0.16	0.04	19	5
5	114.99	0.06	0.02	7	1	149.77	0.07	0.02	11	2	173.57	0.09	0.03	14	2	201.77	0.11	0.03	19	3	224.41	0.13	0.04	22	3	243.43	0.14	0.04	24	4
6	106.50	0.05	0.02	9	1	138.93	0.07	0.02	13	1	161.10	0.08	0.03	16	2	187.63	0.10	0.03	22	2	208.47	0.12	0.04	26	3	226.85	0.13	0.04	28	3
7	99.33	0.05	0.02	10	1	129.73	0.06	0.02	15	1	150.52	0.07	0.03	18	2	175.59	0.10	0.03	24	2	194.94	0.12	0.04	28	2	212.68	0.13	0.04	31	3
8	93.16	0.05	0.02	11	1	121.83	0.06	0.02	16	1	141.42	0.07	0.03	20	1	165.20	0.09	0.03	26	2	183.29	0.11	0.04	31	2	200.41	0.12	0.04	34	2
9	87.81	0.04	0.02	11	1	114.96	0.06	0.02	17	1	133.51	0.07	0.03	21	1	156.14	0.08	0.03	28	2	173.15	0.10	0.04	33	2	189.66	0.11	0.04	36	2
10	83.11	0.04	0.02	12	0	108.92	0.05	0.02	18	1	126.55	0.06	0.03	22	1	148.15	0.08	0.03	29	1	164.22	0.10	0.04	35	2	180.15	0.11	0.04	38	2
11	78.94	0.04	0.02	12	0	103.57	0.05	0.02	19	1	120.37	0.06	0.03	23	1	141.05	0.08	0.03	31	1	156.30	0.09	0.04	36	1	171.69	0.10	0.04	40	2
12	75.23	0.04	0.02	13	0	98.78	0.05	0.02	19	1	114.85	0.06	0.03	24	1	134.69	0.07	0.03	32	1	149.22	0.09	0.04	38	1	164.09	0.10	0.04	42	1
13	71.88	0.04	0.02	13	0	94.48	0.05	0.02	20	0	109.89	0.05	0.03	24	1	128.97	0.07	0.03	33	1	142.84	0.08	0.04	39	1	157.23	0.09	0.04	43	1
14	68.86	0.03	0.02	13	0	90.58	0.04	0.02	20	0	105.39	0.05	0.03	25	1	123.77	0.07	0.03	34	1	137.07	0.08	0.04	40	1	151.00	0.09	0.04	44	1
15	66.12	0.03	0.02	13	0	87.04	0.04	0.02	21	0	101.30	0.05	0.03	26	0	119.04	0.06	0.03	35	1	131.81	0.08	0.04	41	1	145.31	0.09	0.04	45	1
16	63.61	0.03	0.02	13	0	83.80	0.04	0.02	21	0	97.56	0.05	0.03	26	0	114.71	0.06	0.03	35	1	127.00	0.07	0.04	42	1	140.09	0.08	0.04	46	1
17	61.31	0.03	0.02	14	0	80.82	0.04	0.02	21	0	94.12	0.05	0.03	26	0	110.72	0.06	0.03	36	1	122.58	0.07	0.04	42	1	135.29	0.08	0.04	47	1
18	59.19	0.03	0.02	14	0	78.08	0.04	0.02	21	0	90.95	0.04	0.03	27	0	107.05	0.06	0.03	36	0	118.50	0.07	0.04	43	0	130.86	0.08	0.04	48	1
19	57.23	0.03	0.02	14	0	75.55	0.04	0.02	22	0	88.02	0.04	0.03	27	0	103.64	0.06	0.03	37	0	114.72	0.07	0.04	43	0	126.75	0.07	0.04	48	1
20	55.41	0.03	0.02	14	0	73.19	0.04	0.02	22	0	85.30	0.04	0.03	27	0	100.48	0.05	0.03	37	0	111.22	0.07	0.04	44	0	122.92	0.07	0.04	49	0
21	53.72	0.03	0.02	13	0	71.00	0.04	0.02	22	0	82.77	0.04	0.03	27	0	97.53	0.05	0.03	37	0	107.95	0.06	0.04	44	0	119.35	0.07	0.04	49	0
22	52.14	0.03	0.02	13	0	68.95	0.03	0.02	22	0	80.40	0.04	0.03	28	0	94.78	0.05	0.03	38	0	104.90	0.06	0.04	44	0	116.02	0.07	0.04	50	0
23	50.67	0.03	0.02	13	0	67.04	0.03	0.02	22	0	78.18	0.04	0.03	28	0	92.19	0.05	0.03	38	0	102.04	0.06	0.04	45	0	112.89	0.07	0.04	50	0
24	49.28	0.02	0.02	13	0	65.24	0.03	0.02	22	0	76.10	0.04	0.03	28	0	89.77	0.05	0.03	38	0	99.36	0.06	0.04	45	0	109.95	0.06	0.04	50	0
25	47.98	0.02	0.02	13	0	63.55	0.03	0.02	22	0	74.15	0.04	0.03	28	0	87.49	0.05	0.03	38	0	96.84	0.06	0.04	45	0	107.18	0.06	0.04	50	0
26	46.76	0.02	0.02	13	0	61.96	0.03	0.02	22	0	72.31	0.04	0.03	28	0	85.34	0.05	0.03	38	0	94.46	0.06	0.04	45	0	104.57	0.06	0.04	50	0
27	45.60	0.02	0.02	13	0	60.46	0.03	0.02	22	0	70.57	0.03	0.03	28	0	83.31	0.05	0.03	38	0	92.21	0.05	0.04	45	0	102.10	0.06	0.04	51	0
28	44.51	0.02	0.02	12	-12	59.04	0.03	0.02	21	0	68.92	0.03	0.03	28	0	81.39	0.04	0.03	38	0	90.09	0.05	0.04	45	0	99.76	0.06	0.04	51	0
29	43.47	0.02	0.00	0	0	57.69	0.03	0.02	21	0	67.36	0.03	0.03	28	0	79.56	0.04	0.03	38	0	88.07	0.05	0.04	45	0	97.55	0.06	0.04	51	0
30	42.49	0.02	0.00	0	0	56.41	0.03	0.02	21	0	65.88	0.03	0.03	27	0	77.83	0.04	0.03	38	0	86.16	0.05	0.04	45	0	95.44	0.06	0.04	50	0

Maximum Storage Volume

45 - 51 Penetang Street, Barrie
Permeable Pavers Sizing Calculations

Infiltration volumes from MOE Stormwater Management Planning and Design Manual to size Permeable Pavers
Table 3.2 Water Quality Storage Requirements are as follows:

Design Area Total	=	0.21	ha		
Total Imperviousness	=	84%			
Storage Volume	=	39.3	m^3/ha		(Enhanced 80% long-term S.S. removal)
Area 1 Storage Volume Required	=	0.21		x	39.3
	=	8.3	m^3		

Required storage volume calculated over 12.5 mm of the total impervious area on the site as per the LSRCA Volume Control:

Storage Volume	=	2,092	x	0.0125
Area Storage Volume Required	=	26.2	m^3	

Note: Therefore, the storage required with 12.5 mm over the total impervious area on the site governs.

Find Storage Volume provided in Permeable Pavers:

Area of Pavers (A)	=	48.2	m^2
Depth of Trench (d)	=	0.50	m
Storage Volume (V)	=	0.4(A x d)	
	=	9.6	m^3

		Required		Provided	
Area Storage Volume	=	26.2	m^3	9.6	m^3

Remaining volume will be provided in the rooftop infiltration chambers, resulting in a total storage of 27.6 m^3.

Use MOE Equation 4.12 to find Area of Permeable Pavers:

Area Design Volume (V)	=	9.6	m^3
Depth of Controlling Filter Medium (d)	=	0.50	m
Coefficient of Permeability of the Controlling Filter Media (k)	=	45.0	mm/hr
Operating Head of Water On the Filter (h)	=	0.15	m
Design Drawdown Time (t)	=	24	hr
Surface Area Of Filter (A)	=	$\frac{1000Vd}{k(h+d)t}$	
	=	6.9	m^2

		Required		Provided	
Area 1 Surface Area	=	18.6	m^2	48.2	m^2

Q = 0.0028*C*I*A (m^3/s)

C = Runoff Coefficient

I = Rainfall Intensity = $A/(Time+B)^C$

A = Area (ha)

45 - 51 Penetang Street, Barrie
Storm Sewer Design
5-Year Storm Event

Date: 3-Dec-19

File: 17048

Contract/Project: Penetang St., Barrie

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)	(m^3/s)	(%)	(mm)	(m^3/s)	(m/s)
Area 2	ROOF	CBMH1	5.3	0.07	0.95	0.07	0.07	10.00	0.06	108.92	0.02	1.0	300	0.10	1.37
-	CBMH1	STM TANKS 1	9.3	0.00	0.00	0.00	0.07	10.06	0.11	108.56	0.02	1.1	300	0.10	1.44
-	STM TANKS 1	CBMH2	17.3	0.00	0.00	0.00	0.07	10.17	0.20	107.95	0.02	1.1	300	0.10	1.44
-	STM TANKS 2	CBMH2	11.2	0.00	0.00	0.00	0.00	10.00	0.14	108.92	0.00	1.0	300	0.10	1.37
Area 1	CBMH2	MH2	21.2	0.77	0.14	0.10	0.17	10.37	0.26	106.85	0.05	1.0	300	0.10	1.37
Area 3	CB1	MH2	5.2	0.51	0.03	0.02	0.02	10.00	0.06	108.92	0.01	1.0	300	0.10	1.37
-	MH2	OGS	3.4	0.00	0.00	0.00	0.17	10.63	0.04	105.47	0.04*	1.0	300	0.10	1.37
-	OGS	MH1	6.7	0.00	0.00	0.00	0.24	10.67	0.08	105.25	0.04*	1.0	300	0.10	1.37

* denotes 100-year storm event flow through orifice tube taken from SSD calculation sheet.

Appendix B

Water Balance Calculations

PEARSON ENGINEERING LTD.

45 - 51 Penetang Street, Barrie
Pre Development Water Balance

Catchment Designation	Site				
	Grassed	Paved	Building	Total	
Area	1591	521	609	2721	
Pervious Area	1591	0	0	1591	
Impervious Area	0	521	609	1129	
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	585.4	
Net Surplus	371.9	886.3	886.3	585.4	
Evapotranspiration	561.0	46.6	46.6	347.5	
				0.0	
Infiltration	186.0	0.0	0.0	108.8	
Rooftop Infiltration	0.0	0.0	0.0	0.0	
Total Infiltration	186.0	0.0	0.0	108.8	
Runoff Pervious Areas	186.0	0.0	0.0	108.8	
Runoff Impervious Areas	0.0	886.3	886.3	367.9	
Total Runoff	186.0	886.3	886.3	476.7	
Total Outputs	932.9	932.9	932.9	932.9	
Difference (Inputs - Outputs)	0.0	0.0	0.0	0.0	
Inputs (Volumes)					
Precipitation	1485	486	568	2538	
Run-On	0	0	0	0	
Other Inputs	0	0	0	0	
Total Inputs	1485	486	568	2538	
Outputs (Volumes)					
Precipitation Surplus	592	462	539	1593	
Net Surplus	592	462	539	1593	
Evapotranspiration	893	24	28	945	
Infiltration	296	0	0	296	
Rooftop Infiltration	0	0	0	0	
Total Infiltration	296	0	0	296	
Runoff Pervious Areas	296	0	0	296	
Runoff Impervious Areas	0	462	539	1001	
Total Runoff	296	462	539	1297	
Total Outputs	1485	486	568	2538	
Difference (Inputs - Outputs)	0	0	0	0	

Note: Highlighted cells are input cells.

PEARSON ENGINEERING LTD.

45 - 51 Penetang Street, Barrie.
Post Development Water Balance (No Infiltration)

Catchment Designation	Site				
	Grassed	Paved	Building	Total	
Area	629	1392	701	2721	
Pervious Area	629	0	0	629	
Impervious Area	0	1392	701	2092	
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	767.4	
Net Surplus	371.9	886.3	886.3	767.4	
Evapotranspiration	561.0	46.6	46.6	165.5	
Infiltration	186.0	0.0	0.0	43.0	
Rooftop Infiltration	0.0	0.0	0.0	0.0	
Total Infiltration	186.0	0.0	0.0	43.0	
Runoff Pervious Areas	186.0	0.0	0.0	43.0	
Runoff Impervious Areas	0.0	886.3	886.3	681.5	
Total Runoff	186.0	886.3	886.3	724.5	
Total Outputs	932.9	932.9	932.9	932.9	
Difference (Inputs - Outputs)	0.0	0.0	0.0	0.0	
Inputs (Volumes)					
Precipitation	586	1298	654	2538	
Run-On	0	0	0	0	
Other Inputs	0	0	0	0	
Total Inputs	586	1298	654	2538	
Outputs (Volumes)					
Precipitation Surplus	234	1233	621	2088	
Net Surplus	234	1233	621	2088	
Evapotranspiration	353	65	33	450	
Infiltration	117	0	0	117	
Rooftop Infiltration	0	0	0	0	
Total Infiltration	117	0	0	117	
Runoff Pervious Areas	117	0	0	117	
Runoff Impervious Areas	0	1233	621	1854	
Total Runoff	117	1233	621	1971	
Total Outputs	586	1298	654	2538	
Difference (Inputs - Outputs)	0	0	0	0	

Note: Highlighted cells are input cells.

PEARSON ENGINEERING LTD.

45 - 51 Penetang Street, Barrie
Post Development Water Balance (With Infiltration)

Catchment Designation	Site				
	Grassed	Paved	Building (with Infil.)	Total	
Area	629	1392	701	2721	
Pervious Area	629	0	0	629	
Impervious Area	0	1392	701	2092	
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	767.4	
Net Surplus	371.9	886.3	886.3	767.4	
Evapotranspiration	561.0	46.6	46.6	165.5	
Infiltration	186.0	0.0	0.0	43.0	
Rooftop Infiltration	0.0	0.0	**256.0**	65.9	Depth of rainfall over the rooftop required to be infiltrated to achieve water balance.
Total Infiltration	186.0	0.0	256.0	108.9	
Runoff Pervious Areas	186.0	0.0	0.0	43.0	
Runoff Impervious Areas	0.0	886.3	630.3	615.6	
Total Runoff	186.0	886.3	630.3	658.6	
Total Outputs	932.9	932.9	932.9	932.9	
Difference (Inputs - Outputs)	0.0	0.0	0.0	0.0	
Inputs (Volumes)					
Precipitation	586	1298	654	2538	
Run-On	0	0	0	0	
Other Inputs	0	0	0	0	
Total Inputs	586	1298	654	2538	
Outputs (Volumes)					
Precipitation Surplus	234	1233	621	2088	
Net Surplus	234	1233	621	2088	
Evapotranspiration	353	65	33	450	
Infiltration	117	0	0	117	
Rooftop Infiltration	0	0	179	179	
Total Infiltration	117	0	179	296	
Runoff Pervious Areas	117	0	0	117	
Runoff Impervious Areas	0	1233	442	1675	
Total Runoff	117	1233	442	1792	
Total Outputs	586	1298	654	2538	
Difference (Inputs - Outputs)	0	0	0	0	

Note: Highlighted cells are input cells.

45 - 51 Penetang Street, Barrie
Water Balance Calculations

Annual Rainfall Depth Required:

Required Rainfall Depth	=	256.0	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
% Annual Rainfall	=	256.0	mm
		932.9	mm
	=	27%	

From MECP Figure C-2, 27% of annual rainfall occurs for storm events of 3 mm or less.

Find storage volume required for rainfall events of 3 mm to rooftop infiltration gallery:

Roof Top Area	=	701	m^2		
Rainfall Depth	=	3	mm		
Storage Volume Required	=	A		x	D
	=	701		x	3
	=	2	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 Required	=	Site Area		x	5 mm
	=	2,721		x	0.005
	=	14	m^3		

It is proposed to provide storage volume for the 25 mm storm in the rooftop infiltration gallery:

Roof Top Area	=	701	m^2		
Rainfall Depth	=	25	mm		
Storage Volume Required	=	A		x	D
	=	701		x	25
	=	18	m^3		

Therefore, the City of Barrie requirements for water balance/infiltration are achieved.

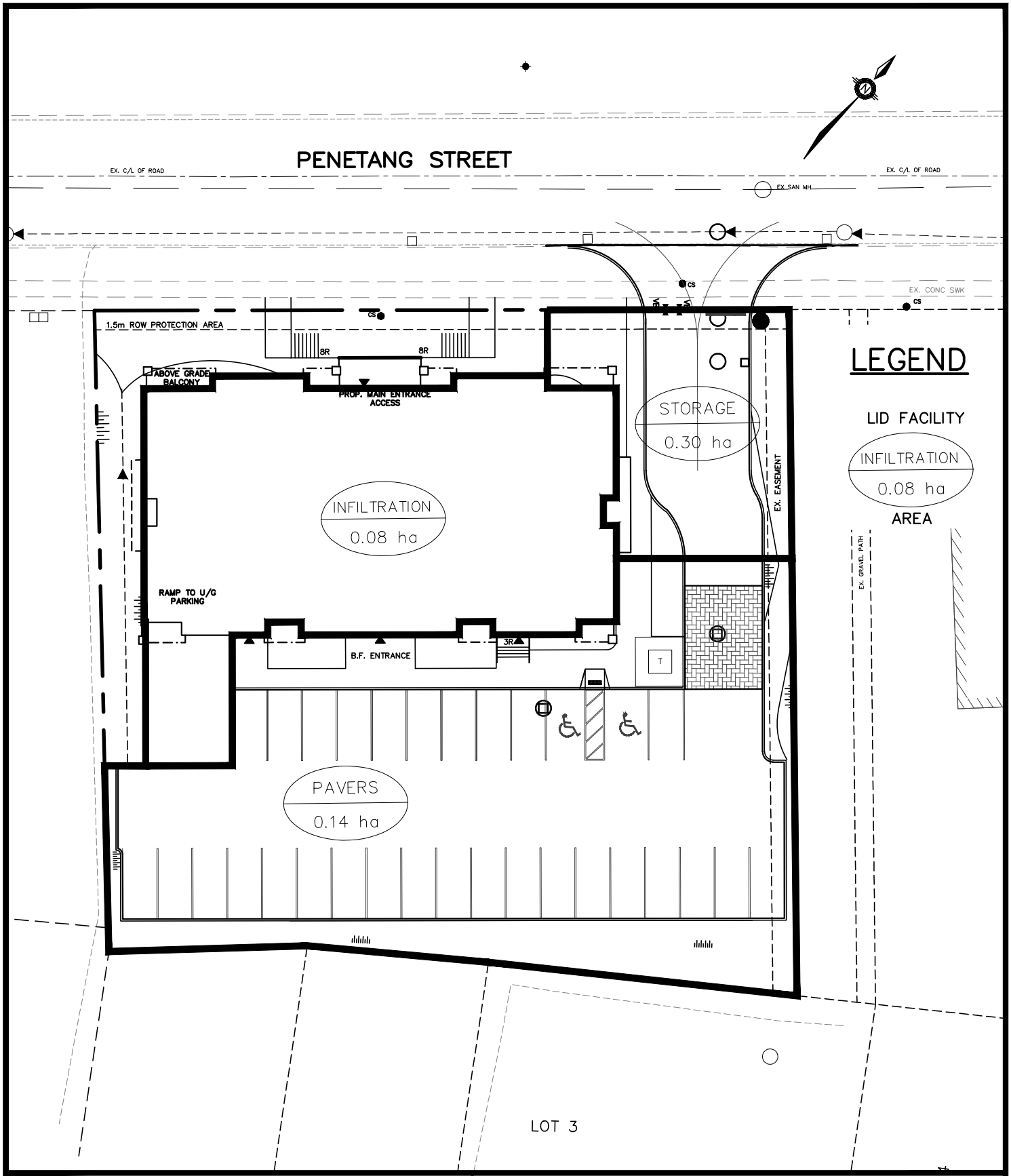
Stormtech storage chambers required will be based on the roof area of proposed building to provide 18 m^3:

Total Roof Top Area	=	701	m^2
Storage Volume Required	=	18	m^3
Storage Volume per Chamber	=	1.30	m^3
Storage Chambers Required	=	13.5	
	=	14	Chambers

Therefore, water balance for the site is achieved.

Appendix C

Phosphorus Calculations



45–51 PENETANG STREET
BARRIE, ONTARIO
COUNTY OF SIMCOE

PHOSPHORUS CATCHMENT AREAS

PEARSON ENGINEERING LTD.
PEARSONENG.COM PH. 705.719.4785

DESIGNED BY	MWD	HORIZ SCALE	NTS	PROJECT #	17048
DRAWN BY	MJWP	VERT SCALE		DRAWING #	FIG–2
CHECKED BY	MWD	DATE	DECEMBER 2019	REVISION #	0

PEARSON ENGINEERING LTD.

45 - 51 Penetang Street, Barrie
Phosphorus Budget Tool

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

Pre-Development Condition

	Residential	Commercial	Pasture	Forest
Area (ha):	0.11	0.00	0.16	0.00
Total P (kg):	0.15	0.00	0.01	0.00

Total Pre-Development P (kg): **0.16**

Post-Development Condition (Uncontrolled)

Total Area	Residential	Commercial	Pasture	Forest
Area (ha):	0.27	0.00	0.00	0.00
Total P (kg):	0.36	0.00	0.00	0.00

Total Post-Development P (kg): **0.36**

Post-Development Condition (Controlled)

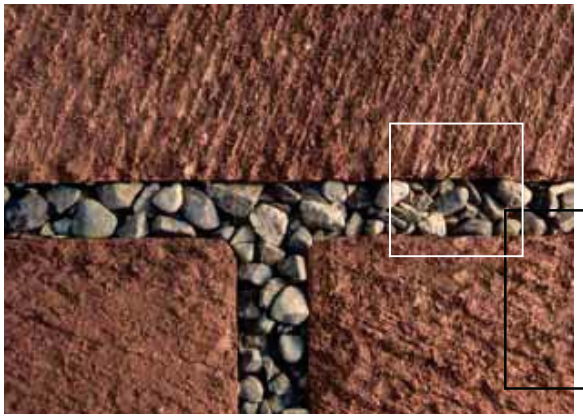
Untreated Area	Residential	Commercial	Pasture	Forest
Area (ha):	0.02	0.00	0.00	0.00
Total P (kg):	0.03	0.00	0.00	0.00
Area Draining to Underground Infiltration				
Area (ha):	0.08	0.00	0.00	0.00
Total P (kg):	0.10	0.00	0.00	0.00
Underground Infiltration Trench Treatment				
Underground Infiltation Trench Proficiency (%):		60		
P Removed (kg):		0.06		
P Remaining (kg):		0.04		
Area Draining to Only Storage Treatment				
Area (ha):	0.03	0.00	0.00	0.00
Total P (kg):	0.05	0.00	0.00	0.00
Underground Storage Chambers Treatment				
Underground Storage Chambers Proficiency (%):		25		
P Removed (kg):		0.01		
P Remaining (kg):		0.03		
Area Draining to Permeable Pavers and Underground Storage				
Area (ha):	0.14	0.00	0.00	0.00
Total P (kg):	0.18	0.00	0.00	0.00
Permeable Paver Treatment				
Total P to be Treated (kg):		0.18		
Permeable Paver Proficiency (%):		45		
P Removed (kg):		0.08		
P Remaining (kg):		0.10		
Underground Storage Chambers Treatment				
P from Permeable Pavers (kg):		0.10		
Underground Storage Chambers Proficiency (%):		25		
P Removed (kg):		0.02		
P Remaining (kg):		0.07		

Total Post-Development P (kg) : **0.18**

Appendix D

Permeable Pavers Details

Permeable Paver Maintenance Guide



UNILOCK

UNILOCK

This guide is specific for Unilock permeable pavers as a maintainable system for stormwater runoff and does not cover cleaning concrete pavers themselves. Please see the Unilock Paver Care for information on cleaning concrete pavers. The maintenance information in this guide is intended for Unilock permeable paver systems only and not for other types of permeable pavers or pervious systems.

Much like any impervious paving surfaces with catch basins and underground infrastructure, maintenance is necessary with any type of permeable systems. Over the lifetime of the permeable paver system there will be a need to clean any sediment, soil, dirt and debris from the joint aggregate material to maintain a sufficient infiltration rate. Every project will vary in performance needs, as well as to the frequency in which the joint material must be cleaned. The surface infiltration rate must be greater than the regional, 100 year rainfall intensity to adequately ensure no runoff is generated, which is only one goal for using permeable pavers. Unilock suggests establishing a maintenance plan using the techniques in this document to prevent clogging.

Preceding Maintenance

Before providing maintenance on permeable paver systems, proper installation and protection during construction is required. Here are a few conditions to observe, require and prevent for establishing a successful system:

1. Verify correct installation and materials:
- Hire contractors with knowledgeable experience installing permeable pavers.
- Review and approve all sub-base, base and joint aggregate materials.
- Do not allow sand and dense-graded aggregates.

2. Prevent construction damage:
- Limit subgrade soil compaction when infiltration is necessary.
- Restrict vehicles with muddy tires from driving over newly placed pavers.
- Do not mix aggregate materials.

3. Refill joint material:
- Once between 3 and 6 months after initial installation.
- Repeat as needed - approximately every 5-10 years.

4. Avoid stockpiling of materials such as:
- Topsoil.
- Mulch.

The proper materials and installation execution can be found in the Unilock specifications for permeable pavers. Both residential and commercial projects will utilize the same base, setting bed and joint aggregates. Some projects many not require sub-base materials, underdrainage or geotextile. It is not necessary to separate the setting bed from the base aggregates with a geotextile.

Examples of Common Maintenance Issues

Below are several warning signs and visual clues of common maintenance issues which must be prevented and addressed or remediated to ensure continued surface infiltration.

1. Slow Draining/Runoff:
- Verify with simple infiltration testing or observe after rain storms.
- Surface should drain immediately.

2. Ponding and Bird Baths:
- Rule of thumb: if more than a nickel deep one minute after a rainfall event, maintenance is necessary.
- Verify correct materials were installed.
- Exceptions at bottom of slopes.

3. Surface Crusting:
- Identify if there is a problem such as run on sediments.
- Increase cleaning frequency in troubled areas.
- Remove debris immediately.

4. Weeds:
- Weeds will not germinate unless there is a collection of soil or moisture.
- Remove weeds immediately.
- Clean sediment from joint material.
- Chemical treatment may be required prior to maintenance removal.

5. Covered Joint Material:
- Identify problem and correct.
- Remove immediately.
- Joint material should appear as photo on right.

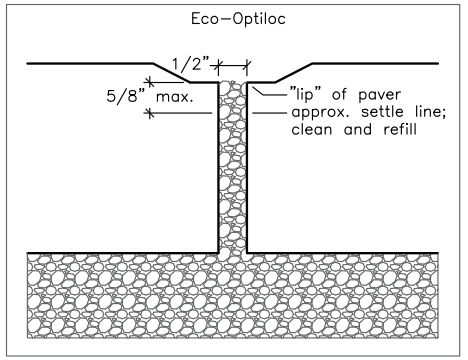
These common problems can often be easily remedied by maintaining the proper joint aggregate level.

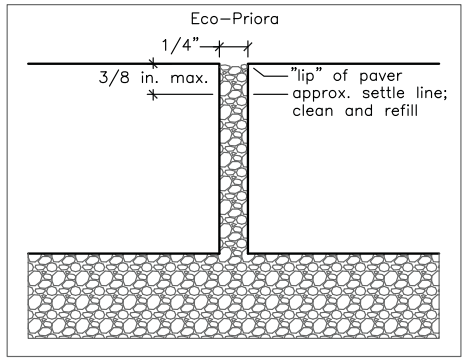
Maintenance Types

There are two service types for maintaining the integrity of a permeable paver system.

1. Preventative – removes most miscellaneous debris before being trapped in the joint aggregate material causing clogging. This usually does not require removal of any joint material to restore infiltration.

2. Restorative – requires some removal or complete removal of the joint material to renew infiltration. Occurs after miscellaneous debris has been captured and lodged in the joint aggregate.





*__Note:__ *Both maintenance types will be most effective when the joint aggregate material is filled to the "lip" of the paver. If the joint material has settled more than the joint width, plus 1/8 inch below the paver lip, the maintenance equipment is significantly less effective and potentially more expensive.*

Maintenance Equipment

There are two service types for maintaining the integrity of a permeable paver system.

Project Type 1: For smaller pedestrian type areas such as sidewalks, driveways, plazas, patios or similar:

Preventative:

1. Hand-Held Bristle Broom
- Available at any hardware store.
- Sweep as needed to keep the surface clear of debris.
- Approximate cost: $15.

2. Leaf Blower
- Electric or gas powered.
- Minimum air speed of 120 mph.
- Joint aggregate material will remain in place while removing debris from paver surface.
- Approximate cost: $50 to $300.

3. Rotary Brush
- Poly bristles only.
- Flips debris from joint.
- Will require slight refilling of the joint aggregate material.
- Approximate cost: varies depending on attachment vehicle.

Restorative:

1. Wet/Dry Shop Vacuum
- Minimum 4 HP (peak) motor with 130 cubic feet per minute suction.
- Will remove some joint aggregate material.
- Replenish removed joint aggregate material to "lip" of paver.
- Approximate cost: $50 to $150.

2. Riding Litter Vacuum
- Tennant ATLV 4300.
- 48 inch wide vacuum head.
- 110 gallon capacity.
- Can also be used as a preventative technique.
- Will evacuate most debris from joint except for aggregate material.
- Approximate cost: approx. $25K new.

3. Powerwasher
- Capable of spraying 1,400 to 1,800 psi.
- Spray at a 30 degree angle approximately 18 to 24 inches from the surface.
- Will evacuate joint material.
- Replenish removed joint aggregate material to "lip" of paver.
- Approximate cost: $125 to $500.

<u>Project Type 2:</u> For larger vehicular areas such as roads, parking lots, alleys, plazas or similar that can support vehicles:

Preventative:

1. Rotary Brush
- Poly bristles only.
- Flips debris from joint.
- Will require slight refilling of the joint aggregate material.
- Approximate cost: Varies depending on attachment vehicle.

2. Broom Sweepers
- Typical "street sweeper" type.
- Rotating curb brushes with center pickup.
- Poly bristles only.
- Do not utilize water to clean the surface as this can have detrimental effects on the cleaning.
- Best for seasonal cleaning.
- Approximate cost: $100 to $120 per hour from a service company.

3. Regenerative Air Sweepers
- Light duty suction cleaning.
- Utilizes stream of air blowing horizontally across surface and vacuuming.
- No rotating brushes.
- Approximate cost: $45 to $65 per hour from a service company.

Restorative:

1. Vacuum Sweepers
- Vacall Dynamic Multi-Purpose Vacuum. *(top photo)*
- Elgin Whirlwind. *(bottom photo)*
- Heavy duty cleaning.
- Minimum suction of 14,000 cubic feet per minute.
- Complete evacuation of joint aggregate material.
- Replenish removed joint aggregate material to "lip" of paver.
- Approximate cost: $2.50 to $4.50 per parking space.

2. Powerwashers
- Capable of spraying 1,400 to 1,800 psi.
- Spray at a 30 degree angle approximately 18 to 24 inches from the surface.
- Will evacuate joint aggregate material.
- Replenish removed joint aggregate material to "lip" of paver.

Strategic Procedures for Maintaining Infiltration

Observe and implement the following habitual procedures to ensure longevity of the system.

1. Weekly – prevent contamination from routine landscape maintenance such as grass clippings from mowing, hedge trimming, mulching plant beds, etc. by implementing the following joint opening cleaning procedures immediately after contamination occurs:
- Hand broom debris from the paver surface.
- Blow debris from the paver surface with backpack blower type device, collect and dispose.
- Mechanically sweep paver surface.

2. Monthly – observe any collection areas of debris, dirt, topsoil, mulch, etc. after season events such as snowfall, rain storms, leaf litter, etc. and investigate if clogging is occurring. Immediately restore infiltration using the following cleaning options:
- Break up any crust covering the joint aggregate material with hand broom for smaller areas or mechanically with a rotary sweeper for larger areas. Remove debris material.
- When necessary, restore infiltration using wet/dry shop vacuum for small areas or vacuum truck for larger areas by removing debris from joint aggregate material.
- Replenish joint aggregate material to "lip" of paver.

3. Yearly – establish a seasonal maintenance schedule that includes the following:
- Sweep entire permeable paving surface with appropriate preventative sweeping devices.
- Replenish joint aggregate material to "lip" of paver.

4. Ten years plus – plan long term maintenance to rejuvenate infiltration rates:
- Complete restoration of the joint aggregate material.
- Replenish joint with cleaned or new aggregate material to "lip" of paver.

Recommended Seasonal Maintenance Schedule

Unilock suggests establishing a best practices maintenance program to ensure longevity of the systems before restorative action is required. Biannual preventative maintenance is suggested as shown in the schedule below. This includes sweeping once in the early spring and once again in the late fall. Below is a preventative maintenance timeline that includes four maintenance suggestions:

1. After the snow melt – March 1 through April 15
- Broom, blow, rotary brush or sweep entire surface.
- Clean debris from paver surface in location of snow stockpile area.
- Replenish joint aggregate material after cleaning.
- Every fifth year, vacuum or power wash problem areas and refill joint material.

2. Late Spring – April 1 through May 15
- Broom, blow, rotary brush or sweep flowers from trees and shrubs.
- Collect any additional debris from areas mulched or planted with annual flowers.
- Replenish joint aggregate material as necessary.

3. Late Summer – July 15 through August 30
- Broom, blow, rotary brush or sweep lawn and shrub clippings or tree fruits.
- Collect any additional debris from summer activities such as charcoal coals inadvertently dumped on the permeable surface, beach sand, etc.
- Replenish joint aggregate material as necessary.

4. Late Fall – October 15 through November 30
- Broom, blow, rotary brush or sweep plant leaves.
- Replenish joint aggregate material as necessary.

Various factors will affect each project's preventative maintenance timeline and must be reviewed individually.

See the Recommended Seasonal Maintenance Schedule chart on next page.

Recommended Maintenance Schedule		Seasonal BMP			
		After Snow Melt	Late Spring	Late Summer	Late Fall
Techniques	**Project Type 1: Preventative - choose one**		1x per season	optional	1x per season
	Bristle Broom	**	*	*/**	*
	Leaf Blower	**	*	*/**	*
	Rotary Brush		*	*/**	*
	Project Type 1: Restorative		**		**
	Wet-Dry Vacuum	**	**	**	**
	Riding Litter Vacuum		*	**1x every 5 yrs.	*
	Powerwasher	**	**	**	**
	Project Type 2: Preventative - choose one		1x per season	optional	1x per season
	Rotary Brush		*	*	*
	Broom Sweepers		*		*
	Regenerative Air Sweepers		*		*
	Project Type 2: Restorative				
	Vacuum Sweepers			** 1x every 10 yrs.	
	Powerwasher	**	**	**	**

* recommended

** as needed per Strategic Procedures

Winter Maintenance and De-icing

Durability is one benefit that Unilock paving stones are known for. Almost all Unilock paving stones have a slight bevel around the edge of the stone. This helps protect the edges from potential chipping by snow clearing equipment. Always use a plastic snow shovel for paving stones. Also fit snow blowers with plastic shoes on the adjustable gliders and on the scoop edge.

When using commercial snow removal companies, confirm in writing they have protective edges on the snowplow equipment to avoid scratching the surface. Although the metal on snow clearing equipment will not adversely affect Unilock paving stones structurally, the contact of any steel on concrete can potentially leave tiny particles of metal in the paver surface which will rust and leave unsightly brown streaks. (A good example of this can be seen on the municipal curbs at the street). To reduce aesthetic damage to the paver surface, only use a polymer or rubber cutting edge on the plow.

De-icing substances, when used in proper amounts, will not damage good-quality concrete. They will, however, speed up the surface wear on some styles of pavers. Many of the exposed aggregate products and tumbled products are unaffected by virtue of their style.

There are three primary types of de-icing salts:
- Sodium chloride (common rock salt) is the most popular de-icing salt. It is widely available and it will melt snow and ice at temperatures down to approximately 16° F. Below 16° F, rock salt stops melting snow and ice. Sodium chloride can damage adjacent grass, plants and metal. Apply with caution and use as sparingly as possible.

- Calcium chloride is another de-icing salt. It generally looks like small, white, round, pellets. It will melt snow down to about 0° F. It can irritate skin. Studies indicate that depending on the concentration, calcium chloride is less damaging to grass than sodium chloride is. Heavy concentrations of calcium chloride can chemically attack concrete.

- Potassium chloride is a de-icing salt available in some markets. It will not hurt skin or damage plants. However, it melts ice only when the air temperature is above 15° F, but it can be combined with sand to improve effectiveness.

Note: *Do not use Magnesium chloride.*

Note: *Do not use sand for anti-skid with permeable pavers as it will clog the joint material.*

Note: *Fertilizers that contain ammonium nitrate and ammonium sulfate should not be used for de-icing since these substances attack the integrity of concrete. Always read the manufacturer's recommendations for use and heed all warnings and cautions.*

Notes

"When we take care of the earth, it will ultimately take care of us."

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Uxbridge, MA 01569
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Fax: (508) 278-4572

BUFFALO
510 Smith St.
Buffalo, NY 14210
Tel: (716) 822-6074
Fax: (716) 822-6076

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Aurora, IL 60505
Tel: (630) 892-9191
Fax: (630) 892-9215

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Rittman, OH 44270
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Fax: (330) 927-4100

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Brighton, MI 48116
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Fax: (248) 437-4619

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Elkhorn, WI 53121
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Brewster, NY 10509
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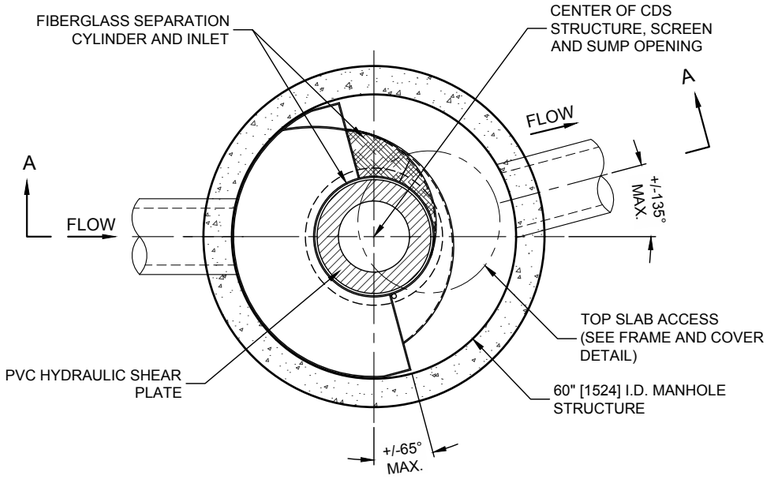
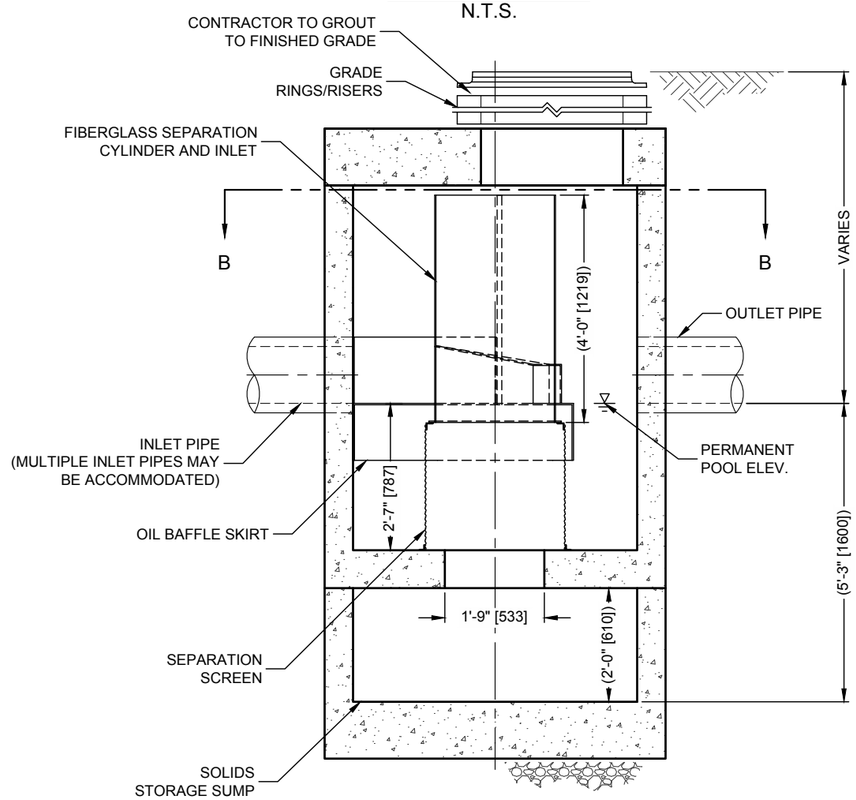
Appendix E

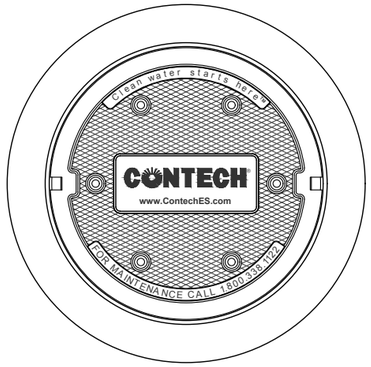
Oil/Grit Separator Details & Maintenance Manual



PLAN VIEW B-B
N.T.S.



ELEVATION A-A
N.T.S.



FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

CDS-5-C DESIGN NOTES

THE STANDARD CDS-5-C CONFIGURATION IS SHOWN.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID	
WATER QUALITY FLOW RATE (CFS OR L/s)	*
PEAK FLOW RATE (CFS OR L/s)	*
RETURN PERIOD OF PEAK FLOW (YRS)	*
SCREEN APERTURE (2400 OR 4700)	*

PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	*	*	*
INLET PIPE 2	*	*	*
OUTLET PIPE	*	*	*

RIM ELEVATION	*

ANTI-FLOTATION BALLAST	WIDTH	HEIGHT
	*	*

NOTES/SPECIAL REQUIREMENTS:

* PER ENGINEER OF RECORD

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
4. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
5. STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET HS20 (AASHTO M 306) AND BE CAST WITH THE CONTECH LOGO.
6. IF REQUIRED, PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE (LIFTING CLUTCHES PROVIDED).
C. CONTRACTOR TO ADD JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS, AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES. MATCH PIPE INVERTS WITH ELEVATIONS SHOWN.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

CONTECH ENGINEERED SOLUTIONS LLC
www.ContechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

CDS-5-C
ONLINE CDS
STANDARD DETAIL

CDS Average Annual Efficiency For TSS Removal & Total Annual Volume Treated

Area =	0.21	ha	**Upstream Storage:**			**Engineer:**	**Pearson Engineering**
Impervious:	86	%	Storage	51	m^3	**Contact:**	M. Dejean, P.Eng.
CDS Model:	CDS 5					**Date:**	27-Nov-19
Flowrate:	42	l/s					
IDF Data:	Barrie					**Project:**	45 - 51 Penetang Street
PSD:	ETV					**Location:**	Barrie, ON
						OGS ID:	OGS

Return	Period	Peak Flow	TSS Percentage Captured	Treated Flow Volume	Total Flow Volume	Annual Exceedance Probability	System Flow	CDS Flow	By-Pass Flow	Volume Percentage Treated
month / yr	Yr	l/s	%	litres	litres	%	l/s	l/s	l/s	%
1-M	0.08	3.24	71.47	2012	2012	**100.00**	3.24	3.24	0.00	100.00
2-M	0.17	5.25	68.12	3245	3245	**99.75**	5.25	5.25	0.00	100.00
3-M	0.25	6.93	65.58	4286	4286	**98.17**	6.93	6.93	0.00	100.00
4-M	0.33	8.46	63.45	5243	5243	**95.04**	8.46	8.46	0.00	100.00
5-M	0.42	9.65	61.97	5993	5993	**90.91**	9.65	9.65	0.00	100.00
6-M	0.50	10.84	60.49	6743	6743	**86.47**	10.84	10.84	0.00	100.00
7-M	0.58	11.73	59.52	7315	7315	**82.01**	11.73	11.73	0.00	100.00
8-M	0.67	12.63	58.56	7887	7887	**77.67**	12.63	12.63	0.00	100.00
9-M	0.75	13.52	57.59	8460	8460	**73.64**	13.52	13.52	0.00	100.00
10-M	0.83	14.23	56.94	8918	8918	**69.90**	14.23	14.23	0.00	100.00
11-M	0.92	14.94	56.28	9376	9376	**66.40**	14.94	14.94	0.00	100.00
1-Yr	1	15.64	55.62	9835	9835	**63.21**	15.64	15.64	0.00	100.00
2-Yr	2	21.51	51.33	13727	13727	**39.35**	21.51	21.51	0.00	100.00
5-Yr	5	25.88	49.01	16699	16699	**18.13**	25.88	25.88	0.00	100.00
10-Yr	10	27.02	48.49	17487	17487	**9.52**	27.02	27.02	0.00	100.00
25-Yr	25	32.66	46.19	21471	21471	**3.92**	32.66	32.66	0.00	100.00
50-Yr	50	40.15	43.12	26988	26988	**1.98**	40.15	40.15	0.00	100.00
100-Yr	100	44.77	40.76	30344	30542	**1.00**	44.77	42.48	2.30	99.35
Average Annual TSS Removal Efficiency [%]:					**62**	Ave. Ann. T. Volume [%]:				**100**

NOTE:
1) TSS Removal Rate Based on ETV Testing

ECHELON ENVIRONMENTAL

CDS TECHNOLOGIES

SECTION **[_____]**

STORM WATER TREATMENT DEVICE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope

The Contractor shall furnish all labor, equipment and materials necessary to install the storm water treatment device(s) (SWTD) and appurtenances specified in the Drawings and these specifications.

B. Related Sections – **if applicable**

Section ****: Dewatering
Section ****: Excavation Support and Protection
Section ****: Excavation and Fill
Section ****: Soil Stabilization

1.2 QUALITY ASSURANCES

A. Inspection

All components shall be subject to inspection by the engineer at the place of manufacture and/or installation. All components are subject to being rejected or identified for repair if the quality of materials and manufacturing do not comply with the requirements of this specification. Components which have been identified as defective may be subject for repair where final acceptance of the component is contingent on the discretion of the Engineer.

B. Warranty

The manufacturer shall guarantee the SWTD components against all manufacturer originated defects in materials or workmanship for a period of twelve (12) months from the date the components are delivered to the owner for installation. The manufacturer shall upon its determination repair, correct or replace any manufacturer originated defects advised in writing to the manufacturer within the referenced warranty period.

C. Manufacturer's Installation Certificate

The SWTD manufacturer shall submit a "Manufacturer's Installation Certificate" certifying that each SWTD has been installed in accordance with manufacturer's installation instructions.

1.3 SUBMITTALS

A. Shop Drawings

The contractor shall prepare and submit shop drawings in accordance with Section **[_____]** of the contract documents.

B. Manufacturer's Performance Certificate

The SWTD manufacturer shall submit to the Engineer of Record a "Manufacturer's Performance Certification" certifying that each SWTD is capable of achieving the specified removal efficiencies listed in this specification section. The certification shall be supported by independent third-party research.

C. Hydraulic Performance

The SWTD manufacturer shall submit a hydraulic report that verifies the system weir is sized correctly for the design treatment flowrate and in addition, indicates the effect the SWTD has on the hydraulic grade line during both treatment flow conditions and peak flow conditions. The hydraulic report shall be sealed by a Professional Engineer licensed in the Province of Ontario.

PART 2.0 – PRODUCTS

2.1 MATERIALS AND DESIGN

A. Precast concrete components shall conform to applicable sections of CSA standards, CAN/CSA A257.0, A257.2, A257.3, A257.4, ASTM C507M and OPSS 1351.

B. Internal Components and appurtenances shall conform to the following:

1. Screen and support structure shall be manufactured of Type 316 and 316L stainless steel conforming to ASTM F 1267-01;
2. Hardware shall be manufactured of Type 316 stainless steel conforming to ASTM A 320;
3. Fiberglass components shall conform to the National Bureau of Standards PS-15 and coated with an isophalic polyester gelcoat.

2.2 PERFORMANCE

A. REMOVAL EFFICIENCIES

1. The SWTD must have completed testing following The Procedure for Laboratory Testing of Oil-Grit Separators (Version 3.0, June 2014) prepared by the Toronto and Region Conservation Authority (TRCA) for Environment Canada's Environmental Technology Verification (ETV) program requirements. Furthermore, the SWTD must have an active technology fact sheet listed on etvcanada.com.
2. The SWTD shall be sized to achieve a 60 percent average annual reduction in the total suspended solid load with the Canada ETV particle size distribution (listed in Table 1.)

Table 1: Canada ETV Particle Size Distribution

Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	97	250-500	5
250	94	150-250	15
150	90	100-150	15
100	86	75-100	10
75	82	50-75	5
50	76	20-50	10
20	69	8-20	15
8	59	5-8	10
5	50	2-5	5
2	30	<2	5

3. The SWTD shall be capable of capturing and retaining 100 percent of pollutants greater than or equal to 2.4 mm regardless of the pollutant's specific gravity (i.e.: floatable and neutrally buoyant materials) for flows up to the device's rated treatment capacity. The SWTD shall be designed to retain all previously captured pollutants addressed by this subsection under all flow conditions.
4. The SWTD shall retain no less than 99% of light liquids (hydrocarbons) when operating at 2600 L/min/m2. Testing shall be verified following the Environmental Technology Verification program requirements as stated in 2.2.A.1 above.

B. HYDRAULIC CAPACITY

1. The SWTD shall be equipped with an internal high flow bypass that is capable of conveying the maximum design flowrate from the treated drainage area with no flow going through the treatment portion of the unit.
2. The SWTD shall convey the flow from the peak storm event of the drainage network, in accordance with required hydraulic upstream conditions as defined by the Engineer. If a substitute SWTD is proposed, supporting documentation shall be submitted that demonstrates equal or better upstream hydraulic conditions compared to that specified herein. This documentation shall be signed and sealed by a Professional Engineer licensed in the Province of Ontario. All costs associated with preparing and certifying this documentation shall be born solely by the Contractor.

C. STORAGE CAPACITY AND SYSTEM ACCESS

1. The SWTD shall be designed with a sump chamber for the storage of captured sediments and other negatively buoyant pollutants in between maintenance cycles. The minimum storage capacity provided by the sump chamber shall be in accordance with the volume listed in Table 2. The sump chamber shall be physically separated from the treatment section of the SWTD such that accumulated grit does not reduce the treatment chamber volume of the unit. SWTD that use the same chamber for treatment and grit storage are not acceptable. The minimum dimension providing access from the ground surface to the sump chamber shall be 406mm in diameter.
2. The SWTD shall be designed to capture and retain Total Petroleum Hydrocarbons generated by wet-weather flow and dry-weather gross spills and have a capacity listed in Table 2 of the required unit. The SWTD shall be capable of utilizing sorbent media to enhance removal and retention of petroleum based pollutants.

TABLE 2
Storm Water Treatment Device
Storage Capacities

CDS Model	Minimum Sump Storage Capacity (m^3)	Minimum Oil Storage Capacity (L)
CDS4	0.8	232
CDS5	1.6	376
CDS6	2.4	895
CDS8	4.2	1,970
CDS10	6.7	3,652
CDS12	9.6	6,918

2.3 MANUFACTURER

1. The manufacturer of the SWTD shall be one that is regularly engaged in the engineering design and production of systems deployed for the treatment of storm water runoff for at least five (5) years and which have a history of successful production, acceptable to the Engineer. In accordance with the Drawings, the SWTD(s) shall be a Contech CDS® device as supplied by:

Echelon Environmental
505 Hood Road
Markham, ON
L3R 5B6
Tel: 905-948-0000

2. 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 shall be responsible for all updating applicable regulatory approvals.

PART 3 – EXECUTION

3.1 INSTALLATION

1. The SWTD shall be installed in accordance with the manufacturer's recommendations and related sections of the contract documents. The manufacturer shall provide the contractor installation instructions and offer on-site guidance during the important stages of the installation as identified by the manufacturer at no additional expense.
2. The contractor shall fill all voids associated with lifting provisions provided by the manufacturer. These voids shall be filled with non-shrinking grout providing a finished surface consistent with adjacent surfaces.

END OF SECTION

CDS® System

Maintenance

Procedures For
General Inspection and Cleaning

Maintenance

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit. For example unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant deposition and transport may vary from year to year and regular inspections will help insure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (i.e. spring and fall), however; more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Additionally, installations where excessive amounts of trash are expected should be inspected more frequently.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions to inlet and/or separation screen. The inspection should also identify evidence of vector infestation and accumulations of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If sorbent material is used for enhanced removal of hydrocarbons then the level of discoloration of the sorbent material should also be identified during inspection. It is useful and often required as part of a permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (center cylinder and screen) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained behind the screen. For units possessing a sizable depth below grade (depth to pipe), a single manhole access point would allow both sump cleanout and access behind the screen.

The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump and/or when an appreciable level of hydrocarbons and trash has accumulated. If sorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded; however, it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Finer, silty particles at the top of the pile typically offer less resistance to the end of the rod than larger particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine if the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump.

Cleaning

Cleaning of the CDS systems should be done during dry weather conditions when no flow is entering the system. Cleanout of the CDS with a vacuum truck is generally the most effective and convenient method of excavating pollutants from the system. Simply remove the manhole

covers and insert the vacuum hose into the sump through the center cylinder. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should be pumped out also if pollutant build-up exists in this area.

In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, an oil or gasoline spill should be cleaned out immediately. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use adsorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash can be netted out if you wish to separate it from the other pollutants. If the screen requires cleaning, it can be washed from the surface or from the CDS inlet structure through the center cylinder.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure proper safety precautions. Confined Space Entry procedures need to be followed.

Disposal of all material removed from the CDS system should be done is accordance with local regulations. In many locations, disposal of evacuated sediments may be handled in the same manner as disposal of sediments removed from catch basins or deep sump manholes. Check your local regulations for specific requirements on disposal.

SAMPLE INSPECTION & MAINTENANCE LOG

DATE/ INSPECTOR	FUNCTIONALITY/ COMPONENTS	FLOATABLES LAYER THICKNESS (IN)	DEPTH TO SEDIMENT (A) (FT)	SEDIMENT CAPACITY USED ((B-A)/D*100) %	SORBENT DISCOLORATION	MAINTENANCE PERFORMED
11/1/06/TPG	**OK**	**.5**	**14**	**33**	**SLIGHT**	**NONE**
5/1/07	**OK**	**1**	**13**	**67**	**MODERATE**	**NONE**
10/1/07	**OK**	**2**	**12.5**	**83**	**HIGH**	**CLEANING SCHEDULED**
11/1/07	**OK**	**0**	**15**	**0**	**NONE**	**SYSTEM CLEANED**

(B) DEPTH FROM GROUND SURFACE TO BOTTOM OF SUMP: 15 (FT)

(C) DEPTH FROM GROUND SURFACE TO TOP SUMP: 12 (FT)

(D) HEIGHT OF SUMP = B - C = 3 (FT)

OBSERVATIONS OF FUNCTION: _____

_____

_____

CDS SYSTEM INSPECTION AND MAINTENANCE LOG

DATE/ INSPECTOR	FUNCTIONALITY/ COMPONENTS	FLOATABLES LAYER THICKNESS (IN)	DEPTH TO SEDIMENT (A) (FT)	SEDIMENT CAPACITY USED ((B-A)/D*100) %	SORBENT DISCOLORATION	MAINTENANCE PERFORMED

(B) DEPTH FROM GOUND SURFACE TO BOTTOM OF SUMP: ________________ (FT)

(C) DEPTH FROM GROUND SURFACE TO TOP SUMP: _______________ (FT)

(D) HEIGHT OF SUMP = B - C = ______________ (FT)

OBSERVATIONS OF FUNCTION: ____

____

____

Appendix F

StormTech Underground Storage Chambers Details & Maintenance Manual

StormTech®

Detention • Retention • Water Quality

A division of ADS

Product Catalog

This catalog is not intended to provide requirements for design or installation of StormTech chambers. Refer to the appropriate "StormTech Design Manual" and "StormTech Construction Guide" for design and installation specifications.

StormTech Subsurface Stormwater Management

Table of Contents

StormTech has thousands of chamber systems in service throughout the world. All StormTech chambers are designed to meet the most stringent industry performance standards for superior structural integrity. The StormTech system is designed primarily to be used under parking lots, roadways and heavy earth loads saving valuable land and protecting water resources for commercial and municipal applications. In our continuing desire to answer designers' challenges, StormTech has expanded the family of products providing engineers, developers, regulators and contractors with additional site specific flexibility.

Advanced Structural Performance for Greater Long-Term Reliability

StormTech developed a state of the art chamber design through:

- Collaboration with world-renowned experts of buried drainage structures to develop and evaluate the structural testing program and product design
- Designing chambers to exceed American Association of State Highway and Transportation Officials (AASHTO) LRFD design specifications for HS-20 live loads and deep burial earth loads
- Subjecting the chambers to rigorous full scale testing, under severe loading conditions to verify the AASHTO safety factors for live load and deep burial applications
- Designing chambers to conform to the product requirements of ASTM F2418 (polypropylene chambers) and ASTM F2922 (polyethylene chambers) and design requirements of ASTM F2787 ensuring both the assurance of product quality and safe structural design

Our Chambers Provide...

- Large capacity that *fits very tight footprints* providing developers with more useable land for development.
- *A proven attenuation alternative* to cumbersome large diameter metal pipe or snap together plastic crates and unreliable multi-layer systems.
- Provides the *strength* of concrete vaults at a very competitive price.
- The robust *continuous true elliptical arch design* which effectively transfers loads to the surrounding backfill providing the long-term safety factor required by AASHTO. Offers developers a cost-effective underground system that will perform as designed for decades.
- *Designed in accordance with the AASHTO LRFD Bridge Design Specifications* providing engineers with a structural performance standard for live and long-term dead loads.
- *Polypropylene and polyethylene* resins tested using ASTM standards to ensure long and short-term structural properties.
- *Injection molded* for uniform wall thickness and repeatable quality.
- Third party *tested and patented Isolator Row* for less frequent maintenance, water quality and long-term performance.
- Incorporates *traditional manifold/header designs* using conventional hydraulic equations that can easily verify flow equalization and scour velocity.
- *Open chamber design* requiring only one chamber model to construct each row assuring ease of construction and no repeating end walls to obstruct access or flow.

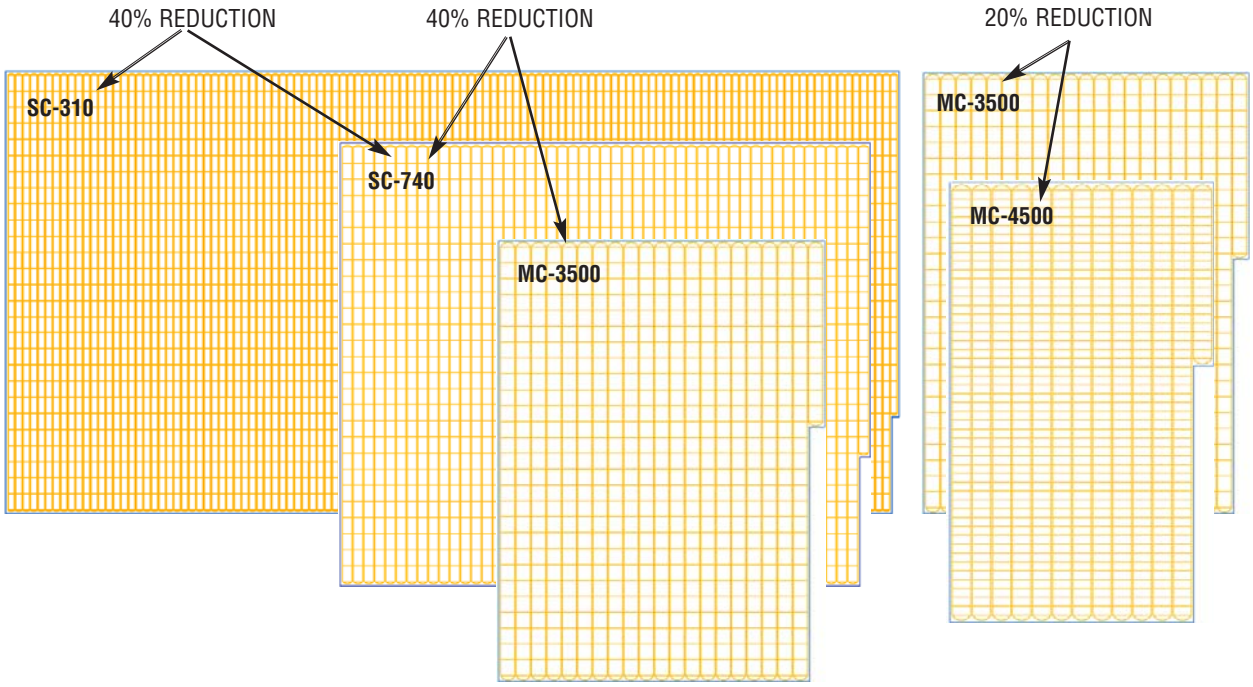
StormTech offers a variety of chamber sizes (SC-310, SC-740, DC-780, MC-3500 and MC-4500) so the consulting design engineer can choose the chamber that is best suited for the site conditions and regulatory requirements. StormTech has thousands of chamber systems in service worldwide. We provide plan layout and cost estimate services at no charge for consulting engineers and developers.

StormTech Subsurface Stormwater Management

PRODUCT SPECIFICATIONS	SC-310	SC-740	DC-780	MC-3500	MC-4500
Height, in. (mm)	16 (406)	30 (762)	30 (762)	45 (1143)	60 (1524)
Width, in. (mm)	34 (864)	51 (1295)	51 (1295)	77 (1956)	100 (2540)
Length, in. (mm)	90.7 (2300)	90.7 (2300)	90.7 (2300)	90 (2286)	52 (1321)
Installed Length, in. (mm)	85.4 (2170)	85.4 (2170)	85.4 (2170)	86.0 (2184)	48.3 (1227)
Bare Chamber Storage, cf (cm)	14.7 (0.42)	45.9 (1.30)	46.2 (1.30)	109.9 (3.11)	106.5 (3.01)
Stone above, in. (mm)	6 (152)	6 (152)	6 (152)	12 (305)	12 (305)
Minimum Stone below, in. (mm)	6 (152)	6 (152)	9 (229)	9 (229)	9 (229)
Row Spacing, in. (mm)	6 (152)	6 (152)	6 (152)	9 (229)	9 (229)
Minimum Installed Storage, cf (cm)	**31.0 (0.88)**	**74.9 (2.12)**	**78.4 (2.22)**	**178.9 (5.06)**	**162.6 (4.60)**
Storage Per Unit Area, cf/sf (cm/sm)	1.31 (0.39)	2.21 (0.67)	2.32 (0.70)	3.48 (1.06)	4.45 (1.35)

***NOTE**: Spec sheets for our RC-310 and RC-750, recycled chambers, are available upon request.*

Example: Footprint Comparison – 100,000 CF Project



StormTech and LEED

List of LEED Credits that StormTech may contribute towards:

SUSTAINABLE SITES

- **SS Credit 5.1 - Site Development: Protect or Restore Habitat**
  Utilizing StormTech System beneath roadways, surface parking, walkways, etc. may reduce overall site disturbance
- **SS Credit 5.2 - Site Development: Maximize Open Space**
  Utilizing StormTech System can increase overall open space and may reduce overall site disturbance
- **SS Credit 6.1 - Stormwater Design: Quantity Control**
  Design StormTech System per local or LEED stormwater quantity requirements, whichever is more stringent
- **SS Credit 6.2 - Stormwater Design: Quality Control**
  Use of Isolator Row provides sediment removal, and can also promote infiltration and groundwater recharge
- **SS Credit 7.1 - Heat Island Effect: Non-Roof**
  Use of StormTech System may eliminate need for above ground detention ponds, thus reducing thermal impacts of stormwater runoff

Water Efficiency

- **WE Credit 1 - Water Efficient Landscaping**
  Utilize StormTech System to store captured rainwater for landscape irrigation
- **WE Credit 2 - Innovative Wastewater Technologies**
  Utilize StormTech System to store captured rainwater to reduce potable water demand.
- **WE Credit 3 - Water Use Reduction**
  Utilize StormTech System to store captured rainwater and allow reuse for non-potable applications

Materials and Resources

- **MR Credit 4 – Recycled Content**
  Utilize recycled concrete as the backfill material for the StormTech System.
- **MR Credit 5 – Regional Materials**
  Stone backfill material for the StormTech System will apply if extracted within 500 miles of project site.

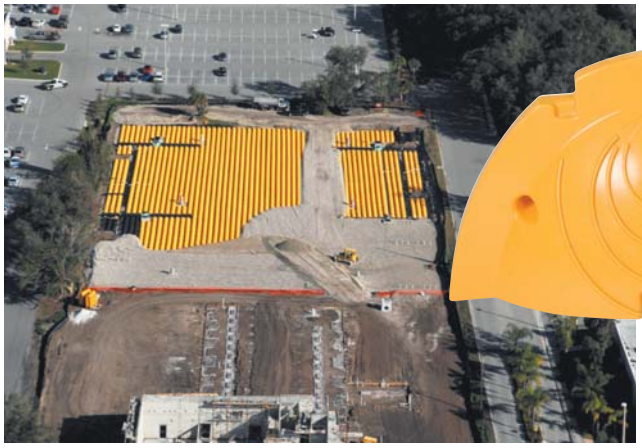
Innovation & Design

- **ID Credit 1 – Innovation in Design**
  Utilize StormTech System to substantially exceed a performance credit

StormTech SC-310 Chamber

SC-310 Chamber

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots thus maximizing land usage for commercial and municipal applications.



StormTech SC-310 Chamber (not to scale)

Nominal Chamber Specifications

Size (L x W x H)	85.4" x 34.0" x 16.0" (2170 x 864 x 406 mm)
Chamber Storage	14.7 ft³ (0.42 m³)
Min. Installed Storage*	31.0 ft³ (0.88 m³)
Weight	37.0 lbs (16.8 kg)

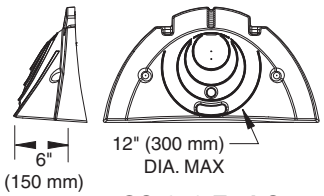
*Assumes 6" (150 mm) stone above, below and between chambers and 40% stone porosity.

Shipping

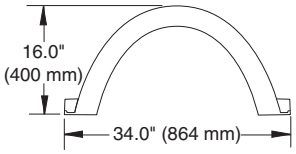
41 chambers/pallet

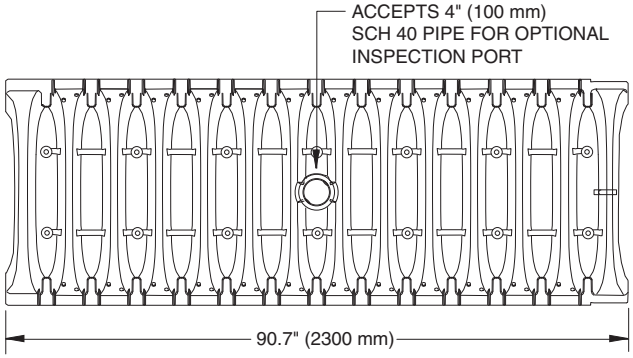
108 end caps/pallet

18 pallets/truck

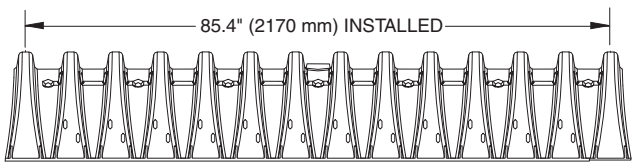


SC-310 End Cap





SC-310 Chamber



StormTech SC-310 Chamber

SC-310 Cumulative Storage Volumes Per Chamber

Assumes 40% Stone Porosity. Calculations are Based Upon a 6" (150 mm) Stone Base Under the Chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
28 (711)	14.70 (0.416)	31.00 (0.878)
27 (686)	14.70 (0.416)	30.21 (0.855)
26 (680)	Stone 14.70 (0.416)	29.42 (0.833)
25 (610)	Cover 14.70 (0.416)	28.63 (0.811)
24 (609)	14.70 (0.416)	27.84 (0.788)
23 (584)	14.70 (0.416)	27.05 (0.766)
22 (559)	14.70 (0.416)	26.26 (0.748)
21 (533)	14.64 (0.415)	25.43 (0.720)
20 (508)	14.49 (0.410)	24.54 (0.695)
19 (483)	14.22 (0.403)	23.58 (0.668)
18 (457)	13.68 (0.387)	22.47 (0.636)
17 (432)	12.99 (0.368)	21.25 (0.602)
16 (406)	12.17 (0.345)	19.97 (0.566)
15 (381)	11.25 (0.319)	18.62 (0.528)
14 (356)	10.23 (0.290)	17.22 (0.488)
13 (330)	9.15 (0.260)	15.78 (0.447)
12 (305)	7.99 (0.227)	14.29 (0.425)
11 (279)	6.78 (0.192)	12.77 (0.362)
10 (254)	5.51 (0.156)	11.22 (0.318)
9 (229)	4.19 (0.119)	9.64 (0.278)
8 (203)	2.83 (0.081)	8.03 (0.227)
7 (178)	1.43 (0.041)	6.40 (0.181)
6 (152)	0	4.74 (0.134)
5 (127)	0	3.95 (0.112)
4 (102)	0	3.16 (0.090)
3 (76)	Stone Foundation 0	2.37 (0.067)
2 (51)	0	1.58 (0.046)
1 (25)	0	0.79 (0.022)

Note: Add 0.79 cu. ft. (0.022 m³) of storage for each additional inch (25 mm) of stone foundation.

Storage Volume Per Chamber ft³ (m³)

	Bare Chamber Storage	Chamber and Stone Stone Foundation Depth in. (mm)		
	ft³ (m³)	6 (150)	12 (300)	18 (450)
StormTech SC-310	14.7 (0.4)	31.0 (0.9)	35.7 (1.0)	40.4 (1.1)

Note: Assumes 6" (150 mm) of stone above chambers, 6" (150 mm) row spacing and 40% stone porosity.

Amount of Stone Per Chamber

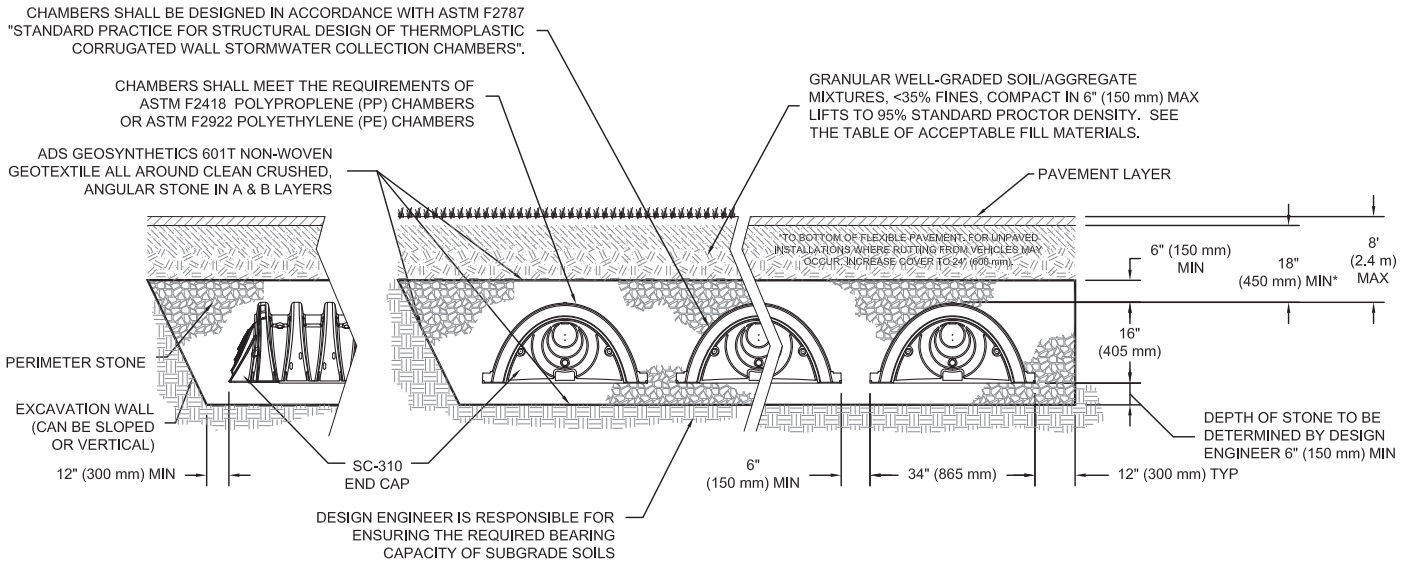
	Stone Foundation Depth		
ENGLISH TONS (yds³)	6"	12"	18"
StormTech SC-310	2.1 (1.5 yd³)	2.7 (1.9 yd³)	3.4 (2.4 yd³)
METRIC KILOGRAMS (m³)	**150 mm**	**300 mm**	**450 mm**
StormTech SC-310	1830 (1.1 m³)	2490 (1.5 m³)	2990 (1.8 m³)

Note: Assumes 6" (150 mm) of stone above, and between chambers.

Volume of Excavation Per Chamber yd³ (m³)

	Stone Foundation Depth		
	6" (150 mm)	12" (300 mm)	18" (450 mm)
StormTech SC-310	2.9 (2.2)	3.4 (2.6)	3.8 (2.9)

Note: Assumes 6" (150 mm) of row separation and 18" (450 mm) of cover. The volume of excavation will vary as the depth of the cover increases.



THE INSTALLED CHAMBER SYSTEM SHALL PROVIDE THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS SECTION 12.12 FOR EARTH AND LIVE LOADS, WITH CONSIDERATION FOR IMPACT AND MULTIPLE VEHICLE PRESENCES.

StormTech SC-310-3 Chamber

SC-310-3 Chamber

The proven strength and durability of the SC-310-3 Chamber allows for a design option for sites where limited cover, limited space, high water table and escalated aggregate cost are a factor. The SC-310-3 has a minimum cover requirement of 16" (400 mm) to bottom of pavement and reduces the spacing requirement between chambers by 50% to 3" (76 mm). This provides a reduced footprint overall and allows the designer to offer a traffic bearing application yet comply with water table separation regulations.

StormTech SC-310-3 Chamber (not to scale)

Nominal Chamber Specifications

Size (L x W x H)	85.4" x 34.0" x 16.0" (2170 x 864 x 406 mm)
Chamber Storage	14.7 ft³ (0.42 m³)
Min. Installed Storage*	29.3 ft³ (0.83 m³)
Weight	37.0 lbs (16.8 kg)

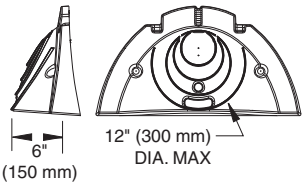
*Assumes 6" (150 mm) stone above and below chambers, 3" (76 mm) row spacing and 40% stone porosity.

Shipping

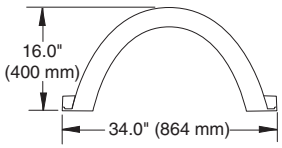
41 chambers/pallet

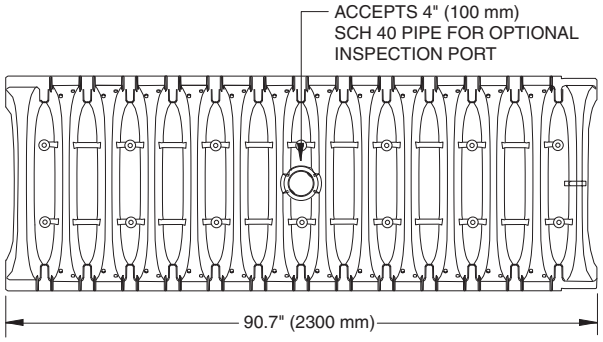
108 end caps/pallet

18 pallets/truck

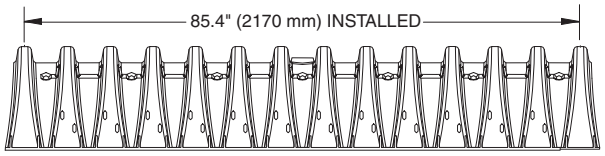


SC-310 End Cap

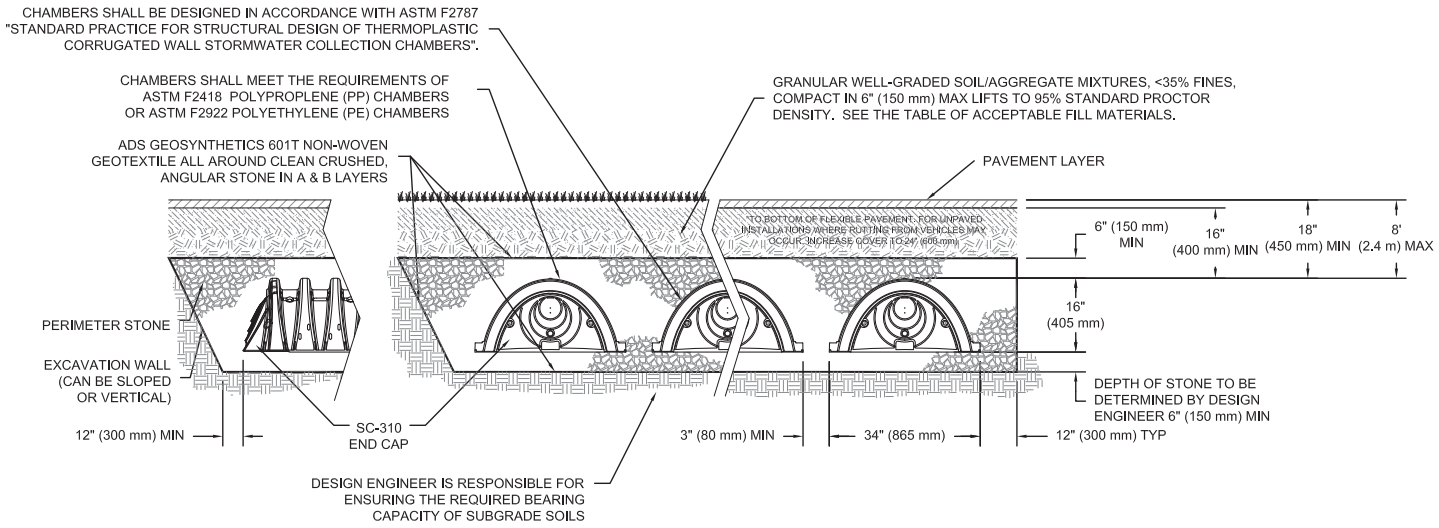




SC-310 Chamber



Typical Cross Section Detail



THE INSTALLED CHAMBER SYSTEM SHALL PROVIDE THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS SECTION 12.12 FOR EARTH AND LIVE LOADS, WITH CONSIDERATION FOR IMPACT AND MULTIPLE VEHICLE PRESENCES.

StormTech SC-310-3 Chamber

SC-310-3 Cumulative Storage Volume Per Chamber

Assumes 40% Stone Porosity. Calculations are Based Upon a 6" (150 mm) Stone Base Under the Chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
28 (711)	14.7 (0.416)	29.34 (0.831)
27 (686)	14.7 (0.416)	28.60 (0.810)
26 (660)	Stone 14.7 (0.416)	27.87 (0.789)
25 (635)	Cover 14.7 (0.416)	27.14 (0.769)
24 (610)	14.7 (0.416)	26.41 (0.748)
23 (584)	14.7 (0.416)	25.68 (0.727)
22 (559)	14.7 (0.416)	24.95 (0.707)
21 (533)	14.64 (0.415)	24.18 (0.685)
20 (508)	14.49 (0.410)	23.36 (0.661)
19 (483)	14.22 (0.403)	22.47 (0.636)
18 (457)	13.68 (0.387)	21.41 (0.606)
17 (432)	12.99 (0.368)	20.25 (0.573)
16 (406)	12.17 (0.345)	19.03 (0.539)
15 (381)	11.25 (0.319)	17.74 (0.502)
14 (356)	10.23 (0.290)	16.40 (0.464)
13 (330)	9.15 (0.260)	15.01 (0.425)
12 (305)	7.99 (0.226)	13.59 (0.385)
11 (279)	6.78 (0.192)	12.13 (0.343)
10 (254)	5.51 (0.156)	10.63 (0.301)
9 (229)	4.19 (0.119)	9.11 (0.258)
8 (203)	2.83 (0.080)	7.56 (0.214)
7 (178)	1.43 (0.040)	5.98 (0.169)
6 (152)	0	4.39 (0.124)
5 (127)	0	3.66 (0.104)
4 (102)	Stone Foundation 0	2.93 (0.083)
3 (76)	0	2.19 (0.062)
2 (51)	0	1.46 (0.041)
1 (25)	0	0.73 (0.021)

Note: Add 0.73 ft³ (0.021 m³) of storage for each additional inch (25 mm) of stone foundation.

Storage Volume per Chamber ft³ (m³)

	Bare Chamber Storage	Chamber and Stone Volume Stone Foundation Depth in. (mm)		
	ft³ (m³)	6 (150)	12 (300)	18 (450)
SC-310-3	14.7 (0.42)	29.3 (0.83)	33.7 (0.95)	38.1 (1.08)

Note: Assumes 6" (150 mm) of stone above chambers, 3" (76 mm) row spacing and 40% stone porosity.

Volume of Excavation Per Chamber yd³ (m³)

	Stone Foundation Depth		
	6" (150)	12" (300)	18" (450)
SC-310-3	2.6 (2.0)	3.0 (2.3)	3.4 (2.6)

Note: Assumes 3" (76 mm) of row separation, 6" (150 mm) of stone above the chambers and 16" (400 mm) of cover. The volume of excavation will vary as depth of cover increases.

Amount of Stone Per Chamber

ENGLISH TONS (yd³)	Stone Foundation Depth		
	6"	12"	18"
SC-310-3	1.9 (1.4)	2.5 (1.8)	3.1 (2.2)
METRIC KILOGRAMS (m³)	**150 mm**	**300 mm**	**450 mm**
SC-310-3	1724 (1.0)	2268 (1.3)	2812 (1.7)

Note: Assumes 6" (150 mm) of stone above chambers and 3" (76 mm) row spacing.

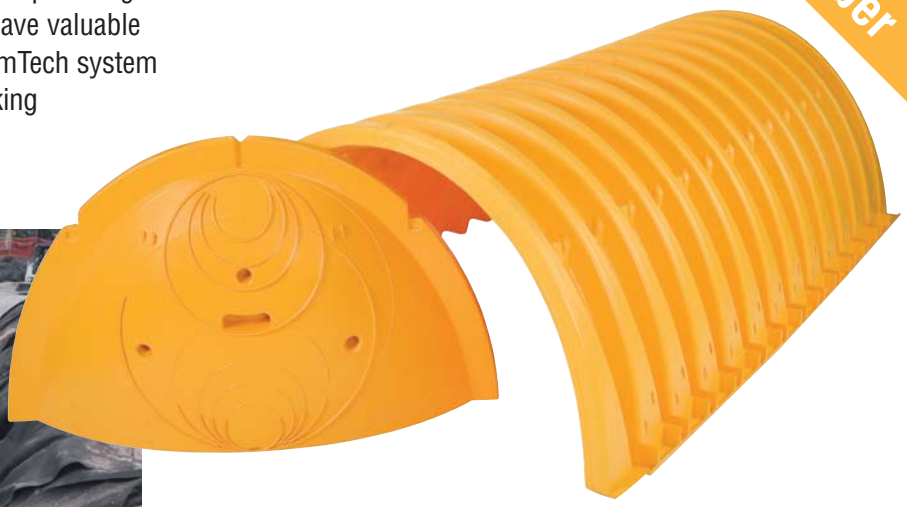
Cover ft (m)	Minimum Required Bearing Resistance for Service Loads ksf (kPa)										
	3.0 (144)	2.9 (139)	2.8 (134)	2.7 (129)	2.6 (124)	2.5 (120)	2.4 (115)	2.3 (110)	2.2 (105)	2.1 (101)	2.0 (96)
1.5 (0.46)	6 (152)	9 (229)	9 (229)	9 (229)	9 (229)	9 (229)	12 (305)	12 (305)	12 (305)	15 (381)	15 (381)
2 (0.61)	6 152)	6 (152)	9 (229)	9 (229)	9 (229)	9 (229)	12 (305)	12 (305)	12 (305)	15 (381)	15 (381)
2.5 (0.76)	6 (152)	6 (152)	6 (152)	6 (152)	6 (152)	9 (229)	9 (229)	9 (229)	12 (305)	12 (305)	12 (305)
3 (0.91)	6 (152)	6 (152)	6 (152)	6 (152)	6 (152)	6 (152)	9 (229)	9 (229)	9 (229)	9 (229)	12 (305)
3.5 (1.07)	6 (152)	6 (152)	6 (152)	6 (152)	6 (152)	6 (152)	6 (152)	9 (229)	9 (229)	9 (229)	12 (305)
4 (1.22)	6 152)	6 (152)	6 (152)	6 (152)	6 (152)	6 (152)	6 (152)	9 (229)	9 (229)	9 (229)	9 (229)
4.5 (1.37)	6 152)	6 (152)	6 (152)	6 (152)	6 (152)	6 (152)	6 (152)	6 (152)	9 (229)	9 (229)	9 (229)
5 (1.52)	6 (152)	6 (152)	6 (152)	6 (152)	6 (152)	6 (152)	6 (152)	9 (229)	9 (229)	9 (229)	9 (229)
5.5 (1.68)	6 (152)	6 (152)	6 (152)	6 (152)	6 (152)	6 (152)	6 (152)	9 (229)	9 (229)	9 (229)	12 (305)
6 (1.83)	6 (152)	6 (152)	6 (152)	6 (152)	6 (152)	6 (152)	9 (229)	9 (229)	9 (229)	9 (229)	12 (305)
6.5 (1.98)	6 (152)	6 (152)	6 (152)	6 (152)	6 (152)	6 (152)	9 (229)	9 (229)	9 (229)	12 (305)	12 (305)
7 (2.13)	6 (152)	6 (152)	6 (152)	6 (152)	6 (152)	9 (229)	9 (229)	9 (229)	9 (229)	12 (305)	12 (305)
7.5 (2.29)	6 (152)	6 (152)	6 (152)	6 (152)	9 (229)	9 (229)	9 (229)	9 (229)	12 (305)	12 (305)	12 (305)
8 (2.44)	6 (152)	6 (152)	6 (152)	9 (229)	9 (229)	9 (229)	9 (229)	12 (305)	12 (305)	12 (305)	15 (381)

NOTE: The design engineer is solely responsible for assessing the bearing resistance (allowable bearing capacity) of the subgrade soils and determining the depth of foundation stone. Subgrade bearing resistance should be assessed with consideration for the range of soil moisture conditions expected under a stormwater system.

StormTech SC-740 Chamber

SC-740 Chamber

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots thus maximizing land usage for commercial and municipal applications.



StormTech SC-740 Chamber (not to scale)

Nominal Chamber Specifications

Size (L x W x H)	85.4" x 51.0" x 30.0" (2170 x 1295 x 762 mm)
Chamber Storage	45.9 ft³ (1.30 m³)
Min. Installed Storage*	74.9 ft³ (2.12 m³)
Weight	74.0 lbs (33.6 kg)

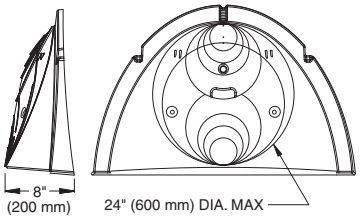
*Assumes 6" (150 mm) stone above, below and between chambers and 40% stone porosity.

Shipping

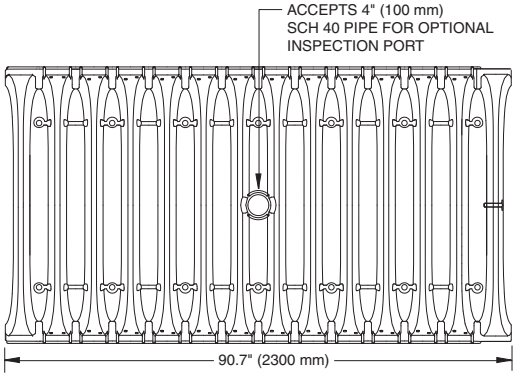
30 chambers/pallet

60 end caps/pallet

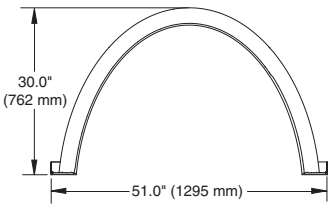
12 pallets/truck

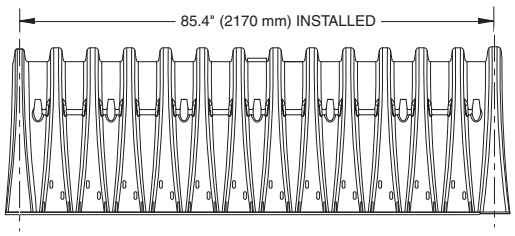


SC-740 End Cap



SC-740 Chamber





StormTech SC-740 Chamber

SC-740 Cumulative Storage Volumes Per Chamber

Assumes 40% Stone Porosity. Calculations are Based Upon a 6" (150 mm) Stone Base Under the Chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage Ft³ (m³)	Total System Cumulative Storage Ft³ (m³)
42 (1067)	45.90 (1.300)	74.90 (2.121)
41 (1041)	45.90 (1.300)	73.77 (2.089)
40 (1016)	Stone 45.90 (1.300)	72.64 (2.057)
39 (991)	Cover 45.90 (1.300)	71.52 (2.025)
38 (965)	45.90 (1.300)	70.39 (1.993)
37 (948)	45.90 (1.300)	69.26 (1.961)
36 (914)	45.90 (1.300)	68.14 (1.929)
35 (889)	45.85 (1.298)	66.98 (1.897)
34 (864)	45.69 (1.294)	65.75 (1.862)
33 (838)	45.41 (1.286)	64.46 (1.825)
32 (813)	44.81 (1.269)	62.97 (1.783)
31 (787)	44.01 (1.246)	61.36 (1.737)
30 (762)	43.06 (1.219)	59.66 (1.689)
29 (737)	41.98 (1.189)	57.89 (1.639)
28 (711)	40.80 (1.155)	56.05 (1.587)
27 (686)	39.54 (1.120)	54.17 (1.534)
26 (660)	38.18 (1.081)	52.23 (1.479)
25 (635)	36.74 (1.040)	50.23 (1.422)
24 (610)	35.22 (0.977)	48.19 (1.365)
23 (584)	33.64 (0.953)	46.11 (1.306)
22 (559)	31.99 (0.906)	44.00 (1.246)
21 (533)	30.29 (0.858)	41.85 (1.185)
20 (508)	28.54 (0.808)	39.67 (1.123)
19 (483)	26.74 (0.757)	37.47 (1.061)
18 (457)	24.89 (0.705)	35.23 (0.997)
17 (432)	23.00 (0.651)	32.96 (0.939)
16 (406)	21.06 (0.596)	30.68 (0.869)
15 (381)	19.09 (0.541)	28.36 (0.803)
14 (356)	17.08 (0.484)	26.03 (0.737)
13 (330)	15.04 (0.426)	23.68 (0.670)
12 (305)	12.97 (0.367)	21.31 (0.608)
11 (279)	10.87 (0.309)	18.92 (0.535)
10 (254)	8.74 (0.247)	16.51 (0.468)
9 (229)	6.58 (0.186)	14.09 (0.399)

SC-740 Cumulative Storage Volumes Per Chamber (cont.)

Depth of Water in System Inches (mm)	Cumulative Chamber Storage Ft³ (m³)	Total System Cumulative Storage Ft³ (m³)
8 (203)	4.41 (0.125)	11.66 (0.330)
7 (178)	2.21 (0.063)	9.21 (0.264)
6 (152)	0	6.76 (0.191)
5 (127)	0	5.63 (0.160)
4 (102)	Stone Foundation 0	4.51 (0.125)
3 (76)	0	3.38 (0.095)
2 (51)	0	2.25 (0.064)
1 (25)	0	1.13 (0.032)

Note: Add 1.13 cu. ft. (0.032 m³) of storage for each additional inch (25 mm) of stone foundation.

Storage Volume Per Chamber ft³ (m³)

	Bare Chamber Storage ft³ (m³)	Chamber and Stone Stone Foundation Depth in. (mm)		
		6 (150)	12 (300)	18 (450)
StormTech SC-740	45.9 (1.3)	74.9 (2.1)	81.7 (2.3)	88.4 (2.5)

Note: Assumes 6" (150 mm) of stone above chambers, 6" (150 mm) row spacing and 40% porosity.

Amount of Stone Per Chamber

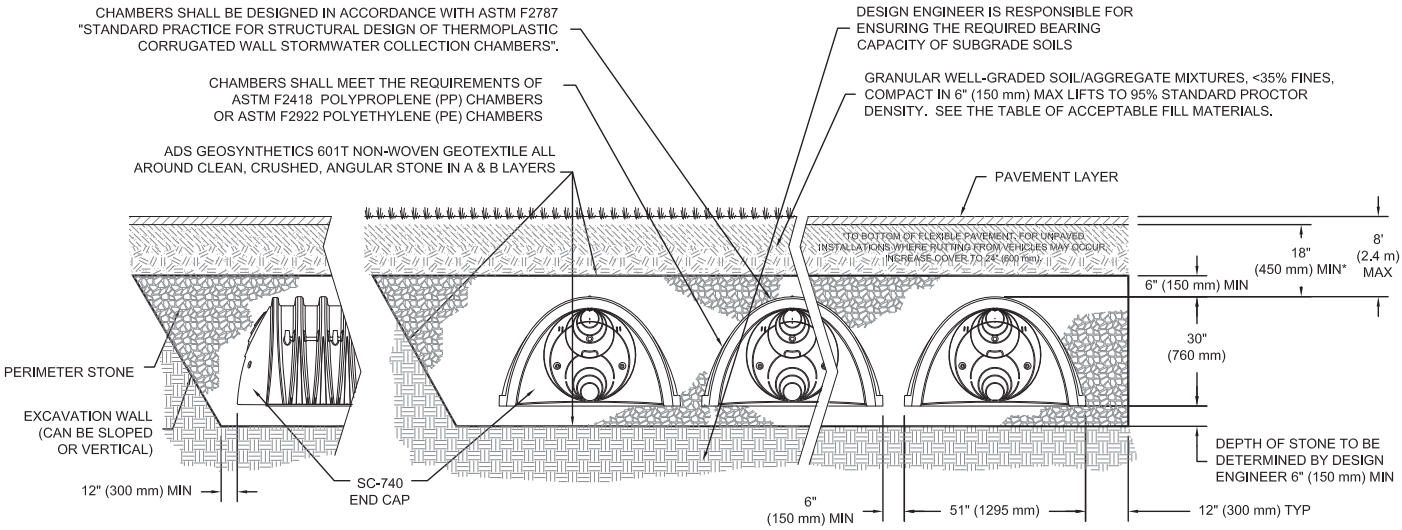
	Stone Foundation Depth		
ENGLISH TONS (yd³)	6"	12"	18"
StormTech SC-740	3.8 (2.8 yd³)	4.6 (3.3 yd³)	5.5 (3.9 yd³)
METRIC KILOGRAMS (m³)	**150 mm**	**300 mm**	**450 mm**
StormTech SC-740	3450 (2.1 m³)	4170 (2.5 m³)	4490 (3.0 m³)

Note: Assumes 6" (150 mm) of stone above, and between chambers.

Volume of Excavation Per Chamber yd³ (m³)

	Stone Foundation Depth		
	6" (150 mm)	12" (300 mm)	18" (450 mm)
StormTech SC-740	5.5 (4.2)	6.2 (4.7)	6.8 (5.2)

Note: Assumes 6" (150 mm) of row separation and 18" (450 mm) of cover. Volume of excavation will vary as depth of cover increases.



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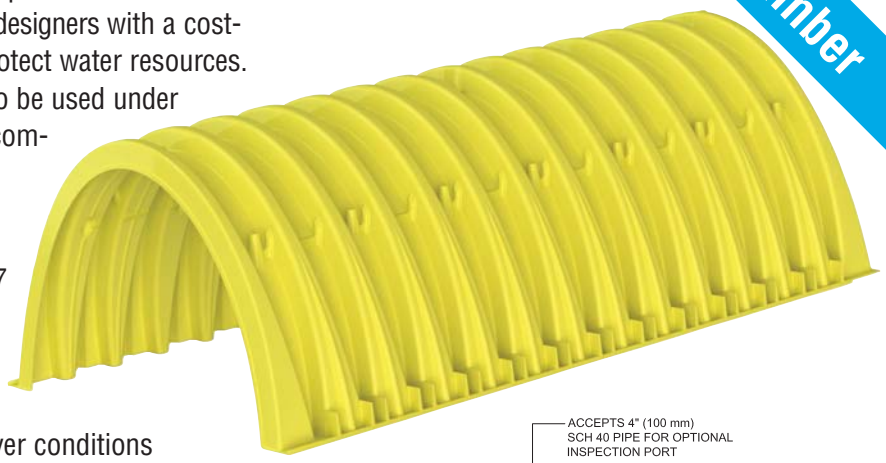
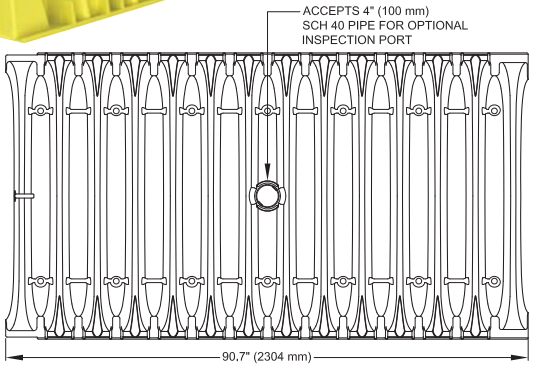
StormTech DC-780 Chamber

DC-780 Chamber

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots thus maximizing land usage for commercial and municipal applications.

- 12' Deep Cover applications.
- Designed in accordance with ASTM F 2787 and produced to meet the ASTM F 2418 product standard.
- AASHTO safety factors provided for AASHTO Design Truck (H20) and deep cover conditions





StormTech DC-780 Chamber (not to scale)

Nominal Chamber Specifications

Size (L x W x H)	85.4" x 51.0" x 30.0" (2169 x 1295 x 762 mm)
Chamber Storage	46.2 ft³ (1.3 m³)
Min. Installed Storage*	78.4 ft³ (2.2 m³)

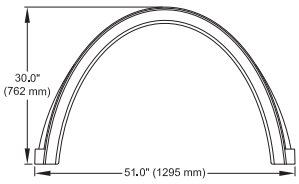
* Assumes 9" (230 mm) stone below, 6" (150 mm) stone above, 6" (150 mm) row spacing and 40% stone porosity.

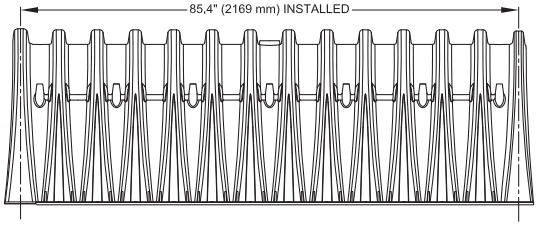
Shipping

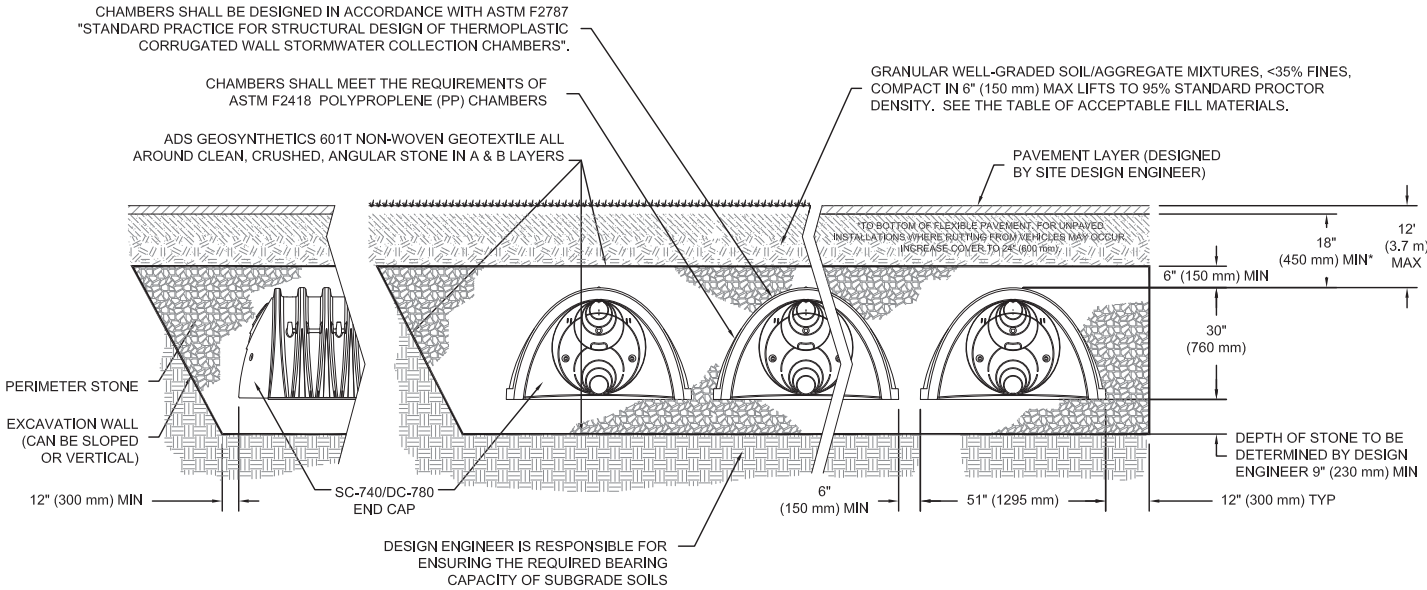
24 chambers/pallet

60 end caps/pallet

12 pallets/truck







THE INSTALLED CHAMBER SYSTEM SHALL PROVIDE THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS SECTION 12.12 FOR EARTH AND LIVE LOADS, WITH CONSIDERATION FOR IMPACT AND MULTIPLE VEHICLE PRESENCES.

StormTech DC-780 Chamber

DC-780 Cumulative Storage Volumes Per Chamber

Assumes 40% Stone Porosity. Calculations are Based Upon a 9" (230 mm) Stone Base Under the Chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
45 (1143)	46.27 (1.310)	78.47 (2.222)
44 (1118)	46.27 (1.310)	77.34 (2.190)
43 (1092)	Stone 46.27 (1.310)	76.21 (2.158)
42 (1067)	Cover 46.27 (1.310)	75.09 (2.126)
41 (1041)	46.27 (1.310)	73.96 (2.094)
40 (1016)	46.27 (1.310)	72.83 (2.062)
39 (991)	46.27 (1.310)	71.71 (2.030)
38 (965)	46.21 (1.309)	70.54 (1.998)
37 (940)	46.04 (1.304)	69.32 (1.963)
36 (914)	45.76 (1.296)	68.02 (1.926)
35 (889)	45.15 (1.278)	66.53 (1.884)
34 (864)	44.34 (1.255)	64.91 (1.838)
33 (838)	43.38 (1.228)	63.21 (1.790)
32 (813)	42.29 (1.198)	61.43 (1.740)
31 (787)	41.11 (1.164)	59.59 (1.688)
30 (762)	39.83 (1.128)	57.70 (1.634)
29 (737)	38.47 (1.089)	55.76 (1.579)
28 (711)	37.01 (1.048)	53.76 (1.522)
27 (686)	35.49 (1.005)	51.72 (1.464)
26 (660)	33.90 (0.960)	49.63 (1.405)
25 (635)	32.24 (0.913)	47.52 (1.346)
24 (610)	30.54 (0.865)	45.36 (1.285)
23 (584)	28.77 (0.815)	43.18 (1.223)
22 (559)	26.96 (0.763)	40.97 (1.160)
21 (533)	25.10 (0.711)	38.72 (1.096)
20 (508)	23.19 (0.657)	36.45 (1.032)
19 (483)	21.25 (0.602)	34.16 (0.967)
18 (457)	19.26 (0.545)	31.84 (0.902)
17 (432)	17.24 (0.488)	29.50 (0.835)
16 (406)	15.19 (0.430)	27.14 (0.769)
15 (381)	13.10 (0.371)	24.76 (0.701)
14 (356)	10.98 (0.311)	22.36 (0.633)
13 (330)	8.83 (0.250)	19.95 (0.565)
12 (305)	6.66 (0.189)	17.52 (0.496)
11 (279)	4.46 (0.126)	15.07 (0.427)

DC-780 Cumulative Storage Volumes Per Chamber (cont.)

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
10 (254)	2.24 (0.064)	12.61 (0.357)
9 (229)	0	10.14 (0.287)
8 (203)	0	9.01 (0.255)
7 (178)	0	7.89 (0.223)
6 (152)	0	6.76 (0.191)
5 (127)	Stone Foundation 0	5.63 (0.160)
4 (102)	0	4.51 (0.128)
3 (76)	0	3.38 (0.096)
2 (51)	0	2.25 (0.064)
1 (25)	0	1.13 (0.032)

Note: Add 1.13 cu. ft. (0.032 m³) of storage for each additional inch (25 mm) of stone foundation.

Storage Volume Per Chamber ft³ (m³)

	Bare Chamber Storage ft³ (m³)	Chamber and Stone Volume- Stone Foundation Depth inches (millimeters)		
		9 (230)	12 (300)	18 (450)
StormTech DC-780	46.2 (1.3)	78.4 (2.2)	81.8 (2.3)	88.6 (2.5)

Note: Assumes 40% porosity for the stone, the bare chamber volume, 6" (150 mm) stone above, and 6" (150 mm) row spacing.

Amount of Stone Per Chamber

	Stone Foundation Depth		
ENGLISH TONS (YD³)	9"	12"	18"
StormTech DC-780	4.2 (3.0 yd³)	4.7 (3.3 yd³)	5.6 (3.9 yd³)
METRIC KILOGRAMS (M³)	**230 mm**	**300 mm**	**450 mm**
StormTech DC-780	3810 (2.3 m³)	4264 (2.5 m³)	5080 (3.0 m³)

Note: Assumes 6" (150 mm) of stone above, and between chambers.

Volume of Excavation Per Chamber yd³ (m³)

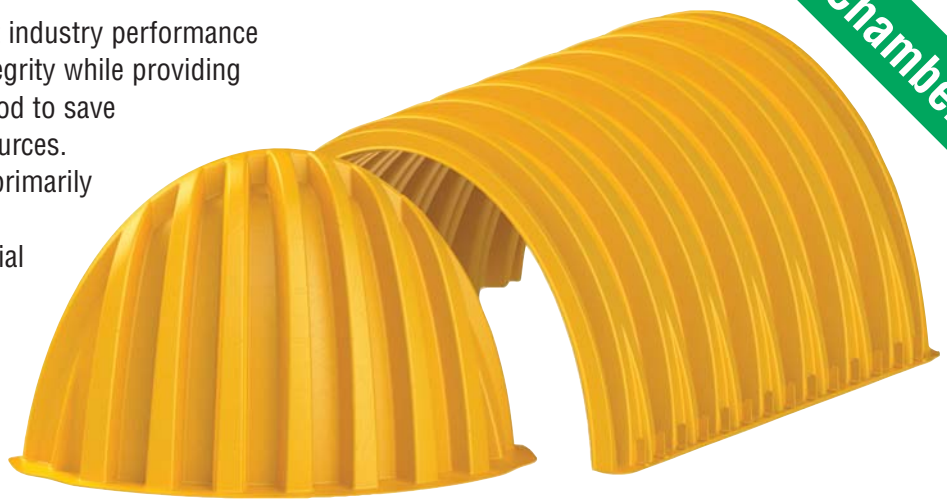
	Stone Foundation Depth		
	9" (230 mm)	12" (300 mm)	18" (450 mm)
StormTech DC-780	5.9 (4.5)	6.3 (4.8)	6.9 (5.3)

Note: Assumes 6" (150 mm) of separation between chamber rows and 18" (450 mm) of cover. The volume of excavation will vary as the depth of the cover increases.

StormTech MC-3500 Chamber

MC-3500 Chamber

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots thus maximizing land usage for commercial and municipal applications.



StormTech MC-3500 Chamber (not to scale)

Nominal Chamber Specifications

Size (L x W x H)	90" (2286 mm) x 77" (1956 mm) x 45" (1143 mm)
Chamber Storage	109.9 ft³ (3.11 m³)
Min. Installed Storage*	178.9 ft³ (5.06 m³)
Weight	134 lbs (60.8 kg)

* This assumes a minimum of 12" (300 mm) of stone above, 9" (230 mm) of stone below chambers, 9" (230 mm) of stone between chambers/end caps and 40% stone porosity.

StormTech MC-3500 End Cap (not to scale)

Nominal End Cap Specifications

Size (L x W x H)	26.5" (673 mm) x 71" (1803 mm) x 45.1" (1145 mm)
End Cap Storage	14.9 ft³ (0.42 m³)
Min. Installed Storage*	46.0 ft³ (1.30 m³)
Weight	49 lbs (22.2 kg)

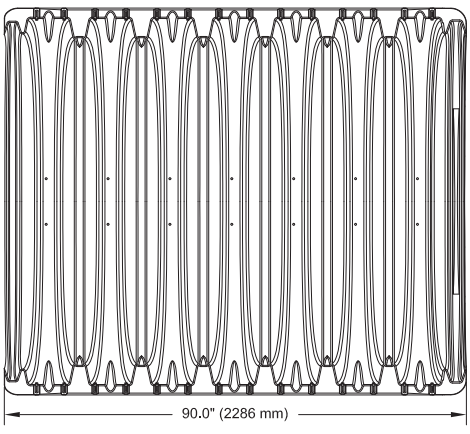
*This assumes a minimum of 12" (300 mm) of stone above, 9" (230 mm) of stone below, 6" (150 mm) of stone perimeter, 9" (230 mm) of stone between chambers/end caps and 40% stone porosity.

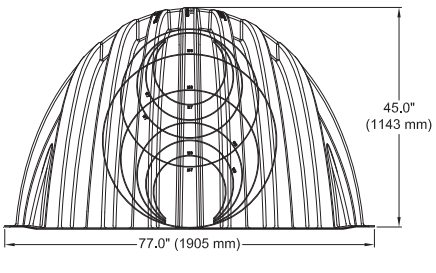
Shipping

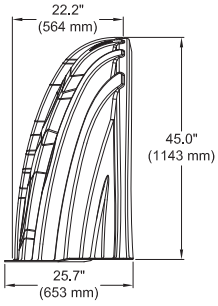
15 chambers/pallet

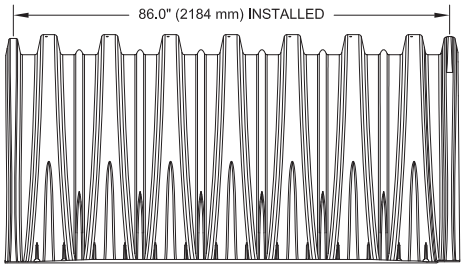
16 end caps/pallet

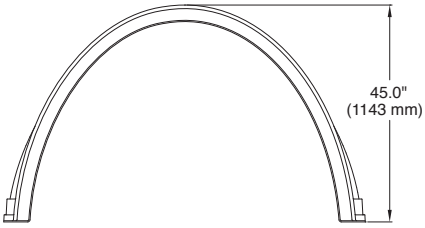
7 pallets/truck











StormTech MC-3500 Chamber

Storage Volume Per Chamber/End Cap ft³ (m³)

	Bare Unit Storage	Chamber/End Cap and Stone Volume — Stone Foundation Depth in. (mm)			
	ft³ (m³)	9 (230)	12 (300)	15 (375)	18 (450)
MC-3500 Chamber	109.9 (3.11)	178.9 (5.06)	184.0 (5.21)	189.2 (5.36)	194.3 (5.5)
MC-3500 End Cap	14.9 (0.42)	46.0 (1.33)	47.7 (1.35)	49.4 (1.40)	51.1 (1.45)

NOTE: Assumes 9" (230 mm) row spacing, 40% stone porosity, 12" (300 mm) stone above and includes the bare chamber/end cap volume. End cap volume assumes 6" (150 mm) stone perimeter.

Amount of Stone Per Chamber

ENGLISH tons (yd³)	Stone Foundation Depth			
	9"	12"	15"	18"
MC-3500	9.1 (6.4 yd³)	9.7 (6.9 yd³)	10.4 (7.3 yd³)	11.1 (7.8 yd³)
End Cap	4.1 (2.9 yd³)	4.3 (3.0 yd³)	4.5 (3.2 yd³)	4.7 (3.3 yd³)
METRIC kg (m³)	**230 mm**	**300 mm**	**375 mm**	**450 mm**
MC-3500	8220 (4.9 m³)	8831 (5.3 m³)	9443 (5.6 m³)	10054 (6.0 m³)
End Cap	3699 (2.2 m³)	3900 (2.3 m³)	4100 (2.5 m³)	4301 (2.6 m³)

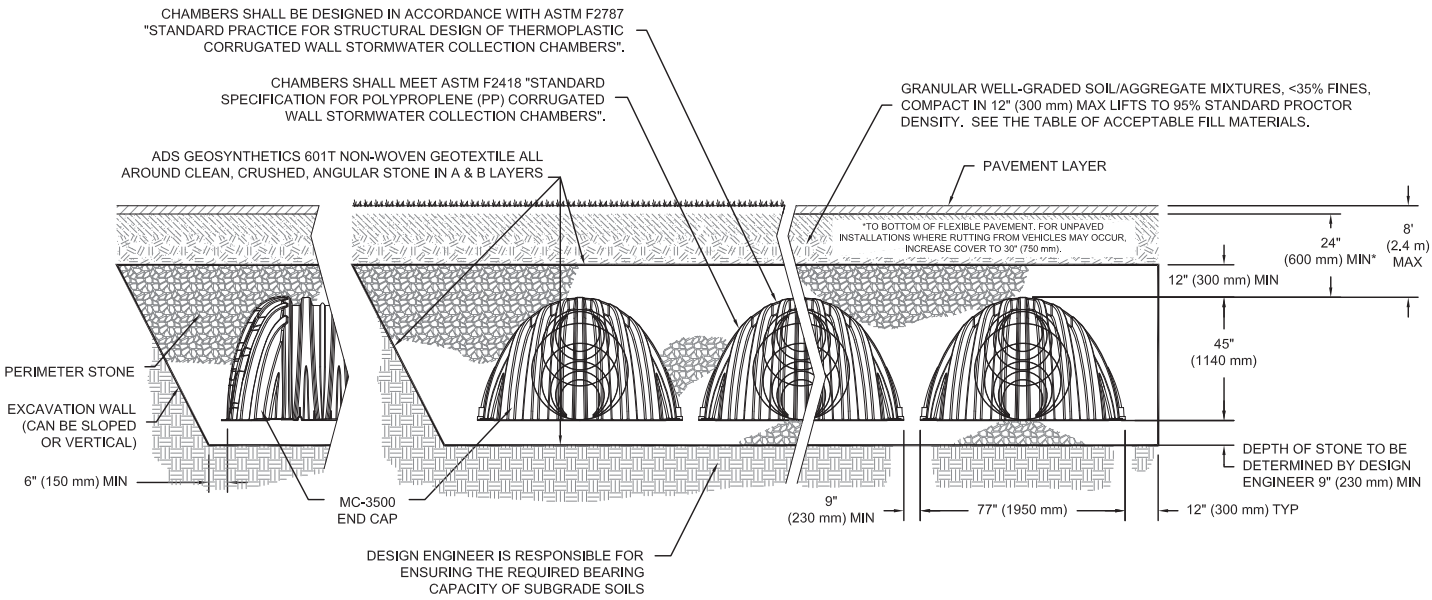
NOTE: Assumes 12" (300 mm) of stone above, and 9" (230 mm) row spacing, and 6" (150 mm) of perimeter stone in front of end caps.

Volume of Excavation Per Chamber/End Cap in yd³ (m³)

	Stone Foundation Depth			
	9" (230 mm)	12" (300 mm)	15" (375 mm)	18" (450 mm)
MC-3500	12.4 (9.5)	12.8 (9.8)	13.3 (10.2)	13.8 (10.5)
End Cap	4.1 (3.1)	4.2 (3.2)	4.4 (3.3)	4.5 (3.5)

NOTE: Assumes 9" (230 mm) of separation between chamber rows and 24" (600 mm) of cover. The volume of excavation will vary as the depth of cover increases.

General Cross Section

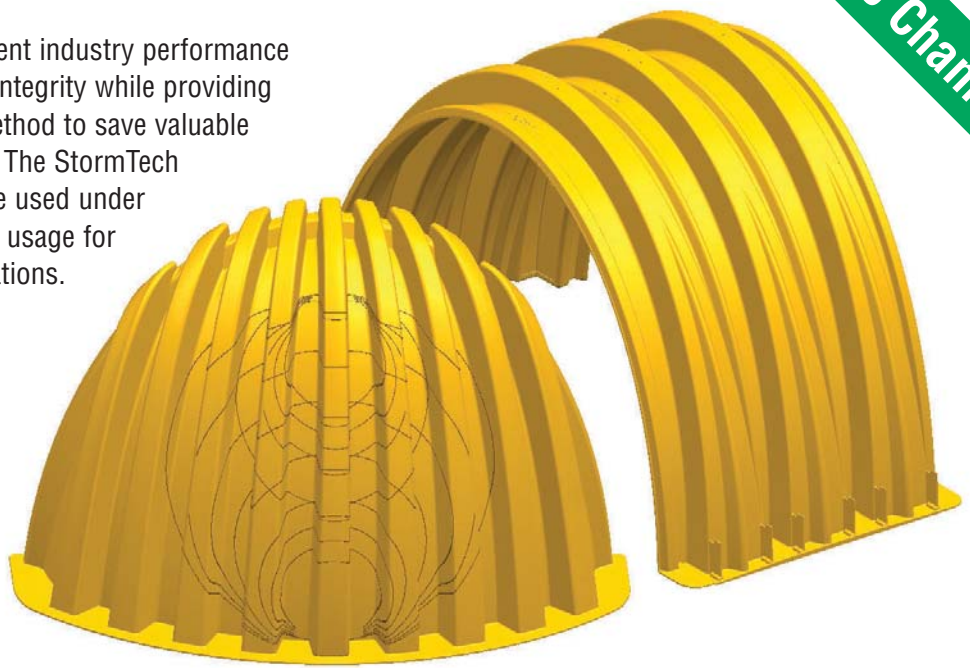


THE INSTALLED CHAMBER SYSTEM SHALL PROVIDE THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS SECTION 12.12 FOR EARTH AND LIVE LOADS, WITH CONSIDERATION FOR IMPACT AND MULTIPLE VEHICLE PRESENCES.

StormTech MC-4500 Chamber

MC-4500 Chamber

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots thus maximizing land usage for commercial and municipal applications.



StormTech MC-4500 Chamber (not to scale)

Nominal Chamber Specifications

Size (L x W x H)	52" (1321 mm) x 100" (2540 mm) x 60" (1524 mm)
Chamber Storage	106.5 ft³ (3.01 m³)
Min. Installed Storage*	162.6 ft³ (4.60 m³)
Nominal Weight	120 lbs (54.4 kg)

* This assumes a minimum of 12" (300 mm) of stone above, 9" (230 mm) of stone below chambers, 9" (230 mm) of stone between chambers/end caps and 40% stone porosity.

StormTech MC-4500 End Cap (not to scale)

Nominal End Cap Specifications

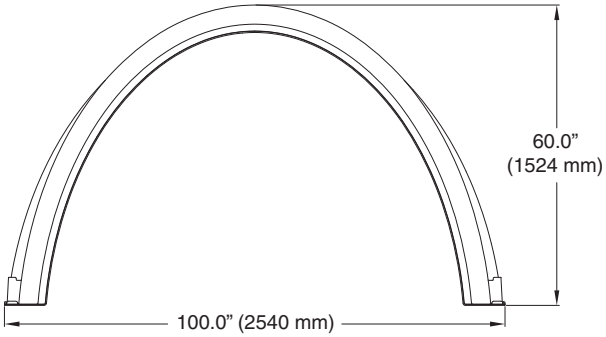
Size (L x W x H)	35.1" (891 mm) x 90.2" (2291 mm) x 59.4" (1509 mm)
End Cap Storage	35.7 ft³ (1.01 m³)
Min. Installed Storage*	108.7 ft³ (3.08 m³)
Nominal Weight	120 lbs (54.4 kg)

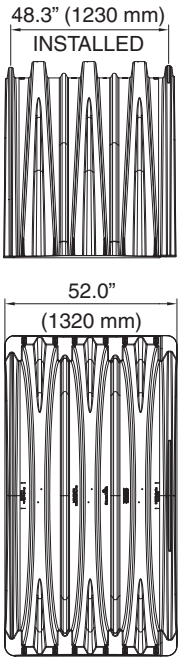
*This assumes a minimum of 12" (300 mm) of stone above, 9" (230 mm) of stone below, 12" (300 mm) of stone perimeter, 9" (230 mm) of stone between chambers/end caps and 40% stone porosity.

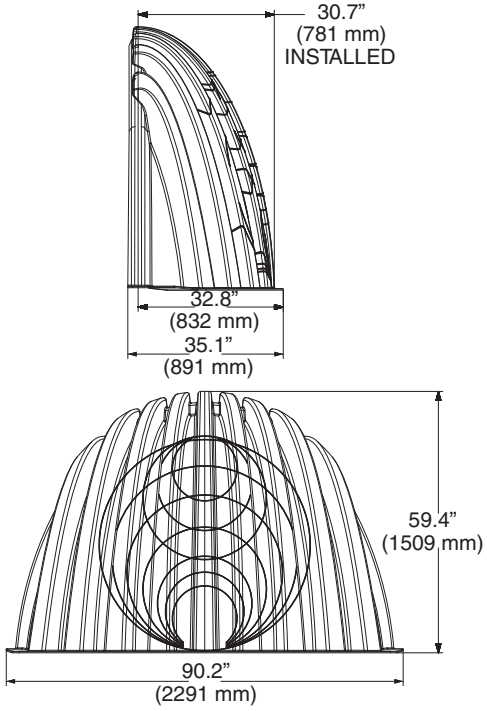
Shipping

7 chambers/pallet

11 pallets/truck







StormTech MC-4500 Chamber

Storage Volume Per Chamber/End Cap ft³ (m³)

	Bare Unit Storage	Chamber/End Cap and Stone Volume — Stone Foundation Depth in. (mm)			
	ft³ (m³)	9 (230)	12 (300)	15 (375)	18 (450)
MC-4500 Chamber	106.5 (3.02)	162.6 (4.60)	166.3 (4.71)	169.9 (4.81)	173.6 (4.91)
MC-4500 End Cap	35.7 (1.01)	108.7 (3.08)	111.9 (3.17)	115.2 (3.26)	118.4 (3.35)

NOTE: Assumes 9" (230 mm) row spacing, 40% stone porosity, 12" (300 mm) stone above and includes the bare chamber/end cap volume. End cap volume assumes 12" (300 mm) stone perimeter.

Amount of Stone Per Chamber

ENGLISH tons (yd³)	Stone Foundation Depth			
	9"	12"	15"	18"
MC-4500	7.4 (5.2)	7.8 (5.5)	8.3 (5.9)	8.8 (6.2)
End Cap	9.6 (6.8)	10.0 (7.1)	10.4 (7.4)	10.9 (7.7)
METRIC kg (m³)	**230 mm**	**300 mm**	**375 mm**	**450 mm**
MC-4500	6681 (4.0)	7117 (4.2)	7552 (4.5)	7987 (4.7)
End Cap	8691 (5.2)	9075 (5.4)	9460 (5.6)	9845 (5.9)

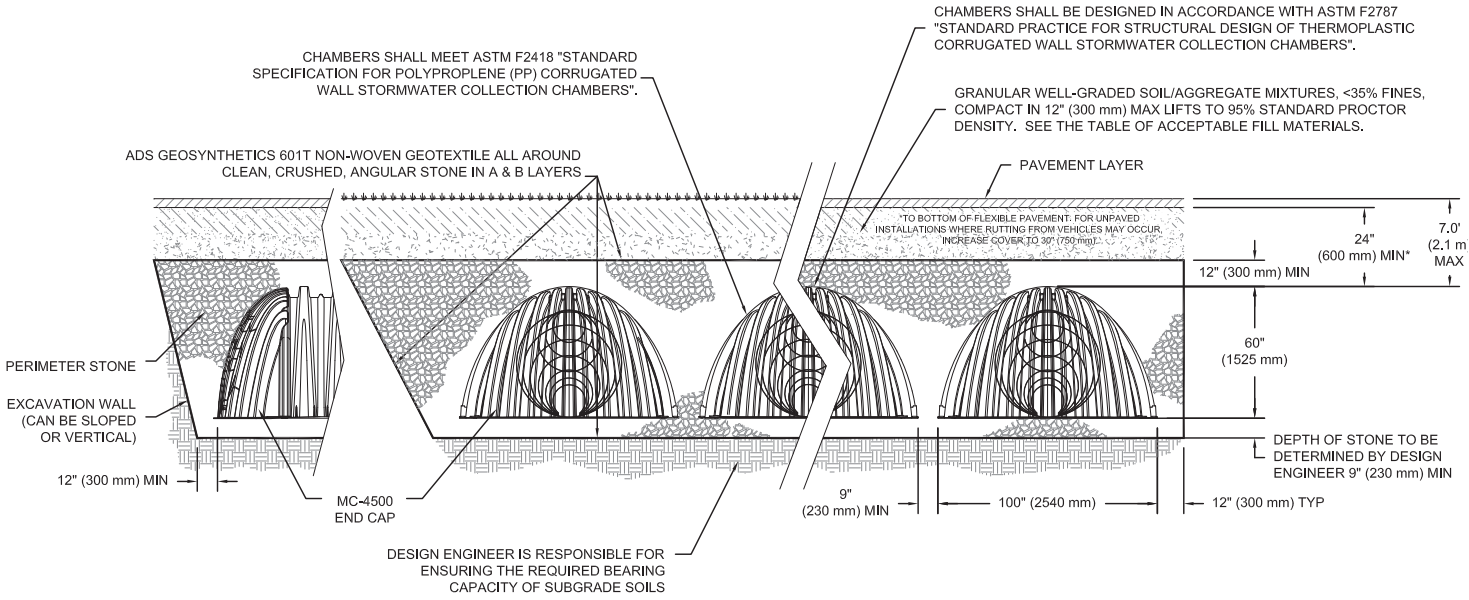
NOTE: Assumes 12" (300 mm) of stone above, 9" (230 mm) row spacing, and 12" (300 mm) of perimeter stone in front of end caps.

Volume of Excavation Per Chamber/End Cap in yd³ (m³)

	Stone Foundation Depth			
	9" (230 mm)	12" (300 mm)	15" (380 mm)	18" (450 mm)
MC-4500	10.5 (8.0)	10.8 (8.3)	11.2 (8.5)	11.5 (8.8)
End Cap	9.3 (7.1)	9.6 (7.3)	9.9 (7.6)	10.2 (7.8)

NOTE: Assumes 9" (230 mm) of separation between chamber rows, 12" (300 mm) of perimeter in front of end caps, and 24" (600 mm) of cover. The volume of excavation will vary as the depth of cover increases.

General Cross Section



THE INSTALLED CHAMBER SYSTEM SHALL PROVIDE THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS SECTION 12.12 FOR EARTH AND LIVE LOADS, WITH CONSIDERATION FOR IMPACT AND MULTIPLE VEHICLE PRESENCES.

StormTech Isolator™ Row

An important component of any Stormwater Pollution Prevention Plan is inspection and maintenance. The StormTech Isolator Row is a patent pending technique to inexpensively enhance Total Suspended Solids (TSS) removal and provide easy access for inspection and maintenance.

The Isolator Row is a row of StormTech chambers that is surrounded with filter fabric and connected to a closely located manhole for easy access. The fabric-wrapped chambers provide for settling and filtration of sediment as stormwater rises in the Isolator Row and ultimately passes through the filter fabric. The open bottom chambers and perforated sidewalls (SC-310, SC-310-3, and SC-740 models) allow stormwater to flow both vertically and horizontally out of the chambers. Sediments are captured in the Isolator Row, protecting the storage areas of the adjacent stone and chambers from sediment accumulation.

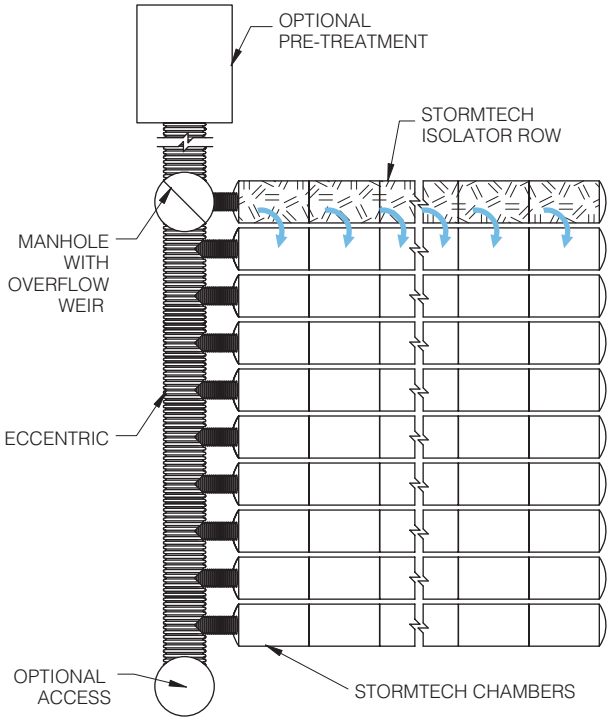
Two different fabrics are used for the Isolator Row. A woven geotextile fabric is placed between the stone and the Isolator Row chambers. The tough geotextile provides a media for stormwater filtration and provides a durable surface for maintenance operations. It is also designed to prevent scour of the underlying stone and remain intact during high pressure jetting. A non-woven fabric is placed over the chambers to provide a filter media for flows passing through the perforations in the sidewall of the chamber. The non-woven fabric is not required over the DC-780, MC-3500 or MC-4500 models as these chambers do not have perforated side walls.

The Isolator Row is typically designed to capture the "first flush" and offers the versatility to be sized on a volume basis or flow rate basis. An upstream manhole not only provides access to the Isolator Row, but typically includes a high flow weir such that stormwater flow rates or volumes that exceed the capacity of the Isolator Row crest the weir and discharge through a manifold to the other chambers.

The Isolator Row may also be part of a treatment train. By treating stormwater prior to entry into the chamber system, the service life can be extended and pollutants such as hydrocarbons can be captured. Pre-treatment best management practices can be as simple as deep sump catch basins and oil-water separators or can be innovative storm water treatment devices. The design of the treatment train and selection of pretreatment devices by the design engineer is often driven by regulatory requirements. Whether pretreatment is used or not, the Isolator Row is recommended by StormTech as an effective means to minimize maintenance requirements and maintenance costs.

Note: See the StormTech Design Manual for detailed information on designing inlets for a StormTech system, including the Isolator Row.

StormTech Isolator Row with Overflow Spillway
(not to scale)



StormTech Isolator Row

INSPECTION

The frequency of Inspection and Maintenance varies by location. A routine inspection schedule needs to be established for each individual location based upon site specific variables. The type of land use (i.e. industrial, commercial, residential), anticipated pollutant load, percent imperviousness, climate, etc. all play a critical role in determining the actual frequency of inspection and maintenance practices.

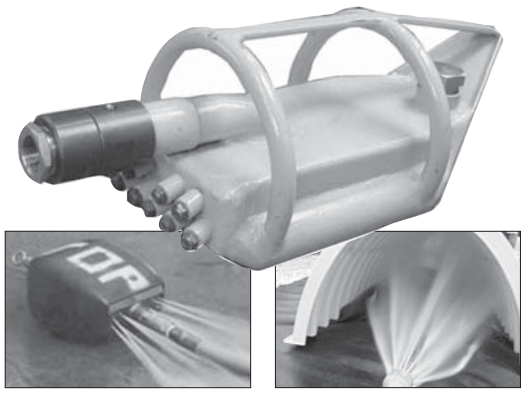
At a minimum, StormTech recommends annual inspections. Initially, the Isolator Row should be inspected every 6 months for the first year of operation. For subsequent years, the inspection should be adjusted based upon previous observation of sediment deposition.

The Isolator Row incorporates a combination of standard manhole(s) and strategically located inspection ports (as needed). The inspection ports allow for easy access to the system from the surface, eliminating the need to perform a confined space entry for inspection purposes.

If, upon visual inspection it is found that sediment has accumulated, a stadia rod should be inserted to determine the depth of sediment. When the average depth of sediment exceeds 3 inches throughout the length of the Isolator Row, clean-out should be performed.

MAINTENANCE

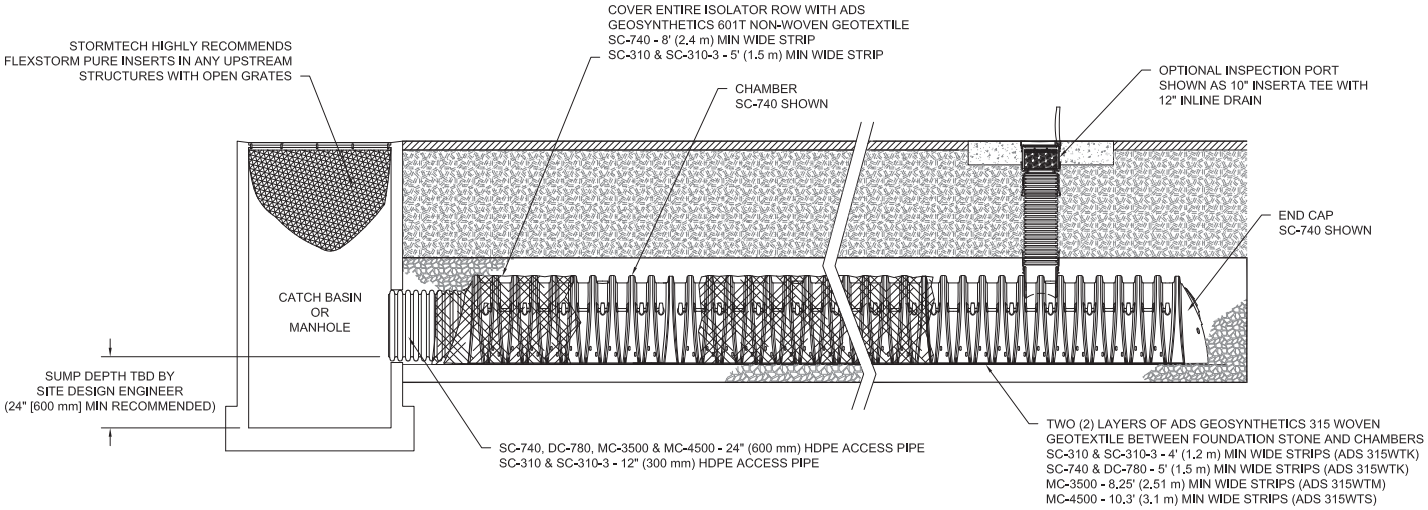
The Isolator Row was designed to reduce the cost of periodic maintenance. By "isolating" sediments to just one row, costs are dramatically reduced by eliminating the need to clean out each row of the entire storage bed. If inspection indicates the potential need for maintenance, access is provided via a manhole(s) located on the end(s) of the row for cleanout. If entry into the manhole is required, please follow local and OSHA rules for a confined space entries.



Examples of culvert cleaning nozzles appropriate for Isolator Row maintenance. (These are not StormTech products.)

Maintenance is accomplished with the jetvac process. The jetvac process utilizes a high pressure water nozzle to propel itself down the Isolator Row while scouring and suspending sediments. As the nozzle is retrieved, the captured pollutants are flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/jetvac combination vehicles. Selection of an appropriate jetvac nozzle will improve maintenance efficiency. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45" are best. Most jetvac reels have 400 feet of hose allowing maintenance of an Isolator Row up to 50 chambers long. **The jetvac process shall only be performed on StormTech Isolator Rows that have AASHTO class 1 woven geotextile (as specified by StormTech) over their angular base stone.**

StormTech Isolator Row (not to scale)



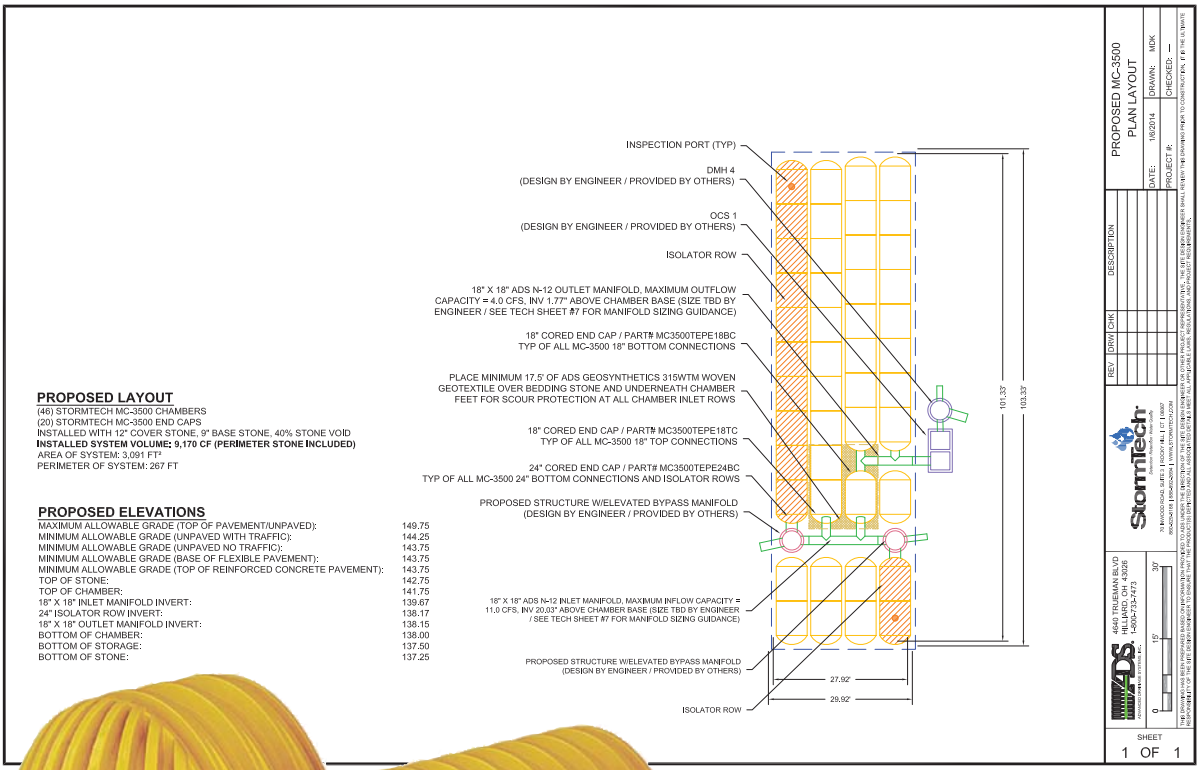
*NOTE: NON-WOVEN FABRIC IS ONLY REQUIRED OVER THE INLET PIPE CONNECTION INTO THE END CAP FOR DC-780, MC-3500 & MC-4500 CHAMBER MODELS AND IS NOT REQUIRED OVER THE ENTIRE ISOLATOR ROW.

A Family of Products and Services

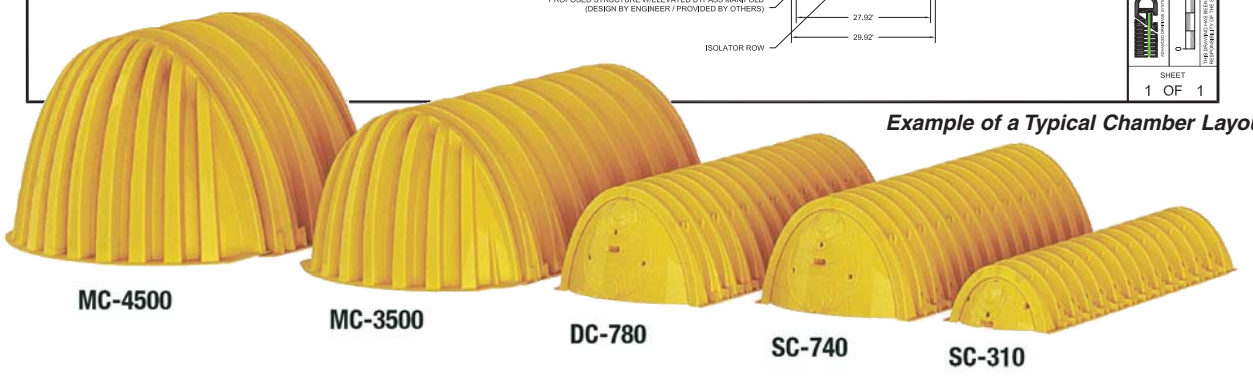
- MC-4500 Chambers and End Caps
- MC-3500 Chambers and End Caps
- SC-310 Chambers and End Caps
- SC-310-3 Chambers and End Caps
- DC-780 Chambers and End Caps
- SC-740 Chambers and End Caps
- SC, DC and MC Fabricated End Caps
- Fabricated Manifold Fittings
- Patented Isolator™ Row for Maintenance and Water Quality
- Inserta Tee Connections
- Nyloplast Basins and Inline Drains
- Flexstorm Inserts
- In-House System Layout Assistance
- On-Site Educational Seminars
- Worldwide Technical Sales Group
- Centralized Product Applications Department
- Research and Development Team
- Technical Literature, O&M Manuals and Detailed CAD drawings all downloadable via our Web Site

StormTech provides state of the art products and services that meet or exceed industry performance standards and expectations. We offer designers, regulators, owners and contractors the highest quality products and services for stormwater management that "Saves Valuable Land and Protects Water Resources."

Please contact one of our inside Technical Service professionals or Engineered Product Managers (EPMs) to discuss your particular application. A wide variety of technical support material is available from our website at **www.stormtech.com.** For any questions, please call StormTech at **888-892-2694**.



Example of a Typical Chamber Layout



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Detention • Retention • Water Quality
A division of ADS

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860.529.8188 | 888.892.2694 | fax 866.328.8401 | fax 860-529-8040 | www.stormtech.com

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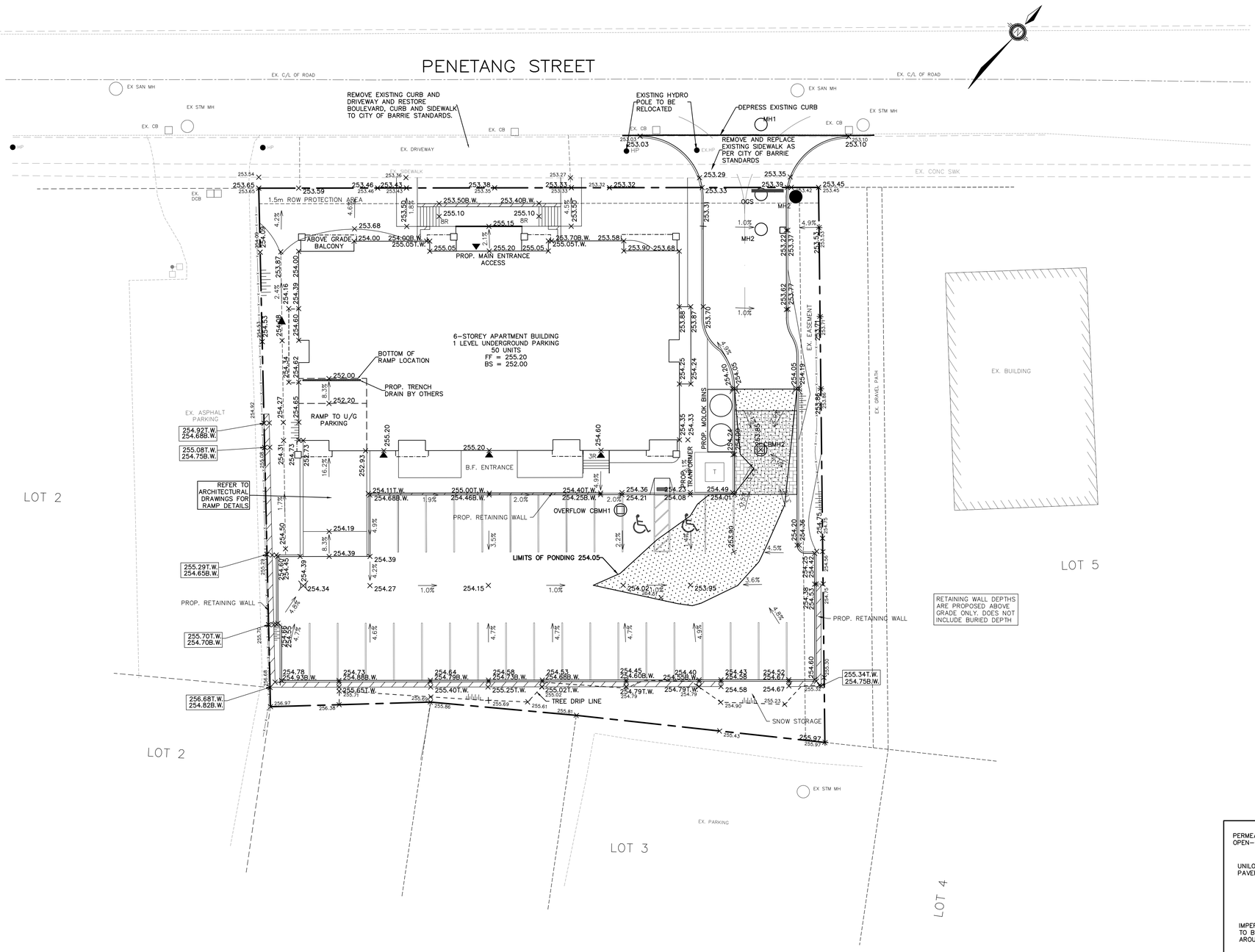
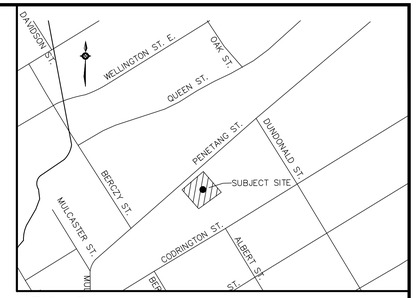
Appendix G

Pearson Engineering Drawings

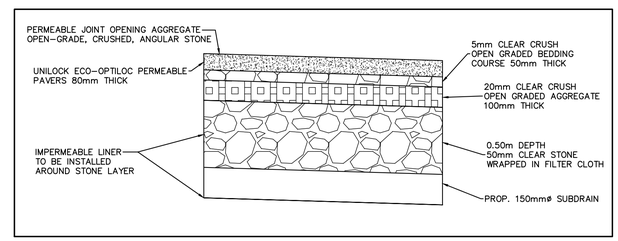




KEYMAP

LEGEND

- CB — CATCH BASIN
- DCB — DOUBLE CATCH BASIN
- CBMH — CATCH BASIN
- MH — STORM MANHOLE
- MH — SANITARY MANHOLE
- SERVICE CAP
- HYD. — FIRE HYDRANT
- VB — WATER VALVE
- CS — CURB STOP W/ SERVICE
- 254.63 / 254.09 — PROPOSED ELEVATION / EXISTING ELEVATION
- 2.0% — PROPOSED DIRECTION AND GRADE
- BACK OF CURB
- EDGE OF PAVEMENT
- CURB CUT LOCATION
-) (— HIGH POINT
- LIMITS OF UNDERGROUND PARKING
- ABOVE GRADE BALCONY
- PROPOSED 100 YEAR PONDING LIMIT
- PROPOSED PERMEABLE PAVERS
- EXISTING DRIP LINE
- T — PROPOSED TRANSFORMER



TYPICAL PERMEABLE PAVER DETAIL

N.T.S

NO.	REVISION NOTE	DATE	BY
1.	AS PER CITY OF BARRIE COMMENTS	12/03/19	JPE

BENCHMARK:

HORIZONTAL
MTO MONUMENT 01019860464 MONUMENT IS LOCATED AT THE INTERSECTION OF MULCASTER ST. AND PENETANG ST. MONUMENT IS ON THE WEST SIDE OF MULCASTER ST. IMMEDIATELY NORTH OF HOUSE #108 ON THE SOUTH EDGE OF GRAVEL DRIVE.
MTO MONUMENT 01019860476 MONUMENT IS LOCATED ON THE EAST SIDE OF BAYFIELD ST. AND NORTH OF WELLINGTON ST. MONUMENT IS SET IN SIDEWALK ON THE EASTERLY PRODUCTION OF THE SOUTH WALL OF HOUSE #162.
VERTICAL
MTO MONUMENT 03120030003 MONUMENT IS SET FLUSH IN THE NORTH END OF THE SOPHIA CREEK CULVERT AT THE INTERSECTION OF SOPHIA ST. AND PEEL ST. CULVERT IS ON THE EAST SIDE OF PEEL ST. THE TABLET IS CENTERED IN THE WALL IN LINE WITH HANDRAIL AND 140MM BELOW TOP OF WALL. ELEV. 236.902
MTO MONUMENT 00119680502 BARRIE COLLIER ST. UNITED CHURCH, ON THE NORTH SIDE OF COLLIER ST. AND WEST OF POINTZ ST. TABLET IS IN CENTRE OF FRONT OR SOUTH STONE FOUNDATION OF MOST WESTERLY COLUMN OF BELL TOWER, 60CM BELOW BRICK SIDING. ELEV. 241.012

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M.W. DEJEAN
3-DEC-2019
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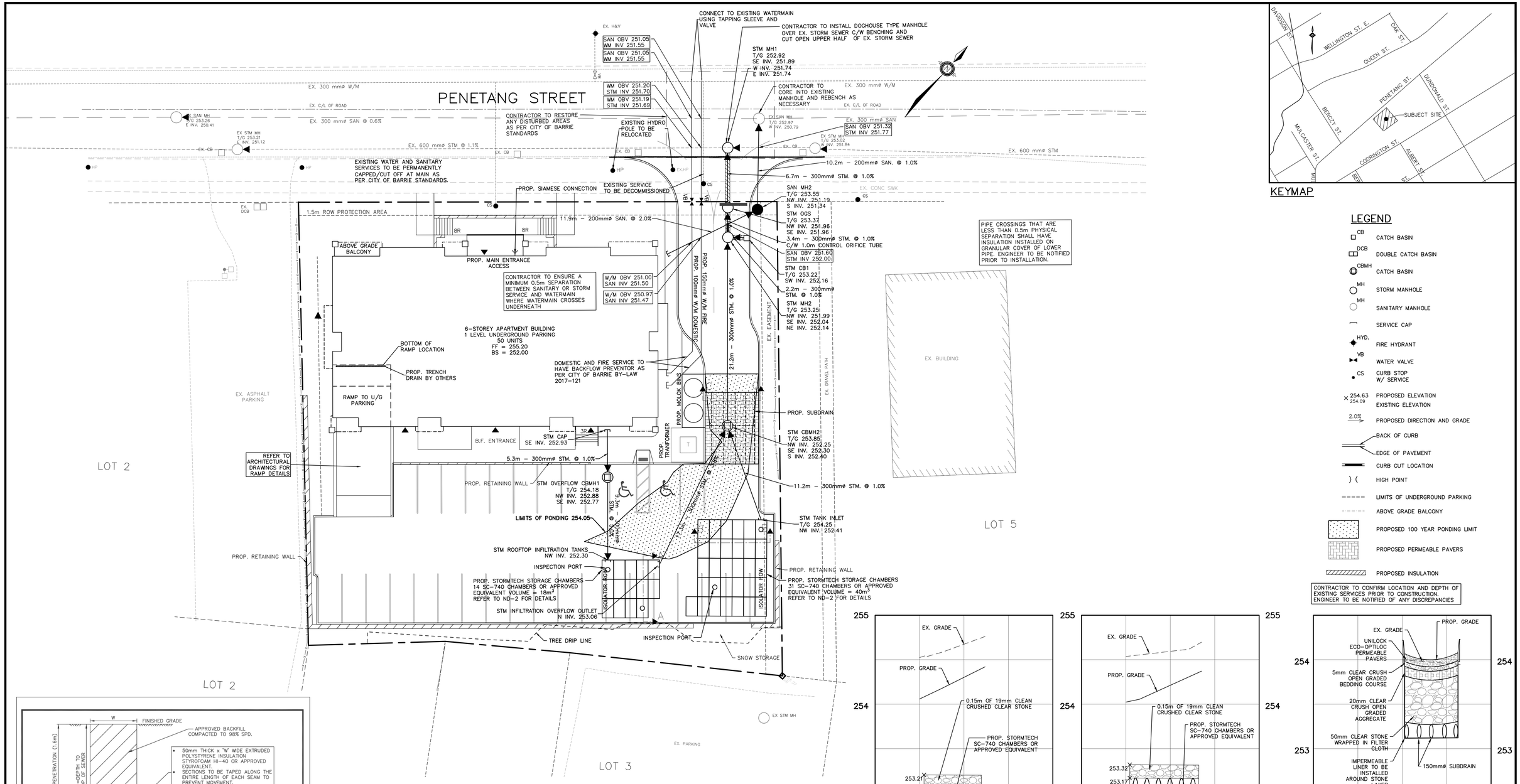
BARRIE, ONTARIO

SITE GRADING PLAN

PEARSON ENGINEERING LTD.
PEARSONENG.COM PH. 705.719.4785

DESIGNED BY	MWD	HORIZ SCALE 1:200	PROJECT # 17048
DRAWN BY	JPE/MJWP	VERT SCALE	DRAWING # SG-1
CHECKED BY	MWD	DATE FEB 2019	REVISION # 1



KEYMAP

LEGEND

- CB — CATCH BASIN
- DCB — DOUBLE CATCH BASIN
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-) (— HIGH POINT
- LIMITS OF UNDERGROUND PARKING
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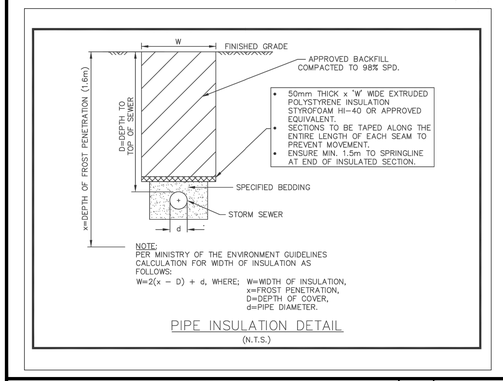
- PROPOSED 100 YEAR PONDING LIMIT
- PROPOSED PERMEABLE PAVERS
- PROPOSED INSULATION

CONTRACTOR TO CONFIRM LOCATION AND DEPTH OF EXISTING SERVICES PRIOR TO CONSTRUCTION. ENGINEER TO BE NOTIFIED OF ANY DISCREPANCIES



PIPE INSULATION DETAIL
(N.T.S.)

45 - 51 Penetang Street, Barrie
Sanitary Sewer Pipe Design Sheet

n = 0.013
$Q_{Residential} = (P/1000)*Q*M/86.4$ (Q = 225 L/day/person)
$M = 1+(14/(4+(P/1000)^{0.5}))$ (1.5 <= M <= 4)
Q_I = 0.23 L/ha/day
$Q_{Commercial}$ = 28 m³/ha/day
$Q_{tot} = Q_{Residential} + Q_{Commercial} + Q_I$

Date: 3-Dec-19
File: 17048
Contract/Project: Penetang St., Barrie

Areas	Manhole From	Manhole To	Dwelling Units	Area (ha)	Density (P.P.U.)	Pop. (P)	Pop. (ACC.)	M	Residential Flow (L/s)	Length (m)	Q (ACC.) (L/s)	Total Q (L/s)	D (mm)	S (%)	Q Full (L/s)	V Full (m/s)	Percent Full (%)
-	SAN CAP	SAN MH2	50	0.07	2.34	117	117	4.00	1.22	11.9	0.02	1.23	200	2.00	46.39	1.48	2.66
-	SAN MH2	EX. SAN MH	0	0.00	2.34	0.00	117	4.00	1.22	10.2	0.02	1.23	200	1.00	32.80	1.04	3.76

SECTION A–A
H–1:200 V–1:20

SECTION B–B
H–1:200 V–1:20

SECTION C–C
H–1:200 V–1:20

NO.	REVISION NOTE	DATE	BY
1.	AS PER CITY OF BARRIE COMMENTS	12/03/19	JPE

BENCHMARK:
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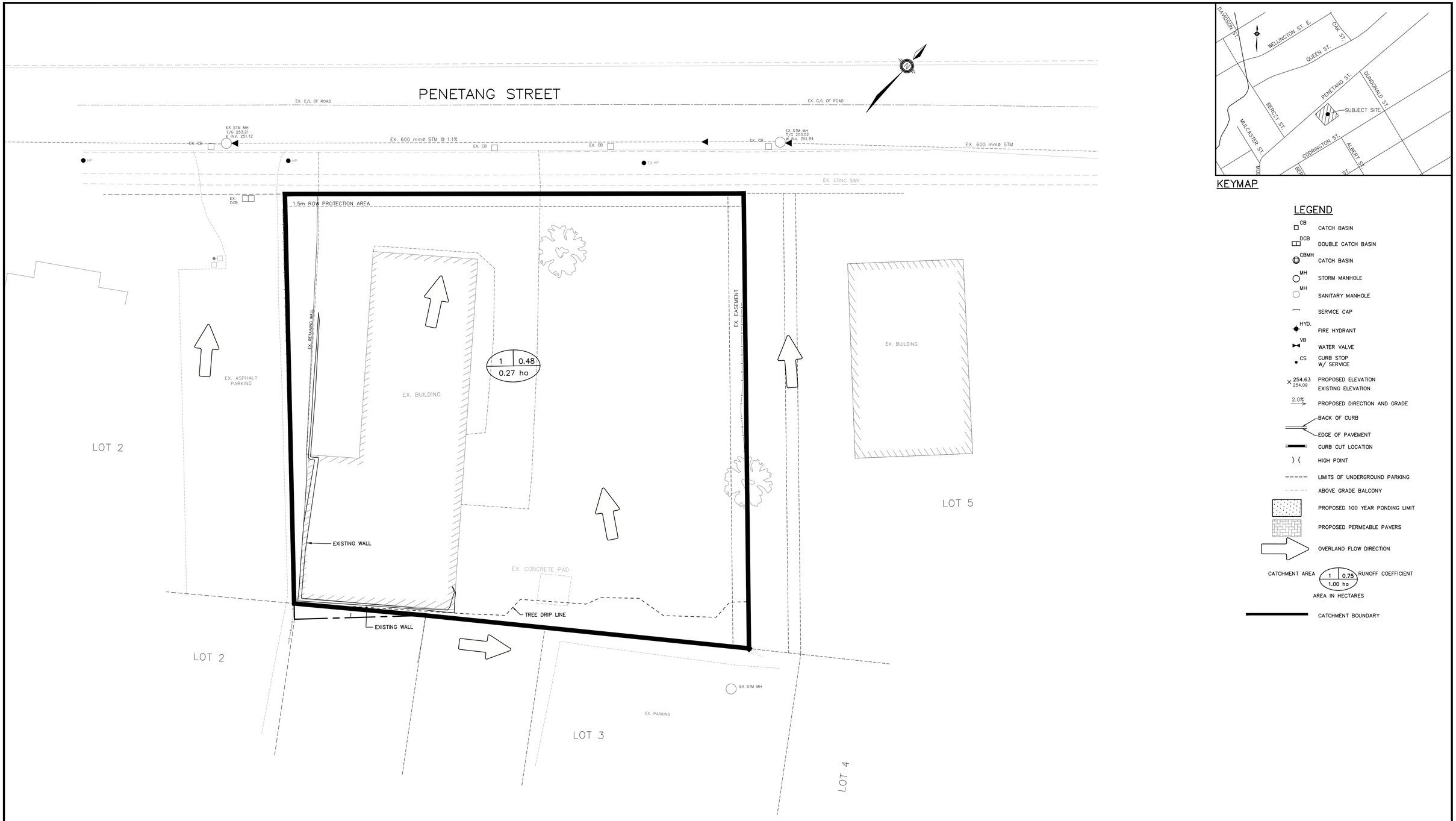
LICENCED PROFESSIONAL ENGINEER
M.W. DEJEAN
3-DEC-2019
PROVINCE OF ONTARIO

PIVAG INC.
45 – 51 PENETANG STREET
BARRIE, ONTARIO

SITE SERVICING PLAN

PEARSON ENGINEERING LTD.
PEARSONENG.COM PH. 705.719.4785

DESIGNED BY	MWD	HORIZ SCALE 1:200	PROJECT # 17048
DRAWN BY	MJWP	VERT SCALE	DRAWING # SS–1
CHECKED BY	MWD	DATE FEB 2019	REVISION # 1



KEYMAP

LEGEND

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- OVERLAND FLOW DIRECTION
- CATCHMENT AREA — 1 / 0.75 / 1.00 ha — RUNOFF COEFFICIENT / AREA IN HECTARES
- CATCHMENT BOUNDARY

NO.	REVISION NOTE	DATE	BY
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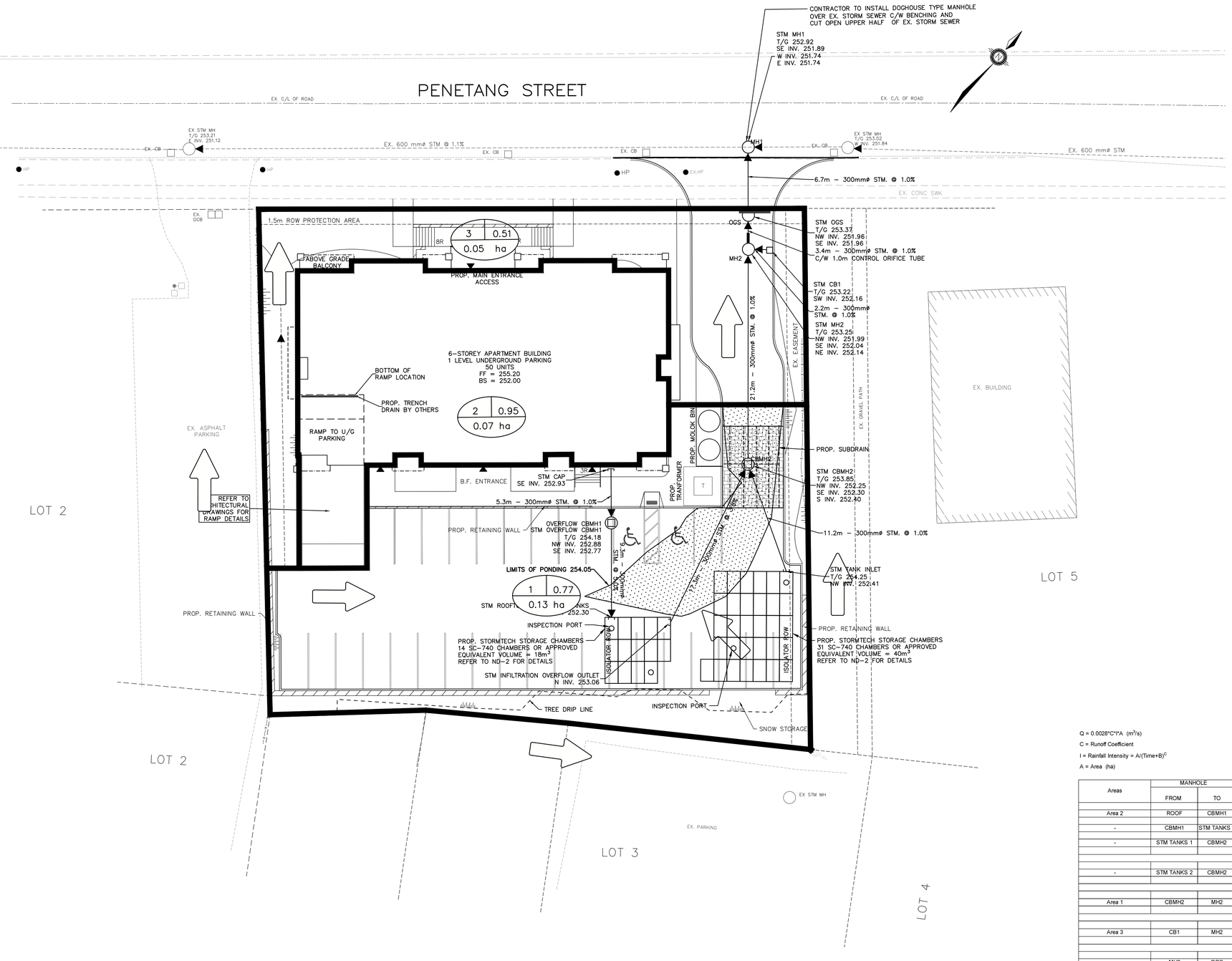
LICENCED PROFESSIONAL ENGINEER — M.W. DEJEAN — 3-DEC-2019 — PROVINCE OF ONTARIO

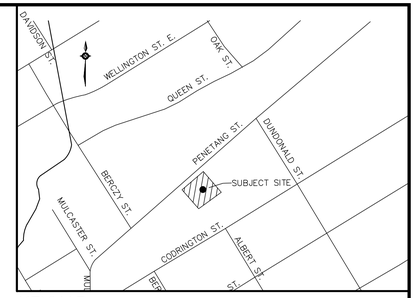
PIVAG INC.
45 – 51 PENETANG STREET
BARRIE, ONTARIO

PRE–DEVELOPMENT STORMWATER MANAGEMENT PLAN

PEARSON ENGINEERING LTD.
PEARSONENG.COM PH. 705.719.4785

DESIGNED BY	MWD	HORIZ SCALE 1:200	PROJECT # 17048
DRAWN BY	MJWP	VERT SCALE	DRAWING # STM–1
CHECKED BY	MWD	DATE FEB 2019	REVISION # 1





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- CATCHMENT AREA 1 / 0.75 / 1.00 ha — RUNOFF COEFFICIENT / AREA IN HECTARES

Q = 0.0028*C*I*A (m^3/s)
C = Runoff Coefficient
I = Rainfall Intensity = A/(Time+B)^C
A = Area (ha)

45 - 51 Penetang Street, Barrie
Storm Sewer Design
5-Year Storm Event

Date: 3-Dec-19
File: 17048
Contract/Project: Penetang St., Barrie

Areas	MANHOLE FROM	MANHOLE TO	LENGTH (m)	INCREMENT C	INCREMENT A	INCREMENT CA	TOTAL CA	FLOW TIME (min) TO	FLOW TIME (min) IN	I (mm/h)	TOTAL Q (m^3/s)	S (%)	D (mm)	Q FULL (m^3/s)	V FULL (m/s)
Area 2	ROOF	CBMH1	5.3	0.07	0.95	0.07	0.07	10.00	0.06	108.92	0.02	1.0	300	0.10	1.37
-	CBMH1	STM TANKS 1	9.3	0.00	0.00	0.00	0.07	10.06	0.11	108.56	0.02	1.1	300	0.10	1.44
-	STM TANKS 1	CBMH2	17.3	0.00	0.00	0.00	0.07	10.17	0.20	107.95	0.02	1.1	300	0.10	1.44
-	STM TANKS 2	CBMH2	11.2	0.00	0.00	0.00	0.00	10.00	0.14	108.92	0.00	1.0	300	0.10	1.37
Area 1	CBMH2	MH2	21.2	0.77	0.14	0.10	0.17	10.37	0.26	106.85	0.05	1.0	300	0.10	1.37
Area 3	CB1	MH2	5.2	0.51	0.03	0.02	0.02	10.00	0.06	108.92	0.01	1.0	300	0.10	1.37
-	MH2	OGS	3.4	0.00	0.00	0.00	0.17	10.63	0.04	105.47	0.04*	1.0	300	0.10	1.37
-	OGS	MH1	6.7	0.00	0.00	0.00	0.24	10.67	0.08	105.25	0.04*	1.0	300	0.10	1.37

* denotes 100-year storm event flow through orifice tube taken from SSD calculation sheet.

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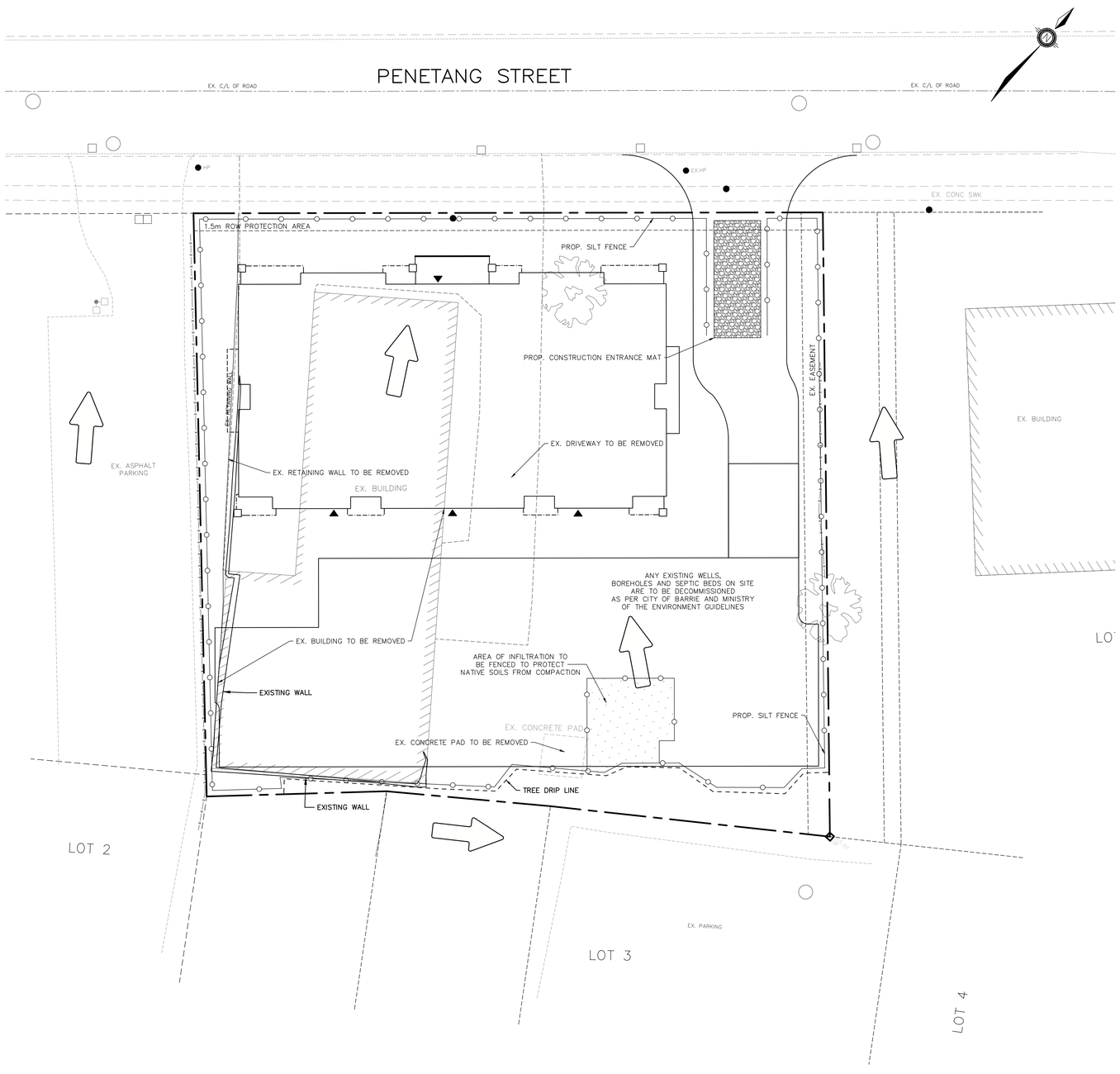
LICENCED PROFESSIONAL ENGINEER
M.W. DEJEAN
3-DEC-2019
PROVINCE OF ONTARIO

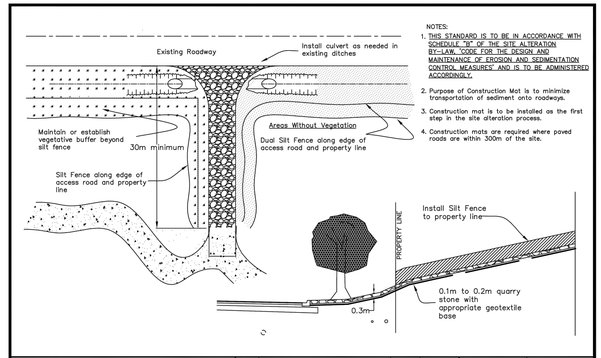
PIVAG INC.
45 – 51 PENETANG STREET
BARRIE, ONTARIO

POST DEVELOPMENT STORMWATER MANAGEMENT PLAN

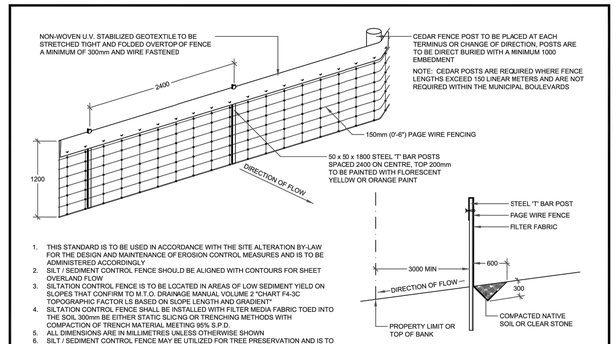
PEARSON ENGINEERING LTD.
PEARSONENG.COM PH. 705.719.4785

DESIGNED BY	MWD	HORIZ SCALE 1:200	PROJECT # 17048
DRAWN BY	MJWP	VERT SCALE	DRAWING # STM-2
CHECKED BY	MWD	DATE FEB 2019	REVISION # 1





CITY OF BARRIE STANDARD					
CONSTRUCTION ENTRANCE MAT	1.	Standardized Dimension Text	J.S.	05.10.28	APR'D: R.G.N. DATE: 04.03.16
					DRAWN: A.S.C SCALE: N.T.S
	NO.	REVISION	APR'D	DATE	BSD-23D



1. THIS STANDARD IS TO BE USED IN ACCORDANCE WITH THE SITE ALTERATION BY-LAW FOR THE DESIGN AND MAINTENANCE OF EROSION CONTROL MEASURES AND IS TO BE ADMINISTERED ACCORDINGLY
2. SILT / SEDIMENT CONTROL FENCE SHOULD BE ALIGNED WITH CONTOURS FOR SHEET OVERLAND FLOW
3. SILTATION CONTROL FENCE IS TO BE LOCATED IN AREAS OF LOW SEDIMENT YIELD ON SLOPES THAT CONFIRM TO M.T.O. DRAINAGE MANUAL VOLUME 2 "CHART F4-3C TOPOGRAPHIC FACTOR LS BASED ON SLOPE LENGTH AND GRADIENT"
4. SILTATION CONTROL FENCE SHALL BE INSTALLED WITH FILTER MEDIA FABRIC TOED INTO THE SOIL 300mm BE EITHER STATIC SLICING OR TRENCHING METHODS WITH COMPACTION OF TRENCH MATERIAL MEETING 95% S.P.D.
5. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN
6. SILT / SEDIMENT CONTROL FENCE MAY BE UTILIZED FOR TREE PRESERVATION AND IS TO BE USED IN CONJUNCTION WITH BSD-1211, BSD-1232 AND BSD-1235

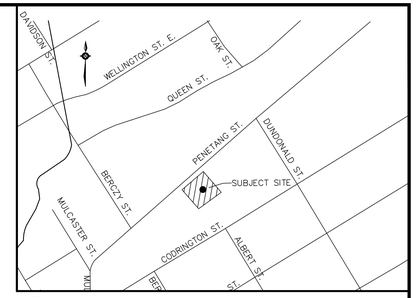
Barrie STANDARD DETAIL	SILTATION CONTROL FENCING	REV No. 2	DATE: OCT 2017 SCALE: N.T.S.	APPROVED Oct 10/17 DATE Original Signed By DIRECTOR OF ENGINEERING
			BSD-1233 FORMERLY BSD-23A	

SEQUENCE OF CONSTRUCTION

1. ENGINEER TO BE NOTIFIED PRIOR TO INITIATION OF ANY ON SITE WORKS.
2. SILT FENCE AND MUD MAT CONSTRUCTION ENTRANCE IS TO BE INSTALLED PRIOR TO THE COMMENCEMENT OF ANY WORKS ONSITE.
3. VEGETATION REMOVAL MAY COMMENCE AFTER ALL SILT FENCE IS INSTALLED AND APPROVED BY THE ENGINEER.
4. EROSION CONTROL MEASURES TO BE MAINTAINED AS DIRECTED BY THE ENGINEER DURING THE CONSTRUCTION PERIOD. ADDITIONAL CONTROL MEASURES MAY BE REQUIRED AT THE DISCRETION OF THE ENGINEER.
5. ALL DISTURBED GROUND LEFT INACTIVE FOR MORE THAN 30 DAYS SHALL BE STABILIZED WITH SEED, SOD, MULCH OR OTHER ADEQUATE COVERING, AS INSTRUCTED BY THE ENGINEER.

NOTES FOR SEDIMENT & EROSION CONTROL

1. DISTURBED AREAS THAT HAVE FAILED TO HAVE STABLE GROUND COVER ESTABLISHED BY OCTOBER 30TH SHALL BE PROTECTED WITH A SILTATION CONTROL FENCE OR STRAW MULCH ETC. AND MAINTAINED BY THE CONTRACTOR UNTIL VEGETATION BECOMES ESTABLISHED IN THE SUBSEQUENT GROWING SEASON.
2. ANY DEWATERING WASTE SHALL BE DISCHARGED TO A VEGETATED AREA AT LEAST 30m FROM ANY WATERCOURSE AND FILTERED. FILTERING METHODS MUST BE APPROVED BY THE SITE ADMINISTRATOR. DISCHARGE TO MUNICIPAL SERVICES MUST BE APPROVED BY THE CITY OF BARRIE PRIOR TO STARTING WORK AND ADHERE TO CITY OF BARRIE STANDARDS
3. SILT FENCE SHALL BE PUT IN PLACE PRIOR TO AND MAINTAINED DURING ALL GRADING. SILT FENCE TO BE INSPECTED PRIOR TO COMMENCEMENT OF EARTH GRADING ACTIVITIES. SILT FENCE TO BE INSPECTED AND REPAIRED OR REPLACED IF DAMAGED AS DIRECTED BY THE SITE ADMINISTRATOR. SILT CONTROLS TO BE INSPECTED ON A REGULAR BASIS AND AFTER EVERY RAIN EVENT. INSTALLATION SHALL BE TO THE MANUFACTURER'S SUGGESTED SPECIFICATIONS.
4. THE CONTRACTOR SHALL BE PREPARED FOR UNEXPECTED CONDITIONS AND ACCORDINGLY HAVE STOCKPILED MATERIALS ON SITE FOR NECESSARY REPAIRS AS A RESULT OF FAILED OR INADEQUATE CONTROL MEASURES. ALL SEDIMENT AND EROSION CONTROL MEASURES SHALL BE INSPECTED AT LEAST ONCE A WEEK, AND AFTER EVERY RAINFALL EVENT.
5. CONTRACTOR SHALL OBTAIN A CURRENT COPY AND BECOME FAMILIAR WITH OPSS 577, CONSTRUCTION SPECIFICATION FOR TEMPORARY EROSION AND SEDIMENT CONTROL MEASURES AS WELL AS ALL APPLICABLE MUNICIPAL STANDARDS.
6. THE CONTRACTOR MAY CONSIDER ALTERNATIVE SEDIMENT AND EROSION CONTROL MEASURES. SUCH MEASURES SHOULD BE PRESENTED IN WRITING FOR APPROVAL OF THE SITE ADMINISTRATOR AND MUST BE APPROVED IN WRITING BY THE MUNICIPALITY AND CONSERVATION AUTHORITY.
7. THE TOPS OF ALL FILTER FABRIC MUST BE A MINIMUM OF 1.0 METRES ABOVE THE GROUND LEVEL AND ATTACHED TO THE FENCE WITH A CONTINUOUS STEEL WIRE. ALTERNATIVELY, THE FILTER FABRIC MUST BE FOLDED OVER THE TOP OF THE FENCE AND ATTACHED TO THE FENCE WITH WIRE LOOPED THROUGH THE FABRIC ON BOTH SIDES OF THE FENCE. FILTER FABRIC IS TO BE TERRAFIX 270R OR EQUIVALENT.
8. ALL DISTURBED GROUND LEFT INACTIVE SHALL BE STABILIZED BY SEEDING, SODDING, MULCHING, OR COVERING OR OTHER EQUIVALENT CONTROL MEASURES. THIS PERIOD OF INACTIVITY SHALL BE AT THE DISCRETION OF THE CITY OF BARRIE MANAGER OF ENGINEERING BUT SHALL NOT EXCEED THIRTY DAYS.
9. CONTRACTOR SHALL INSTALL AND MAINTAIN CATCHBASIN SEDIMENT BARRIERS THROUGHOUT THE SITE DURING ALL CONSTRUCTION ACTIVITIES IN ORDER TO TRAP SEDIMENT. REFER TO DETAIL



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LICENCED PROFESSIONAL ENGINEER — M.W. DEJEAN — 3-DEC-2019 — PROVINCE OF ONTARIO

PIVAG INC.
45 – 51 PENETANG STREET
BARRIE, ONTARIO

ENVIRONMENTAL PROTECTION PLAN

PEARSON ENGINEERING LTD.
PEARSONENG.COM PH. 705.719.4785

DESIGNED BY MWD	HORIZ SCALE 1: 200	PROJECT #	17048
DRAWN BY MJWP	VERT SCALE	DRAWING #	EP–1
CHECKED BY MWD	DATE FEB 2019	REVISION #	1