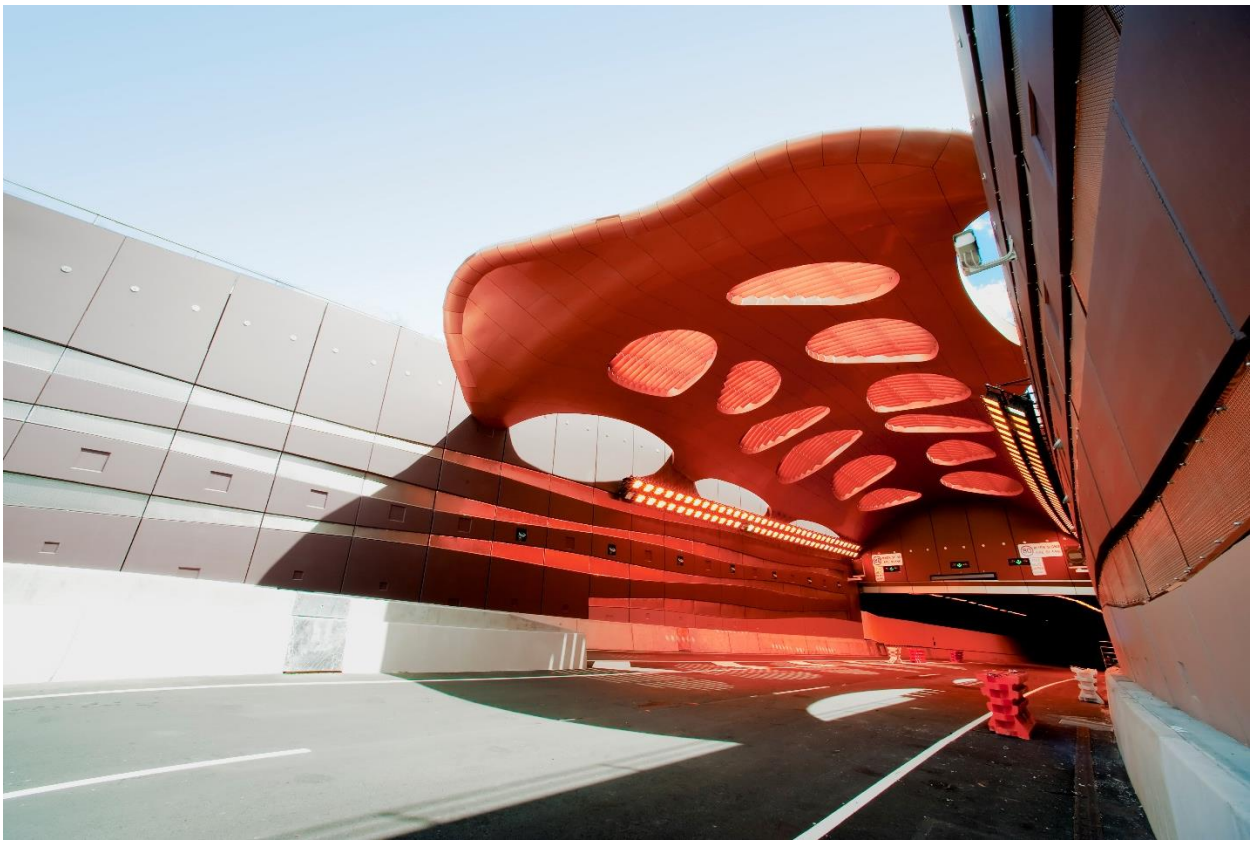
Director Industrial Holdings Limited

603-643, 645-699 Kingston Road Pickering, ON

Stormwater Management Report

April 16, 2020



603-643, 645-699 Kingston Road Pickering, ON

Stormwater Management Report

Director Industrial Holdings Limited

Rezoning Application

Project No.: 19M-00841-00
Date: April 16, 2020

WSP
100 Commerce Valley Drive West
Thornhill, ON, Canada L3T 0A1

wsp.com

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Prepared by	Reviewed and Approved by			
Gordon Wong, EIT	Iain Smith, P.Eng.			
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Prepared by	Reviewed by	Approved By		
Ivan Mock, EIT	Iain Smith, P.Eng.			
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Prepared by	Reviewed by	Approved By		
Ivan Mock, EIT	Iain Smith, P.Eng.			
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Prepared by	Reviewed by	Approved By		

Signatures

Prepared by

04/16/2020

Ivan Mock, EIT
Designer, Water Resources

Date

Approved[1] by (must be reviewed for technical accuracy prior to approval)

Iain Smith, P.Eng.
Project Engineer

Date

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Contributors

Client

Director Industrial Holdings Limited

WSP

Designer	Ivan Mock, EIT
Designer	Gordon Wong, EIT
Project Engineer	Iain Smith, P.Eng.

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1 INTRODUCTION

1.1 Scope

WSP Canada Group Limited has been retained by Director Industrial Holdings Limited to prepare a Stormwater Management (SWM) report to support the rezoning application for the proposed development at 603-643, 645-699 Kingston Road Pickering, ON in the City of Pickering.

The current development concept, as represented in the conceptual site plan drawings and development statistics prepared by Graziani + Corazza Architects, dated April 6, 2020, enclosed with this submission, is preliminary in nature and subject to change.

The current development concept, which represents a high-level master plan for a new mixed-use community, is primarily intended to form the basis of the proposed Draft Official Plan Amendment, which is required to facilitate the proposed density and Floor Space Index on the subject lands, as well as the proposed Draft Zoning By-law Amendment which is required to establish a new site-specific zoning framework that will implement the City's current land use vision for the subjects lands.

This proposed official plan and zoning by-law amendment framework is intended to provide flexibility in order to ensure that the development of the lands responds to market conditions and can result in implementation of plans and alternative plans to achieve principles of intensification based on good planning and urban design principles.

As such, it is anticipated that the development concept as presented to be sconsidered conceptual and will be revised, as necessary, to account for new and/or evolving considerations related to the master-planned community.

This SWM report examines the potential water quality, water quantity, erosion control, and water balance impacts of the proposed development and summarizes how each parameter will be addressed in accordance with the City of Pickering Stormwater Management Design Guidelines dated July 2019.

1.2 Site Location

The site is located north of Highway 401, west of Whites Road North, and south of Kingston Road in the City of Pickering. The subject site is currently occupied by 42 municipal addresses which consist mainly of commercial/retail buildings and a restaurant. The location of the proposed re-development is illustrated in Figure 1.

1.3 Stormwater Management Plan Objectives

The objectives of the stormwater management plan are as follows:

– Determine site specific stormwater management requirements to ensure that the proposals are in conformance with the City of Pickering Stormwater Management Design Guidelines;

– Evaluate various stormwater management practices that meet the requirements of the City and recommend a preferred strategy; and

– Prepare a stormwater management report documenting the strategy along with the technical information necessary for the justification and preliminary sizing of the proposed stormwater management facilities.

1.4 Design Criteria

The City of Pickering issued the Stormwater Management Design Guidelines in July 2019 to provide direction on the management of rainfall and runoff inside the City's jurisdiction. A summary of the stormwater management criteria applicable to this project are as follows:

1.4.1 Water Quantity

The guideline requires the development to attenuate post-development flows for all storms up to and including the 100-year storm to pre-development levels. In a pre-consultation meeting on May 27th, 2019, the city noted that the 100-year post-development flow shall be controlled to the 2-year pre-development level.

1.4.2 Water Quality

The guideline requires the development to provide water quality measures that are designed to provide Enhanced (Level 1) level of protection as defined in the 2003 Stormwater Management Planning and Design Manual by the Ministry of the Environment, Conservation and Parks (MECP). This was also noted in the pre-consultation meeting with the municipality.

1.4.3 Erosion Control

The guideline states that for small sites (<5 ha), the minimum erosion control requirements are:

– Extended detention of the 4-hour, 25 mm Chicago distribution rainfall event for a minimum of 24 hours, or

– Runoff reduction from the site through infiltration, evapotranspiration and reuse of a minimum 5 mm of rainfall depth across all impervious surfaces

In addition, appropriate erosion and sediment controls shall be implemented and maintained during construction

1.4.4 Water Balance

The guideline does not explicitly state the requirements regarding water balance. It is encouraged to maintain the natural water balance of the site and to use SWM facilities that reduces runoff volumes, which will result in reduced loading of pollutants.

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TITLE

603–643, 645 & 699 KINGSTON ROAD PICKERING, ON

SITE LOCATION

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Scale AS SHOWN	Figure No. 1 / Gr.No. 00

FIGURE 1.dwg - 603-643_645 & 699 Kingston Rd - Site Location \\tfhier1.mmm.ca\ENGCAD$\DIV38\2019\19M-00841-00 603-643, 645 & 699 Kingston Road, Pickering\CAD\dwgs\ Apr 14, 2020 - 3:08pm

2 PRE-DEVELOPMENT CONDITIONS

2.1 General

The 4.85 ha site is currently occupied by mainly commercial/retail buildings and a restaurant. The existing runoff coefficient is estimated to be 0.90 as majority of the site is comprised of impervious surfaces. Based on the topographic survey, an external area of approximately 0.09 ha currently discharges into the site. This area will be accounted for in the post-development condition to meet the water quantity requirement. The existing condition of the site is shown in Figure 2.

2.2 Rainfall Information

The rainfall intensity for the site was calculated using the following equation as stated in the Section 6.2.4. of the City of Pickering Stormwater Management Design Guidelines:

$$I = \frac{A}{(t_c + B)^C}$$

Where;

I = Rainfall intensity in mm/hr

T_c = Time of concentration in minutes

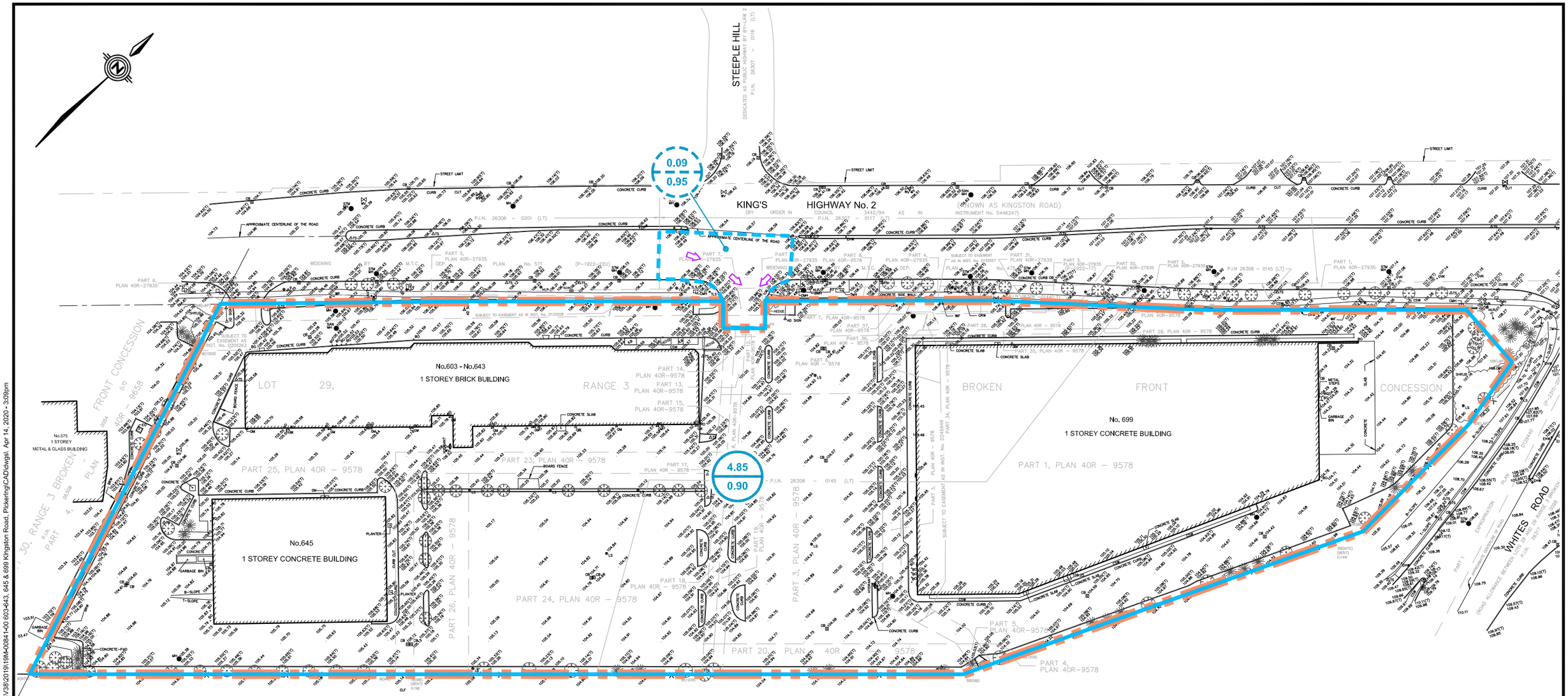
A, B and C = Constant parameters as stated in "Table 12 – Pickering IDF Parameters" in the City of Pickering Stormwater Management Design Guidelines. The parameters are summarized in Table 2-1.

Table 2-1: IDF Parameters used by the City of Pickering

Return Period (Years)	2	5	10	25	50	100
A	715.076	1,082.901	1,313.979	1,581.718	1,828.009	2,096.425
B	5.262	6.007	6.026	6.007	6.193	6.485
C	0.815	0.837	0.845	0.848	0.856	0.863

Source: City of Pickering Stormwater Management Design Guidelines (July 2019)

An initial time of concentration, T_c, of 10 minutes was assumed for the calculation for rainfall intensity.



LEGEND

- PROPERTY BOUNDARY
- SUB-CATCHMENT BOUNDARY
- EXTERNAL SUB-CATCHMENT BOUNDARY
- 4.85 / 0.90 — DRAINAGE AREA (ha) / RUNOFF COEFFICIENT
- DRAINAGE DIRECTION

0 10 20 30 40 50m

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TITLE
603–643, 645 & 699 KINGSTON ROAD PICKERING, ON

EXISTING CONDITIONS

wsp

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FIGURE 2.dwg - 603-643_645 & 699 Kingston Rd - Existing Conditions \\hfiler1.mmm.ca\ENGCAD$\DIV\38\2019\19M-00841+00 603-643, 645 & 699 Kingston Road, Pickering\CAD\dwgs\ Apr 14, 2020 - 3:09pm

2.3 Allowable Flow Rates

As noted in Section 1.4.2, from the City of Pickering Stormwater Management Design Guidelines and the pre-consultation meeting, the discharge rate from this site in the post-development condition shall be controlled to the allowable release rate which is defined as the 2-year pre-development discharge from the site.

This site is proposed to have permanent groundwater discharge rate of 0.8 Ls which will be detailed in section 2.4 of this report. This stormwater shall be discharged to the sanitary sewers and therefore, be subtracted from the flows exiting the site.

There is an external drainage area located north of the site. It is assumed that the runoff from this area will be collected by the onsite stormwater infrastructure and conveyed to the proposed system. This flow shall therefore be added to the allowable release rate.

The calculated pre-development peak flow rates for the existing site for the 2-year to 100-year storm events are summarized in Table 2-2. Detailed calculations are provided in Appendix A.

Table 2-2: Pre-Development Peak Flow Rate and Maximum Allowable Site Discharge Rate

Return Period (Years)	Rainfall Intensity, I (mm/hr)	Runoff Coefficient Adjustment Factor, Ca*	Existing Peak Runoff Rates, Q (L/s)**	Proposed Permanent Dewatering Rate, Q_{GW} (L/s)	External Area Release Rate Q_{EX} (L/s)***	Maximum Allowable Release Rate, Q_p (L/s)
2	77.6	1.00	943.4	0.8	18.8	**961.4**
5	106.3	1.00	1,292.9		25.7	
10	126.3	1.00	1,532.8		30.5	
25	150.6	1.10	2,014.8		38.4	
50	168.6	1.20	2,274.7		42.9	
100	186.7	1.25	2,519.2		47.6	

**Runoff Coefficient Adjust Factor are required for storms greater than the 25-year storm event when calculating the peak flows using the Rational Method, as stated in Section 6.2.3 of the City of Pickering Stormwater Management Design Guidelines. Note the product of C and Ca cannot be larger than 1.00.*
***C = 0.90, pre-development catchment area of 4.85 ha and time of concentration of 10 minutes.*
****C = 0.95, catchment area of 0.09 ha and a time of concentration of 10 minutes.*

2.4 Groundwater, Hydrogeology and Groundwater Characterization

A Hydrogeological investigation was carried out by Toronto Inspections Ltd. in the spring and summer of 2019 to assess the groundwater conditions and soil characteristics of the development, and test the presence of groundwater contamination.

Based on the report dated June 19, 2019, the estimated permanent dewatering rate is approximately 69,471 L/day, which is equivalent to approximately 0.80 L/s. The groundwater quality for the discharge water during construction does not meet the City's Sewer By-Law requirements for discharge to the storm sewer but it does meet the requirements for discharge to the sanitary sewer. It was not stated where the groundwater will be discharged in the long-term scenario. As a conservative measure, it is assumed the groundwater will be discharged to the storm sewers after construction and will be accounted for when checking the water quantity requirement.

The subsurface of the site is composed of mainly sandy silt till. From in-situ hydraulic conductivity tests conducted at various monitoring wells, the hydraulic conductivity ranged between $1.6x10^{-6}$ cm/s and $1.8x10^{-5}$ cm/s with a geometric mean of $6.0x10^{-6}$ cm/s. The Credit Valley Conservation (CVC) Low Impact Development Stormwater Management Planning and Design Guide has a table from the Ontario Building Code relating the hydraulic conductivity and infiltration rate in its supplementary guideline, SG-6 Percolation Time and Soil Descriptions. The table has been summarized in Table 2-3.

Table 2-3: Relationship between Hydraulic Conductivity and Infiltration Rate

Hydraulic Conductivity (cm/s)	Infiltration Rate (mm/hr)
0.1	300
0.01	150
0.001	75
0.0001	50
0.00001	30
0.000001	12

Source: CVC Low Impact Development Stormwater Management Planning and Design Guide – Appendix C (2011)

Based on the table above, it is assumed that the infiltration rate of the sandy silt till ranges from 12 mm/hr and 30 mm/hr, with a geometric mean of approximately 22 mm/hr. This value is greater than the minimum infiltration rate, 15 mm/hr, for stormwater management system that uses infiltration, as recommended in the 2003 Stormwater Management

Planning and Design Manual created by the Ministry of the Environment, Conservation and Parks.

In addition, the water table level ranges from 96.53 and 103.57 m above sea level and the depth between the water table and the ground surfaces ranges from 1.4 m to 8.9 m. From the borehole testing, it is estimated that bedrock is located deeper than 20 m below the ground surfaces.

Based on the analysis above, stormwater management facilities that uses infiltration measures are recommended for this site since the soil has a favourable infiltration rate and there is sufficient distance from the ground surface to the water table and bedrock. However, more analysis would need to be taken at the location of the proposed stormwater management facilities before finalizing the design.

3 POST-DEVELOPMENT CONDITIONS

3.1 General

The total Site area is 4.85 ha (11.98 acres). The current concept development will consist of six high-rise towers, two mid-rise towers, and four townhouse blocks:

1. Blocks 1 to 4 are 4-storey townhouse blocks with stacked back-to-back units. Blocks 1 and 2 are located toward the northwest corner of the site. Blocks 3 and 4 are located toward the northeast corner of the site.

2. Towers 1, 2 and 3 are located along the south property line, at the west side for the site. The towers range in height from 29 to 36 storeys, which are connected by a 4-storey podium (Podium 1).

3. Towers 4 and 5 are each “U”-shaped buildings and are located along the north property line, at the centre of the site. Both mid-rise towers are 18 storeys.

4. Towers 6 and 7 are located along the south property line, near the centre of the site. Towers 6 and 7 are 29 and 42 storeys, respectively. The towers are connected by a 4-storey podium (Podium 4).

5. Tower 8 is located at the northeast corner of the site. The tower is 24 storeys, with a 4-storey commercial area located within a 4-storey podium (Podium 5).

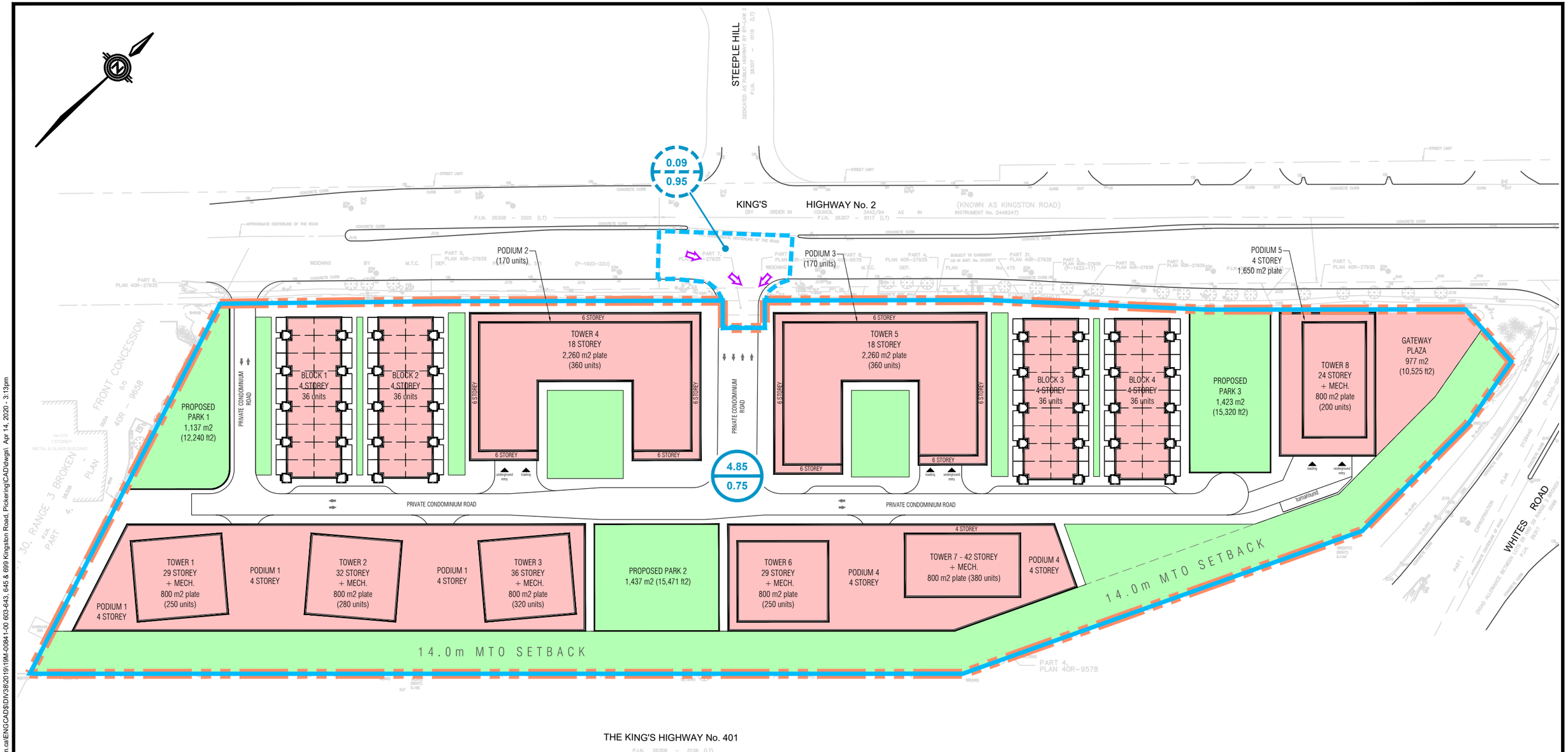
Grade-level parks will be provided at the south side of the site (between Towers 3 and 6) as well as the northeast and northwest corners of the site. A private internal road network with two access points off of Kingston Road and access to the below grade parking. The concept development includes two levels of underground parking with the exception of Podium 1, which will have one level of underground parking, as well as parking in Podiums 1 and 4.

As mentioned in Section 2.1, the site receives flows from a 916 m^2 asphalt external area north of the site. This area will be included in the hydrologic analysis to meet the water quantity requirements.

An area breakdown for the new layout is provided below in Table 3-1. Please refer to Figure 3 for details of the post-development conditions and land-uses. Detailed calculations can be found in Appendix A.

Table 3-1: Proposed Land-Use Area Breakdown

Land-Use	Area (m^2)	Runoff Coefficient (2,5,10 yr)	Runoff Coefficient (25 yr)	Runoff Coefficient (50 yr)	Runoff Coefficient (100 yr)	% Coverage
Impervious Roof Area	19,757	0.95	1.00	1.00	1.00	41%
Soft Landscaping	14,117	0.25	0.28	0.30	0.31	29%
At-Grade Impervious	14,665	0.95	1.00	1.00	1.00	30%
Total Site Area	48,539	0.75	0.79	0.80	0.80	100%



LEGEND

- PROPERTY BOUNDARY
- SUB-CATCHMENT BOUNDARY
- EXTERNAL SUB-CATCHMENT BOUNDARY
- 4.85 / 0.89 — DRAINAGE AREA (ha) / RUNOFF COEFFICIENT
- DRAINAGE DIRECTION
- LANDSCAPE
- IMPERVIOUS ROOF

0 10 20 30 40 50m

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603–643, 645 & 699 KINGSTON ROAD PICKERING, ON

PROPOSED CONDITIONS

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FIGURE 3.dwg - 603-643_645 & 699 Kingston Rd - Proposed Conditions \\hfiler1.mmm.ca\ENGCAD$\DIV38\2019\19M-00841-00 603-643, 645 & 699 Kingston Road, Pickering\CAD\dwgs\ Apr 14, 2020 - 3:13pm

3.2 Water Quantity Control

As mentioned in Section 1.4.1, the post-development discharge rates for all storms up to and including the 100-year storm event are to be attenuated to the 2-year pre-development discharge rate, less the groundwater discharge, plus the external drainage area which is equivalent to 961.4 L/s.

It is proposed that the runoff from the entire site will be collected into a subsurface storage system located underneath of the proposed park between Tower 3 and Tower 6. The subsurface storage system comprises of 60 rows of 40 Brentwood 48" StormTank® units. The system will have a stone base of 165 mm, stone cover of 305 mm and 305 mm wide wall of stone surrounding the system. The system will have a footprint of approximately 1,043 m^2 and provide a storage volume of approximately 1,238.5 m^3. The system will be gravity drained via a 600 mm diameter orifice tube set at 0.12 m above the internal bottom of the StormTank® units. The installation guide for the Brentwood StormTank® can be found in Appendix C.

The 'HydroCAD' sottware package (Version 10) has been used to model the behaviour of the proposed SWM system, and to determine its response under various storm events. This software utilises the Modified Rational Method to calculate flow rates and related storage values. Detailed output from the modelling is included in Appendix B. Please note the runoff coefficient adjustment factors were also considered for the modelled catchments in HydroCAD. Based on the criteria defined in Section 1.4.1, all stormwater runoff from events up to and including the 100-year storm must be contained on site and released at or below the allowable rate.

As mentioned before, the 916 m^2 asphalt external area located north of the site will be draining into the site. It is assumed that runoff from that area will be collected by onsite measures (i.e. catchbasins) and conveyed to the subsurface storage system. Therefore, the target release rate would be the addition of the 2-year pre-development release rate and the release rate from the external area for each storm event. In addition, as mentioned in Section 2.4, there is a flow of 0.8 L/s from the groundwater pumping system which would be discharged into the storm sewers and that amount would have to be subtracted from the allowable release rate as a conservative measure. These groundwater flows will not enter the subsurface chamber. Calculations for the release rate of the external area can be found in Appendix A.

Summaries of the modelled peak offsite discharge rates for the subsurface storage system are provided in Table 3-2.

Table 3-2: Summary of Modelling Results

Return Period (years)	Peak Elevation in system /1.54 (m)	System Storage /1238.5(m^3)	System Discharge (L/s)	Allowable Release Rate (L/s)
2	0.688	580.3	321.7	**961.4**
5	0.805	694.2	470.2	
10	0.885	772.3	549.7	
25	1.033	917.1	670.7	
50	1.129	1010.6	738.8	
100	1.225	1,104.9	801.7	

The modelling results demonstrate that the post-development peak flow rates for all events up to the 100-year storm are lower than the target release rate. The maximum required storage volume to control the 100-year post-development runoff is 1,104.9 m^3, while the provide storage volume is 1,238.5 m^3. Note that this total utilized storage volume includes the water quality/erosion control volume described in the following sections.

As most of the flow rates are controlled by the site's subsurface storage system, the rainfall intensity and storm duration resulting in the maximum utilized storage produces the largest flows. This has been iteratively determined at t_d = 20 minutes (for the 100-year event).

3.3 Water Quality Control

As mentioned in Section 1.4.2, Enhanced Level of protection is required for the proposed development. The target is to treat 90% of the annual runoff volume and remove 80% of the total suspended solids (TSS). A treatment train which consists of an oil/grit separator upstream of the subsurface storage system is proposed.

The proposed treatment train approach consists of an OGS (Stormceptor EFO 12) which has been sized to capture approximately 60% of TSS and over 90% of the annual runoff volume. The OGS has been sized using Imbrium's online PCSWMM for Stormceptor tool with the CA ETV particle size distribution. Please refer to Appendix D for the sizing report. It is to be noted that from the pre-consultation meeting with the City of Pickering, OGS are credited for only 50% of TSS, this will be considered in the calculation of the overall TSS removal of the treatment train.

The OGS will act as a pre-treatment device for the runoff before it flows to the subsurface storage system. Using Table 3.2 of the 2003 Stormwater Management Planning and Design Manual from the Ministry of the Environment, Conservation and Parks, it was determined that an infiltration volume of 175.5 m^3 is required to achieve an 80% TSS removal for a 4.95 ha drainage area with an imperviousness of 71%. The subsurface storage system will provide 191.1 m^3 of infiltration volume which exceeds the requirement to achieve 80% TSS removal. By proposing the treatment train, it is expected the overall TSS removal efficiency is 90%. Please refer to Appendix A for the detailed calculations.

3.4 Erosion Control

As noted in Section 1.4.3, for site plans smaller than 5 ha there are minimum requirements that the development must meet. The site has been designed to meet the second requirement in the City of Pickering Stormwater Management Design Guidelines which states "runoff reduction from the site through infiltration, evapotranspiration and reuse of a minimum 5mm of rainfall depth across all impervious surfaces."

Allowing for an initial abstraction of 1 mm from impervious surfaces and 5 mm pervious surfaces (soft landscaping), a water balance volume for the post-development conditions is calculated. Table 3-3 outlines the water balance volume to retain the runoff from a 5 mm storm on site in the post-development condition. Detailed water balance calculations can be found in Appendix A of this report.

Table 3-3: Water Balance Calculation for Post-Development Condition

Surface Type	Area (m^2)	Initial Abstraction (m^3)	Volume Abstracted (m^3)	5 mm Volume (m^3)	Water Balance (m^3)
Impervious Roof Area	19,757	0.001	19.76	98.78	79.03
Soft Landscaping	14,117	0.005	70.59	70.59	0.00
At-Grade Impervious	14,665	0.001	14.66	73.32	58.66
Total	**48,539**	**-**	**105.01**	**242.69**	**137.69**

The water balance volume of 137.69 m^3 shall be stored in the stone base and the bottom of the subsurface storage units. As stated in Section 3.3, a sump volume of 191.1 m^3 will be provided in the subsurface storage system to meet the water quality requirement therefore the erosion control requirement will also be satisfied. Detailed calculations can in found in Appendix A of this report. During construction, appropriate erosion and sediment controls shall be implemented to ensure the impact from construction of the proposed development is minimized.

It is assumed that the captured stormwater will infiltrate into the native soil below the subsurface storage system. Based on the information from Borehole 9, which was located between proposed Tower 3 and 6, the base of the subsurface storage system will be approximately 1.0 m above the water table and at least 20 m above the bedrock. It is recommended to conduct more site investigation to determine the infiltration capacity of the soil surrounding the subsurface storage system before further analysis and finalizing the design.

3.5 Water Balance

As noted in Section 1.4.4, the objective for water balance is that the water balance volume in the post-development conditions shall be equal to or lesser than the pre-development condition. To compare the water balance volume between the pre- and post-development conditions, the runoff volume from a 5 mm rainfall on site was calculated under both conditions.

Allowing for an initial abstraction of 1 mm from impervious surfaces and 5 mm pervious surfaces (soft landscaping), a water balance volume for the pre-development conditions is calculated. Table 3-4 outlines the water balance volume to retain the runoff from a 5 mm storm in the pre-development condition and Table 3-3 outlines the water balance volume to retain the runoff from a 5 mm storm in the post-development condition. Detailed water balance calculations can be found in Appendix A of this report.

Table 3-4: Water Balance Calculation for Pre-Development Condition

Surface Type	Area (m^2)	Initial Abstraction (m^3)	Volume Abstracted (m^3)	5 mm Volume (m^3)	Water Balance (m^3)
Impervious Roof Area	15,249	0.001	15.25	76.25	61.00
Soft Landscaping	2,959	0.005	14.80	14.80	0
At-Grade Impervious	30,330	0.001	30.33	151.65	121.32
Total	**48,539**	**-**	**60.38**	**242.66**	**182.32**

As shown in Table 3-3 and Table 3-4, the post-development water balance (137.69 m^3) is smaller than the pre-development water balance volume (182.32 m^3) due to the increase in soft landscaping area in the post-development condition. The result illustrates that in 5 mm storms or for any other storms, there will be more runoff in the pre-development condition than in the post-development condition. It is also important to note that in the post-development condition, at least 191.1 m^3 of the runoff volume from any storm will be retained in the subsurface storage system and infiltrated into the native soil. Therefore, not only is the runoff volume lower in the post-development condition due to the increase in landscaped areas but a volume of 191.1 m^3 of the runoff will be infiltrated into the ground through the subsurface storage system.

4 CONCLUSIONS

A stormwater management plan has been prepared to support the rezoning application for the proposed redevelopment of 603-643, 645 and 699 Kingston Road in the City of Pickering. The key points are summarized below.

Water Quantity

Runoff from the entire site and external area will directed to the 1,238.5 m^3 Brentwood StormTank® subsurface storage system located in the proposed park between Tower 3 and 6. The maximum storage volume utilized is 1,104.9 m^3, including the sump volume for reuse and water quality. Outflow from the system will be controlled to below the 2-year pre-development discharge rate by a 600 mm orifice tube, while accounting for potential groundwater discharge and runoff from external area.

Water Quality

A treatment train consisting of an oil/grit separator and the subsurface storage system is proposed to achieve the required Enhanced level of water protection. The overall TSS removal of the treatment train is approximately 90%, which exceeds the 80% TSS requirement for Enhanced level of protection

Erosion Control

A minimum water reuse volume of 191.06 m^3 will be provided in a sump volume below the invert of the outlet of the subsurface storage system to store the required volume for reuse. It is proposed that the water stored in the sump volume will infiltrate into the native soil on site.

Water Balance

Due to the increase in pervious areas from pre- to post-development, the water balance volume has decreased when compared to post-development conditions. In addition, the 5 mm erosion control requirement has been addressed.

This report has demonstrated that the proposed SWM strategy will address stormwater management related impacts from this project and meet the intent of the City of Pickering Stormwater Management Design Guidelines.

Respectfully submitted,

WSP Canada Group Limited

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APPENDIX

A

Stormwater Management Calculations

	Stormwater Management Calculations	**Project:**	**603-643, 645 & 699 Kingston Road**	**No.:**	**19M-00841-00**
	Existing Offsite Discharge Rate	**By:**	**GW**	**Date:** **2020-03-19**	**Page:** **1**
		Checked:	**IS**		

Calculation of existing runoff rate is undertaken using the Rational Method: Q = 2.78 C*I*A*Ca

Where: Q = Peak flow rate (L/s)
C = Runoff coefficient
I = Rainfall intensity (mm/hr)
A = Catchment area (ha)
Ca = Runoff Coefficient Adjustment Factor

Area, A 4.85 hectares
Runoff Coef, C* 0.90

$$I = \frac{A}{(t_c + B)^C}$$

Where: A, B and C = Parameters defined in City of Pickering Stormwater Guidelines Table 12
I = Rainfall intensity (mm/hr)
Tc = Time of concentration (mins)

Return Period (Years)	2	5	10	25	50	100
A	715.1	1082.9	1314.0	1581.7	1828.0	2096.4
B	5.3	6.0	6.0	6.0	6.2	6.5
C	0.82	0.84	0.85	0.85	0.86	0.86
T (mins) *	10	10	10	10	10	10
I (mm/hr)	77.6	106.3	126.0	150.6	168.6	186.7
Runoff Coefficient Adjustment Factor*	1.00	1.00	1.00	1.10	1.20	1.25
Modified Runoff Coefficient	0.90	0.90	0.90	0.99	1.00	1.00
Q (litres/sec)	943.4	1292.9	1532.8	2014.8	2274.7	2519.2
Q (m^3/sec)	0.94	1.29	1.53	2.01	2.27	2.52

*Assume the time of concentration is 10 minutes

**City of Pickering Stormwater Management Guidelines requires a Runoff Coefficient Adjustment for 25-100 Year storms. The coefficients are defined in Section 6.2.3 in the guideline. The product of Ca and C cannot be greater than 1.00

Calculation of existing runoff rate is undertaken using the Rational Method: Q = 2.78 C*I*A*Ca

Where: Q = Peak flow rate (L/s)
C = Runoff coefficient
I = Rainfall intensity (mm/hr)
A = Catchment area (ha)
Ca = Runoff Coefficient Adjustment Factor

Area, A 0.09 hectares
Runoff Coef, C* 0.95

$$I = \frac{A}{(t_c + B)^C}$$

Where: A, B and C = Parameters defined in City of Pickering Stormwater Guidelines Table 12
I = Rainfall intensity (mm/hr)
Tc = Time of concentration (mins)

Return Period (Years)	2	5	10	25	50	100
A	715.1	1082.9	1314.0	1581.7	1828.0	2096.4
B	5.3	6.0	6.0	6.0	6.2	6.5
C	0.82	0.84	0.85	0.85	0.86	0.86
T (mins) *	10	10	10	10	10	10
I (mm/hr)	77.6	106.3	126.0	150.6	168.6	186.7
Runoff Coefficient Adjustment Factor*	1.00	1.00	1.00	1.10	1.20	1.25
Modified Runoff Coefficient	0.95	0.95	0.95	1.00	1.00	1.00
Q (litres/sec)	18.8	25.7	30.5	38.4	42.9	47.6
Q (m^3/sec)	0.02	0.03	0.03	0.04	0.04	0.05

*Assume the time of concentration is 10 minutes

**City of Pickering Stormwater Management Guidelines requires a Runoff Coefficient Adjustment for 25-100 Year storms. The coefficients are defined in Section 6.2.3 in the guideline. The product of Ca and C cannot be greater than 1.00

For less frequent storms an Antecedent Precipiation Factor (Ca) should be used and Rational Formula to be modified accordingly to:

Q = 0.00278 A x I x Ca x C where:

'Ca' values are listed below:

1 to 10 year storm - Ca = 1.00
25 year storm - Ca = 1.10
50 year storm - Ca = 1.20
100 year storm - Ca = 1.25

and the product of 'Ca x C' should not exceed 1.00.

As per City of Pickering Stormwater Management Design Guidelines (July 2019) Section 6.2.3.

Existing Conditions		Runoff Coefficients C, Return Period (Years)					
Land Use	Area (m^2)	2	5	10	25	50	100
Impervious Roof	15249	0.95	0.95	0.95	1.00	1.00	1.00
Impervious At-Grade	30330	0.95	0.95	0.95	1.00	1.00	1.00
Landscaping	2959	0.15	0.15	0.15	0.17	0.18	0.19
Total Area	**48539**	**0.90**	**0.90**	**0.90**	**0.95**	**0.95**	**0.95**

Proposed Conditions		Runoff Coefficients C, Return Period (Years)					
Land Use	Area (m^2)	2	5	10	25	50	100
Impervious Roof Area	19757	0.95	0.95	0.95	1.00	1.00	1.00
Soft Landscaping	14117	0.25	0.25	0.25	0.28	0.30	0.31
At-Grade Impervious	14665	0.95	0.95	0.95	1.00	1.00	1.00
Total Area	**48539**	**0.75**	**0.75**	**0.75**	**0.79**	**0.80**	**0.80**
Ex 1	916	0.95	0.95	0.96	0.97	0.97	0.98
Total Site Area + Ext Area:	**49455**	**0.75**	**0.75**	**0.75**	**0.79**	**0.80**	**0.80**

The City of Pickering Stormwater Management Guidelines requires runoff reduction from the site through infiltration, evapotranspiration and reuse of a minimum 5 mm of rainfall depth across all impervious surfaces - Section 4.2
In this case, the minimum on-site runoff retention will require the site to retain all runoff from 5 mm storm event through evapotranspiration, infiltration, or rainwater reuse.

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

Land Use	Area (m^2)	Runoff C	Impervious
Impervious Roof Area	15,249	0.95	100%
Green Roof	0	0.50	0%
Soft Landscaping	2,959	0.25	0%
Vehicular Surfaces	0	0.95	100%
At-Grade Impervious	30,330	0.95	100%
Total Site Area:	48,539	0.75	71%

Surface Type	Area (m^2)	Initial Abstraction (m)	Volume Abstracted (m^3)	5 mm Volume (m^3)	Water Balance (m^3)
Impervious Roof Area	15,249	0.001	15.25	76.25	61.00
Green Roof	0	0.005	0.00	0.00	0.00
Soft Landscaping	2,959	0.005	14.80	14.80	0.00
Vehicular Surfaces	0	0.001	0.00	0.00	0.00
At-Grade Impervious	30,330	0.001	30.33	151.65	121.32
Total Site Area:	**48,539**	-	**60.38**	**242.69**	**182.32**

For the purposes of the water balance calculation, it is assumed that the remaining hard surfaces on the site can abstract 1 mm of rainfall and that all soft landscaped areas can absorb 5 mm.

Therefore, the volume of runoff during a 5 mm storm event: **182.3** m^3

The City of Pickering Stormwater Management Guidelines requires runoff reduction from the site through infiltration, evapotranspiration and reuse of a minimum 5 mm of rainfall depth across all impervious surfaces - Section 4.2
In this case, the minimum on-site runoff retention will require the site to retain all runoff from 5 mm storm event through evapotranspiration, infiltration, or rainwater reuse.

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

Land Use	Area (m^2)	Runoff C	Impervious
Impervious Roof Area	19,757	0.95	100%
Green Roof	0	0.50	0%
Soft Landscaping	14,117	0.25	0%
Vehicular Surfaces	0	0.95	100%
At-Grade Impervious	14,665	0.95	100%
Total Site Area:	48,539	0.75	71%

Surface Type	Area (m^2)	Initial Abstraction (m)	Volume Abstracted (m^3)	5 mm Volume (m^3)	Water Balance (m^3)
Impervious Roof Area	19,757	0.001	19.76	98.78	79.03
Green Roof	0	0.005	0.00	0.00	0.00
Soft Landscaping	14,117	0.005	70.59	70.59	0.00
Vehicular Surfaces	0	0.001	0.00	0.00	0.00
At-Grade Impervious	14,665	0.001	14.66	73.32	58.66
Total Site Area:	**48,539**	-	**105.01**	**242.69**	**137.69**

For the purposes of the water balance calculation, it is assumed that the remaining hard surfaces on the site can abstract 1 mm of rainfall and that all soft landscaped areas can absorb 5 mm.

Therefore, the volume of runoff during a 5 mm storm event: **137.7** **m^3**

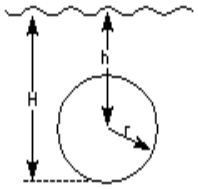
Discharge for a circular orifice is given by the following formula: $Q = Ca(2gh)^{0.5}$

Where: Q = Flow rate (m^3/s)
C = Discharge coefficient (unitless)
a = Submerged area (m^2)
g = Gravitational constant (m/s^2)
h = effective head (m)

For an orifice opening in a vertical plane, the effective head is given by the following formulae:

Fully Submerged:

$$h = H - \max(r, TW)$$



Where: H = Head above invert level (m)
r = Radius of orifice (m)
TW = Tailwater depth above invert level (m)

Variables:

C =	**0.8**	-	(Orifice Tube)
Orifice diameter =	**600**	mm	
r =	**300**	mm	
r =	**0.300**	m	
a =	**0.28274**	sqm	
g =	**9.81**	m/s^2	
H =	**0.94**	m	
TW =	**0.00**	m	(0.00 = assume free discharge)
h =	**0.64**	m	

Calculation:

Q =	**0.80153**	m^3/s
Q =	**801.53**	l/sec

1) Percolation Rate (mm/hr)

22	mm/hr*	>	15	mm/hr

2) Groundwater Table Depth

Assume cover about Subsurface Storage System**		0.38	m
Height of Subsurface Storage System		1.54	m
Ground Surface***		104.89	m
Bottom of Chamber System		102.97	m
Groundwater Elevation****		101.92	m
Height between bottom of system to water table		1.05	m
	and >	1	m

3) Bedrock Depth

Assume cover about Subsurface Storage System**		0.38	m
Height of Subsurface Storage System		1.54	m
Ground Surface***		104.89	m
Bottom of Chamber System		102.97	m
Height between bottom of system to bedrock*****		>20.88	m
	and >	1	m

4) Drawdown Time

Equation 4.2 in 2003 MOE SWMPDM is used to calculate the allowable depth of the infiltration trench

$$d = \frac{PT}{1{,}000}$$

Equation 4.2: Maximum Allowable Soakaway Pit Depth

where d = maximum allowable depth of the soakaway pit (m)
P = percolation rate (Table 4.1) (mm/h)
T = drawdown time (24 - 48 h) (h)

d	=	0.30	m	
P	=	22.00	mm/hr	
Note that a safety factor of		2.50		is appliled to the in-situ infiltration rate
T	=	**34.09**	hr	

Notes:

*Geometric Mean Infiltration Rate calculated from Section 4.4.3 in the Hydrogeological Report dated Jun 19, 2019

**Based on the StormTank Installation Guide and Drawing P-612 City of Pickering Road Standard for Asphalt Walkway

***Based on the ground surface of BH9 from the Borehole Logs in the Hydrogeological Report dated Jun 19, 2019

****Based on the highest measurement for BH9 in Table 4-3 in the Hydrogeological Report dated Jun 19, 2019

*****Based on Section 4.3 in the Hydrogeological Report dated Jun 19, 2019

1) Required Quality Treatment Volume

The TSS removal efficiency of the infiltration system shall be evaluated per Table 3.2 of 2003 MOE SWMPDM

Table 3.2 Water Quality Storage Requirements based on Receiving Waters[1, 2]

Protection Level	SWMP Type	Storage Volume (m^3/ha) for Impervious Level			
		35%	55%	70%	85%
Enhanced 80% long-term S.S. removal	Infiltration	25	30	35	40
	Wetlands	80	105	120	140
	Hybrid Wet Pond/Wetland	110	150	175	195
	Wet Pond	140	190	225	250

Catchment Area (ha)*	Imperviousness (%)
4.95	71%

SWMP Type	Infiltration	
Target TSS Removal	80	%
Required Storage Volume (m^3/ha)	35.5	m^3/ha
Required Storage Volume (m^3)	**175.5**	m^3

2) Provided Quality Treatment Volume

Length of System excluding stone (m)	36.58	m
Width of System excluding stone (m)	27.42	m
Width of stone at the perimeter (m)	0.305	m
Stone Base (m)	0.165	m
Stone Porosity (%)	40.0	%
Provided Storage Volume in the Base (m^3)	68.80	m^3
Orifice invert about base of storage units (m)	0.12	m
Provided Storage Volume above the Base (m^3)	122.25	m^3
Total Provided Storage Volume (m^3)	**191.055**	m^3

3) Pretreatment Practices

An Oil/Grit Separator (OGS) unit is proposed as pretreatment measures

OGS Model, Stormceptor	EFO 12	
Drainage Area (ha)	4.95	ha
Imperviousness (%)	94	%

TSS Removal Efficiency	60	%
Runoff Treated	90	%

4) Treatment Train Overall Treatment Train Efficiency

OGS TSS Removal Efficiency**	50	%
Subsurface Storage System Removal Efficiency	80	%

A simplified equation for the total TSS removal rate (R) for two BMPs in series is:

$$R = A + B - [(A \times B) / 100] \quad \text{(Equation 4-1)}$$

Where:

R = Total TSS Removal Rate

A = TSS Removal Rate of the First or Upstream BMP

B = TSS Removal Rate of the Second or Downstream BMP

Equation 4-1 is from New Jersey Stormwater Best Management Practices Manual

Overall TSS Removal Efficiency	**90**	**%**

Refer to Appendix C and D for more information on the Water Quantity and Water Quality Sizing Report and Specifications, respectively

Notes

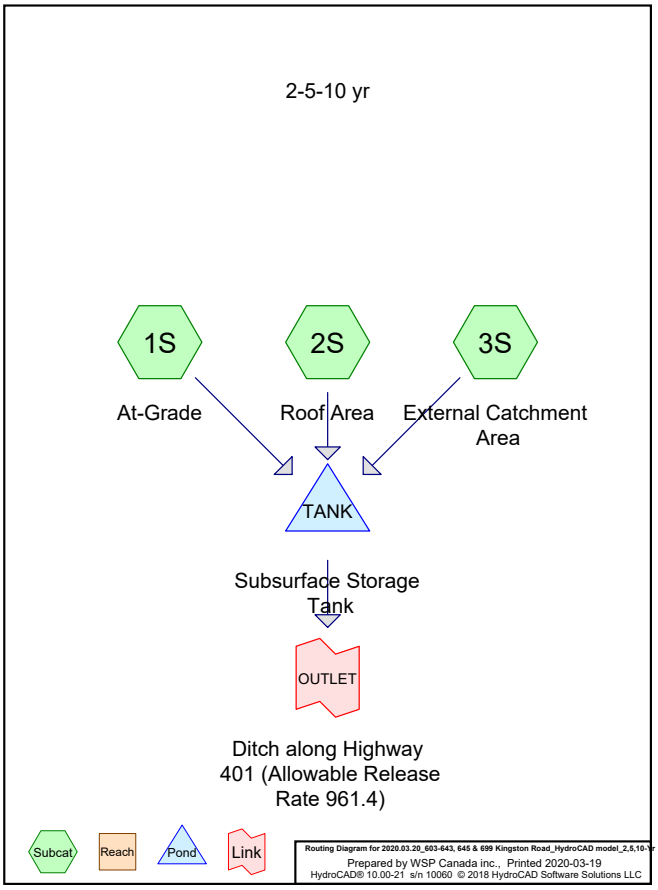
*Catchment area includes the site area and the external area

**City of Pickering only credits OGS with 50% TSS removal efficiency

APPENDIX

B

Hydrologic Model Output (HydroCAD)



Area Listing (all nodes)

Area (sq-meters)	C	Description (subcatchment-numbers)
916.0	0.95	External Catchment Area North of the Site (3S)
14,665.0	0.95	Impervious Area At-grade (1S)
19,757.0	0.95	Impervious Roof Area (2S)
14,117.0	0.25	Park area (1S)
49,455.0	**0.75**	**TOTAL AREA**

Notes Listing (all nodes)

Line#	Node Number	Notes
1	1S	Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.
2		The modified C should be less than 1.00
3	2S	Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.
4		The modified C should be less than 1.00
5	3S	Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.
6		The modified C should be less than 1.00
7	TANK	A levelling base with a minimum depth of 152 mm of angular stone and a top layer with minimum depth of 305 mm angular stone is a requirement in addition to the minimum width of 305 mm angular stone surrounding the sides of the system.

Time span=0.00-6.00 hrs, dt=0.01 hrs, 601 points
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: At-Grade Runoff Area=28,782.0 m² 50.95% Impervious Runoff Depth=10 mm
Tc=10.0 min C=0.61 Runoff=0.2509 m³/s 301.0 m³

Subcatchment2S: Roof Area Runoff Area=19,757.0 m² 100.00% Impervious Runoff Depth=16 mm
Tc=10.0 min C=0.95 Runoff=0.2682 m³/s 321.7 m³

Subcatchment3S: External Catchment Runoff Area=916.0 m² 100.00% Impervious Runoff Depth=16 mm
Tc=10.0 min C=0.95 Runoff=0.0124 m³/s 14.9 m³

Pond TANK: Subsurface Storage Tank Peak Elev=0.688 m Storage=580.3 m³ Inflow=0.5315 m³/s 637.6 m³
Outflow=0.3217 m³/s 620.0 m³

Link OUTLET: Ditch along Highway 401 (Allowable Release Rate 961.4) Inflow=0.3217 m³/s 620.0 m³
Primary=0.3217 m³/s 620.0 m³

Total Runoff Area = 49,455.0 m² Runoff Volume = 637.6 m³ Average Runoff Depth = 13 mm
28.55% Pervious = 14,117.0 m² 71.45% Impervious = 35,338.0 m²

Summary for Subcatchment 1S: At-Grade

Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.

The modified C should be less than 1.00

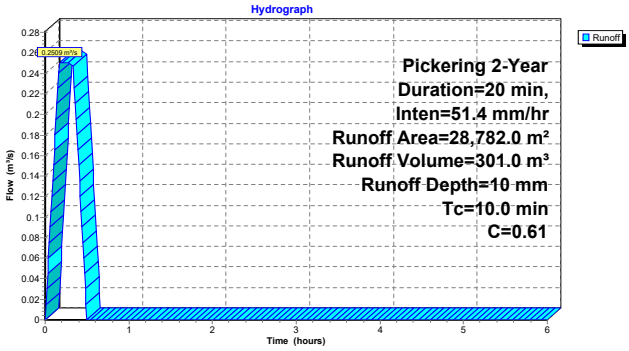
Runoff = 0.2509 m³/s @ 0.17 hrs, Volume= 301.0 m³, Depth= 10 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Pickering 2-Year Duration=20 min, Inten=51.4 mm/hr

Area (m²)	C	Description
14,117.0	0.25	Park area
14,665.0	0.95	Impervious Area At-grade
28,782.0	0.61	Weighted Average
14,117.0		49.05% Pervious Area
14,665.0		50.95% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry, Time of Concentration (Assumed)**

Subcatchment 1S: At-Grade



Summary for Subcatchment 2S: Roof Area

Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.

The modified C should be less than 1.00

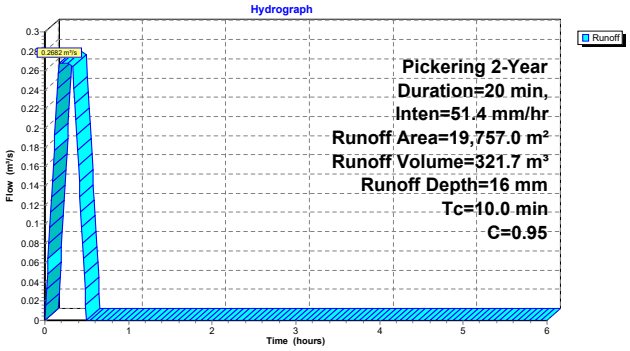
Runoff = 0.2682 m³/s @ 0.17 hrs, Volume= 321.7 m³, Depth= 16 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Pickering 2-Year Duration=20 min, Inten=51.4 mm/hr

Area (m²)	C	Description
19,757.0	0.95	Impervious Roof Area
19,757.0		100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry, Time of Concentration (Assumed)**

Subcatchment 2S: Roof Area



Summary for Subcatchment 3S: External Catchment Area

Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.

The modified C should be less than 1.00

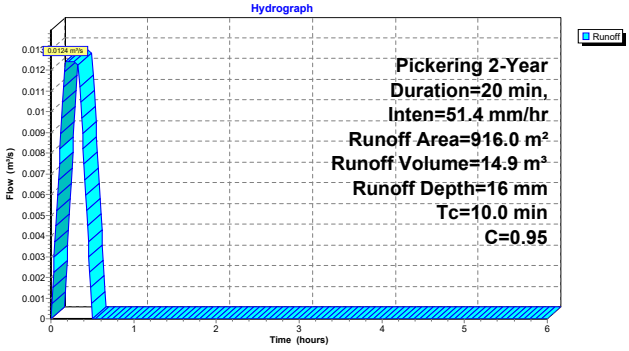
Runoff = 0.0124 m³/s @ 0.17 hrs, Volume= 14.9 m³, Depth= 16 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Pickering 2-Year Duration=20 min, Inten=51.4 mm/hr

Area (m²)	C	Description
916.0	0.95	External Catchment Area North of the Site
916.0		100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry, Time of Concentration (Assumed)**

Subcatchment 3S: External Catchment Area



Summary for Pond TANK: Subsurface Storage Tank

A levelling base with a minimum depth of 152 mm of angular stone and a top layer with minimum depth of 305 mm angular stone is a requirement in addition to the minimum width of 305 mm angular stone surrounding the sides of the system.

Inflow Area = 49,455.0 m², 71.45% Impervious, Inflow Depth = 13 mm for 2-Year event
Inflow = 0.5315 m³/s @ 0.17 hrs, Volume= 637.6 m³
Outflow = 0.3217 m³/s @ 0.40 hrs, Volume= 620.0 m³, Atten= 39%, Lag= 13.8 min
Primary = 0.3217 m³/s @ 0.40 hrs, Volume= 620.0 m³

Routing by Stor-Ind method, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Starting Elev= 0.285 m Surf.Area= 1,042.8 m² Storage= 186.1 m³
Peak Elev= 0.688 m @ 0.40 hrs Surf.Area= 1,042.8 m² Storage= 580.3 m³ (394.2 m³ above start)

Plug-Flow detention time= 48.1 min calculated for 433.2 m³ (68% of inflow)
Center-of-Mass det. time= 32.5 min (47.5 - 15.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	0.000 m	212.9 m³	**28.04 mW x 37.19 mL x 1.54 mH Field A** 1,602.5 m³ Overall - 1,070.4 m³ Embedded = 532.2 m³ x 40.0% Voids
#2A	0.165 m	1,025.6 m³	**Brentwood StormTank 42"** x 2400 Inside #1 Inside= 457 mmW x 1,067 mmH => 0.467 m² x 0.91 mL = 0.43 m³ Outside= 457 mmW x 1,067 mmH => 0.488 m² x 0.91 mL = 0.45 m³ 60 Rows of 40 Chambers
		1,238.5 m³	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	0.285 m	**600 mm Vert. Orifice/Grate** C= 0.800

Primary OutFlow Max=0.3217 m³/s @ 0.40 hrs HW=0.688 m (Free Discharge)
↑**1=Orifice/Grate** (Orifice Controls 0.3217 m³/s @ 1.59 m/s)

Pond TANK: Subsurface Storage Tank - Chamber Wizard Field A

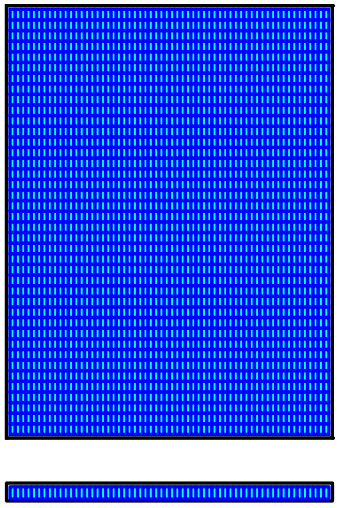
Chamber Model = Brentwood StormTank 42" (Brentwood Industries StormTank)
Inside= 457 mmW x 1,067 mmH => 0.467 m² x 0.91 mL = 0.43 m³
Outside= 457 mmW x 1,067 mmH => 0.488 m² x 0.91 mL = 0.45 m³

40 Chambers/Row x 0.91 m Long = 36.58 m Row Length +305 mm End Stone x 2 = 37.19 m Base Length
60 Rows x 457 mm Wide + 305 mm Side Stone x 2 = 28.04 m Base Width
165 mm Base + 1,067 mm Chamber Height + 305 mm Cover = 1.54 m Field Height

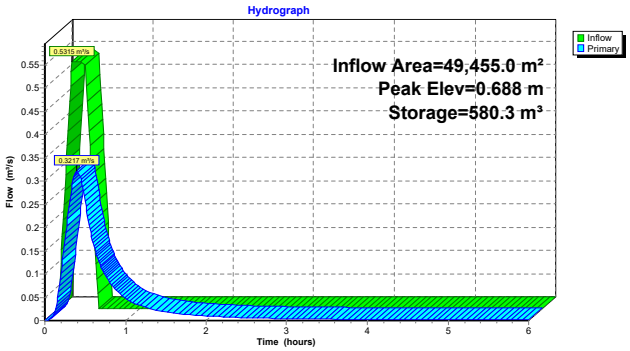
2,400 Chambers x 0.43 m³ = 1,025.64 m³ Chamber Storage
2,400 Chambers x 0.45 m³ = 1,070.38 m³ Displacement

1,602.53 m³ Field - 1,070.38 m³ Chambers = 532.15 m³ Stone x 40.0% Voids = 212.86 m³ Stone Storage

Chamber Storage + Stone Storage = 1,238.50 m³ = 1.238 MI
Overall Storage Efficiency = 77.3%
Overall System Size = 37.19 m x 28.04 m x 1.54 m



Pond TANK: Subsurface Storage Tank

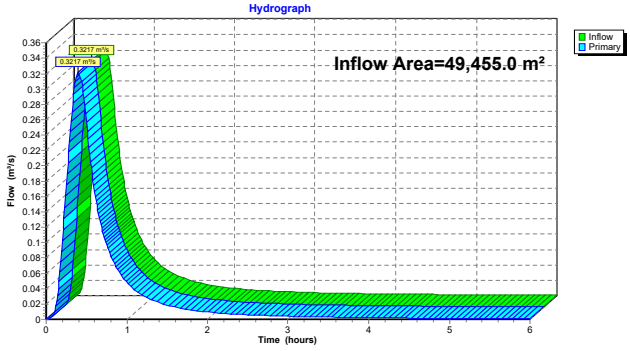


Summary for Link OUTLET: Ditch along Highway 401 (Allowable Release Rate 961.4)

Inflow Area = 49,455.0 m², 71.45% Impervious, Inflow Depth > 13 mm for 2-Year event
Inflow = 0.3217 m³/s @ 0.40 hrs, Volume= 620.0 m³
Primary = 0.3217 m³/s @ 0.40 hrs, Volume= 620.0 m³, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs

Link OUTLET: Ditch along Highway 401 (Allowable Release Rate 961.4)



Time span=0.00-6.00 hrs, dt=0.01 hrs, 601 points
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: At-Grade Runoff Area=28,782.0 m² 50.95% Impervious Runoff Depth=14 mm
Tc=10.0 min C=0.61 Runoff=0.3454 m³/s 414.3 m³

Subcatchment2S: Roof Area Runoff Area=19,757.0 m² 100.00% Impervious Runoff Depth=22 mm
Tc=10.0 min C=0.95 Runoff=0.3692 m³/s 442.9 m³

Subcatchment3S: External Catchment Runoff Area=916.0 m² 100.00% Impervious Runoff Depth=22 mm
Tc=10.0 min C=0.95 Runoff=0.0171 m³/s 20.5 m³

Pond TANK: Subsurface Storage Tank Peak Elev=0.805 m Storage=694.2 m³ Inflow=0.7317 m³/s 877.7 m³
Outflow=0.4702 m³/s 859.8 m³

Link OUTLET: Ditch along Highway 401 (Allowable Release Rate 961.4) Inflow=0.4702 m³/s 859.8 m³
Primary=0.4702 m³/s 859.8 m³

Total Runoff Area = 49,455.0 m² Runoff Volume = 877.7 m³ Average Runoff Depth = 18 mm
28.55% Pervious = 14,117.0 m² 71.45% Impervious = 35,338.0 m²

Summary for Subcatchment 1S: At-Grade

Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.

The modified C should be less than 1.00

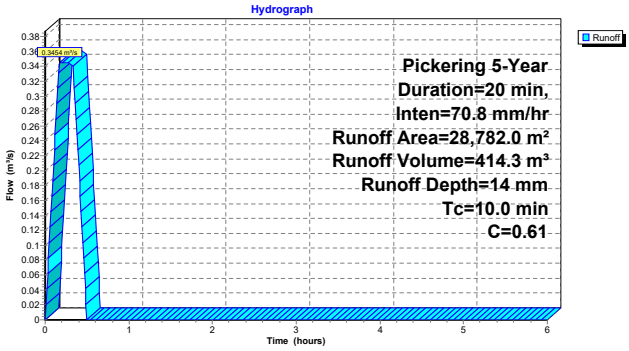
Runoff = 0.3454 m³/s @ 0.17 hrs, Volume= 414.3 m³, Depth= 14 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Pickering 5-Year Duration=20 min, Inten=70.8 mm/hr

Area (m²)	C	Description
14,117.0	0.25	Park area
14,665.0	0.95	Impervious Area At-grade
28,782.0	0.61	Weighted Average
14,117.0		49.05% Pervious Area
14,665.0		50.95% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry, Time of Concentration (Assumed)**

Subcatchment 1S: At-Grade



Summary for Subcatchment 2S: Roof Area

Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.

The modified C should be less than 1.00

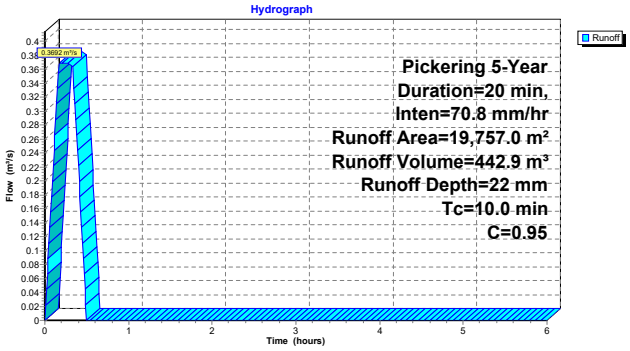
Runoff = 0.3692 m³/s @ 0.17 hrs, Volume= 442.9 m³, Depth= 22 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Pickering 5-Year Duration=20 min, Inten=70.8 mm/hr

Area (m²)	C	Description
19,757.0	0.95	Impervious Roof Area
19,757.0		100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry, Time of Concentration (Assumed)**

Subcatchment 2S: Roof Area



Summary for Subcatchment 3S: External Catchment Area

Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.

The modified C should be less than 1.00

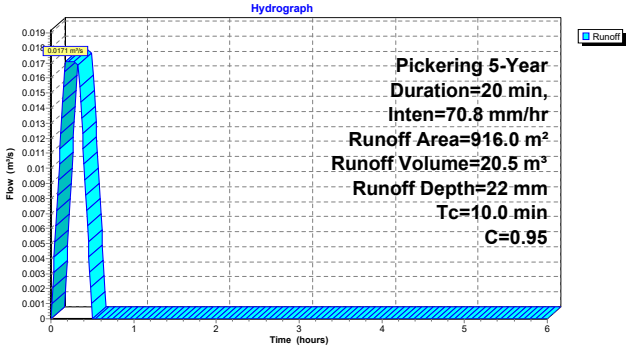
Runoff = 0.0171 m³/s @ 0.17 hrs, Volume= 20.5 m³, Depth= 22 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Pickering 5-Year Duration=20 min, Inten=70.8 mm/hr

Area (m²)	C	Description
916.0	0.95	External Catchment Area North of the Site
916.0		100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry, Time of Concentration (Assumed)**

Subcatchment 3S: External Catchment Area



Summary for Pond TANK: Subsurface Storage Tank

A levelling base with a minimum depth of 152 mm of angular stone and a top layer with minimum depth of 305 mm angular stone is a requirement in addition to the minimum width of 305 mm angular stone surrounding the sides of the system.

Inflow Area = 49,455.0 m², 71.45% Impervious, Inflow Depth = 18 mm for 5-Year event
Inflow = 0.7317 m³/s @ 0.17 hrs, Volume= 877.7 m³
Outflow = 0.4702 m³/s @ 0.39 hrs, Volume= 859.8 m³, Atten= 36%, Lag= 13.4 min
Primary = 0.4702 m³/s @ 0.39 hrs, Volume= 859.8 m³

Routing by Stor-Ind method, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Starting Elev= 0.285 m Surf.Area= 1,042.8 m² Storage= 186.1 m³
Peak Elev= 0.805 m @ 0.39 hrs Surf.Area= 1,042.8 m² Storage= 694.2 m³ (508.1 m³ above start)

Plug-Flow detention time= 37.9 min calculated for 673.8 m³ (77% of inflow)
Center-of-Mass det. time= 27.8 min (42.8 - 15.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	0.000 m	212.9 m³	**28.04 mW x 37.19 mL x 1.54 mH Field A** 1,602.5 m³ Overall - 1,070.4 m³ Embedded = 532.2 m³ x 40.0% Voids
#2A	0.165 m	1,025.6 m³	**Brentwood StormTank 42"** x 2400 Inside #1 Inside= 457 mmW x 1,067 mmH => 0.467 m² x 0.91 mL = 0.43 m³ Outside= 457 mmW x 1,067 mmH => 0.488 m² x 0.91 mL = 0.45 m³ 60 Rows of 40 Chambers
		1,238.5 m³	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	0.285 m	**600 mm Vert. Orifice/Grate** C= 0.800

Primary OutFlow Max=0.4701 m³/s @ 0.39 hrs HW=0.805 m (Free Discharge)
↑**1=Orifice/Grate** (Orifice Controls 0.4701 m³/s @ 1.81 m/s)

Pond TANK: Subsurface Storage Tank - Chamber Wizard Field A

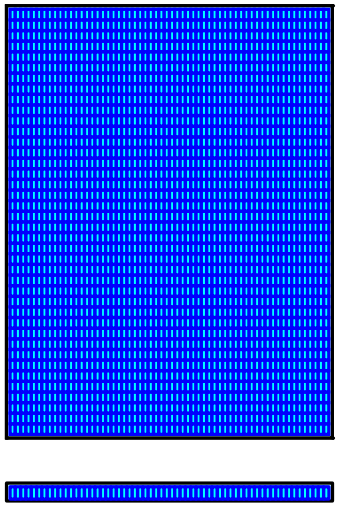
Chamber Model = Brentwood StormTank 42" (Brentwood Industries StormTank)
Inside= 457 mmW x 1,067 mmH => 0.467 m² x 0.91 mL = 0.43 m³
Outside= 457 mmW x 1,067 mmH => 0.488 m² x 0.91 mL = 0.45 m³

40 Chambers/Row x 0.91 m Long = 36.58 m Row Length +305 mm End Stone x 2 = 37.19 m Base Length
60 Rows x 457 mm Wide + 305 mm Side Stone x 2 = 28.04 m Base Width
165 mm Base + 1,067 mm Chamber Height + 305 mm Cover = 1.54 m Field Height

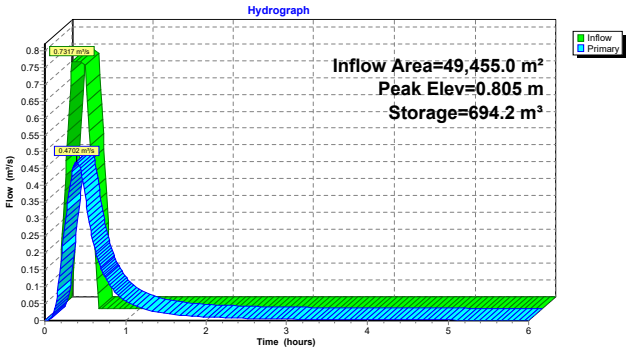
2,400 Chambers x 0.43 m³ = 1,025.64 m³ Chamber Storage
2,400 Chambers x 0.45 m³ = 1,070.38 m³ Displacement

1,602.53 m³ Field - 1,070.38 m³ Chambers = 532.15 m³ Stone x 40.0% Voids = 212.86 m³ Stone Storage

Chamber Storage + Stone Storage = 1,238.50 m³ = 1.238 MI
Overall Storage Efficiency = 77.3%
Overall System Size = 37.19 m x 28.04 m x 1.54 m



Pond TANK: Subsurface Storage Tank

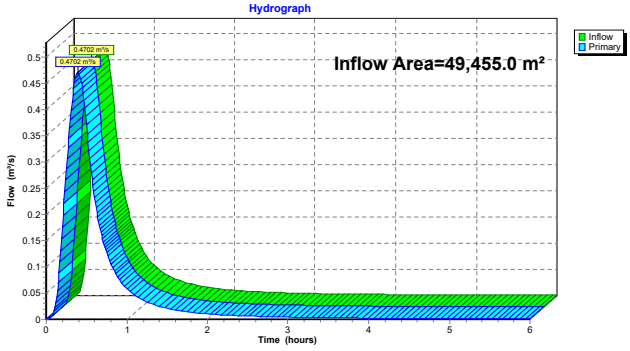


Summary for Link OUTLET: Ditch along Highway 401 (Allowable Release Rate 961.4)

Inflow Area = 49,455.0 m², 71.45% Impervious, Inflow Depth > 17 mm for 5-Year event
Inflow = 0.4702 m³/s @ 0.39 hrs, Volume= 859.8 m³
Primary = 0.4702 m³/s @ 0.39 hrs, Volume= 859.8 m³, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs

Link OUTLET: Ditch along Highway 401 (Allowable Release Rate 961.4)



Time span=0.00-6.00 hrs, dt=0.01 hrs, 601 points
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: At-Grade Runoff Area=28,782.0 m² 50.95% Impervious Runoff Depth=17 mm
Tc=10.0 min C=0.61 Runoff=0.4081 m³/s 489.5 m³

Subcatchment2S: Roof Area Runoff Area=19,757.0 m² 100.00% Impervious Runoff Depth=26 mm
Tc=10.0 min C=0.95 Runoff=0.4362 m³/s 523.3 m³

Subcatchment3S: External Catchment Runoff Area=916.0 m² 100.00% Impervious Runoff Depth=26 mm
Tc=10.0 min C=0.95 Runoff=0.0202 m³/s 24.3 m³

Pond TANK: Subsurface Storage Peak Elev=0.885 m Storage=772.3 m³ Inflow=0.8645 m³/s 1,037.0 m³
Outflow=0.5497 m³/s 1,018.9 m³

Link OUTLET: Ditch along Highway 401 (Allowable Release Rate 961.4) Inflow=0.5497 m³/s 1,018.9 m³
Primary=0.5497 m³/s 1,018.9 m³

Total Runoff Area = 49,455.0 m² Runoff Volume = 1,037.0 m³ Average Runoff Depth = 21 mm
28.55% Pervious = 14,117.0 m² 71.45% Impervious = 35,338.0 m²

Summary for Subcatchment 1S: At-Grade

Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.

The modified C should be less than 1.00

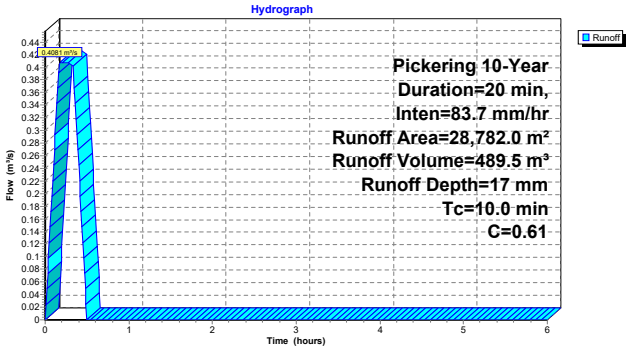
Runoff = 0.4081 m³/s @ 0.17 hrs, Volume= 489.5 m³, Depth= 17 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Pickering 10-Year Duration=20 min, Inten=83.7 mm/hr

Area (m²)	C	Description
14,117.0	0.25	Park area
14,665.0	0.95	Impervious Area At-grade
28,782.0	0.61	Weighted Average
14,117.0		49.05% Pervious Area
14,665.0		50.95% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry, Time of Concentration (Assumed)**

Subcatchment 1S: At-Grade



Summary for Subcatchment 2S: Roof Area

Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.

The modified C should be less than 1.00

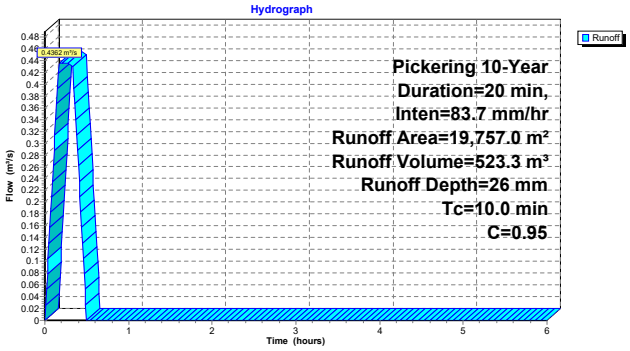
Runoff = 0.4362 m³/s @ 0.17 hrs, Volume= 523.3 m³, Depth= 26 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Pickering 10-Year Duration=20 min, Inten=83.7 mm/hr

Area (m²)	C	Description
19,757.0	0.95	Impervious Roof Area
19,757.0		100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry, Time of Concentration (Assumed)**

Subcatchment 2S: Roof Area



Summary for Subcatchment 3S: External Catchment Area

Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.

The modified C should be less than 1.00

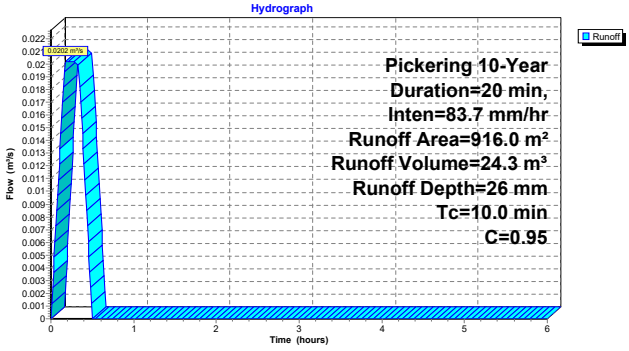
Runoff = 0.0202 m³/s @ 0.17 hrs, Volume= 24.3 m³, Depth= 26 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Pickering 10-Year Duration=20 min, Inten=83.7 mm/hr

Area (m²)	C	Description
916.0	0.95	External Catchment Area North of the Site
916.0		100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry, Time of Concentration (Assumed)**

Subcatchment 3S: External Catchment Area



Summary for Pond TANK: Subsurface Storage Tank

A levelling base with a minimum depth of 152 mm of angular stone and a top layer with minimum depth of 305 mm angular stone is a requirement in addition to the minimum width of 305 mm angular stone surrounding the sides of the system.

Inflow Area = 49,455.0 m², 71.45% Impervious, Inflow Depth = 21 mm for 10-Year event
Inflow = 0.8645 m³/s @ 0.17 hrs, Volume= 1,037.0 m³
Outflow = 0.5497 m³/s @ 0.39 hrs, Volume= 1,018.9 m³, Atten= 36%, Lag= 13.4 min
Primary = 0.5497 m³/s @ 0.39 hrs, Volume= 1,018.9 m³

Routing by Stor-Ind method, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Starting Elev= 0.285 m Surf.Area= 1,042.8 m² Storage= 186.1 m³
Peak Elev= 0.885 m @ 0.39 hrs Surf.Area= 1,042.8 m² Storage= 772.3 m³ (586.2 m³ above start)

Plug-Flow detention time= 33.6 min calculated for 831.5 m³ (80% of inflow)
Center-of-Mass det. time= 25.9 min (40.9 - 15.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	0.000 m	212.9 m³	**28.04 mW x 37.19 mL x 1.54 mH Field A** 1,602.5 m³ Overall - 1,070.4 m³ Embedded = 532.2 m³ x 40.0% Voids
#2A	0.165 m	1,025.6 m³	**Brentwood StormTank 42"** x 2400 Inside #1 Inside= 457 mmW x 1,067 mmH => 0.467 m² x 0.91 mL = 0.43 m³ Outside= 457 mmW x 1,067 mmH => 0.488 m² x 0.91 mL = 0.45 m³ 60 Rows of 40 Chambers
		1,238.5 m³	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	0.285 m	**600 mm Vert. Orifice/Grate** C= 0.800

Primary OutFlow Max=0.5486 m³/s @ 0.39 hrs HW=0.885 m (Free Discharge)
↑**1=Orifice/Grate** (Orifice Controls 0.5486 m³/s @ 1.94 m/s)

Pond TANK: Subsurface Storage Tank - Chamber Wizard Field A

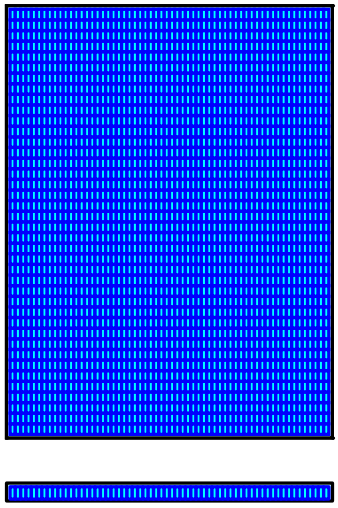
Chamber Model = Brentwood StormTank 42" (Brentwood Industries StormTank)
Inside= 457 mmW x 1,067 mmH => 0.467 m² x 0.91 mL = 0.43 m³
Outside= 457 mmW x 1,067 mmH => 0.488 m² x 0.91 mL = 0.45 m³

40 Chambers/Row x 0.91 m Long = 36.58 m Row Length +305 mm End Stone x 2 = 37.19 m Base Length
60 Rows x 457 mm Wide + 305 mm Side Stone x 2 = 28.04 m Base Width
165 mm Base + 1,067 mm Chamber Height + 305 mm Cover = 1.54 m Field Height

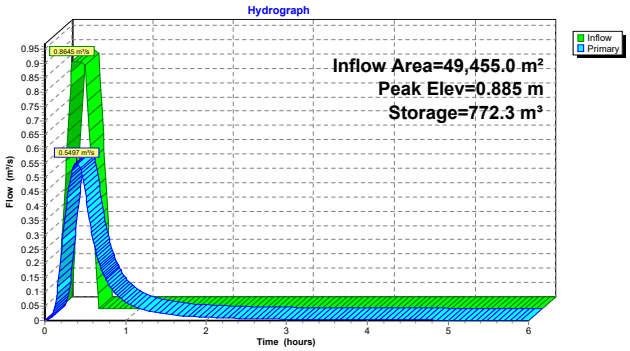
2,400 Chambers x 0.43 m³ = 1,025.64 m³ Chamber Storage
2,400 Chambers x 0.45 m³ = 1,070.38 m³ Displacement

1,602.53 m³ Field - 1,070.38 m³ Chambers = 532.15 m³ Stone x 40.0% Voids = 212.86 m³ Stone Storage

Chamber Storage + Stone Storage = 1,238.50 m³ = 1.238 Ml
Overall Storage Efficiency = 77.3%
Overall System Size = 37.19 m x 28.04 m x 1.54 m



Pond TANK: Subsurface Storage Tank

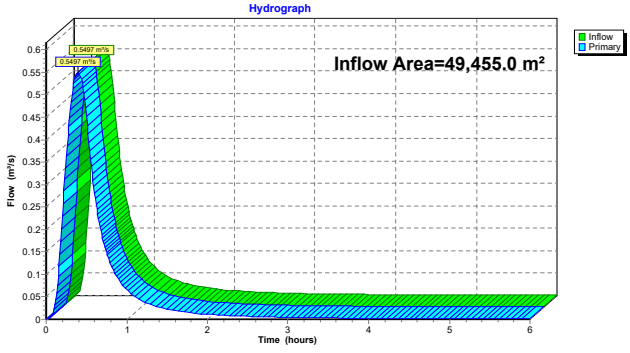


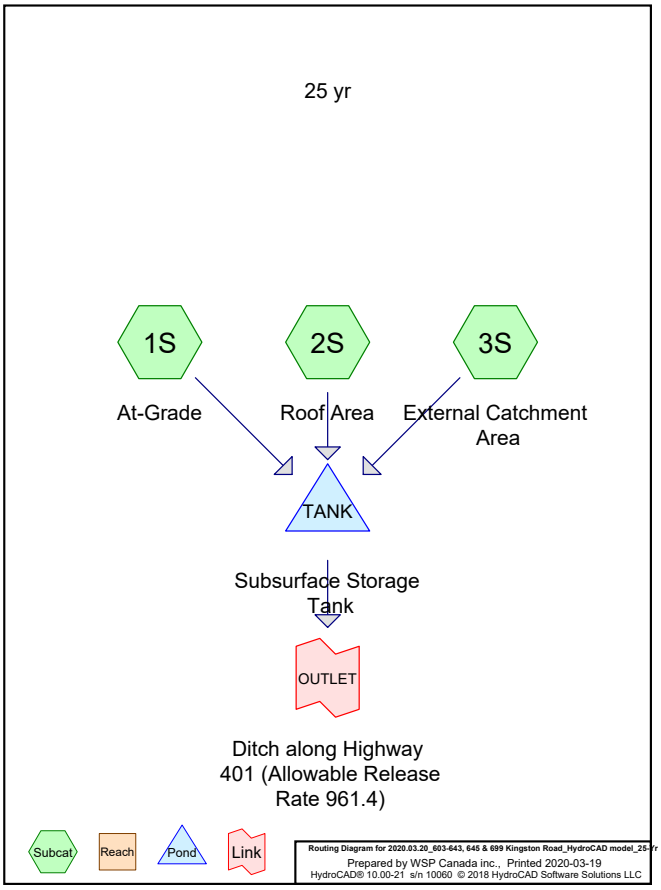
Summary for Link OUTLET: Ditch along Highway 401 (Allowable Release Rate 961.4)

Inflow Area = 49,455.0 m², 71.45% Impervious, Inflow Depth > 21 mm for 10-Year event
Inflow = 0.5497 m³/s @ 0.39 hrs, Volume= 1,018.9 m³
Primary = 0.5497 m³/s @ 0.39 hrs, Volume= 1,018.9 m³, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs

Link OUTLET: Ditch along Highway 401 (Allowable Release Rate 961.4)





Area Listing (all nodes)

Area (sq-meters)	C	Description (subcatchment-numbers)
916.0	1.00	External Catchment Area North of the Site (3S)
14,665.0	1.00	Impervious Area At-grade (1S)
19,757.0	1.00	Impervious Roof Area (2S)
14,117.0	0.28	Park area (1S)
49,455.0	**0.79**	**TOTAL AREA**

Notes Listing (all nodes)

Line#	Node Number	Notes
1	1S	Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.
2		The modified C should be less than 1.00
3	2S	Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.
4		The modified C should be less than 1.00
5	3S	Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.
6		The modified C should be less than 1.00
7	TANK	A levelling base with a minimum depth of 152 mm of angular stone and a top layer with minimum depth of 305 mm angular stone is a requirement in addition to the minimum width of 305 mm angular stone surrounding the sides of the system.

Time span=0.00-6.00 hrs, dt=0.01 hrs, 601 points
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: At-Grade Runoff Area=28,782.0 m² 50.95% Impervious Runoff Depth=22 mm
Tc=10.0 min C=0.65 Runoff=0.5186 m³/s 622.1 m³

Subcatchment2S: Roof Area Runoff Area=19,757.0 m² 100.00% Impervious Runoff Depth=33 mm
Tc=10.0 min C=1.00 Runoff=0.5477 m³/s 657.0 m³

Subcatchment3S: External Catchment Runoff Area=916.0 m² 100.00% Impervious Runoff Depth=33 mm
Tc=10.0 min C=1.00 Runoff=0.0254 m³/s 30.5 m³

Pond TANK: Subsurface Storage Peak Elev=1.033 m Storage=917.1 m³ Inflow=1.0917 m³/s 1,309.6 m³
Outflow=0.6707 m³/s 1,291.3 m³

Link OUTLET: Ditch along Highway 401 (Allowable Release Rate 961.4) Inflow=0.6707 m³/s 1,291.3 m³
Primary=0.6707 m³/s 1,291.3 m³

Total Runoff Area = 49,455.0 m² Runoff Volume = 1,309.6 m³ Average Runoff Depth = 26 mm
28.55% Pervious = 14,117.0 m² 71.45% Impervious = 35,338.0 m²

Summary for Subcatchment 1S: At-Grade

Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.

The modified C should be less than 1.00

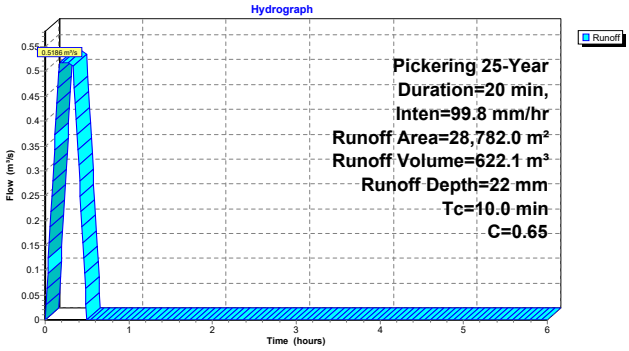
Runoff = 0.5186 m³/s @ 0.17 hrs, Volume= 622.1 m³, Depth= 22 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Pickering 25-Year Duration=20 min, Inten=99.8 mm/hr

Area (m²)	C	Description
14,117.0	0.28	Park area
14,665.0	1.00	Impervious Area At-grade
28,782.0	0.65	Weighted Average
14,117.0		49.05% Pervious Area
14,665.0		50.95% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry, Time of Concentration (Assumed)**

Subcatchment 1S: At-Grade



Summary for Subcatchment 2S: Roof Area

Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.

The modified C should be less than 1.00

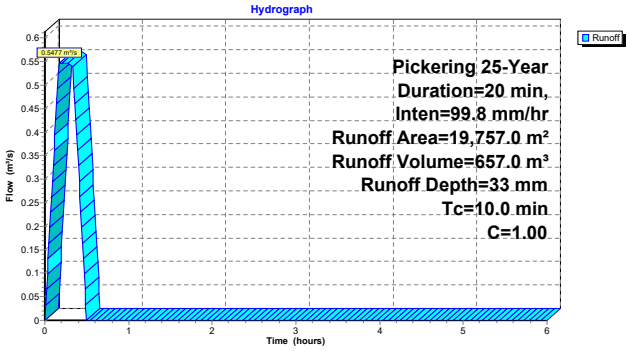
Runoff = 0.5477 m³/s @ 0.17 hrs, Volume= 657.0 m³, Depth= 33 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Pickering 25-Year Duration=20 min, Inten=99.8 mm/hr

Area (m²)	C	Description
19,757.0	1.00	Impervious Roof Area
19,757.0		100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry, Time of Concentration (Assumed)**

Subcatchment 2S: Roof Area



Summary for Subcatchment 3S: External Catchment Area

Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.

The modified C should be less than 1.00

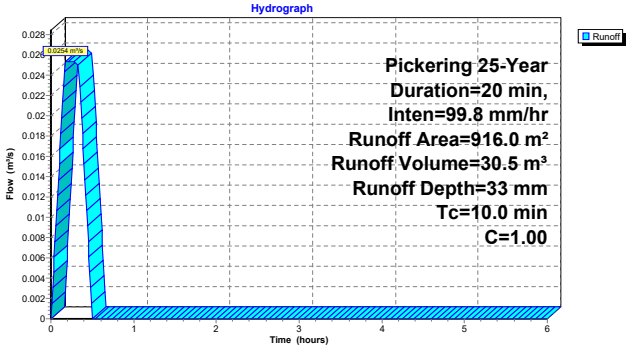
Runoff = 0.0254 m³/s @ 0.17 hrs, Volume= 30.5 m³, Depth= 33 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Pickering 25-Year Duration=20 min, Inten=99.8 mm/hr

Area (m²)	C	Description
916.0	1.00	External Catchment Area North of the Site
916.0		100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry, Time of Concentration (Assumed)**

Subcatchment 3S: External Catchment Area



Summary for Pond TANK: Subsurface Storage Tank

A levelling base with a minimum depth of 152 mm of angular stone and a top layer with minimum depth of 305 mm angular stone is a requirement in addition to the minimum width of 305 mm angular stone surrounding the sides of the system.

Inflow Area = 49,455.0 m², 71.45% Impervious, Inflow Depth = 26 mm for 25-Year event
Inflow = 1.0917 m³/s @ 0.17 hrs, Volume= 1,309.6 m³
Outflow = 0.6707 m³/s @ 0.40 hrs, Volume= 1,291.3 m³, Atten= 39%, Lag= 13.7 min
Primary = 0.6707 m³/s @ 0.40 hrs, Volume= 1,291.3 m³

Routing by Stor-Ind method, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Starting Elev= 0.285 m Surf.Area= 1,042.8 m² Storage= 186.1 m³
Peak Elev= 1.033 m @ 0.40 hrs Surf.Area= 1,042.8 m² Storage= 917.1 m³ (731.1 m³ above start)

Plug-Flow detention time= 29.7 min calculated for 1,103.4 m³ (84% of inflow)
Center-of-Mass det. time= 24.0 min (39.0 - 15.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	0.000 m	212.9 m³	**28.04 mW x 37.19 mL x 1.54 mH Field A** 1,602.5 m³ Overall - 1,070.4 m³ Embedded = 532.2 m³ x 40.0% Voids
#2A	0.165 m	1,025.6 m³	**Brentwood StormTank 42"** x 2400 Inside #1 Inside= 457 mmW x 1,067 mmH => 0.467 m² x 0.91 mL = 0.43 m³ Outside= 457 mmW x 1,067 mmH => 0.488 m² x 0.91 mL = 0.45 m³ 60 Rows of 40 Chambers
		1,238.5 m³	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	0.285 m	**600 mm Vert. Orifice/Grate** C= 0.800

Primary OutFlow Max=0.6706 m³/s @ 0.40 hrs HW=1.033 m (Free Discharge)
└**1=Orifice/Grate** (Orifice Controls 0.6706 m³/s @ 2.37 m/s)

Pond TANK: Subsurface Storage Tank - Chamber Wizard Field A

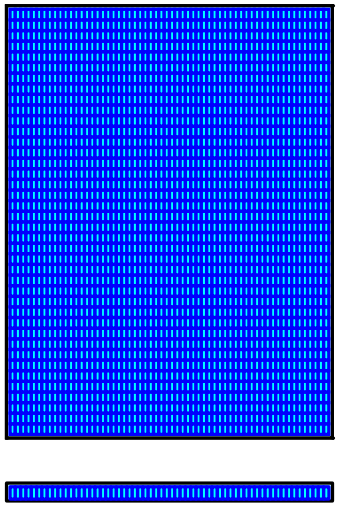
Chamber Model = Brentwood StormTank 42" (Brentwood Industries StormTank)
Inside= 457 mmW x 1,067 mmH => 0.467 m² x 0.91 mL = 0.43 m³
Outside= 457 mmW x 1,067 mmH => 0.488 m² x 0.91 mL = 0.45 m³

40 Chambers/Row x 0.91 m Long = 36.58 m Row Length +305 mm End Stone x 2 = 37.19 m Base Length
60 Rows x 457 mm Wide + 305 mm Side Stone x 2 = 28.04 m Base Width
165 mm Base + 1,067 mm Chamber Height + 305 mm Cover = 1.54 m Field Height

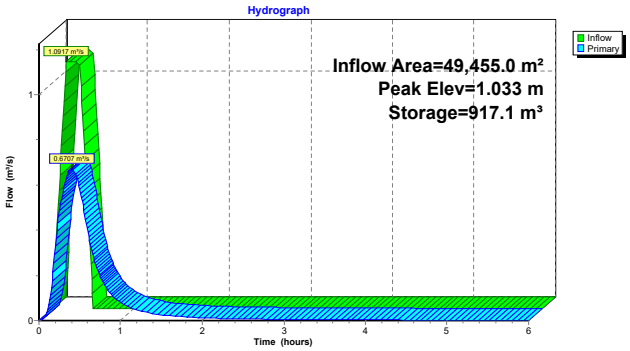
2,400 Chambers x 0.43 m³ = 1,025.64 m³ Chamber Storage
2,400 Chambers x 0.45 m³ = 1,070.38 m³ Displacement

1,602.53 m³ Field - 1,070.38 m³ Chambers = 532.15 m³ Stone x 40.0% Voids = 212.86 m³ Stone Storage

Chamber Storage + Stone Storage = 1,238.50 m³ = 1.238 Ml
Overall Storage Efficiency = 77.3%
Overall System Size = 37.19 m x 28.04 m x 1.54 m



Pond TANK: Subsurface Storage Tank

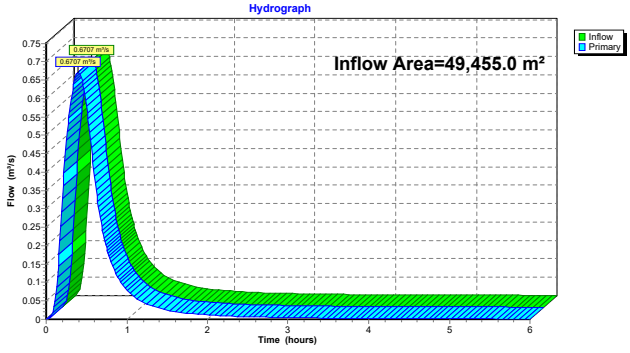


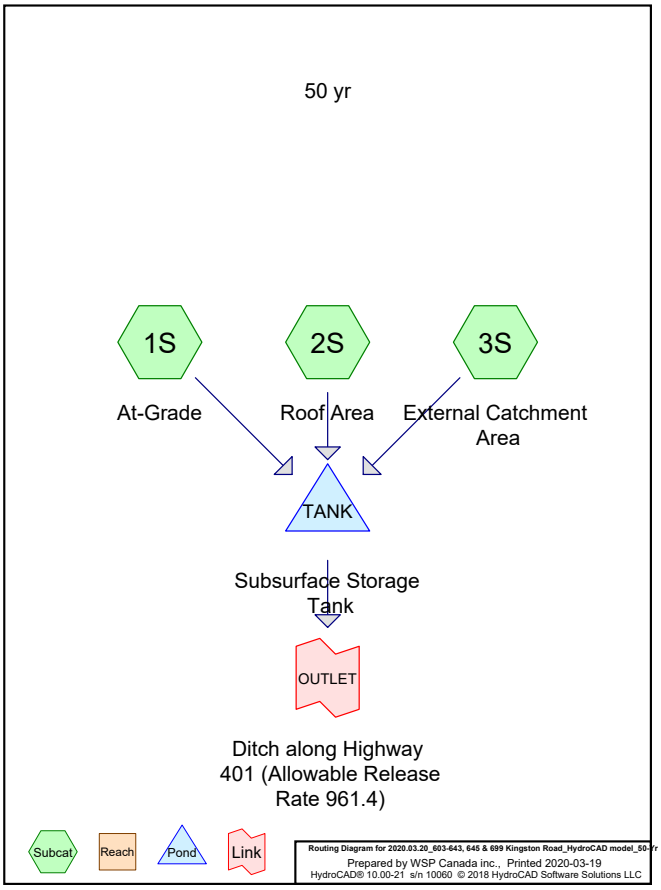
Summary for Link OUTLET: Ditch along Highway 401 (Allowable Release Rate 961.4)

Inflow Area = 49,455.0 m², 71.45% Impervious, Inflow Depth > 26 mm for 25-Year event
Inflow = 0.6707 m³/s @ 0.40 hrs, Volume= 1,291.3 m³
Primary = 0.6707 m³/s @ 0.40 hrs, Volume= 1,291.3 m³, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs

Link OUTLET: Ditch along Highway 401 (Allowable Release Rate 961.4)





Area Listing (all nodes)

Area (sq-meters)	C	Description (subcatchment-numbers)
916.0	1.00	External Catchment Area North of the Site (3S)
14,665.0	1.00	Impervious Area At-grade (1S)
19,757.0	1.00	Impervious Roof Area (2S)
14,117.0	0.30	Park area (1S)
49,455.0	**0.80**	**TOTAL AREA**

Notes Listing (all nodes)

Line#	Node Number	Notes
1	1S	Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.
2		The modified C should be less than 1.00
3	2S	Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.
4		The modified C should be less than 1.00
5	3S	Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.
6		The modified C should be less than 1.00
7	TANK	A levelling base with a minimum depth of 152 mm of angular stone and a top layer with minimum depth of 305 mm angular stone is a requirement in addition to the minimum width of 305 mm angular stone surrounding the sides of the system.

Time span=0.00-6.00 hrs, dt=0.01 hrs, 601 points
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: At-Grade Runoff Area=28,782.0 m² 50.95% Impervious Runoff Depth=25 mm
Tc=10.0 min C=0.66 Runoff=0.5894 m³/s 706.9 m³

Subcatchment2S: Roof Area Runoff Area=19,757.0 m² 100.00% Impervious Runoff Depth=37 mm
Tc=10.0 min C=1.00 Runoff=0.6130 m³/s 735.3 m³

Subcatchment3S: External Catchment Runoff Area=916.0 m² 100.00% Impervious Runoff Depth=37 mm
Tc=10.0 min C=1.00 Runoff=0.0284 m³/s 34.1 m³

Pond TANK: Subsurface Storage Peak Elev=1.129 m Storage=1,010.6 m³ Inflow=1.2307 m³/s 1,476.3 m³
Outflow=0.7388 m³/s 1,457.9 m³

Link OUTLET: Ditch along Highway 401 (Allowable Release Rate 961.4) Inflow=0.7388 m³/s 1,457.9 m³
Primary=0.7388 m³/s 1,457.9 m³

Total Runoff Area = 49,455.0 m² Runoff Volume = 1,476.3 m³ Average Runoff Depth = 30 mm
28.55% Pervious = 14,117.0 m² 71.45% Impervious = 35,338.0 m²

Summary for Subcatchment 1S: At-Grade

Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.

The modified C should be less than 1.00

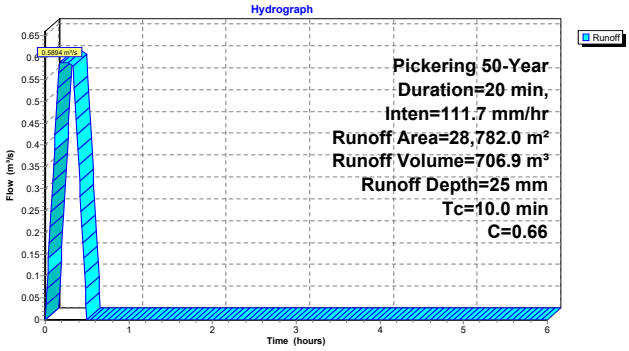
Runoff = 0.5894 m³/s @ 0.17 hrs, Volume= 706.9 m³, Depth= 25 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Pickering 50-Year Duration=20 min, Inten=111.7 mm/hr

Area (m²)	C	Description
14,117.0	0.30	Park area
14,665.0	1.00	Impervious Area At-grade
28,782.0	0.66	Weighted Average
14,117.0		49.05% Pervious Area
14,665.0		50.95% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry, Time of Concentration (Assumed)**

Subcatchment 1S: At-Grade



Summary for Subcatchment 2S: Roof Area

Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.

The modified C should be less than 1.00

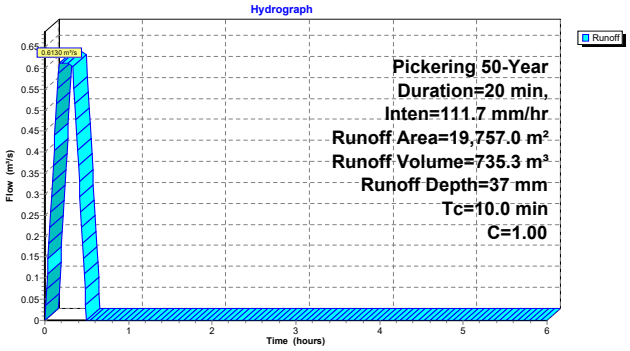
Runoff = 0.6130 m³/s @ 0.17 hrs, Volume= 735.3 m³, Depth= 37 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Pickering 50-Year Duration=20 min, Inten=111.7 mm/hr

Area (m²)	C	Description
19,757.0	1.00	Impervious Roof Area
19,757.0		100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry, Time of Concentration (Assumed)**

Subcatchment 2S: Roof Area



Summary for Subcatchment 3S: External Catchment Area

Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.

The modified C should be less than 1.00

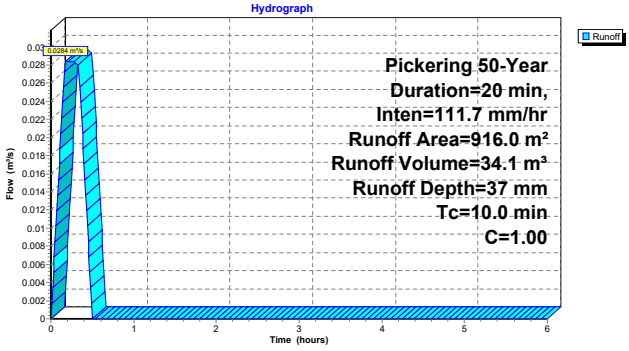
Runoff = 0.0284 m³/s @ 0.17 hrs, Volume= 34.1 m³, Depth= 37 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Pickering 50-Year Duration=20 min, Inten=111.7 mm/hr

Area (m²)	C	Description
916.0	1.00	External Catchment Area North of the Site
916.0		100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry, Time of Concentration (Assumed)**

Subcatchment 3S: External Catchment Area



Summary for Pond TANK: Subsurface Storage Tank

A levelling base with a minimum depth of 152 mm of angular stone and a top layer with minimum depth of 305 mm angular stone is a requirement in addition to the minimum width of 305 mm angular stone surrounding the sides of the system.

Inflow Area = 49,455.0 m², 71.45% Impervious, Inflow Depth = 30 mm for 50-Year event
Inflow = 1.2307 m³/s @ 0.17 hrs, Volume= 1,476.3 m³
Outflow = 0.7388 m³/s @ 0.40 hrs, Volume= 1,457.9 m³, Atten= 40%, Lag= 13.8 min
Primary = 0.7388 m³/s @ 0.40 hrs, Volume= 1,457.9 m³

Routing by Stor-Ind method, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Starting Elev= 0.285 m Surf.Area= 1,042.8 m² Storage= 186.1 m³
Peak Elev= 1.129 m @ 0.40 hrs Surf.Area= 1,042.8 m² Storage= 1,010.6 m³ (824.5 m³ above start)

Plug-Flow detention time= 28.8 min calculated for 1,271.8 m³ (86% of inflow)
Center-of-Mass det. time= 23.4 min (38.4 - 15.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	0.000 m	212.9 m³	**28.04 mW x 37.19 mL x 1.54 mH Field A** 1,602.5 m³ Overall - 1,070.4 m³ Embedded = 532.2 m³ x 40.0% Voids
#2A	0.165 m	1,025.6 m³	**Brentwood StormTank 42"** x 2400 Inside #1 Inside= 457 mmW x 1,067 mmH => 0.467 m² x 0.91 mL = 0.43 m³ Outside= 457 mmW x 1,067 mmH => 0.488 m² x 0.91 mL = 0.45 m³ 60 Rows of 40 Chambers
		1,238.5 m³	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	0.285 m	**600 mm Vert. Orifice/Grate** C= 0.800

Primary OutFlow Max=0.7388 m³/s @ 0.40 hrs HW=1.129 m (Free Discharge)
↑**1=Orifice/Grate** (Orifice Controls 0.7388 m³/s @ 2.61 m/s)

Pond TANK: Subsurface Storage Tank - Chamber Wizard Field A

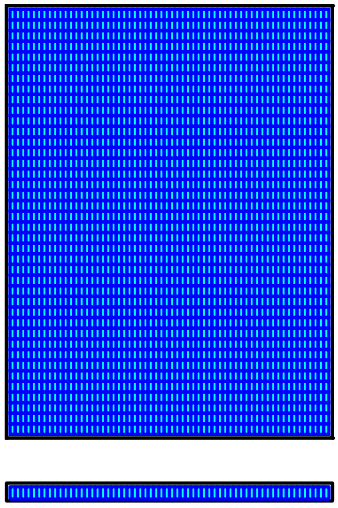
Chamber Model = Brentwood StormTank 42" (Brentwood Industries StormTank)
Inside= 457 mmW x 1,067 mmH => 0.467 m² x 0.91 mL = 0.43 m³
Outside= 457 mmW x 1,067 mmH => 0.488 m² x 0.91 mL = 0.45 m³

40 Chambers/Row x 0.91 m Long = 36.58 m Row Length +305 mm End Stone x 2 = 37.19 m Base Length
60 Rows x 457 mm Wide + 305 mm Side Stone x 2 = 28.04 m Base Width
165 mm Base + 1,067 mm Chamber Height + 305 mm Cover = 1.54 m Field Height

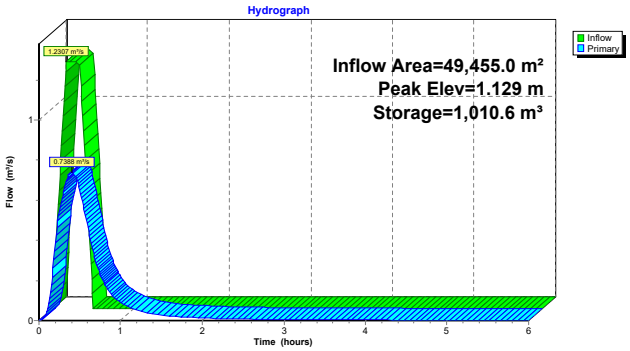
2,400 Chambers x 0.43 m³ = 1,025.64 m³ Chamber Storage
2,400 Chambers x 0.45 m³ = 1,070.38 m³ Displacement

1,602.53 m³ Field - 1,070.38 m³ Chambers = 532.15 m³ Stone x 40.0% Voids = 212.86 m³ Stone Storage

Chamber Storage + Stone Storage = 1,238.50 m³ = 1.238 Ml
Overall Storage Efficiency = 77.3%
Overall System Size = 37.19 m x 28.04 m x 1.54 m



Pond TANK: Subsurface Storage Tank

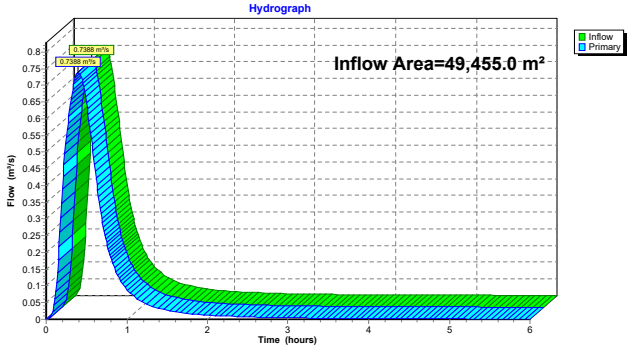


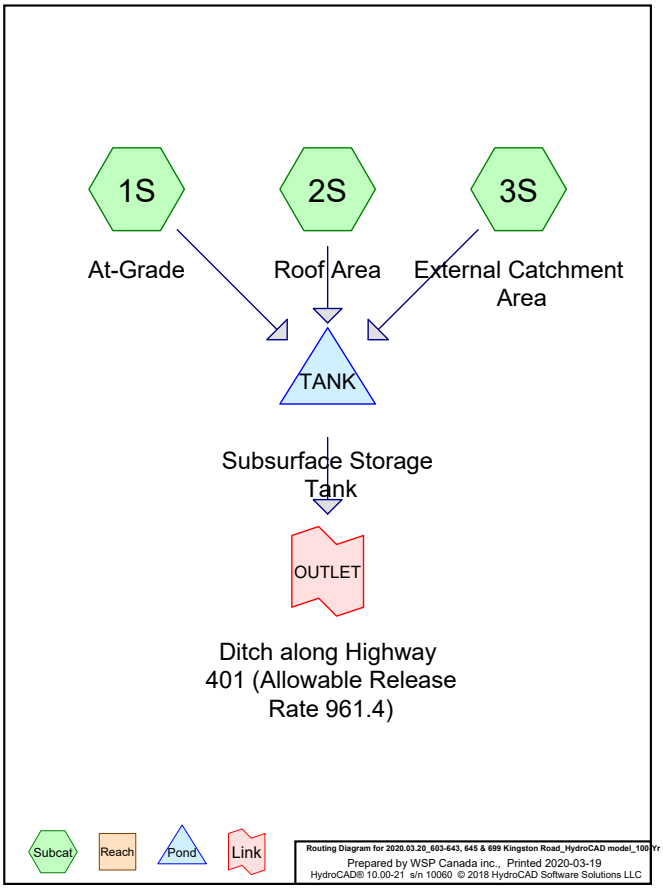
Summary for Link OUTLET: Ditch along Highway 401 (Allowable Release Rate 961.4)

Inflow Area = 49,455.0 m², 71.45% Impervious, Inflow Depth > 29 mm for 50-Year event
Inflow = 0.7388 m³/s @ 0.40 hrs, Volume= 1,457.9 m³
Primary = 0.7388 m³/s @ 0.40 hrs, Volume= 1,457.9 m³, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs

Link OUTLET: Ditch along Highway 401 (Allowable Release Rate 961.4)





Area Listing (selected nodes)

Area (sq-meters)	C	Description (subcatchment-numbers)
916.0	1.00	External Catchment Area North of the Site (3S)
14,665.0	1.00	Impervious Area At-grade (1S)
19,757.0	1.00	Impervious Roof Area (2S)
14,117.0	0.31	Park area (1S)
49,455.0	**0.80**	**TOTAL AREA**

Notes Listing (selected nodes)

Line#	Node Number	Notes
1	1S	Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.
2		The modified C should be less than 1.00
3	2S	Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.
4		The modified C should be less than 1.00
5	3S	Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.
6		The modified C should be less than 1.00
7	TANK	A levelling base with a minimum depth of 152 mm of angular stone and a top layer with minimum depth of 305 mm angular stone is a requirement in addition to the minimum width of 305 mm angular stone surrounding the sides of the system.

Time span=0.00-6.00 hrs, dt=0.01 hrs, 601 points
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: At-Grade Runoff Area=28,782.0 m² 50.95% Impervious Runoff Depth=27 mm
Tc=10.0 min C=0.66 Runoff=0.6543 m³/s 784.9 m³

Subcatchment2S: Roof Area Runoff Area=19,757.0 m² 100.00% Impervious Runoff Depth=41 mm
Tc=10.0 min C=1.00 Runoff=0.6805 m³/s 816.3 m³

Subcatchment3S: External Catchment Runoff Area=916.0 m² 100.00% Impervious Runoff Depth=41 mm
Tc=10.0 min C=1.00 Runoff=0.0316 m³/s 37.8 m³

Pond TANK: Subsurface Storage Peak Elev=1.225 m Storage=1,104.9 m³ Inflow=1.3664 m³/s 1,639.0 m³
Outflow=0.8017 m³/s 1,620.5 m³

Link OUTLET: Ditch along Highway 401 (Allowable Release Rate 961.4) Inflow=0.8017 m³/s 1,620.5 m³
Primary=0.8017 m³/s 1,620.5 m³

Total Runoff Area = 49,455.0 m² Runoff Volume = 1,639.0 m³ Average Runoff Depth = 33 mm
28.55% Pervious = 14,117.0 m² 71.45% Impervious = 35,338.0 m²

Summary for Subcatchment 1S: At-Grade

Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.

The modified C should be less than 1.00

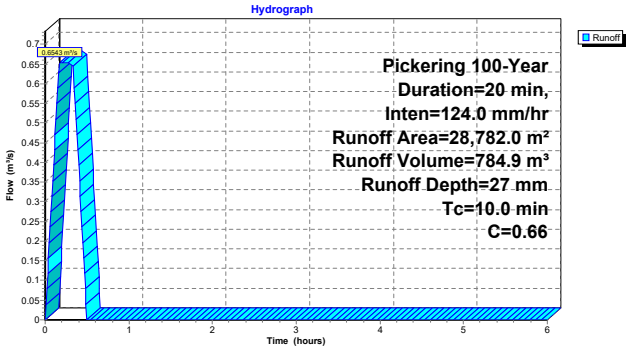
Runoff = 0.6543 m³/s @ 0.17 hrs, Volume= 784.9 m³, Depth= 27 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Pickering 100-Year Duration=20 min, Inten=124.0 mm/hr

Area (m²)	C	Description
14,117.0	0.31	Park area
14,665.0	1.00	Impervious Area At-grade
28,782.0	0.66	Weighted Average
14,117.0		49.05% Pervious Area
14,665.0		50.95% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry, Time of Concentration (Assumed)**

Subcatchment 1S: At-Grade



Summary for Subcatchment 2S: Roof Area

Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.

The modified C should be less than 1.00

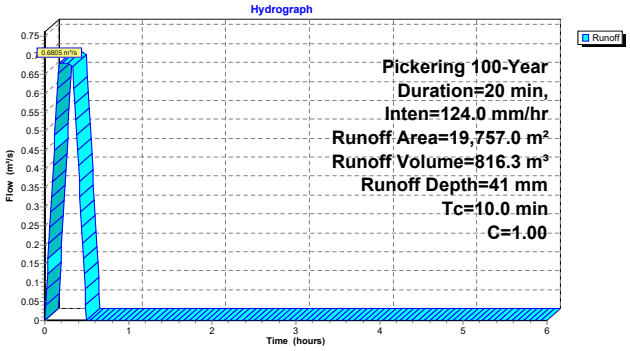
Runoff = 0.6805 m³/s @ 0.17 hrs, Volume= 816.3 m³, Depth= 41 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Pickering 100-Year Duration=20 min, Inten=124.0 mm/hr

Area (m²)	C	Description
19,757.0	1.00	Impervious Roof Area
19,757.0		100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry, Time of Concentration (Assumed)**

Subcatchment 2S: Roof Area



Summary for Subcatchment 3S: External Catchment Area

Runoff Coefficient Adjust Factor of 1.0 should be applied for the 2-year, 5-year and 10-year storm, 1.10 for the 25-year storm, 1.20 for the 50-year storm and 1.25 for the 100-year storm.

The modified C should be less than 1.00

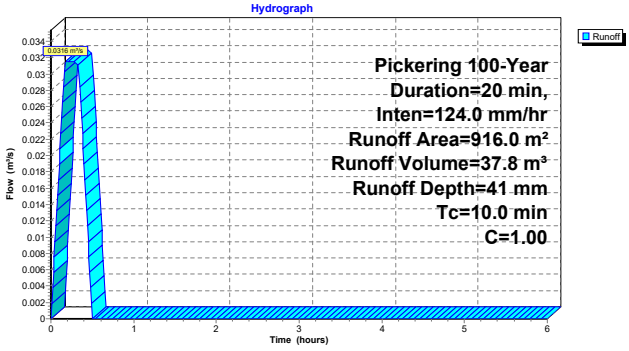
Runoff = 0.0316 m³/s @ 0.17 hrs, Volume= 37.8 m³, Depth= 41 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Pickering 100-Year Duration=20 min, Inten=124.0 mm/hr

Area (m²)	C	Description
916.0	1.00	External Catchment Area North of the Site
916.0		100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry, Time of Concentration (Assumed)**

Subcatchment 3S: External Catchment Area



Summary for Pond TANK: Subsurface Storage Tank

A levelling base with a minimum depth of 152 mm of angular stone and a top layer with minimum depth of 305 mm angular stone is a requirement in addition to the minimum width of 305 mm angular stone surrounding the sides of the system.

Inflow Area = 49,455.0 m², 71.45% Impervious, Inflow Depth = 33 mm for 100-Year event
Inflow = 1.3664 m³/s @ 0.17 hrs, Volume= 1,639.0 m³
Outflow = 0.8017 m³/s @ 0.40 hrs, Volume= 1,620.5 m³, Atten= 41%, Lag= 13.9 min
Primary = 0.8017 m³/s @ 0.40 hrs, Volume= 1,620.5 m³

Routing by Stor-Ind method, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Starting Elev= 0.285 m Surf.Area= 1,042.8 m² Storage= 186.1 m³
Peak Elev= 1.225 m @ 0.40 hrs Surf.Area= 1,042.8 m² Storage= 1,104.9 m³ (918.8 m³ above start)

Plug-Flow detention time= 27.3 min calculated for 1,432.0 m³ (87% of inflow)
Center-of-Mass det. time= 22.9 min (37.9 - 15.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	0.000 m	212.9 m³	**28.04 mW x 37.19 mL x 1.54 mH Field A** 1,602.5 m³ Overall - 1,070.4 m³ Embedded = 532.2 m³ x 40.0% Voids
#2A	0.165 m	1,025.6 m³	**Brentwood StormTank 42"** x 2400 Inside #1 Inside= 457 mmW x 1,067 mmH => 0.467 m² x 0.91 mL = 0.43 m³ Outside= 457 mmW x 1,067 mmH => 0.488 m² x 0.91 mL = 0.45 m³ 60 Rows of 40 Chambers
		1,238.5 m³	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	0.285 m	**600 mm Vert. Orifice/Grate** C= 0.800

Primary OutFlow Max=0.8015 m³/s @ 0.40 hrs HW=1.225 m (Free Discharge)
└**1=Orifice/Grate** (Orifice Controls 0.8015 m³/s @ 2.83 m/s)

Pond TANK: Subsurface Storage Tank - Chamber Wizard Field A

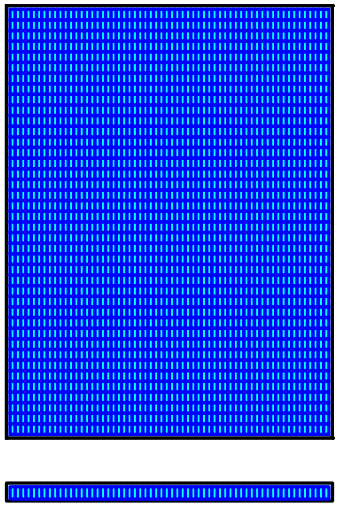
Chamber Model = Brentwood StormTank 42" (Brentwood Industries StormTank)
Inside= 457 mmW x 1,067 mmH => 0.467 m² x 0.91 mL = 0.43 m³
Outside= 457 mmW x 1,067 mmH => 0.488 m² x 0.91 mL = 0.45 m³

40 Chambers/Row x 0.91 m Long = 36.58 m Row Length +305 mm End Stone x 2 = 37.19 m Base Length
60 Rows x 457 mm Wide + 305 mm Side Stone x 2 = 28.04 m Base Width
165 mm Base + 1,067 mm Chamber Height + 305 mm Cover = 1.54 m Field Height

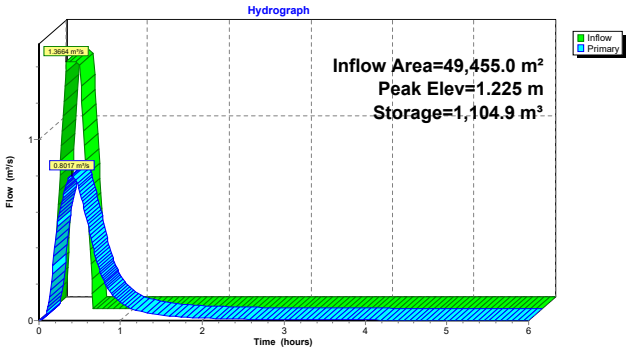
2,400 Chambers x 0.43 m³ = 1,025.64 m³ Chamber Storage
2,400 Chambers x 0.45 m³ = 1,070.38 m³ Displacement

1,602.53 m³ Field - 1,070.38 m³ Chambers = 532.15 m³ Stone x 40.0% Voids = 212.86 m³ Stone Storage

Chamber Storage + Stone Storage = 1,238.50 m³ = 1.238 Ml
Overall Storage Efficiency = 77.3%
Overall System Size = 37.19 m x 28.04 m x 1.54 m



Pond TANK: Subsurface Storage Tank

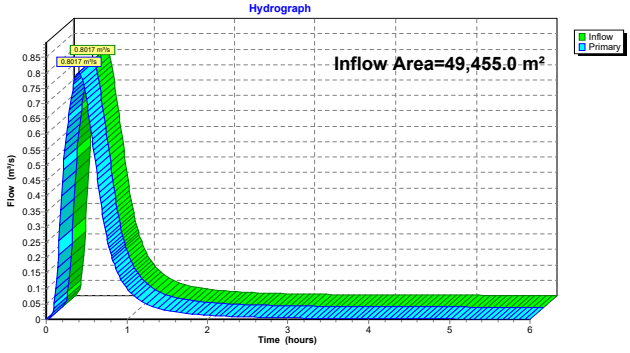


Summary for Link OUTLET: Ditch along Highway 401 (Allowable Release Rate 961.4)

Inflow Area = 49,455.0 m², 71.45% Impervious, Inflow Depth > 33 mm for 100-Year event
Inflow = 0.8017 m³/s @ 0.40 hrs, Volume= 1,620.5 m³
Primary = 0.8017 m³/s @ 0.40 hrs, Volume= 1,620.5 m³, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs

Link OUTLET: Ditch along Highway 401 (Allowable Release Rate 961.4)



APPENDIX

C

Water Quantity Installation Guide and Specifications

DESIGN GUIDE

STORMTANK® Module

BRENTWOOD®

Contents

General Notes

1. Brentwood recommends that the installing contractor contact either Brentwood or the local distributor prior to installation of the system to schedule a pre-construction meeting. This meeting will ensure that the installing contractor has a firm understanding of the installation instructions.
2. All systems must be designed and installed to meet or exceed Brentwood's minimum requirements. Although Brentwood offers support during the design, review, and construction phases of the Module system, it is the ultimate responsibility of the Engineer of Record to design the system in full compliance with all applicable engineering practices, laws, and regulations.
3. Brentwood requires a minimum cover of 24" (610 mm) and/or a maximum Module invert of 11' (3.35 m). Additionally, a minimum 6" (152 mm) leveling bed, 12" (305 mm) side backfill, and 12" (305 mm) top backfill are required on every system.
4. Brentwood recommends a minimum bearing capacity and subgrade compaction for all installations. If site conditions are found not to meet any design requirements during installation, the Engineer of Record must be contacted immediately.
5. All installations require a minimum two layers of geotextile fabric. One layer is to be installed around the Modules, and another layer is to be installed between the stone/soil interfaces.
6. Stone backfilling is to follow all requirements of the most current installation instructions.
7. The installing contractor must apply all protective measures to prevent sediment from entering the system during and after installation per local, state, and federal regulations.
8. The StormTank® Module carries a Limited Warranty, which can be accessed at www.brentwoodindustries.com.

1.0 Introduction

About Brentwood

Brentwood is a global manufacturer of custom and proprietary products and systems for the construction, consumer, medical, power, transportation, and water industries. A focus on plastics innovation, coupled with diverse production capabilities and engineering expertise, has allowed Brentwood to build a strong reputation for thermoplastic molding and solutions development.

Brentwood's product and service offerings continue to grow with an ever-increasing manufacturing presence. By emphasizing customer service and working closely with clients throughout the design, engineering, and manufacturing phases of each project, Brentwood develops forward-thinking strategies to create targeted, tailored solutions.

StormTank® Module

The StormTank Module is a strong, yet lightweight, alternative to other subsurface systems and offers the largest void space (up to 97%) of any subsurface stormwater storage unit on the market. The Modules are simple to assemble on site, limiting shipping costs, installation time, and labor. Their structural PVC columns pressure fit into the polypropylene top/bottom platens, with side panels inserted around the perimeter of the system. This open design and lack of internal walls make the Module system easy to clean compared to other subsurface box structures. When properly designed, applied, installed, and maintained, the Module system has been engineered to achieve a 50-year lifespan.

Technical Support

Brentwood's knowledgeable distributor network and in-house associates emphasize customer service and support by parterning with customers to extend the process beyond physical material supply. These trained specialists are available to assist in the review of proposed systems, conversions of alternatively designed systems, or to resolve any potential concerns before, during, and after the design process. To provide the best assistance, it is recommended that associates be provided with a site plan and cross-sections that include grading, drainage structures, dimensions, etc.

2.0 Product Information

Applications

The Module system can be utilized for detention, infiltration, capture and reuse, and specialty applications across a wide range of industries, including the commercial, residential, and recreational segments. The product's modular design allows the system to be configured in almost any shape (even around utilities) and to be located under almost any pervious or impervious surface.

Module Selection

Brentwood manufactures the Module in five different heights (Table 1) that can be stacked uniformly up to two Modules high. This allows for numerous height configurations up to 6' (1.83 m) tall. The Modules can be buried up to a maximum invert of 11' (3.35 m) and require a minimum cover of 24" (610 mm) for load rating. When selecting the proper Module, it is important to consider the minimum required cover, any groundwater or limiting zone restrictions, footprint requirements, and all local, state, and federal regulations.

Table 1: Nominal StormTank® Module Specificiations

	ST-18	ST-24	ST-30	ST-33	ST-36
Height	18" (457 mm)	24" (610 mm)	30" (762 mm)	33" (838 mm)	36" (914 mm)
Void Space	95.5%	96.0%	96.5%	96.9%	97.0%
Module Storage Capacity	6.54 ft^3 (0.18 m^3)	8.64 ft^3 (0.24 m^3)	10.86 ft^3 (0.31 m^3)	11.99 ft^3 (0.34 m^3)	13.10 ft^3 (0.37 m^3)
Min. Installed Capacity*	9.15 ft^3 (0.26 m^3)	11.34 ft^3 (0.32 m^3)	13.56 ft^3 (0.38 m^3)	14.69 ft^3 (0.42 m^3)	15.80 ft^3 (0.45 m^3)
Weight	22.70 lbs (10.30 kg)	26.30 lbs (11.93 kg)	29.50 lbs (13.38 kg)	31.3 lbs (14.20 kg)	33.10 lbs (15.01 kg)

Min. Installed Capacity includes the leveling bed, Module, and top backfill storage capacity for one Module. Stone storage capacity is based on 40% void space.* ***Side backfill storage is not included.*

3.0 Manufacturing Standards

Brentwood selects material based on long-term performance needs. To ensure long-term performance and limit component deflection over time (creep), Brentwood selected polyvinyl chloride (PVC) for the Module's structural columns and a virgin polypropylene (PP) blend for the top/bottom and side panels. PVC provides the largest creep resistance of commonly available plastics, and therefore, provides the best performance under loading conditions. Materials like polyethylene (HDPE) and recycled PP have lower creep resistance and are not recommended for load-bearing products and applications.

Materials:

Brentwood's proprietary PVC and PP copolymer resins have been chosen specifically for utilization in the StormTank® Module. The PVC is blended in house by experts and is a 100% blend of post-manuacturing/pre-consumer recycled material. Both materials exhibit structural resilience and naturally resist the chemicals typically found in stormwater runoff.

Methods:

Injection Molding

The Module's top/bottom platens and side panels are injection molded, using proprietary molds and materials. This allows Brentwood to manufacture a product that meets structural requirements while maintaining dimensional control, molded-in traceability, and quality control.

Extrusion

Brentwood's expertise in PVC extrusion allows the structural columns to be manufactured in house. The column extrusion includes the internal structural ribs required for lateral support.

Quality Control

Brentwood maintains strict quality control in order to ensure that materials and the final product meet design requirments. This quality assurance program includes full material property testing in accordance with American Society for Testing and Materials (ASTM) standards, full-part testing, and process testing in order to quantify product performance during manufacturing. Additionally, Brentwood conducts secondary finshed-part testing to verify that design requirements continue to be met post-manufacturing.

All Module parts are marked with traceability information that allows for tracking of manufacturing. Brentwood maintains equipment at all manufacturing locations, as well as at its corporate testing lab, to ensure all materials and products meet all requirements.

4.0 Structural Response

Structural Design

The Module has been designed to resist loads calculated in accordance with the American Association of State Highway and Transportation Official's (AASHTO) Load and Resistance Factor Design (LRFD) Bridge Design manual. This fully factored load includes a multiple presence factor, dynamic load allowance, and live load factor to account for real-world situations. This loading was considered when Brentwood developed both the product and installation requirements. The developed minimum cover ensures the system maintains an adequate resistance factor for the design truck (HS-20) and HS-25 loads.

Full-Scale Product Testing

Engineers at Brentwood's in-house testing facility have completed full-scale vertical and lateral tests on the Module to evaluate product response. To date, Brentwood continues in-house testing in order to evaluate long-term creep effects.

Fully Installed System Testing

Brentwood's dedication to providing a premier product extends to fully installed testing. Through a partnership with Queen's University's GeoEngineering Centre in Kingston, Ontario, Brentwood has conducted full-scale installation tests of single- and double-stacked Module systems to analyze short- and long-term performance. Testing includes short-term ultimate limit state testing under fully factored AASHTO loads and minimum installation cover, lateral load testing, long-term performance and lifecycle testing utilizing time-temperature superposition, and load resistance development. Side backfill material tests were also performed to compare the usage of sand, compacted stone, and uncompacted stone.

5.0 Foundation

The foundation (subgrade) of the subsurface storage structure may be the most important part of the Module system installation as this is the location where the system applies the load generated at the surface. If the subgrade lacks adequate support or encounters potential settlement, the entire system could be adversely affected. Therefore, when implementing an underground storage solution, it is imperative that a geotechnical investigation be performed to ensure a strong foundation.

Considerations & Requirements:

Bearing Capacity

The bearing capacity is the ability of the soil to resist settlement. In other words, it is the amount of weight the soil can support. This is important versus the native condition because the system is replacing earth, and even though the system weighs less than the earth, the additional load displacement of the earth is not offset by the difference in weight.

Using the Loading and Resistance Factor Design (LRFD) calculation for bearing capacity, Brentwood has developed a conservative minimum bearing capacity table (see Appendix). The Engineer of Record shall reference this table to assess actual cover versus the soil bearing required for each unit system.

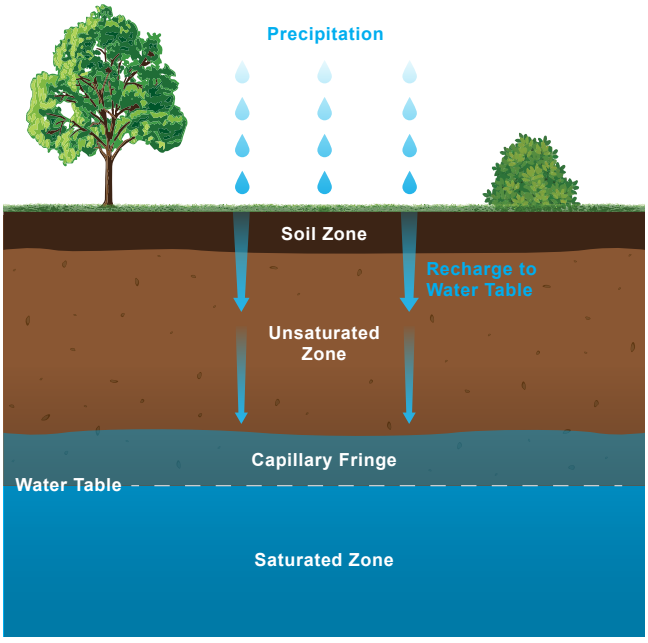
Soil Profile

Limiting Zones

Limiting zones are conditions in the underlying soils that can affect the maximum available depth for installation and can reduce the strength and stability of the underlying subgrade. The three main forms of limiting zones are water tables, bedrock, and karst topography. It is recommended that a system be offset a minimum of 12" (305 mm) from any limiting zones.

Compaction

Soil compaction occurs as the soil particles are pressed together and pore space is eliminated. By compacting the soils to 95% (as recommended by Brentwood), the subgrade strength will increase, in turn limiting both the potential for the soil to move once installed and for differential settlement to occur throughout the system. If designing the specific compaction requirement, settlement should be limited to less than 1" (25 mm) through the entire subgrade and should not exceed a 1/2" (13 mm) of differential settlement between any two adjacent units within the system over time.



Water Table Zones

Mitigation

If a minimum subgrade bearing capacity cannot be achieved because of weak soil, a suitable design will need to be completed by a Geotechnical Engineer. This design may include the over-excavation of the subgrade and an engineered fill or slurry being placed. Additional material such as geogrid or other products may also be required. Please contact a Geotechnical Engineer prior to selecting products or designing the subgrade.

6.0 System Materials

Geotextile Fabric

The 6-ounce geotextile fabric is recommended to be installed between the soil and stone interfaces around the Modules to prevent soil migration.

Leveling Bed

The leveling bed is constructed of 6”-thick (152 mm) angular stone (Table 2). The bed has not been designed as a structural element but is utilized to provide a level surface for the installation of the system and provide an even distribution of load to the subgrade.

Stone Backfill

The stone backfill is designed to limit the strain on the product through displacement of load and ensure the product’s longevity. Therefore, a minimum of 12”-wide (305 mm) angular stone must be placed around all sides of the system. In addition, a minimum layer of 12” (305 mm) angular stone is required on top of the system. All material is to be placed evenly in 12” (305 mm) lifts around and on top of the system and aligned with a vibratory plate compactor.

Table 2: Approved Backfill Material

Material Location	Description	AASHTO M43 Designation	ASTM D2321 Class	Compaction/Density
Finished Surface	Topsoil, hardscape, stone, concrete, or asphalt per Engineer of Record	N/A	N/A	Prepare per engineered plans
Suitable Compactable Fill	Well-graded granular soil/aggregate, typically road base or earthen fill (maximum 4" particle size)	56, 57, 6, 67, 68	I & II III (Earth Only)	Place in maximum 12" lifts to a minimum 90% standard proctor density
Top Backfill	Crushed angular stone placed between Modules and road base or earthen fill	56, 57, 6, 67, 68	I & II	Plate vibrate to provide evenly distributed layers
Side Backfill	Crushed angular stone placed between earthen wall and Modules	56, 57, 6, 67, 68	I & II	Place and plate vibrate in uniform 12" lifts around the system
Leveling Bed	Crushed angular stone placed to provide level surface for installation of Modules	56, 57, 6, 67, 68	I & II	Plate vibrate to achieve level surface

Impermeable Liner

In designs that prevent runoff from infiltrating into the surrounding soil (detention or reuse applications) or groundwater from entering the system, an impermeable liner is required. When incorporating a liner as part of the system, Brentwood recommends using a manufactured product such as a PVC liner. This can be installed around the Modules themselves or installed around the excavation (to gain the benefit of the void space in the stone) and should include an underdrain system to ensure the basin fully drains. This liner is installed with a layer of geotextile fabric on both sides to prevent puncture, in accordance with manufacturer recommendations.

7.0 Connections

Stormwater runoff must be able to move readily in and out of the StormTank® Module system. Brentwood has developed numerous means of connecting to the system, including inlet/outlet ports and direct abutment to a catch basin or endwall. All methods of connection should be evaluated as each one may offer a different solution. Brentwood has developed drawings to assist with specific installation methods, and these are available at www.brentwoodindustries.com.

Inlet/Outlet and Pipe Connections

To facilitate easy connection to the system, Brentwood manufactures two inlet/outlet ports. They are 12" (305 mm) and 14" (356 mm), respectfully, and utilize a flexible coupling connection to the adjoining pipe.

Another common installation method is to directly connect the pipe to the system. In order to do this, an opening is cut into the side panels, the pipe is inserted, and then the system is wrapped in geotextile fabric. When utilizing this connection method, the pipe must be located a minimum of 3" (76 mm) from the bottom of the system. This provides adequate clearance for the bottom platen and the required strength in the remaining side panel. To maintain the required clearances or reduce pipe size, it may be necessary to connect utilizing a manifold system.

Direct Abutment

The system can also be connected by directly abutting Modules to a concrete catch basin or endwall. This allows for a seamless connection of structures in close proximity to the system and eliminates the need for numerous pipe connections. When directly abutting one of these structures, remove any side panels that fully abut the structure, and make sure it is flush with the system to prevent material migration into the structure.

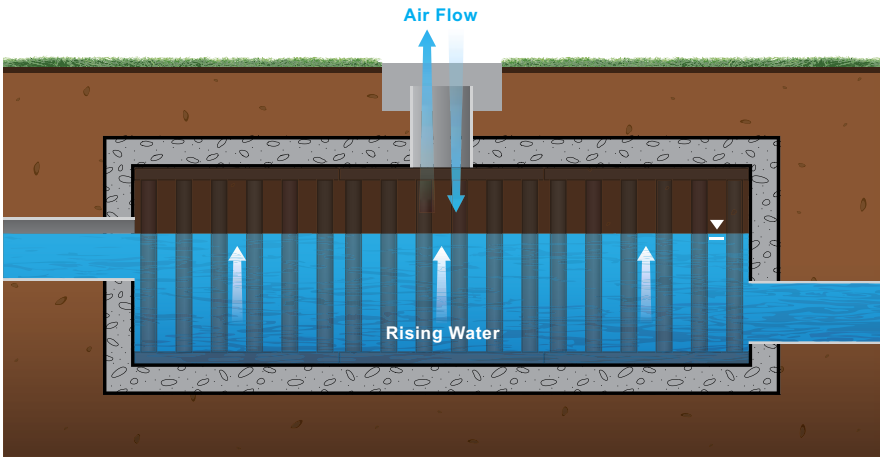
Underdrain

Underdrains are typically utilized in detention applications to ensure the system fully drains since infiltration is limited or prohibited. The incorporation of an underdrain in a detention application will require an impermeable liner between the stone-soil interface.

Cleanout Ports

Brentwood understands the necessity to inspect and clean a subsurface system and has designed the Module without any walls to allow full access. Brentwood offers three different cleanout/observation ports for utilization with the system. The ports are made from PVC, provide an easy means of connection, and are available in 6" (152 mm), 8" (203 mm) and 10" (254 mm) diameters. The 10" (254 mm) port is sized to allow access to the system by a vacuum truck suction hose for easy debris removal.

It is recommended that ports be located a maximum of 30' (9.14 m) on center to provide adequate access, ensure proper airflow, and allow the system to completely fill.



Ventilation and Air Flow

8.0 Pretreatment

Removing pollutants from stormwater runoff is an important component of any stormwater management plan. Pretreatment works to prevent water quality deterioration and also plays an integral part in allowing the system to maintain performance over time and increase longevity. Treatment products vary in complexity, design, and effectiveness, and therefore, should be selected based on specific project requirements.

Typical Stormwater System

StormTank® Shield

Brentwood's StormTank Shield provides a low-cost solution for stormwater pretreatment. Designed to improve sumped inlet treatment, the Shield reduces pollutant discharge through gross sediment removal and oil/water separation. For more information, please visit www.brentwoodindustries.com.

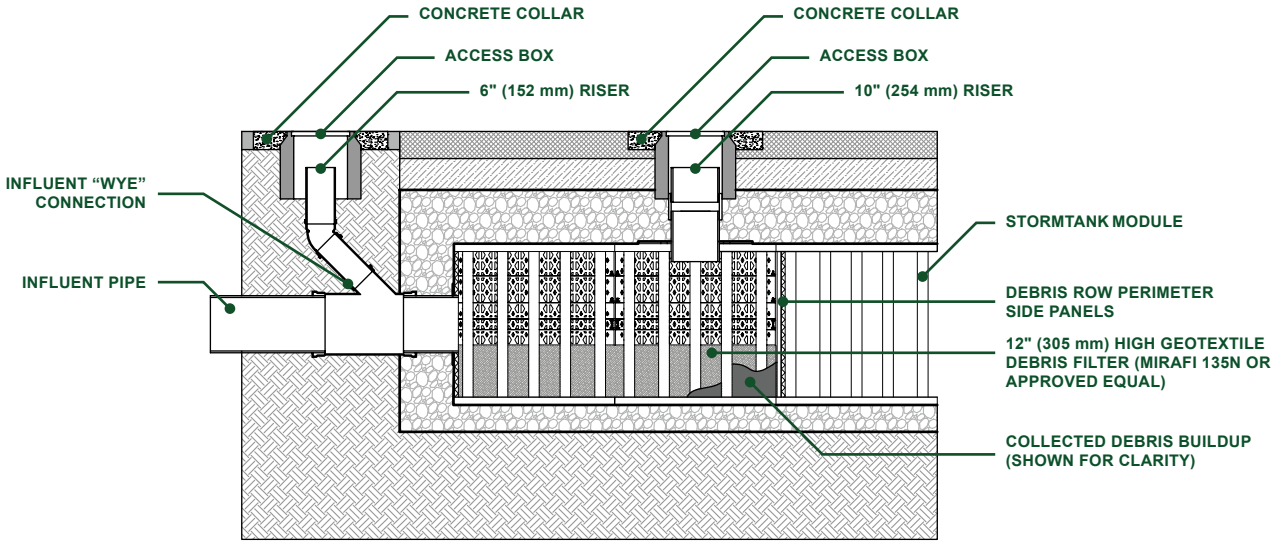
Debris Row (Easy Cleanout)

An essential step of designing, installing, and maintaining a subsurface system is preventing debris from entering the storage. This can be done by incorporating debris rows (or bays) at the inlets of the system to prevent debris from entering the rest of the system.

The debris row is built into the system utilizing side panels with a 12" (305 mm) segment of geotextile fabric. This allows for the full basin capacity to be utilized while storing any debris in an easy-to-remove location. To calculate the number of side panels required to prevent backing up, the opening area of the side panels on the area above the geotextile fabric has been calculated and compared to the inflow pipe diameter.

Debris row cleanout is made easy by including 10" (254 mm) suction ports, based on the length of the row, and a 6" (152 mm) saddle connection to the inflow pipe. If the system is directly abutting a catch basin, the saddle connection is not required, and the flush hose can be inserted through the catch basin. Debris is then flushed from the inlet toward the suction ports and removed.

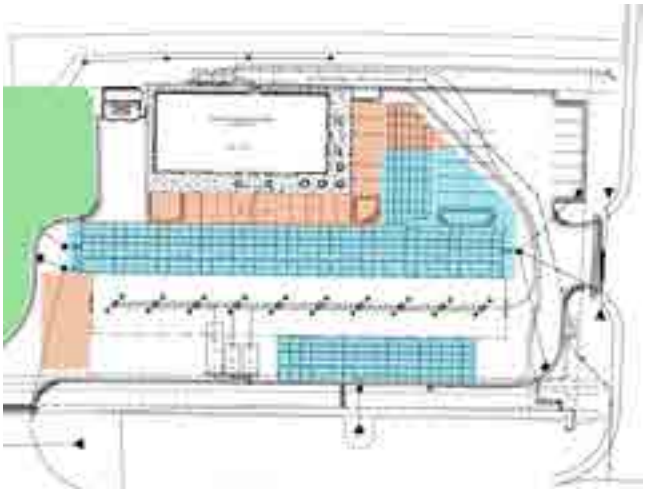
Brentwood has developed drawings and specifications that are available at www.brentwoodindustries.com to illustrate the debris row configuration and layouts.



Debris Row Section Detail

9.0 Additional Considerations

Many variable factors, such as the examples below, must be taken into consideration when designing a StormTank® Module system. As these considerations require complex calculations and proper planning, please contact Brentwood or your local distributor to discuss project-specific requirements.



Site Plan Module Layout Adaptability
(StormTank Modules shown in blue)

Adaptability

The Modules can be arranged in custom configurations to meet tight site constraints and to provide different horizontal and edge configurations. Modules can also be stacked, to a maximum 2 units tall, to meet capacity needs and can be buried to a maximum invert of 11' (3.35 m) to allow for a stacked system or deeper burial.

Adjacent Structures

The location of adjacent structures, especially the location of footings and foundations, must be taken into consideration as part of system design. The foundation of a building or retaining wall produces a load that is transmitted to a footing and then applied to the surface below. The footing is intended to distribute the line load of the wall over a larger area without increasing the larger wall's thickness. The reason this is important is because the load the footing is applying to the earth is distributed through the earth and could potentially affect a subsurface system as either a vertical load to the top of the Module or a lateral load to the side of the Module.

Based on this increased loading, it is recommended that the subsurface system either maintain a distance away from the foundation, footing equal to the height between the Module invert and structure invert of the system, or the foundation or footing extend at a minimum to the invert of the subsurface system. By locating the foundation away from the system or equal to the invert, the loading generated by the structure does not get transferred onto the system. It is recommended that all adjacent structures be completed prior to the installation of the Modules to prevent construction loads from being imparted on the system.

Adjacent Excavation

The subsurface system must be protected before, during, and after the installation. Once a system is installed, it is important to remember that excavation adjacent to the system could potentially cause the system to become unstable. The uniform backfilling will evenly distribute the lateral loads to the system and prohibit the system from becoming unstable and racking from unequal loads. However, it is recommended that any excavation adjacent to a system remain a minimum distance away from the system equal to the invert. This will provide a soil load that is equal to the load applied by the opposite side of the installation. If the excavation is to exceed the invert of the system, additional analysis may be necessary.

Sloped Finished Grade

Much like adjacent excavation, a finished grade with a differential cover could potentially cause a subsurface system to become disproportionately loaded. For example, if one side of the system has 10' (3.05 m) of cover and the adjacent side has 24" (610 mm) of cover, the taller side will generate a higher lateral load, and the opposite side may not have an equal amount of resistance to prevent a racking of the system. Additional evaluation may be required when working on sites where the final grade around a system exceeds 5%.

10.0 Inspection & Maintenance

Description

Proper inspection and maintenance of a subsurface stormwater storage system are vital to ensuring proper product functioning and system longevity. It is recommended that during construction the contractor takes the necessary steps to prevent sediment from entering the subsurface system. This may include the installation of a bypass pipe around the system until the site is stabilized. The contractor should install and maintain all site erosion and sediment per Best Management Practices (BMP) and local, state, and federal regulations.

Once the site is stabilized, the contractor should remove and properly dispose of erosion and sediment per BMP and all local, state, and federal regulations. Care should be taken during removal to prevent collected sediment or debris from entering the stormwater system. Once the controls are removed, the system should be flushed to remove any sediment or construction debris by following the maintenance procedure outlined below.

During the first service year, a visual inspection should be completed during and after each major rainfall event, in addition to semi-annual inspections, to establish a pattern of sediment and debris buildup. Each stormwater system is unique, and multiple criteria can affect maintenance frequency. For example, whether or not a system design includes inlet protection or a pretreatment device has a substantial effect on the system's need for maintenance. Other factors include where the runoff is coming from (hardscape, gravel, soil, etc.) and seasonal changes like autumn leaves and winter salt.

During and after the second year of service, an established annual inspection frequency, based on the information collected during the first year, should be followed. At a minimum, an inspection should be performed semi-annually. Additional inspections may be required at the change of seasons for regions that experience adverse conditions (leaves, cinders, salt, sand, etc).

Maintenance Procedures

Inspection:

1. Inspect all observation ports, inflow and outflow connections, and the discharge area.
2. Identify and log any sediment and debris accumulation, system backup, or discharge rate changes.
3. If there is a sufficient need for cleanout, contact a local cleaning company for assistance.

Cleaning:

1. If a pretreatment device is installed, follow manufacturer recommendations.
2. Using a vacuum pump truck, evacuate debris from the inflow and outflow points.
3. Flush the system with clean water, forcing debris from the system.
4. Repeat steps 2 and 3 until no debris is evident.

11.0 System Sizing

System Sizing Calculation

This section provides a brief description of the process required to size the StormTank® Module system. If you need additional assistance in determining the required number of Modules or assistance with the proposed configuration, it is recommended that you contact Brentwood or your local distributor. Additionally, Brentwood's volume calculator can help you to estimate the available storage volumes with and without stone storage. This tool is available at www.brentwoodindustries.com.

1. Determine the required storage volume (Vs):
It is the sole responsibility of the Engineer of Record to calculate the storage volume in accordance with all local, state, and federal regulations.

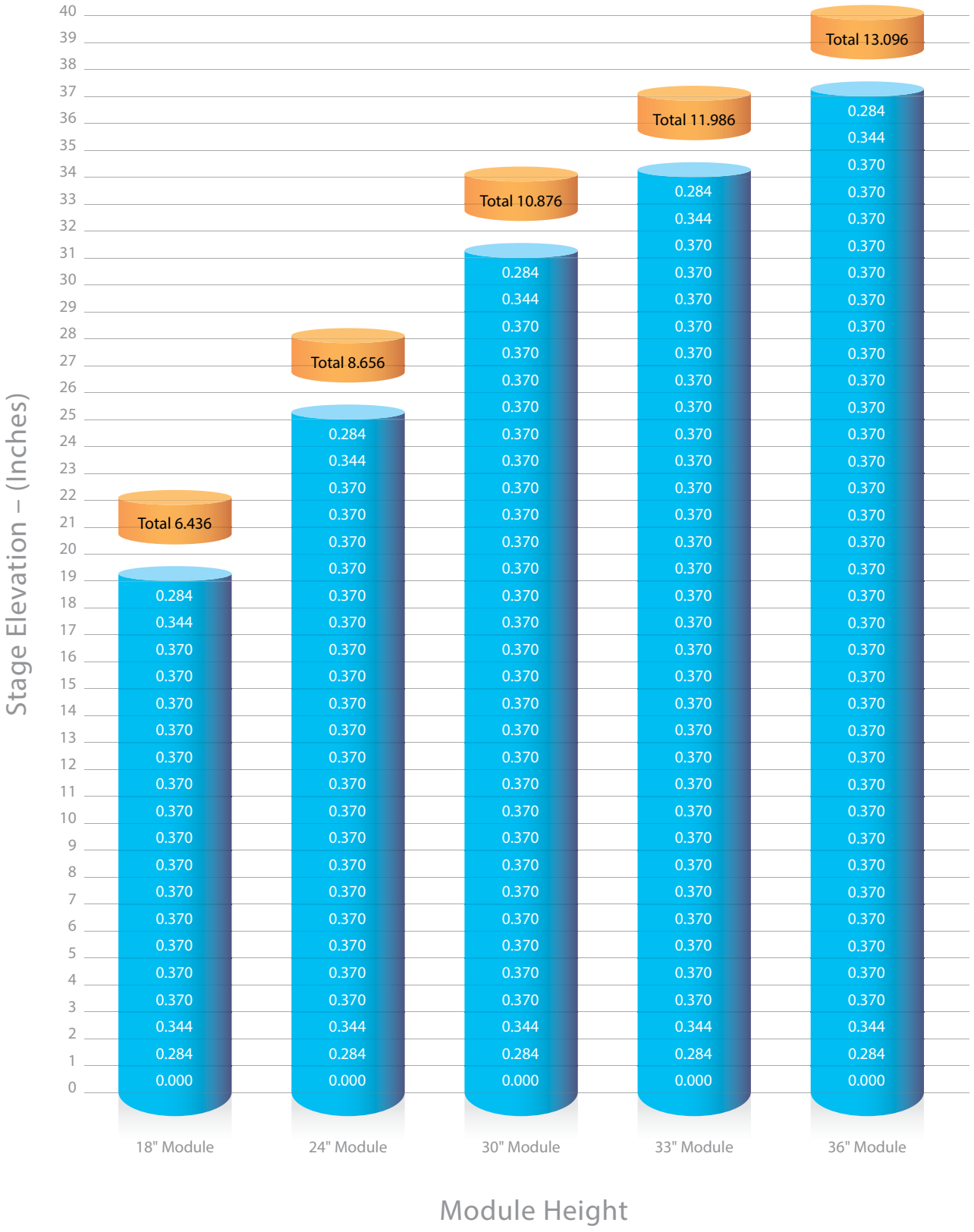
2. Determine the required number of Modules (N):
If the storage volume does not include stone storage, take the total volume divided by the selected Module storage volume. If the stone storage is to be included, additional calculations will be required to determine the available stone storage for each configuration.

3. Determine the required volume of stone (Vstone):
The system requires a minimum 6" (152 mm) leveling bed, 12" (305 mm) backfill around the system, and 12" (305 mm) top backfill utilizing 3/4" (19 mm) angular clean stone. Therefore, take the area of the system times the leveling bed and the top backfill. Once that value is determined, add the volume based on the side backfill width times the height from the invert of the Modules to the top of the Modules.

4. Determine the required excavation volume (Vexcv):
Utilizing the area of the system, including the side backfill, multiply by the depth of the system including the leveling bed. It is noted that this calculation should also include any necessary side pitch or benching that is required for local, state, or federal safety standards.

5. Determine the required amount of geotextile (G):
The system utilizes a multiple layer system of geotextile fabric. Therefore, two calculations are required to determine the necessary amount of geotextile. The first layer surrounds the entire system (including all backfill), and the second layer surrounds the Module system only. It is recommended that an additional 20% be included for waste and overlap.

11.1 Storage Volume



11.2 Material Quantity Worksheet

Project Name: | By:

Location: | Date:

System Requirements

Required Storage		ft^3 (m^3)
Number of Modules		Each
Module Storage		ft^3 (m^3)
Stone Storage		ft^3 (m^3)
Module Footprint		ft^2 (m^2) Number of Modules x 4.5 ft^2 (0.42 m^2)
System Footprint w/ Stone		ft^2 (m^2) Module Footprint + 1 ft (0.3048 m) to each edge
Stone		Tons (kg) Leveling Bed + Side Backfill + Top Backfill
Volume of Excavation		yd^3 (m^3) System Footprint w/ Stone x Total Height
Area of Geotextile		yd^2 (m^2) Wrap around Modules + Wrap around Stone/Soil Interface

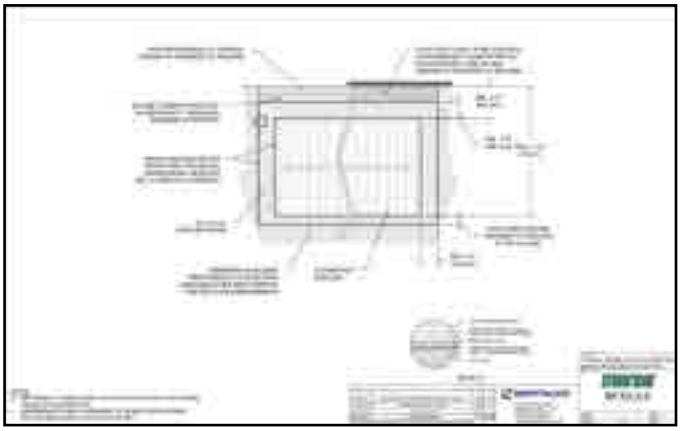
System Cost

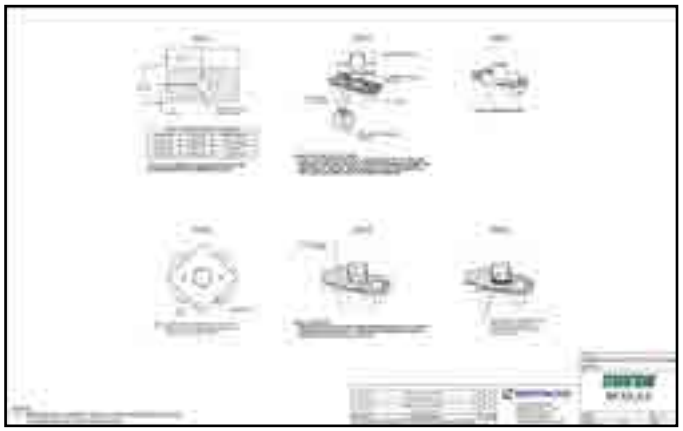
	Quantity			Unit Price			Total
Modules		ft^3 (m^3)	X	$	ft^3 (m^3)	=	$
Stone		Tons (kg)	X	$	Tons (kg)	=	$
Excavation		yd^3 (m^3)	X	$	yd^3 (m^3)	=	$
Geotextile		yd^2 (m^2)	X	$	yd^2 (m^2)	=	$
					Subtotal =		$
					Tons =		$

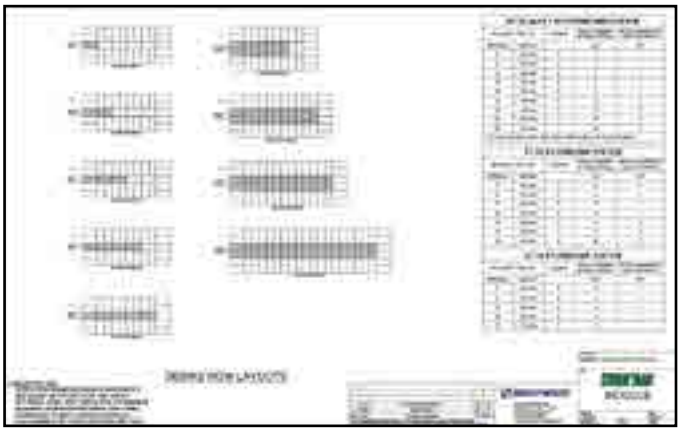
Material costs may not include freight.
Please contact Brentwood or your local distributor for this information.

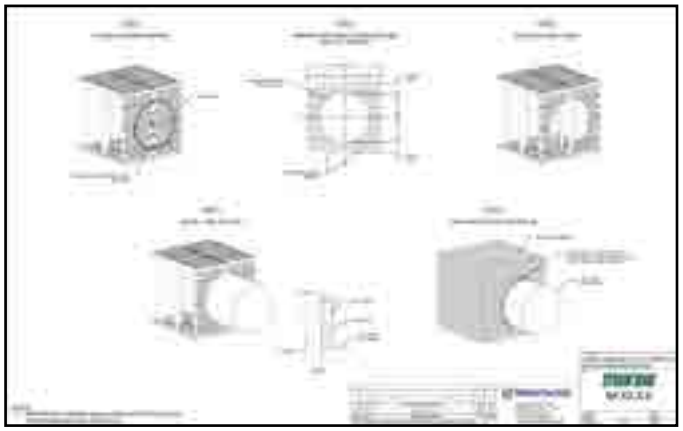
12.0 Detail Drawings

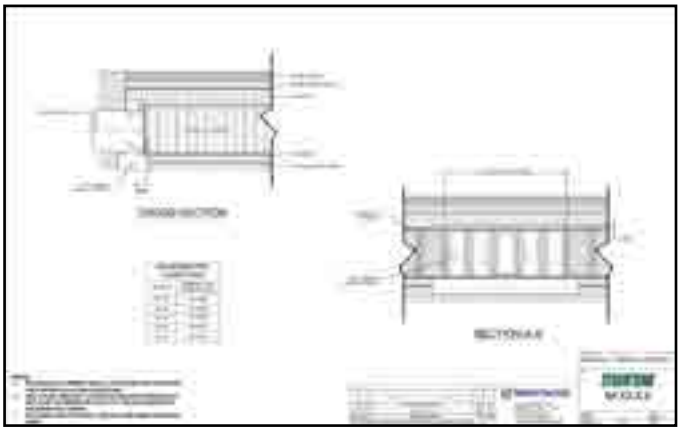
Brentwood has developed numerous drawings for utilization when specifying a StormTank® Module system. Below are some examples of drawings available at [www.brentwoodindustries.com.](http://www.brentwoodindustries.com)











13.0 Specifications

1) General

a) This specification shall govern the implementation, performance, material, and fabrication pertaining to the subsurface stormwater storage system. The subsurface stormwater storage system shall be manufactured by Brentwood Industries, Inc., 500 Spring Ridge Drive, Reading, PA 19610 (610.374.5109), and shall adhere to the following specification at the required storage capacities.

b) All work is to be completed per the design requirements of the Engineer of Record and to meet or exceed the manufacturer's design and installation requirements.

2) Subsurface Stormwater Storage System Modules

a) The subsurface stormwater storage system shall be constructed from virgin polypropylene and 100% recycled PVC to meet the following requirements:

i) High-Impact Polypropylene Copolymer Material

(1) Injection molded, polypropylene, top/bottom platens and side panels formed to a dimension of 36" (914 mm) long by 18" (457 mm) wide [nominal].

ii) 100% Recycled PVC Material

(1) PVC conforming to ASTM D-1784 Cell Classification 12344 b-12454 B.

(2) Extruded, rigid, and 100% recycled PVC columns sized for applicable loads as defined by Section 3 of the AASHTO LRFD Bridge Design Specifications and manufactured to the required length per engineer-approved drawings.

iii) Platens and columns are assembled on site to create Modules, which can be uniformly stacked up to two Modules high, in vertical structures of variable height (custom for each project).

iv) Modular stormwater storage units must have a minimum 95% void space and be continuously open in both length and width, with no internal walls or partitions.

3) Submittals

a) Only systems that are approved by the engineer will be allowed.

b) At least 10 days prior to bid, submit the following to the engineer to be considered for pre-qualification to bid:

i) A list of materials to be provided for work under this article, including the name and address of the materials producer and the location from which the materials are to be obtained.

ii) Three hard copies of the following:

(1) Shop drawings.

(2) Specification sheets.

(3) Installation instructions.

(4) Maintenance guidelines.

c) Subsurface Stormwater Storage System Component Samples for review:

i) Subsurface stormwater storage system Modules provide a single 36" (914 mm) long by 18" (457 mm) wide, height as specified, unit of the product for review.

ii) Sample to be retained by owner.

d) Manufacturers named as acceptable herein are not required to submit samples.

4) Structural Design

a) The structural design, backfill, and installation requirements shall ensure the loads and load factors specified in the AASHTO LRFD Bridge Design Specifications, Section 3 are met.

b) Product shall be tested under minimum installation criteria for short-duration live loads that are calculated to include a 20% increase over the AASHTO Design Truck standard with consideration for impact, multiple vehicle presences, and live load factor.

c) Product shall be tested under maximum burial criteria for long-term dead loads.

d) The engineer may require submission of third-party test data and results in accordance with items 4b and 4c to ensure adequate structural design and performance.

14.0 Appendix - Bearing Capacity Tables

Cover		HS-25 (Unfactored)		HS-25 (Factored)	
English (in)	Metric (mm)	English (ksf)	Metric (kPa)	English (ksf)	Metric (kPa)
24	610	1.89	90.45	4.75	227.43
25	635	1.82	86.96	4.53	216.90
26	660	1.75	83.78	4.34	207.80
27	686	1.69	80.88	4.16	199.18
28	711	1.63	78.24	3.99	191.04
29	737	1.58	75.82	3.84	183.86
30	762	1.54	73.62	3.70	177.16
31	787	1.50	71.60	3.57	170.93
32	813	1.46	69.75	3.45	165.19
33	838	1.42	68.06	3.34	159.92
34	864	1.39	66.51	3.24	155.13
35	889	1.36	65.10	3.14	150.34
36	914	1.33	63.80	3.05	146.03
37	940	1.31	62.62	2.97	142.20
38	965	1.29	61.54	2.90	138.85
39	991	1.26	60.55	2.83	135.50
40	1,016	1.25	59.65	2.76	132.15
41	1,041	1.23	58.54	2.70	129.28
42	1,067	1.21	58.09	2.67	127.84
43	1,092	1.20	57.42	2.60	124.49
44	1,118	1.19	56.81	2.55	122.09
45	1,143	1.18	56.26	2.50	119.70
46	1,168	1.16	55.77	2.46	117.79
47	1,194	1.16	55.33	2.42	115.87
48	1,219	1.15	54.94	2.39	114.43
49	1,245	1.14	54.59	2.36	113.00
50	1,270	1.13	54.29	2.33	111.56
51	1,295	1.13	54.03	2.30	110.12
52	1,321	1.12	53.80	2.27	108.69
53	1,346	1.12	53.62	2.25	107.73
54	1,372	1.12	53.46	2.23	106.77
55	1,397	1.11	53.34	2.21	105.82
56	1,422	1.11	53.24	2.19	104.86
57	1,448	1.11	53.18	2.17	103.90
58	1,473	1.11	53.14	2.16	103.42
59	1,499	1.11	53.12	2.14	102.46
60	1,524	1.11	53.13	2.13	101.98
61	1,549	1.11	53.16	2.12	101.51
62	1,575	1.11	53.21	2.11	101.03
63	1,600	1.11	53.28	2.10	100.55
64	1,626	1.11	53.37	2.09	100.07
65	1,651	1.12	53.48	2.08	99.59
66	1,676	1.12	53.61	2.08	99.59
67	1,702	1.12	53.75	2.07	99.11
68	1,727	1.13	53.91	2.07	99.11
69	1,753	1.13	54.08	2.06	98.63

Cover		HS-25 (Unfactored)		HS-25 (Factored)	
English (in)	Metric (mm)	English (ksf)	Metric (kPa)	English (ksf)	Metric (kPa)
70	1,778	1.13	54.26	2.06	98.63
71	1,803	1.14	54.46	2.06	98.63
72	1,829	1.14	54.67	2.06	98.63
73	1,854	1.15	54.90	2.06	98.63
74	1,880	1.15	55.13	2.06	98.63
75	1,905	1.16	55.38	2.06	98.63
76	1,930	1.16	55.64	2.06	98.63
77	1,956	1.17	55.90	2.06	98.63
78	1,981	1.17	56.18	2.06	98.63
79	2,007	1.18	56.46	2.07	99.11
80	2,032	1.19	56.76	2.07	99.11
81	2,057	1.19	57.06	2.07	99.11
82	2,083	1.20	57.37	2.08	99.59
83	2,108	1.20	57.69	2.08	99.59
84	2,134	1.21	58.02	2.09	100.07
85	2,159	1.22	58.35	2.09	100.07
86	2,184	1.23	58.69	2.10	100.55
87	2,210	1.23	59.04	2.11	101.03
88	2,235	1.24	59.39	2.11	101.03
89	2,261	1.25	59.75	2.12	101.51
90	2,286	1.26	60.11	2.13	101.98
91	2,311	1.26	60.48	2.13	101.98
92	2,337	1.27	60.86	2.14	102.46
93	2,362	1.28	61.24	2.15	102.94
94	2,388	1.29	61.62	2.16	103.42
95	2,413	1.30	62.01	2.17	103.90
96	2,438	1.30	62.41	2.18	104.38
97	2,464	1.31	62.81	2.19	104.86
98	2,489	1.32	63.21	2.20	105.34
99	2,515	1.33	63.62	2.21	105.82
100	2,540	1.34	64.03	2.22	106.29
101	2,565	1.35	64.45	2.23	106.77
102	2,591	1.35	64.87	2.24	107.25
103	2,616	1.36	65.29	2.25	107.73
104	2,642	1.37	65.72	2.27	108.69
105	2,667	1.38	66.15	2.28	109.17
106	2,692	1.39	66.58	2.29	109.65
107	2,718	1.40	67.02	2.30	110.12
108	2,743	1.41	67.45	2.31	110.60
109	2,769	1.42	67.90	2.33	111.56
110	2,794	1.43	68.34	2.34	112.04
111	2,819	1.44	68.79	2.35	112.52
112	2,845	1.45	69.24	2.36	113.00
113	2,870	1.46	69.69	2.38	113.96
114	2,896	1.47	70.15	2.39	114.43

BRENTWOOD®

BRENTWOOD INDUSTRIES, INC.
brentwoodindustries.com
stormtank@brentw.com
+1.610.374.5109

MODULE INSTALLATION GUIDE

STORMTANK®
Expect Results™

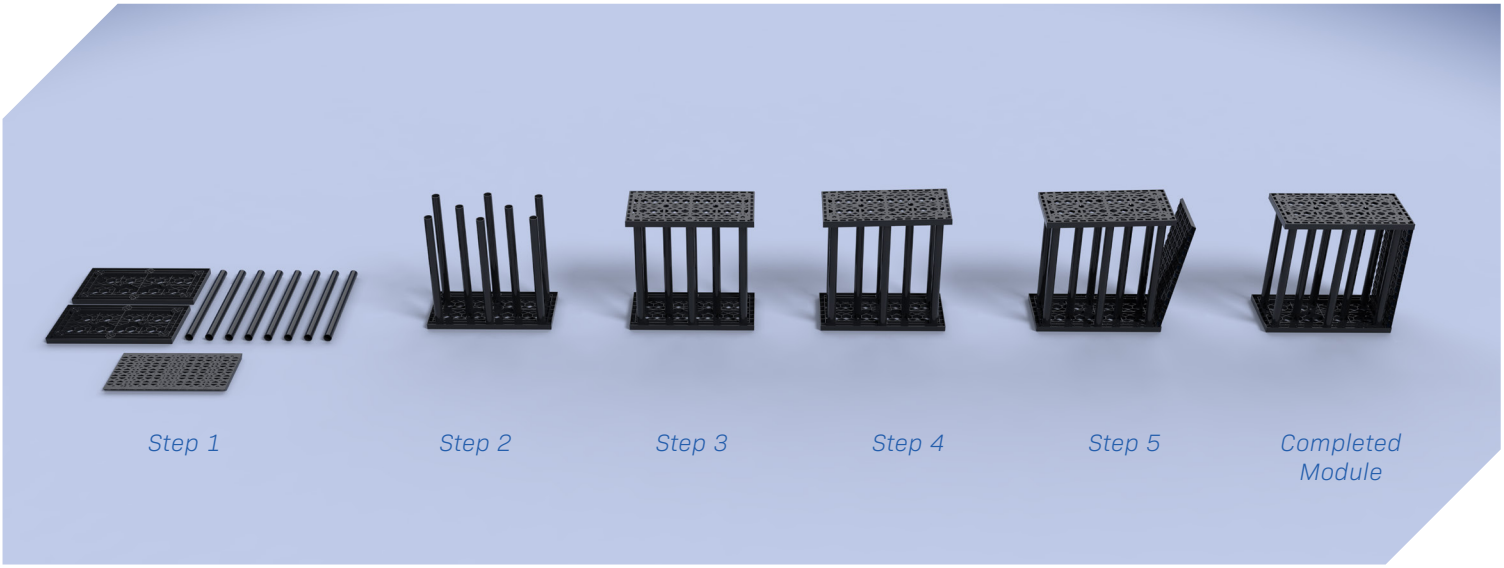
A BRAND OF BRENTWOOD

CONTENT

GENERAL NOTES

1. Review installation procedures and coordinate the installation with other construction activities, such as grading, excavation, utilities, construction access, erosion control, etc.
2. Engineered drawings supersede all provided documentation, as the information furnished in this document is based on a typical installation.
3. Coordinate the installation with manufacturer's representative/distributor to be on-site to review installation instructions.
4. Components shall be unloaded, handled and stored in an area protected from traffic in a manner to prevent damage and UV degradation.
5. Assembled modules may be walked on, but vehicular traffic is prohibited until backfilled per Manufacturer's requirements.
6. Ensure all construction occurs in accordance with Federal, State and Local Laws, Ordinances, Regulations and Safety Requirements.
7. Extra care and caution should be taken when temperatures are at or below 40° F (4.4° C).
8. Check for any damaged material, report damage to a StormTank® Representative. All plastic wrap should be removed to prevent damage from heat or UV.
9. The StormTank® Module carries a Limited Warranty, which can be accessed at *www.stormtank.com*.

1.0 MODULE ASSEMBLY



Step 1:

Prepare the material to be assembled. Required materials include (2) Platens, (8) Columns, (1) Side Panel. (1) 1lb. Rubber Mallet. Note: Side panels only required on perimeter modules, refer to your project's layout drawings for perimeter module locations.

Step 2:

Place a platen on a firm level surface and insert the (8) columns into the platen receiver cups. Firmly tap each column with a rubber mallet to ensure the column is seated.

Step 3:

Install the top platen by aligning the reciever cups with the columns, or flip the previously assembled components upside down onto the second platen, aligning the columns into the platen receiver cups.

Step 4:

Once aligned, seat the top assembly by alternating taps, with a rubber mallet at each structural column until all columns are firmly seated.

Step 5:

If side panels are required, Prior to seating the edge column into the recieveing cups, insert the side panel into the bottom platen.

Step 6:

Align the top of the side panel with the top platen and firmly seat the top platen utilizing a rubber mallet.

Completed Module

A completed module can support vehicular loading when installed per manufacturer recommendations.

2.0 EXCAVATION

1. Stake out and excavate, in accordance with OSHA regulations, to elevations per approved plans. Excavation Requirements:
    a. Reccomended Sub-grade excavation is a minimum of 6” (152 mm) below designed Module invert.
        i. A 4” (102 mm) leveling bed may be acceptable, contact your StormTank Representative for further details.
    b. The excavation should extend a minimum of 12” (305 mm) beyond the module unit's dimensions in each length and width to allow for adequate placement of side backfill material.
    c. Remove objectionable material encountered within the excavation, including protruding material from the walls.

3.0 SUB-GRADE PREPARATION

1. Unstable, unsuitable and/or compromised areas should be brought to the Engineer’s attention and mitigating efforts determined. Sub-grade shall be unfrozen, free of lumps or debris and contain no standing water or mud.

2. Sub-grade must be prepared, per the Engineer of Record, to provide a minimum bearing capacity and prevent settlement.
    a. Maximum applicable settlements cannot exceed long-term 1/2” (12.7 mm) differential settlement between any two adjacent units within the system.
    b. Sub-grade must be designed to ensure soil bearing capacity is maintained throughout all soil saturation levels.

4.0 LEVELING BED INSTALLATION

1. **OPTIONAL**: A layer of geotextile fabric is recommended around the excavation to prevent material migration
    a. Geotextile fabric shall be placed per geotextile fabric manufacturer's recommendations.
    b. An impermeable liner may be incorporated to prevent infiltration. If specified, the liner must be installed per liner manufacturer recommendations.

2. Place a Leveling Bed per engineer plans.
    a. Material should meet Appendix C – Acceptable Fill Material.
    b. Material should be free of voids, lumps, debris, sharp objects and compacted.

5.0 STORMTANK® MODULE PLACEMENT

1. Install geotextile fabric and liner material (if required), as specified.

    a. Geotextile fabric shall be placed per geotextile fabric manufacturer's recommendations.

    b. An impermeable liner may be incorporated to prevent infiltration. If specified, the liner must be installed per liner manufacturer recommendations.

2. Mark the footprint of the modules for placement.

    a. Ensure module starting point is square prior to Module placement, this will ensure proper layout of units.

    b. Care should be taken to note any connections, ports or other irregular units to be placed.

3. Install the individual modules by hand, as detailed below.

    a. The modules should be installed as shown in the StormTank submittal drawings with the short side of perimeter modules facing outward, except as otherwise required.

    b. Make sure the top/bottom platens are in alignment in all directions.

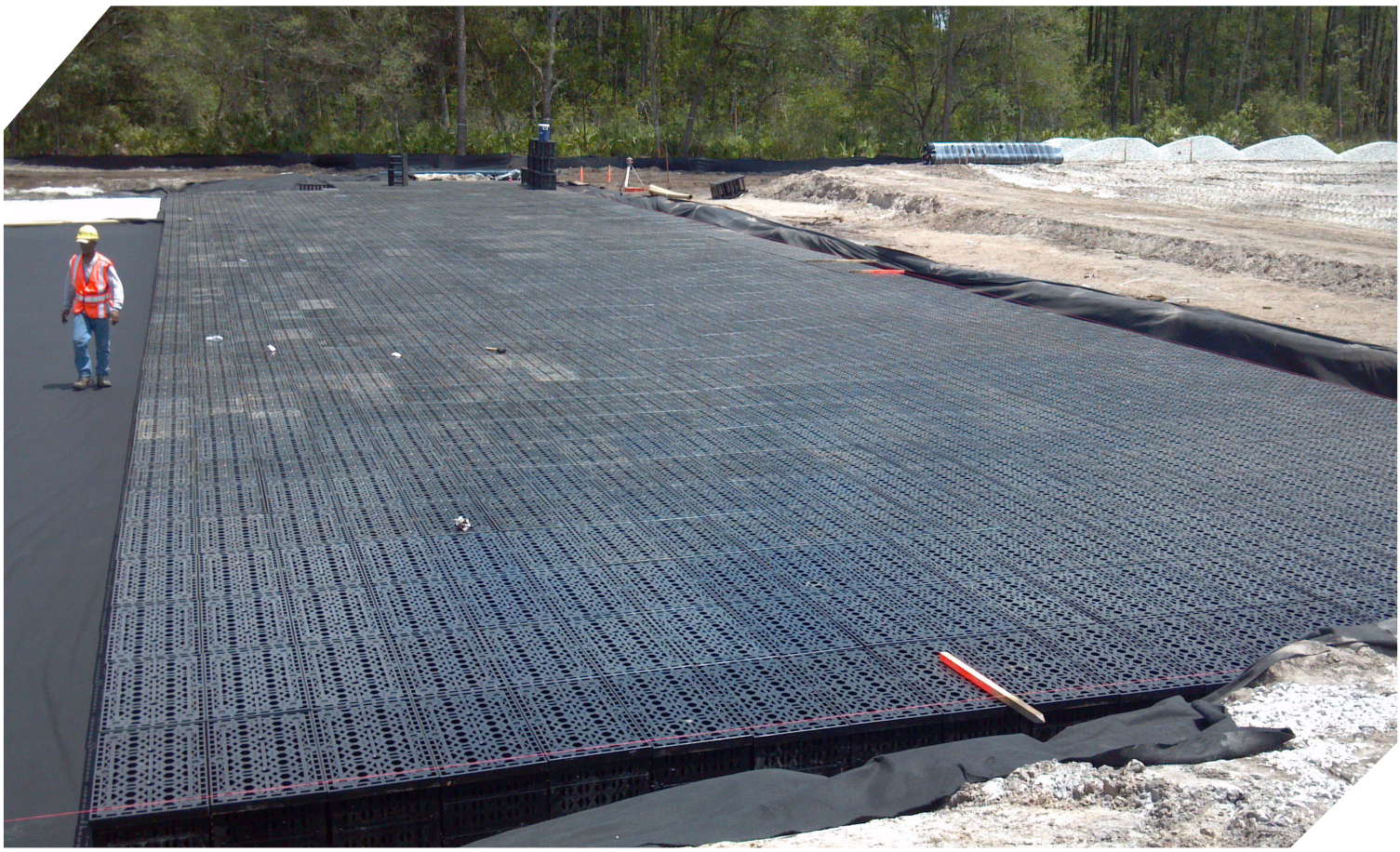
    c. For double stack configurations:

        i. Install the bottom module first. DO NOT INTERMIX VARIOUS MODULE HEIGHTS ACROSS LAYERS.

        ii. Insert stacking pins (2 per module) into the top platen of the bottom module.

        iii. Place the upper module directly on top of the bottom module in the same direction, making sure to engage the pins.

4. Install the modules to completion, taking care to avoid damage to the geotextile and/or liner material.



5.0 STORMTANK® MODULE PLACEMENT

5. Locate any ports or other penetration of the Modules.

For Observation Ports:

a. Layout and cut opening into the center of the top platen.

b. Place port into opening, using stacking pins to locate the flange plate

c. If port is along the perimeter, cut the flange plate flush with the edge of the end Module.

For Connections:

a. Locate and mark the connection opening in the side panels.

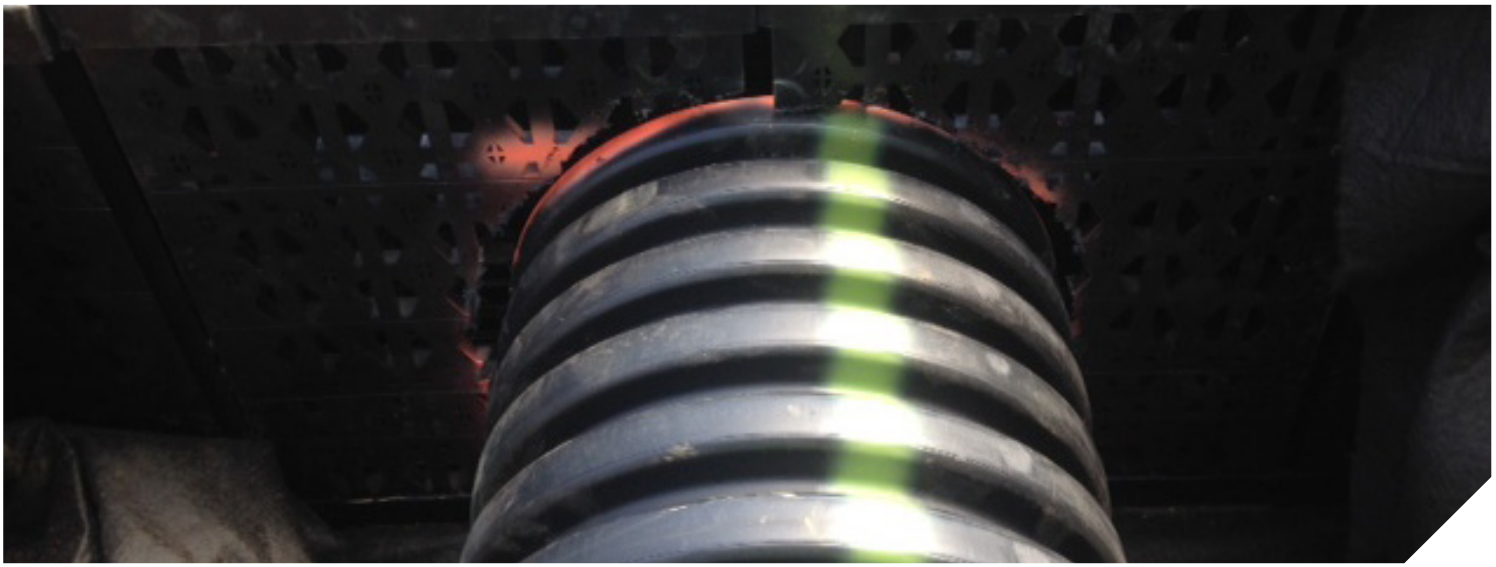
b. Remove side panels and cut opening.

c. Reinstall side panels.

d. Install pipe (slip fit)

Note: When performing lateral connections to the Module system, the platens and columns are not to be modified/cut as to not compromise the integrity of the system. Please contact a StormTank representative for assistance.

6. Upon completion of module installation, wrap the modules in geotextile fabric and/or liner.



6.0 SIDE BACKFILL

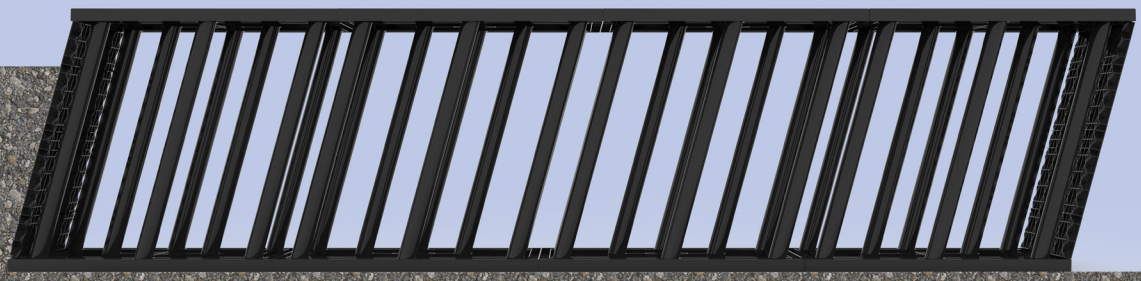
1. Inspect all geotextile, ensuring that no damage exists; which will allow sediment into the module system.

2. Once the geotextile is secured, begin to place the Side Backfill.
    a. Material should meet Appendix C – Acceptable Fill Material.
    b. Backfill sides “evenly” around the perimeter without exceeding single 12” (305 mm) lifts.
    c. Place material utilizing an excavator, dozer or conveyor boom from the native soil surrounding the excavation, do not directly access the system during side backfilling.
    d. Compact the backfill material to settle the stone and provide a uniform distribution.

Modules are to be backfilled evenly in 12" (305mm) lifts.

Correctly Backfilled

Incorrectly Backfilled



Modules unevenly backfilled can shift and compromise the overall installation of the system.

7.0 TOP BACKFILL

1. Begin to place the top backfill.
    a. Material should meet Appendix C – Acceptable Fill Material.
    b. Place material utilizing a low ground pressure (LGP) equipment, dozer (Maximum D5 LGP or similar) or preferably a conveyor boom. DO NOT DRIVE OR DUMP FROM DUMP TRUCKS DIRECTLY ONTO THE MODULES. DO NOT DRIVE ON THE MODULES WITHOUT A MINIMUM 12" (305 mm) COVER.
    c. Compact as required by engineer of record.
        I. Utilize a static roller producing less than 10 psi per roller, unless otherwise approved, while ensuring a minimum 12" (305 mm) of cover. To do so, a minimum 15" (381 mm) layer of material may be required to account for compaction.
        II. Sheep foot rollers are not permitted.

2. Upon completion of top backfilling, if specified, wrap the system in geotextile fabric and/or liner per the material manufacturer's recommendations.

3. **OPTIONAL**: Install metallic tape around the perimeter of the system to mark the area for future utility detection.

8.0 SUITABLE COMPACTABLE FILL

Non-Vehicular Areas

1. The minimum total cover allowable is 12" (305 mm).
    a. This may decrease the depth of top backfill to allow for soil placement.
    b. By installing less cover, the system is not designed to support vehicular traffic.
    c. The maximum installation depth shall be based on lateral load calculations using the Rankine Theory and compared to StormTank Module testing results.

2. Finish to the surface and complete with vegetative cover.

Vehicular Traffic Area

1. Place fill onto the geotextile.
    a. Maximum 12" (305 mm) lifts compacted to meet the Engineer of Record's specification.
    b. Sub-base materials should be referenced by the approved Engineering Drawings.
    c. The minimum top cover to finished grade should not be less than 24" (610 mm) for fully factored HS-25, lower cover depths are acceptable depending loading criteria. Contact your local StormTank representative for more information.
    d. The maximum installation depth shall be based on lateral load calculations using the Rankine Theory and compared to StormTank Module testing results.

2. Finish to the surface and complete with asphalt, concrete, etc.

Fill and Surface Material Placement

Material Location	Placement Methods	Tired Equiptment Limitations	Tracked Equiptment Limitations	Roller Limitations
Finished Surface	Material dumping onto system should be limited to paving materials in paver equipment.	Equipment size is limited to ground pressure generated, most standard paving equipment is acceptable. Calculations must be performed to determine maximum allowable equipment.		
Suitable Compactable Fill	Utilize LGP equipment or a conveyor, to place material.	No tired equipment unless approved by the engineer of record.	Low ground pressure equipment, larger equipment must be verified before use.	Static rollers with a maximum pressure of 15 psi, unless verified before use.

Notes:

1. Storage of materials such as construction materials, equipment, soils, etc. over the module system is strictly prohibited.
2. Please contact a Brentwood representative prior to utilization of any equipment not listed above.

APPENDIX A - BEARING CAPACITY CALCULATION

Applicable bearing capacity calculations are per the AASHTO LRFD for Bridge Design. The calculation considers a dead load, based on cover, with a dead load factor of 1.95. In addition, it applies a live load, with a multiple presence factor of 1.2 and a live load factor of 1.75, which is distributed at a 1.15 factor (for aggregate) through the cover depth. If the cover material is soil, this factor is reduced to 1.00.

The following are two examples of that calculation:

1. HS-25 with 24" aggregate and asphalt cover

   DL = Density * depth * DL Factor = 140.00 pcf * 2.00' * 1.95 = 546.00 psf

   LL = P * DLA * MP * LL Factor = 20,000 lbs * 1 * 1.2 * 1.75 / ((20" + 24" * 1.15) * (10" + 24" * 1.15) / 144)
   LL = 3,379.22 psf

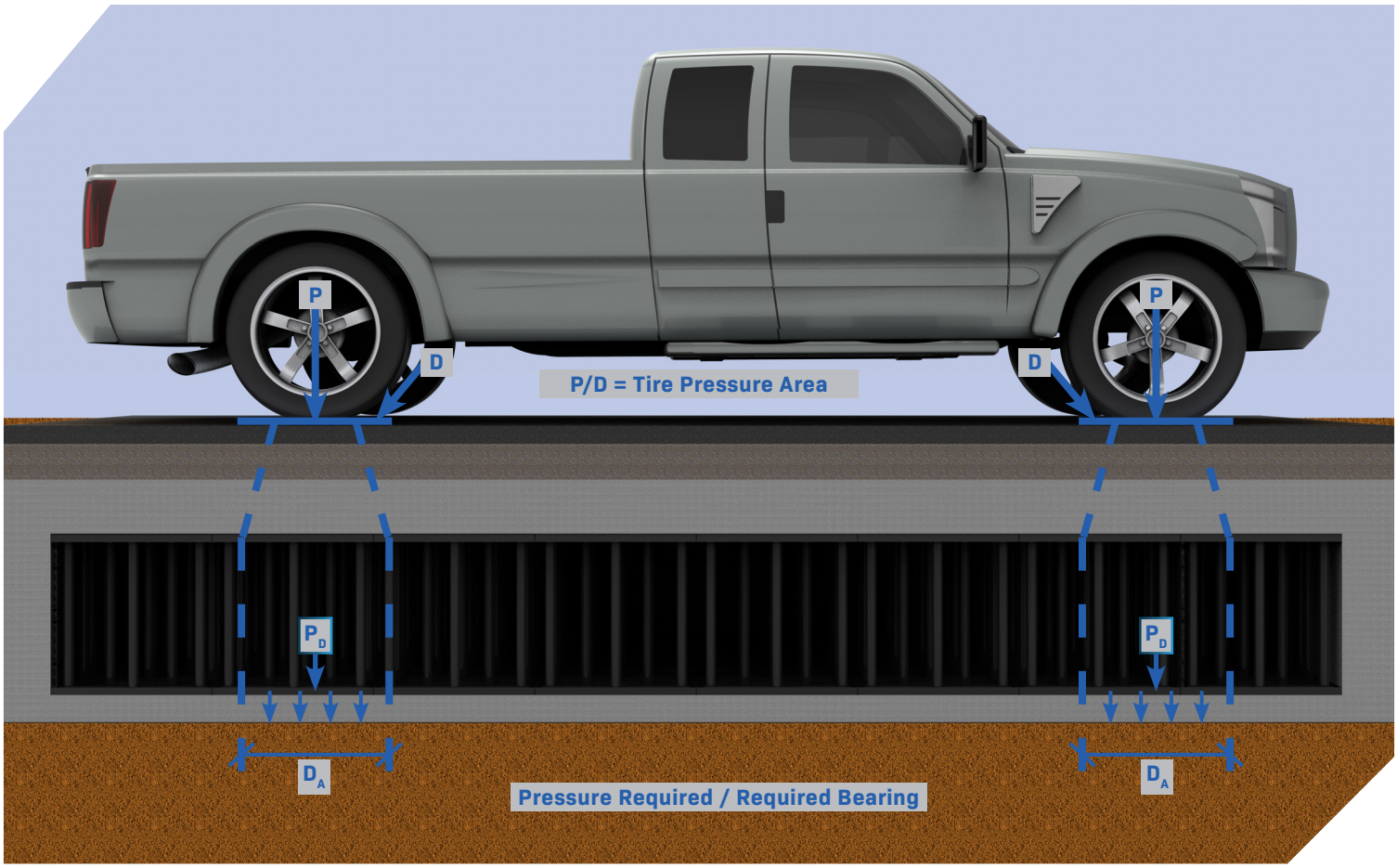
   TL = Required Bearing Capacity = 546.00 + 3,379.22 = 3,925.22 psf

2. HS-20 with 48" aggregate and asphalt cover

   DL = Density * depth * DL Factor = 140.00 pcf * 4.00' * 1.95 = 1,092.00 psf

   LL = P * DLA * MP * LL Factor = 16,000 lbs * 1 * 1.2 * 1.75 / ((20" + 48" * 1.15) * (10" + 48" * 1.15) / 144)
   LL = 986.82 psf

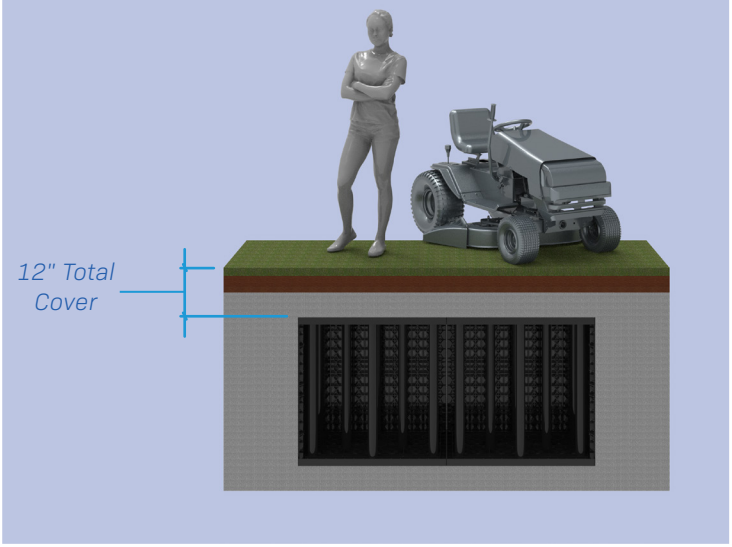
   TL = Required Bearing Capacity = 1,092.00 + 986.82 = 2,078.82 psf



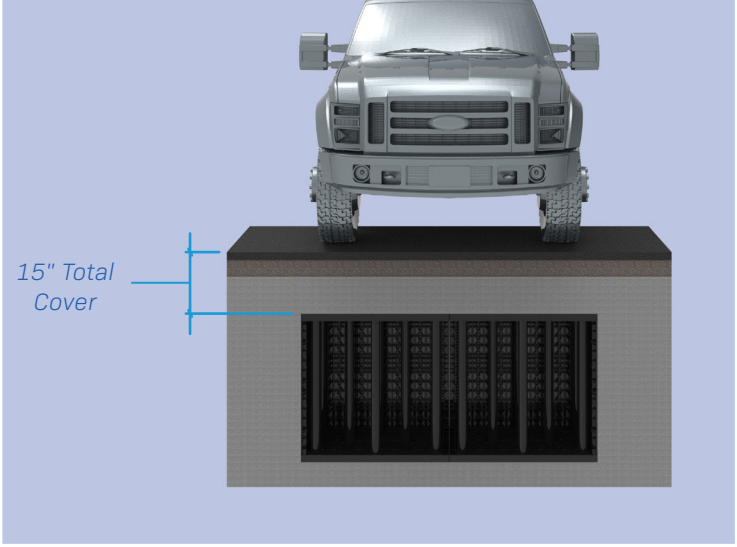
APPENDIX B - LOAD RATING

The Module has been designed to resist loads calculated in accordance with the American Association of State Highway and Transportation Official's (AASHTO) Load and Resistance Factor Design (LRFD) Bridge Design manual. Below are examples of various load ratings the module can achieve with the appropriate cover.

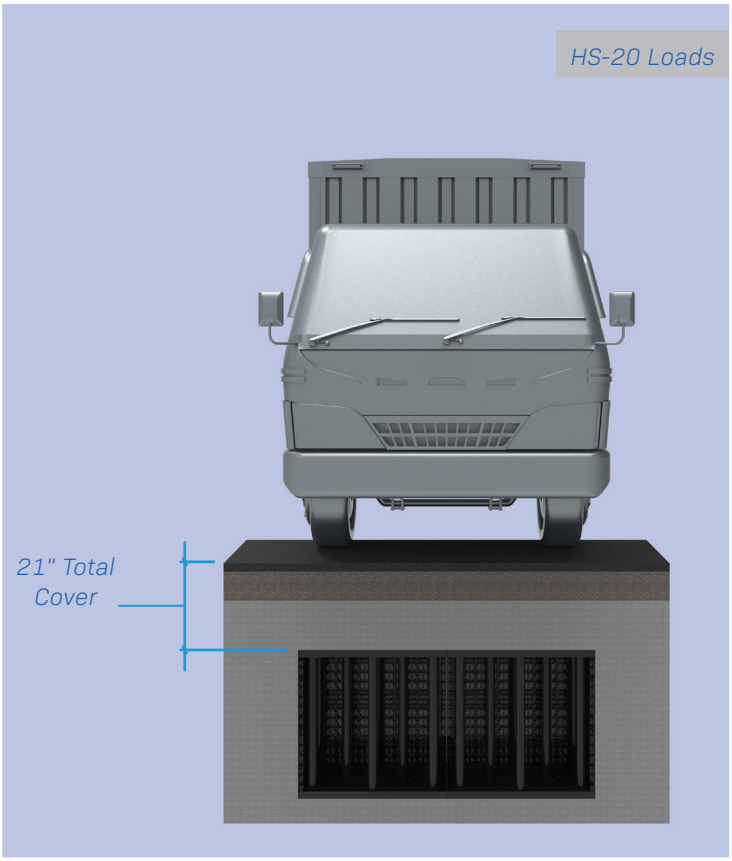
Pedestrian Loads



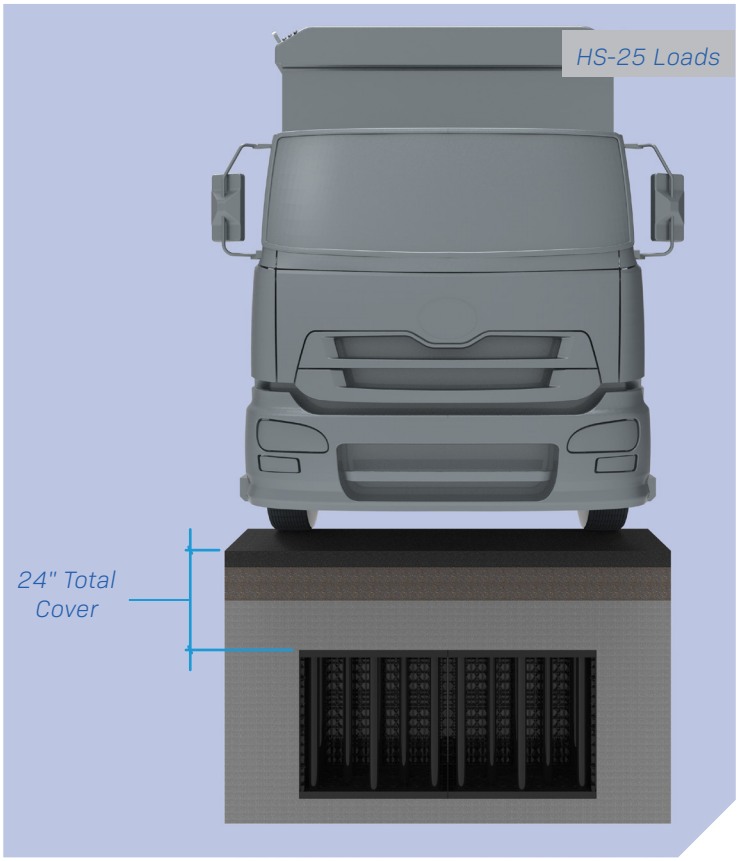
H-10 Loads



HS-20 Loads

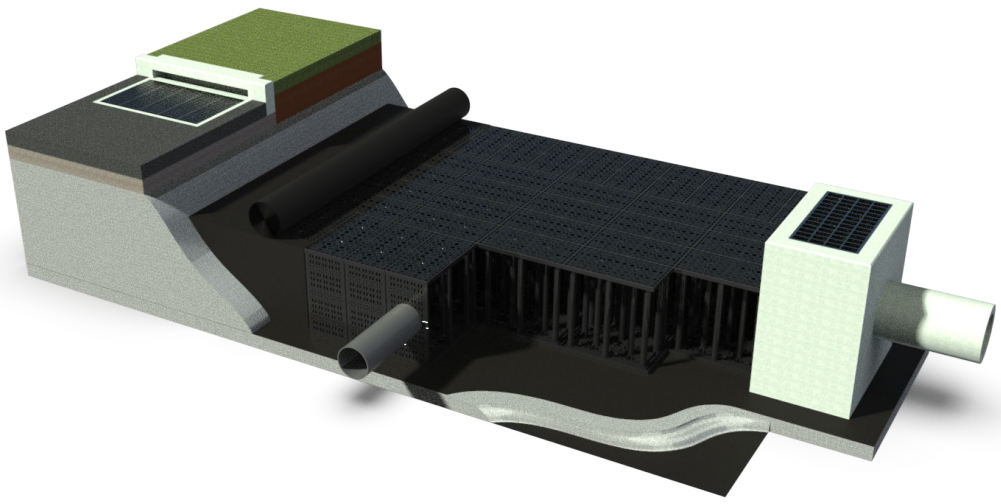


HS-25 Loads



APPENDIX C - ACCEPTABLE FILL MATERIALS

Material Location	Description	AASHTO M43 Designation	ASTM D2321 Class	Compaction/Density
Finished Surface	Topsoil, hardscape, stone, concrete, or asphalt per Engineer of Record	N/A	N/A	Prepare per engineered plans
Suitable Compactable Fill	Well-graded granular soil/aggregate, typically road base or earthen fil (maximum 4" particle size)	56, 57, 6, 67, 68	I & II III (Earth Only)	Place in maximum 12" lifts to a minimum 90% standard proctor density
Top Backfill	Crushed angular stone placed between Modules and road base or earthen fill	56, 57, 6, 67, 68	I & II	Plate vibrate to provide evenly distributed layers
Side Backfill	Crushed angular stone placed between earthen wall and Modules	56, 57, 6, 67, 68	I & II	Place and plate vibrate in uniform 12" lifts around the system
Leveling Bed	Crushed angular stone placed to provide level surface for installation of Modules	56, 57, 6, 67, 68	I & II	Plate vibrate to achieve level surface

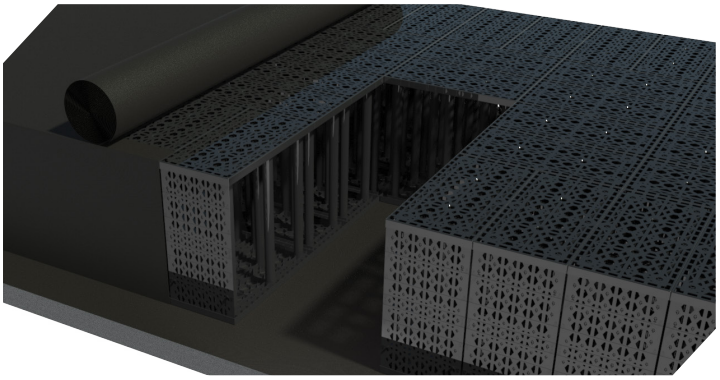


Notes:

1. All stone must be angular stone meeting ASTM D2321. Recycled concrete may be utilized when meeting acceptable gradation and ASTM standards.
2. Storage of materials such as construction materials, equipment, soils, etc. over the module system is strictly prohibited.
3. Please contact a Geotechnical Engineer and the Brentwood representative prior to utilization of any material not listed above.

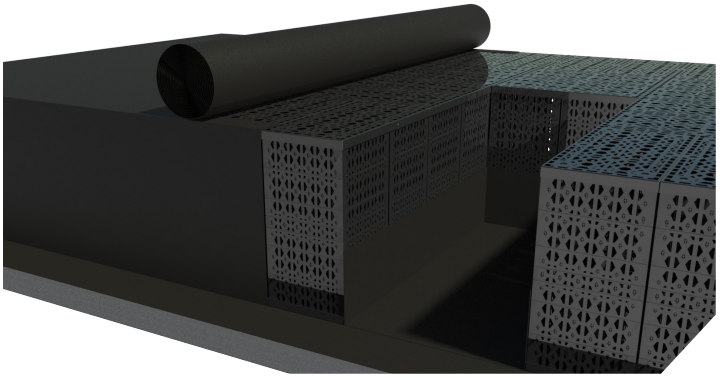
APPENDIX D - DEBRIS ROW

The Debris Row gathers debris and sediment in a section of modules. The Debris Row size is determined by the flow rate of the inflow connection to the system. Observation/cleanout ports are to be installed with a minimum of one port at the inflow pipe location. Based upon Debris Row size and shape, additonal ports may be required. See the approved submittals for debris row size and location.



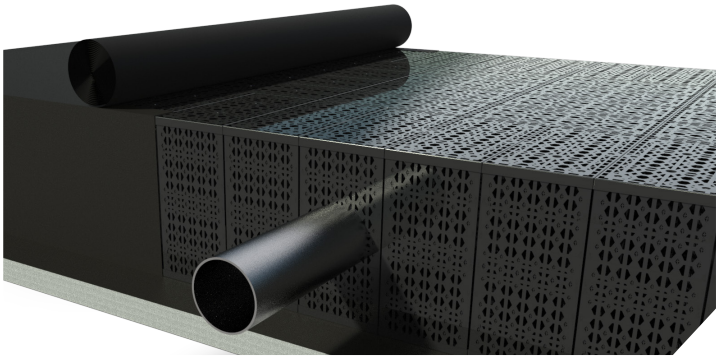
1. Install Debris Row side panels in the modules adjacent to the Debris row, per the approved plans.

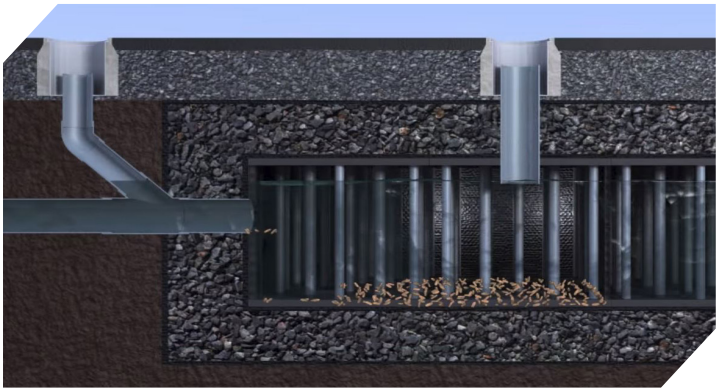
2. Install a layer of geotextile accross the bottom of the Debris Row, extending up the side panels of the adjacent modules. Geotextile Fabric is to be installed to the height specified by the hydrograph elevation of the selected storm (per the engineer of record's plans), or a minimum of 12" (304.8mm), whichever is greater. Secure the geotextile fabric to the side panels with zip ties.

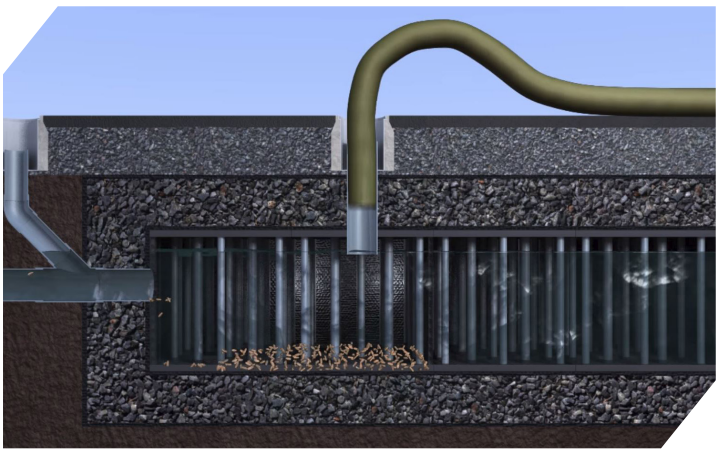


3. Place and install the Debris Row Modules in the appropriate location per the approved StormTank submittal drawings

4. Finally, make any necessary connections and complete the system installation per the StormTank installation instructions.







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info@stormtank.com
+1.610.374.5109

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APPENDIX

D

Water Quality Unit Sizing Report and Specifications

Stormceptor®

FORTERRA

Stormceptor® EF Sizing Report

ESTIMATED NET ANNNUAL SEDIMENT (TSS) LOAD REDUCTION STORMCEPTOR®

Province:	Ontario
City:	City of Pickering
Nearest Rainfall Station:	TORONTO CENTRAL
NCDC Rainfall Station Id:	0100
Years of Rainfall Data:	18

Site Name:	603-643 645 and 699 Kingston Road
Drainage Area (ha):	4.95
% Imperviousness:	94.00

Runoff Coefficient 'c': 0.86

Particle Size Distribution:	CA ETV
Target TSS Removal (%):	60.0

Require Hydrocarbon Spill Capture?	Yes
Upstream Flow Control?	No
Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	67.18
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Project Name:	603-643 645 and 699 Kingston Road
Project Number:	19M-00841-00
Designer Name:	Gordon Wong
Designer Company:	WSP Canada Group Limited
Designer Email/Phone:	gordon.wong1@wsp.com
EOR Name:	
EOR Company:	
EOR Email/Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	35
EFO6	45
EFO8	51
EFO10	56
EFO12	60

Recommended Stormceptor EFO Model: EFO12

Estimated Net Annual Sediment (TSS) Load Reduction (%): 60

Water Quality Runoff Volume Capture (%): > 90

imbrium

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterwavs.

PARTICLE SIZE DISTRIBUTION (PSD)

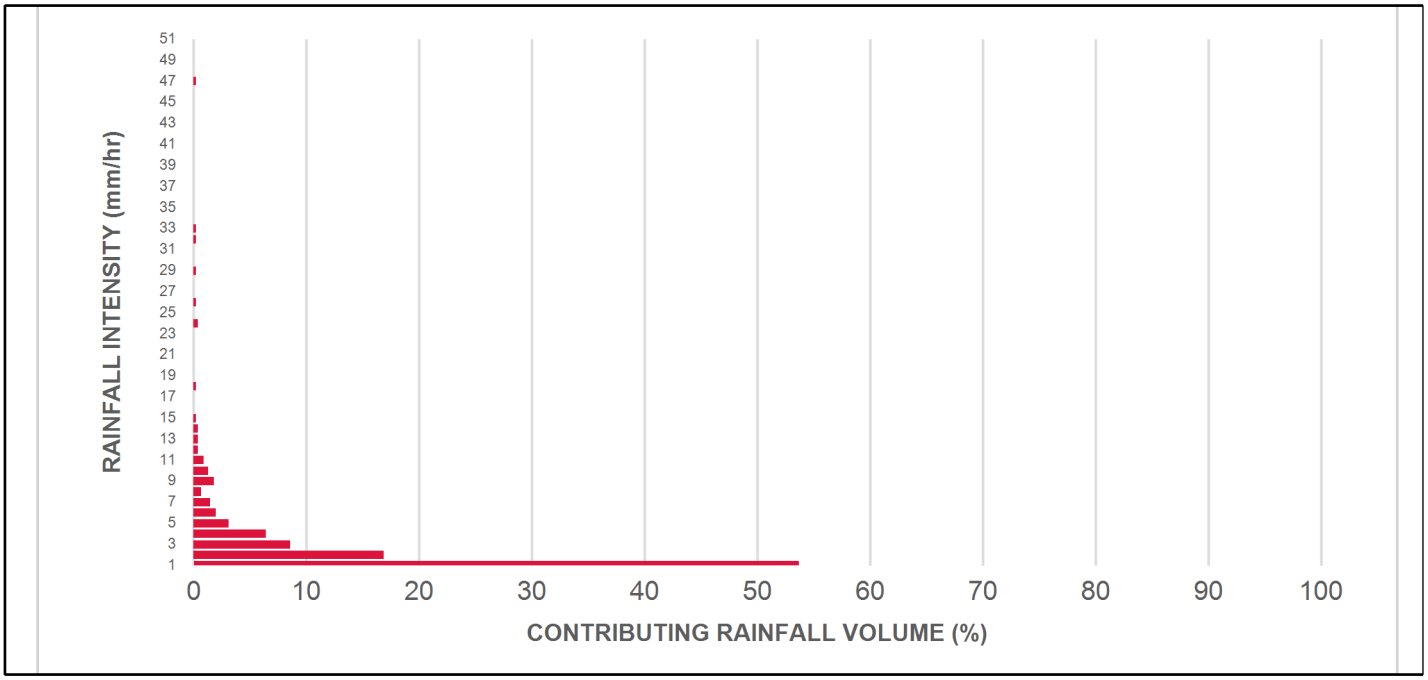
►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

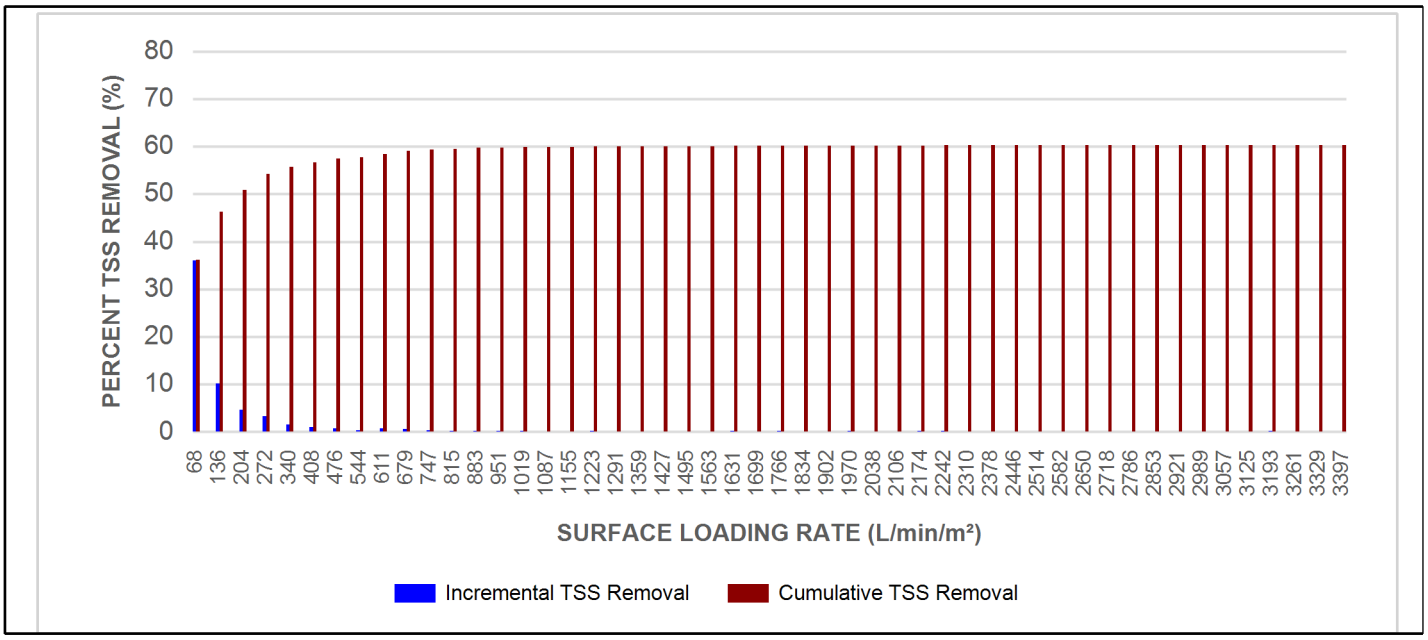
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	53.7	53.7	11.89	713.0	68.0	67	36.1	36.1
2	16.9	70.6	23.78	1427.0	136.0	60	10.1	46.2
3	8.6	79.2	35.67	2140.0	204.0	54	4.6	50.8
4	6.4	85.6	47.56	2853.0	272.0	52	3.3	54.2
5	3.1	88.7	59.45	3567.0	340.0	50	1.5	55.7
6	2.0	90.7	71.34	4280.0	408.0	48	1.0	56.7
7	1.5	92.2	83.23	4994.0	476.0	46	0.7	57.4
8	0.7	92.9	95.12	5707.0	544.0	44	0.3	57.7
9	1.8	94.7	107.01	6420.0	611.0	42	0.8	58.4
10	1.3	96.0	118.90	7134.0	679.0	42	0.5	59.0
11	0.9	96.9	130.78	7847.0	747.0	41	0.4	59.3
12	0.4	97.3	142.67	8560.0	815.0	41	0.2	59.5
13	0.4	97.7	154.56	9274.0	883.0	41	0.2	59.7
14	0.4	98.1	166.45	9987.0	951.0	40	0.2	59.8
15	0.2	98.3	178.34	10701.0	1019.0	40	0.1	59.9
16	0.0	98.3	190.23	11414.0	1087.0	39	0.0	59.9
17	0.0	98.3	202.12	12127.0	1155.0	38	0.0	59.9
18	0.2	98.5	214.01	12841.0	1223.0	37	0.1	60.0
19	0.0	98.5	225.90	13554.0	1291.0	36	0.0	60.0
20	0.0	98.5	237.79	14267.0	1359.0	35	0.0	60.0
21	0.0	98.5	249.68	14981.0	1427.0	34	0.0	60.0
22	0.0	98.5	261.57	15694.0	1495.0	32	0.0	60.0
23	0.0	98.5	273.46	16408.0	1563.0	31	0.0	60.0
24	0.4	98.9	285.35	17121.0	1631.0	29	0.1	60.1
25	0.0	98.9	297.24	17834.0	1699.0	28	0.0	60.1

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	99.1	309.13	18548.0	1766.0	27	0.1	60.1
27	0.0	99.1	321.02	19261.0	1834.0	26	0.0	60.1
28	0.0	99.1	332.91	19974.0	1902.0	25	0.0	60.1
29	0.2	99.3	344.80	20688.0	1970.0	24	0.0	60.2
30	0.0	99.3	356.69	21401.0	2038.0	23	0.0	60.2
31	0.0	99.3	368.57	22114.0	2106.0	23	0.0	60.2
32	0.2	99.5	380.46	22828.0	2174.0	22	0.0	60.2
33	0.2	99.7	392.35	23541.0	2242.0	21	0.0	60.3
34	0.0	99.7	404.24	24255.0	2310.0	21	0.0	60.3
35	0.0	99.7	416.13	24968.0	2378.0	20	0.0	60.3
36	0.0	99.7	428.02	25681.0	2446.0	20	0.0	60.3
37	0.0	99.7	439.91	26395.0	2514.0	19	0.0	60.3
38	0.0	99.7	451.80	27108.0	2582.0	18	0.0	60.3
39	0.0	99.7	463.69	27821.0	2650.0	18	0.0	60.3
40	0.0	99.7	475.58	28535.0	2718.0	18	0.0	60.3
41	0.0	99.7	487.47	29248.0	2786.0	18	0.0	60.3
42	0.0	99.7	499.36	29962.0	2853.0	18	0.0	60.3
43	0.0	99.7	511.25	30675.0	2921.0	18	0.0	60.3
44	0.0	99.7	523.14	31388.0	2989.0	18	0.0	60.3
45	0.0	99.7	535.03	32102.0	3057.0	18	0.0	60.3
46	0.0	99.7	546.92	32815.0	3125.0	18	0.0	60.3
47	0.2	99.9	558.81	33528.0	3193.0	18	0.0	60.3
48	0.0	99.9	570.70	34242.0	3261.0	18	0.0	60.3
49	0.0	99.9	582.59	34955.0	3329.0	18	0.0	60.3
50	0.0	99.9	594.48	35669.0	3397.0	18	0.0	60.3
Estimated Net Annual Sediment (TSS) Load Reduction =								**60 %**

RAINFALL DATA FROM TORONTO CENTRAL RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter		Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter		Max Outlet Pipe Diameter		Peak Conveyance Flow Rate	
	(m)	(ft)		(mm)	(in)	(mm)	(in)	(L/s)	(cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

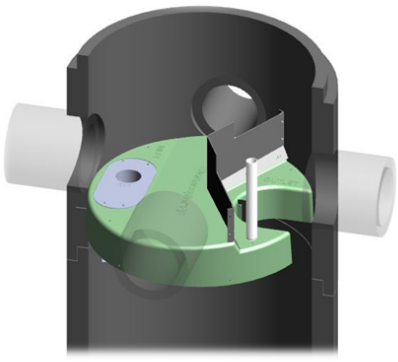
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

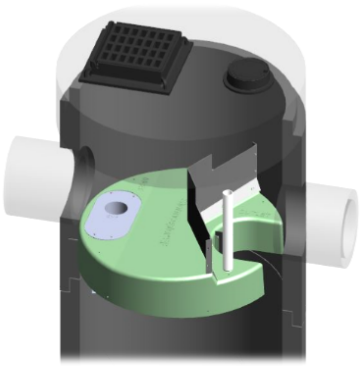
DESIGN FLEXIBILITY

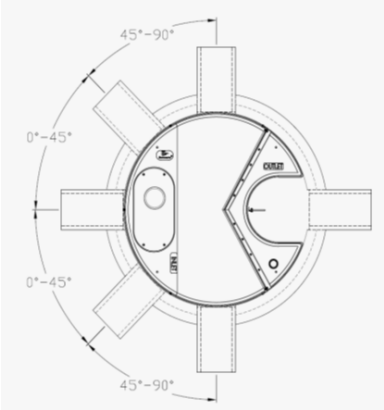
►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.







INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft^3)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	197	52	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	348	92	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	545	144	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	874	231	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	1219	322	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft^3)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results
Stormceptor® EFO

SLR (L/min/m^2)	TSS % REMOVAL	SLR (L/min/m^2)	TSS % REMOVAL	SLR (L/min/m^2)	TSS % REMOVAL	SLR (L/min/m^2)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34

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60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		