S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

Functional Servicing & Stormwater Management Report

130 CORNWALL ROAD

TOWN OF OAKVILLE

INVIZIJ ARCHITECTS INC.
185 YOUNG STREET, HAMILTON, ON

December 2022

SLA File: 20052A

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1.0 INTRODUCTION AND BACKGROUND

1.1 OVERVIEW

S. Llewellyn & Associates Limited has been retained by Invizij Architects Inc. to provide consulting engineering services for the proposed residential development at 130 Cornwall Road in the Town of Oakville (see Figure 1.0 for location plan). The proposed development currently consists of an existing two storey residential dwelling with associated grassed and asphalt areas. The site is bound by Cornwall Road to the north, existing residential dwellings to the east, Sixteen Mile Creek to the south and an existing parkette to the west. The report will outline the functional servicing and stormwater management strategy for the proposed expansion.

The proposed development consists of constructing a 5-storey residential building containing 37 units, as well as associated concrete curbing/sidewalk, an asphalt parking lot and landscaped areas.

This Functional Servicing and Stormwater Management Report will provide detailed information on the proposed servicing and grading scheme for the development. Please refer to the preliminary site engineering plans prepared by S. Llewellyn & Associates Limited and the Site Plan prepared by Invizij Architects Inc. for additional information.

1.2 BACKGROUND INFORMATION

The following documents were referenced in the preparation of this report:

Ref. 1: MOE Stormwater Management Practices Planning and Design Manual (Ministry of Environment, March 2003).

Ref. 2: Development Engineering Procedures and Guidelines Manual (Town of Oakville)

Ref. 3: Halton Region Water and Wastewater Liner Design Manual (Halton Region, May 2014)

Ref. 4: Erosion & Sediment Control Guidelines for Urban Construction (December 2006).

Ref. 5: Oakville Part III Midtown EA, Town of Oakville (Cole Engineering, June 2014)

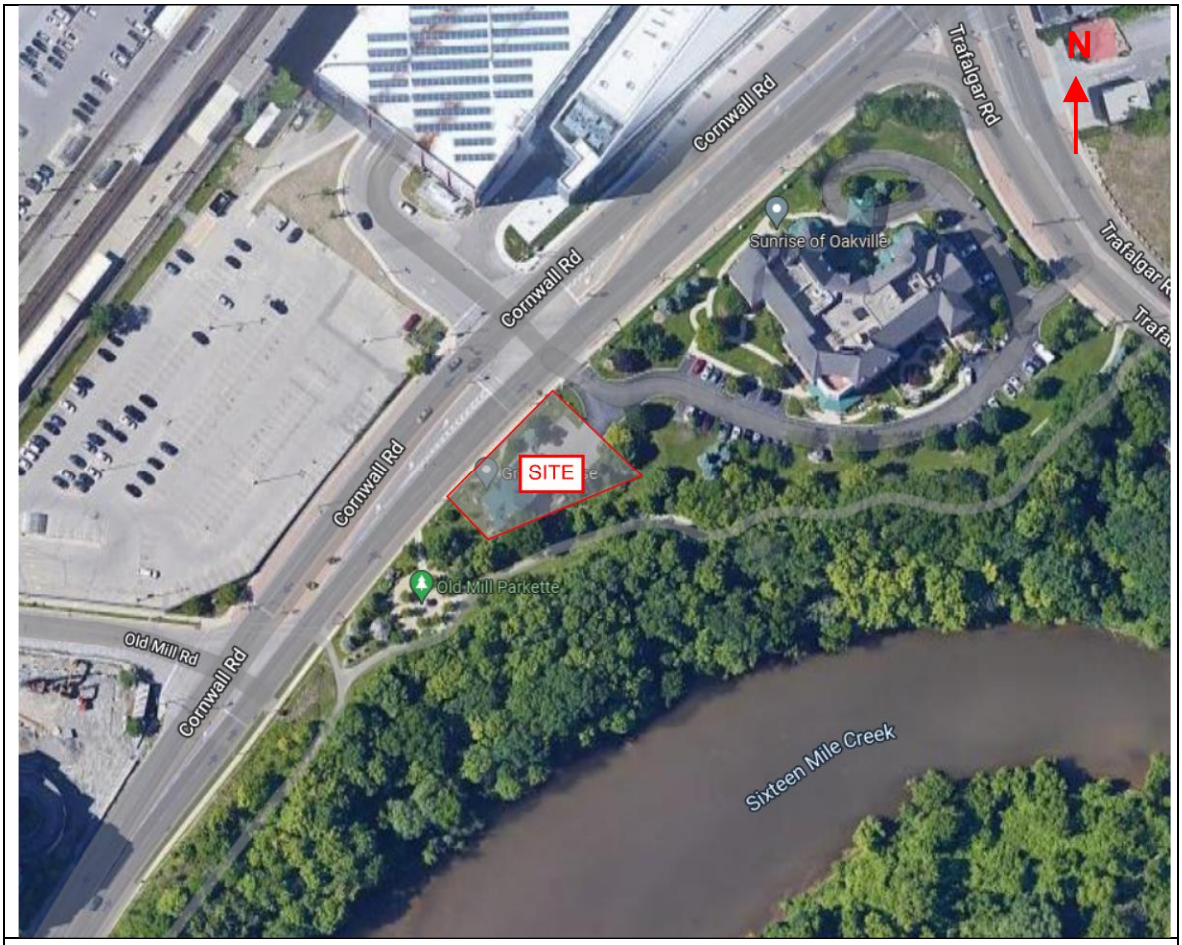


Figure 1.0 – Location Plan

2.0 STORM DRAINAGE AND STORMWATER MANAGEMENT

The following stormwater management (SWM) criteria will be applied to the site, in accordance with the Town of Oakville and Region of Halton requirements:

Quantity Control

The stormwater discharge rate from the proposed site shall be controlled to the allowable discharge rate based on Table 2.7 – Target Flows (24-hr Chicago) in the Oakville Part III Midtown EA, Town of Oakville Report completed by Cole Engineering dated June 2014.

Quality Control

The stormwater runoff from the proposed site must meet Level 1 (Enhanced) stormwater quality control (80% TSS removal, 90% average annual runoff treatment).

Erosion Control

Erosion and sediment control measures will be implemented in accordance with the standards of the Town of Oakville.

2.1 EXISTING CONDITIONS

In the existing conditions, the 0.12ha site consists of an existing two storey residential dwelling with associated grassed and asphalt areas. Majority of the existing site (0.08ha) drains to an on-site catch basin that captures and conveys storm discharges to the existing 1200mmø storm sewer on Cornwall Road. The remained of the site sheet drains south to Sixteen Mile Creek.

Two catchment areas, Catchment 101 and 102, have been identified in the existing condition. Catchment 101 represents the drainage area captured by existing catch basins on-site and within the ROW, and directed to the 1200mmø storm sewer along Cornwall Road. Catchment 102 represents the portion of the site which sheet drains south to Sixteen Mile Creek. See Table 2.1 below and the Existing Condition Drainage Area Plan in Appendix A for details.

Table 2.1 – Existing Condition Catchment Areas

Catchment ID	Description	Area (ha)	Percent Impervious	Run-off Coefficient
101	To Cornwall Road	0.08	56	0.63
102	To Sixteen Mile Creek	0.04	20	0.39

Allowable Discharge

The site is subject to peak run-off rates within the Morrison/Wedgewood Diversion Channel watershed found under Table 2-7 Target Flows (24-hr Chicago) in Oakville Part III Midtown EA, Town of Oakville. The target flows rates to Sixteen Mile Creek are for all storm events up to and including the 100-year storm event.

Table 2.2 – Allowable Discharge (16 Mile Creek Subwatershed)

Storm Event	Target Flow Rate at 16 Mile Creek ($m^3/s/ha$)[A]	Area of Site (ha)	Allowable Discharge (m^3/s)
2-Yr	0.156	0.12	0.0187
5-Yr	0.227	0.12	0.0272
10-Yr	0.274	0.12	0.0329
25-Yr	0.338	0.12	0.0406
50-Yr	0.386	0.12	0.0463
100-Yr	0.434	0.12	0.0521

[A] Value calculated from Table 2-7 in 'Oakville Part III Midtown EA, Town of Oakville' Report. Targe Flow Rate=total target flow ÷ total flow area

[B] Allowable Discharge = target flow x area of site

2.2 PROPOSED CONDITIONS

It is proposed to develop the site by constructing a 5-storey residential building containing 37 residential units. The proposed site will also include concrete curbing/sidewalk, an asphalt parking lot and landscaped areas. It is proposed to service the site with a private storm sewer system designed and constructed in accordance with the standards and specifications in accordance with the Town of Oakville and Ontario Building Code standards.

Three catchment areas, Catchment 201, 202, and 203, have been identified in the proposed condition. Catchment 201 represents controlled drainage to the existing 1200mmø storm sewer on Cornwall Road. Catchment 202 represents uncontrolled site frontage drainage to the existing 1200mmø storm sewer on Cornwall Road and Catchment 203 represent uncontrolled drainage to Sixteen Mile Creek. See Table 2.2 and the Proposed Condition Drainage Area Plan in Appendix A for details.

Table 2.3 – Proposed Conditions Catchment Areas

Catchment ID	Description	Area (ha)	Percent Impervious	Run-off Coefficient (C)
201	Controlled Drainage to Cornwall Road	0.09	89	0.84
202	Uncontrolled Drainage to Cornwall Road	0.02	13	0.33
203	Uncontrolled to Sixteen Mile Creek	0.01	0	0.25

Water Quantity Control

It is proposed to apply quantity control measures to the runoff from Catchment 201 by means of an 140mmø orifice plate at the north invert of the MH2 to restrict discharge from the site to the allowable flow rates. See the Servicing Plan for the orifice location.

With the installation of on-site quantity control measures for Catchment 201, it will be required to provide stormwater storage during storm events up to and including the 100-year event. To provide the required storage, it is proposed to install an ACO Stormbrixx SD stormwater storage tank underneath the proposed asphalt parking lot. Details of the proposed storage tank can be found in the Servicing Plan. The stage-storage-discharge characteristics can be seen in Table 2.4 below and Appendix A for details.

Table 2.4 – Catchment 201 Stage-Storage-Discharge

Elevation (m)	Total Cumulative Storage (m^3)	Active Storage (m^3)	Discharge (m^3/s)
95.17 (Bottom of Tank)	0	0	0.0000
95.47 (0.30m Depth)	3	0	0.0000
95.77 (0.60m Depth)	6	0	0.0000
96.08 (Tank Inlet)	9	0	0.0082
96.37 (1.2m Depth)	12	3	0.0239
96.53 (Top of Tank)	13	4	0.0286

The SWM Report – Oakville Part III Midtown EA prepared by Cole Engineering outlines a required amount of on-site storage based on site area as 68.2m^3/ha for Sixteen Mile Creek. Therefore, 8.2m^3 of storage (68.2m^3/ha x 0.12ha) is required for the development. The proposed ACO Stormbrixx storage tank provides 9.0m^2 of dead storage, which satisfies these requirements. Details of the proposed tank can be found on the Preliminary Site Servicing Plan. The stage-storage characteristics can be seen in Table 2.5.

The maximum discharge rates for Catchment 201 were calculated using the Modified Rational Method and Catchments 202 and 203 were calculated using the Rational Method based on the proposed condition runoff coefficients for the 2-year to 100-year storm events. The proposed discharge rates and storage volumes are summarized in Table 2.5 below and in Appendix A for details.

Table 2.5 – Proposed Condition Stormwater Discharge

Storm Event	Catchment 201 Controlled Discharge (m^3/s)[A]	Catchment 201 Required Storage (m^3)[A]	Catchment 202 Uncontrolled Discharge (m^3/s)[B]	Catchment 203 Uncontrolled Discharge (m^3/s)[B]	Total Discharge (m^3/s)[C]	Allowable Discharge (m^3/s)[D]
2-Yr	0.0150	1.4	0.0023	0.0006	0.0179	0.0187
5-Yr	0.0200	2.4	0.0031	0.0008	0.0239	0.0272
10-Yr	0.0283	0	0.0037	0.0009	0.0329	0.0329
25-Yr	0.0341	0	0.0045	0.0011	0.0397	0.0406
50-Yr	0.0382	0	0.0050	0.0013	0.0445	0.0463
100-Yr	0.0422	0	0.0055	0.0014	0.0491	0.0521

[A] Based on Modified Rational Method. Refer to Appendix A.
[B] Based on Rational Method. Refer to Appendix A.
[C] Total Discharge = 201+202+203
[D] Refer to Table 2.2.

This analysis determined the following:

- As per The SWM Report – Oakville Part III Midtown EA by Cole Engineering, the site is required 8.2m^3 of stormwater storage for infiltration purposes, which can be accommodated by the proposed storage tank having a dead storage volume of 9.0m^3. The stormwater tank additionally has 4.0 m^3 of live storage, resulting in a total volume of 13.0 m^3.
- The proposed condition discharge rates will not exceed the allowable discharge rates for all storm events with the installation of an 140mmø orifice plate at MH2.
- Catchment 201 will require 2.4m^3 of stormwater storage during the 5-year event, which can be accommodated by the proposed storage tank having a total live storage volume of 4.0 m^3. The stormwater tank additionally has 9.0 m^3 of dead storage, resulting in a total volume of 13.0 m^3.
- As per The SWM Report – Oakville Part III Midtown EA by Cole Engineering, the site is required 8.2m^3 of stormwater storage for infiltration purposes, which can be accommodated by the proposed storage tank having a dead storage volume of 9.0m^3.

Water Quality Control

Water quality control will be achieved through a treatment train approach, designed and constructed as per the standards of the Town of Oakville. See the Servicing Plan prepared by S. Llewellyn & Associates Limited for details.

The proposed development is required to achieve a "Enhanced" (80% TSS removal) level of water quality protection. To achieve this criterion, discharge from Catchment 201 will be subject to a treatment train that consists of a CB Shield and a a HydroStorm oil/grit separator before ultimately discharging to the existing 1200mmø storm sewer along Cornwall Road.

The HydroStorm sizing software was used to determine the required size of oil/grit separator unit for the site. It was determined that a HydroStorm HS4 will provide 95% TSS removal and 98% average annual runoff treatment but HydroStorm unit has been certified under the NJDEP for a 50% removal credit. See HydroStorm unit sizing procedures in Appendix B for details.

The CB Shield design chart was used to determine the TSS removal efficiency and it was determined that the CB Shields will provide 55% TSS removal. Refer to Appendix B for the CB Shield design chart.

The treatment train mechanisms have been summarized in Table 2.6 below. In order to calculate the total TSS removal from the proposed development, the weighted average has been taken to calculate the cumulative TSS removal.

Table 2.6 – Proposed Condition Stormwater Treatment Train

Surface Type	Drainage Area (m^2)	Treatment Train Mechanism #1 (% TSS Removal)	Treatment Train Mechanism #2 (% TSS Removal)	Total TSS Removal [3] (%)
Asphalt/Concrete Surfaces	405	CB Shield (55%)	Hydrostorm HS4 (50%) [2]	78%
Grass/Roof Surfaces	470	N/A [1] (80%)		90%
TOTAL:	**875**			**84%**

[1] Grass and roof surfaces are considered clean runoff which don't require quality treatment and have been assigned a TSS removal of 80%.
[2] The Hydrostorm HS4 unit has been designed to achieve 95% but credited with only 50% TSS Removal.
[3] Total TSS removal calculated using the following formula: R=A+B-[(AxB)/100], where R=total TSS removal rate, A=TSS removal rate for first mechanism, B=TSS removal rate for second mechanism.

As such, the weighted average of TSS Removal from the proposed development reveals that the treatment train approach will provide 84% TSS removal and meet the 'Enhanced' (80% TSS removal, 90% average annual runoff treatment) level of water quality protection).

Hydrostrom units and CB Shields require regular inspection and maintenance as per the manufacture's specifications to ensure the unit operates properly. See HydroStorm and CB Shield Maintenance Manuals in Appendix B for details

2.3 SEDIMENT AND EROSION CONTROL

In order to minimize erosion during the grading and site servicing period of construction, the following measures will be implemented:

- Install silt fencing along the outer boundary of the site to ensure that sediment does not migrate to the adjacent properties;
- Install sediment control (silt sacks) in the existing catch basins to ensure that no untreated runoff enters the existing conveyance system; and

To ensure and document the effectiveness of the erosion and sediment control structures, an appropriate inspection and maintenance program is necessary. The program will include the following activities:

- Inspection of the erosion and sediment controls (e.g. silt fences, sediment traps, outlets, vegetation, etc.) with follow up reports to the governing municipality; and
- The developer and/or his contractor shall be responsible for any costs incurred during the remediation of problem areas.

For details on the proposed erosion and sediment control for the proposed site, see the Preliminary Grading & Erosion Control Plan included in the engineering drawings.

3.0 SANITARY SEWER SERVICING

3.1 EXISTING CONDITIONS

The site is located along Cornwall Road, between Old Mill Road and Trafalgar Road. There is an existing 250mmø sanitary sewer located on Cornwall Road, flowing north-east at a slope of 0.4%.

3.2 SANITARY DEMAND

The proposed development consists of constructing a 5-storey residential building containing 37 units.

Table 3.1 summarizes the sanitary sewer discharge rates for the proposed development in accordance with the Town of Oakville comprehensive development guidelines.

Table 3.1 – Proposed Sanitary Sewer Discharge

Population [A]	Avg. Dry weather flows (l/s) [B]	Peaking Factor [c]	Infiltration [D] (l/s)	**Peak Flow [F] (l/s)**
74 persons	0.31	5.0	0.048	**1.55**

[A] Population = 2 persons/bed x 1 bed/unit x 37 units = 74 persons
[B] Average Dry Weather Flows = 360 L/Day/cap x 74 persons = 26,640 L/day
[C] Peak Factor (2<Peak Factor<5) = (5/(Population in thousands)$^{0.2}$) = (5/(0.074)$^{0.2}$) =5.0
[E] Infiltration flow based on city of Town of Oakville Standard 0.4 l/sec/ha = 0.286 l/sec x 0.12 ha=0.0343
[F] Peak Flow = (Average Flow x Peaking Factor) + Infiltration

3.3 PROPOSED SANITARY SERVICING AND CAPACITY ANALYSIS

The proposed site will be serviced by a 200mmø sanitary service constructed in accordance with the Town of Oakville, Region of Halton and Ontario Building Code standards. Drainage from this service is proposed to discharge to the existing 250mmø sanitary sewer on Cornwall Road.

The minimum grade of the proposed 200mmø sanitary sewer will be 2.0%. At this minimum grade, the proposed sanitary sewer will have an 85% capacity of 0.039 m^3/s (39 l/s). Therefore, the proposed 200mmø sanitary sewer at a minimum of 2.0% grade is adequately sized to service the proposed site.

4.0 DOMESTIC AND FIRE WATER SUPPLY SERVICING

4.1 EXISTING CONDITIONS

The existing municipal water distribution system consists of a 300mmø watermain along Cornwall Road. There is an existing fire hydrant in close proximity to the property, located at 200 Cross Avenue along Cornwall Road.

4.2 DOMESTIC WATER DEMAND

Water demand for the site was estimated in accordance with the requirement of the Region of Halton and Ontario Building Code. Table 4.1 summarizes the domestic water calculations for the proposed development.

Table 4.1 – Proposed Domestic Water Demand

Component	No. of Fixtures	FU/ Fixture	Total FU
Lavatory (8.3L/min or less per head) (Private)	38	0.7	26.6
Shower Head (9.5L/min or less per head) (Private)	37	1.4	51.8
Water Closet (6 LPF or less with flush tank) (Private)	38	2.2	83.6
Sink (kitchen, domestic, 8.3 L/min or less) (Private)	39	1.4	54.6
Clothes Washer (3.5 kg) (Private)	3	1.4	4.2
		Total FU:	**220.8**

Total peak water usage for the site was derived below from the fixture unit count as per Table 7.4.10.5 of the Ontario Building Code.

Total Fixture Unit Count = 220.8 FU

Water Usage: 75 IGPM (6 l/s)

4.3 FIRE FLOW DEMAND

Fire flow demands for the proposed development are governed by a number of guidelines and criteria, such as the Water Supply for Public Fire Protection (Fire Underwriters Survey, 1999), Ontario Building Code (OBC), and various codes and standards published by the National Fire Protection Association (NFPA). Since the FUS criteria provides adjustment

for sprinklered buildings (OBC does not), the FUS method was used to determine the fire flow demand for the proposed development.

Exposure components are based on the following:
The residential building is a non-combustible construction building (C=0.8), with a limited combustible occupancy (-15% correction).

North Face: 0% correction (>45.0m)
South Face: 0% correction (>45.0m)
East Face: 0% correction (>45.0m)
West Face: 0% correction (>45.0m)

It is estimated that the required fire flow for the proposed development will be **100 l/s**. See Fire Flow Demand Requirements in Appendix C for details.

There is an existing hydrant located to the north-west of the proposed development. A hydrant flow test will be completed for future submissions and the results will be provided in an updated report.

4.4 PROPOSED WATER SERVICING

The proposed water servicing for the subject site consists of installing a 150mmø water service off of the existing 300mmø watermain north-west of the site along Cornwall Road. The proposed 150mm water service will provide domestic and fire water service for the proposed designed and constructed in accordance with the Town of Oakville Standards.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the information provided herein, it is concluded that the proposed development at 130 Cornwall can be constructed to meet the requirements of the Town of Oakville and Region of Halton requirements. Therefore, it is recommended that:

- The development to be graded and serviced in accordance with the Preliminary Grading Plan and the Site Servicing Plan prepared by S. Llewellyn & Associates Limited;
- A storm water storage tank and orifice plate be installed as per the Preliminary Servicing Plan and this report to provide adequate quantity control;
- Erosion and sediment controls be installed as described in this report and shown on the Preliminary Grading & Erosion Control Plan
- A Hydrostorm HS4 oil/grit separator and CB Shield be installed as per the Site Servicing Plan and this report to provide efficient stormwater quality control;
- The proposed sanitary and water servicing system be installed as per the Preliminary Site Servicing Plan and this report to adequately service the proposed development.

We trust the information enclosed herein is satisfactory. Should you have any questions pleased do not hesitate to contact our office.

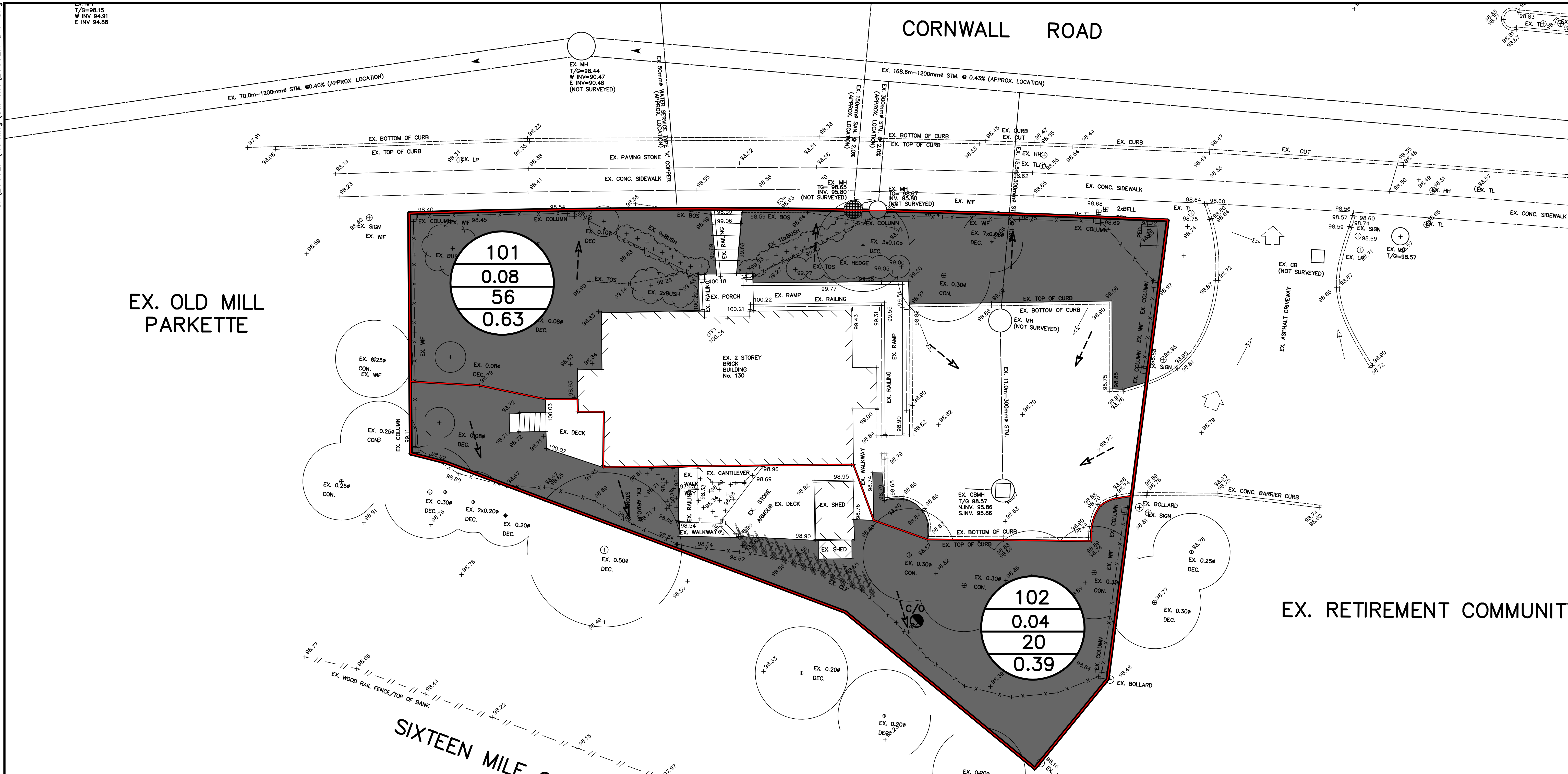
Prepared by:

S. LLEWELLYN & ASSOCIATES LIMITED

A. Stiletto, B.Eng.

S. Frankovich, P.Eng.

APPENDIX A
STORMWATER MANAGEMENT INFORMATION



LEGEND

PERVIOUS AREA

DRAINAGE AREA I.D. (101)
DRAINAGE AREA (ha) (0.08)
PERCENT IMPERVIOUS (56)
RUNOFF COEFFICENT (0.63)

DIRECTION OF SHEET FLOW

DRAINAGE BOUNDARY

FIGURE 2.0
PRE–DEVELOPMENT STORM DRAINAGE AREA PLAN

SCALE: 1:250

PROJECT: 130 CORNWALL, OAKVILLE, ONTARIO
PROJECT No.: 20052A

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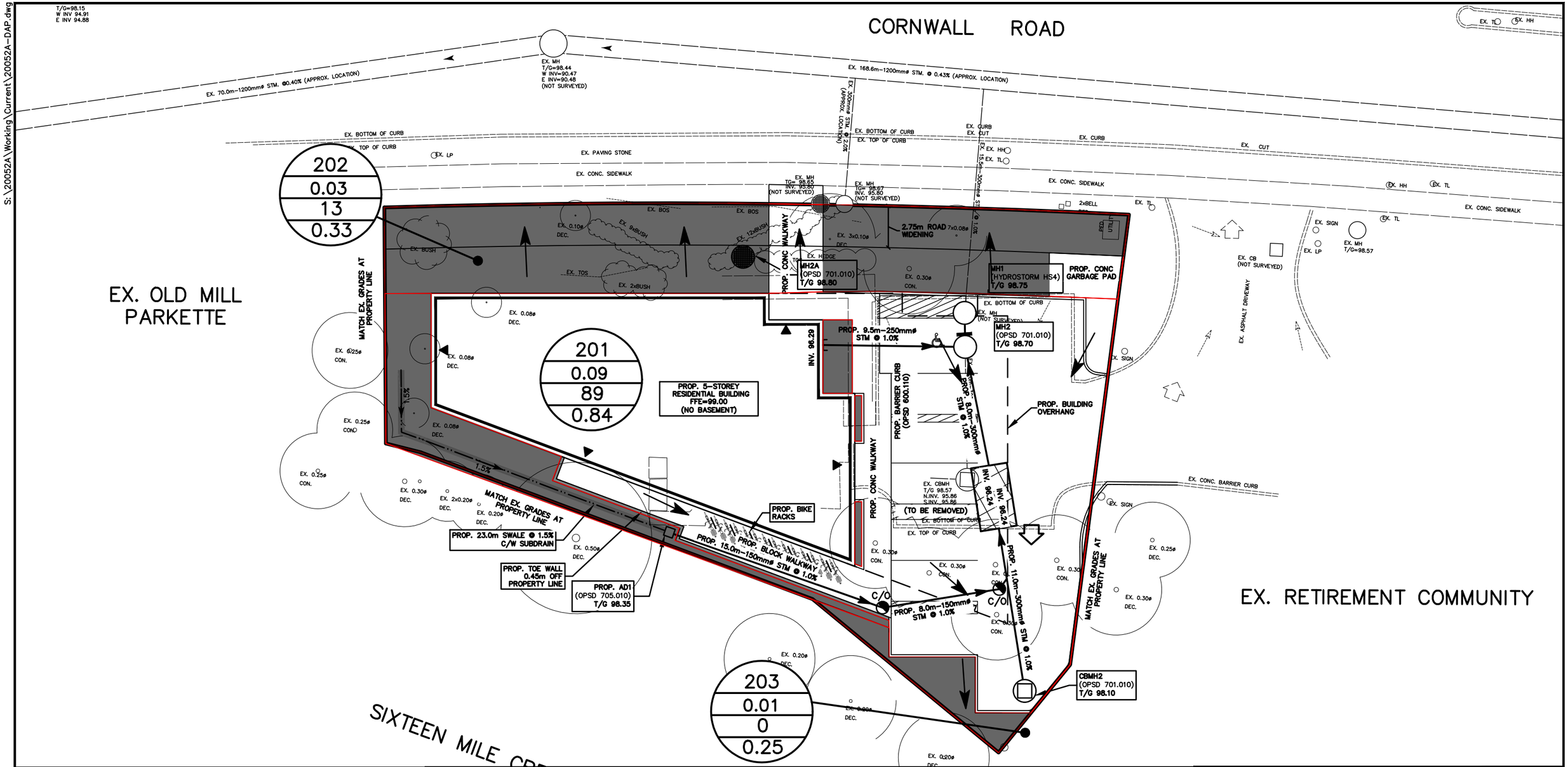

LEGEND

PERVIOUS AREA

201 / 0.09 / 85 / 0.82

DRAINAGE AREA I.D.
DRAINAGE AREA (ha)
PERCENT IMPERVIOUS
RUNOFF COEFFICENT

DIRECTION OF SHEET FLOW

DRAINAGE BOUNDARY

PROPOSED EMERGENCY OVERLAND FLOW ROUTE

FIGURE 2.0
POST-DEVELOPMENT STORM DRAINAGE AREA PLAN

SCALE: 1:250

PROJECT: 130 CORNWALL, OAKVILLE, ONTARIO
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RUNOFF COEFFICIENT CALCULATIONS

Pre

		C-Value
Drainage Area #:	101	
Roof/Building Area (m²):	169.9	0.95
Asphalt/Conc. Area (m²):	283.5	0.90
Interlocking Brick Area (m²):I		0.80
Grass Area - Pervious (m²):	353.3	0.25
Total Area (m²):	806.8	0.63
Impervious	453.5	**0.56**
Pervious	353.3	**0.44**
Site	806.8	

Pre

		C-Value
Drainage Area #:	102	
Roof/Building Area (m²):	56.7	0.95
Asphalt/Conc. Area (m²):	17.6	0.90
Interlocking Brick Area (m²):I		0.80
Grass Area - Pervious (m²):	298.8	0.25
Total Area (m²):	373.0	0.39
Impervious	74.2	**0.20**
Pervious	298.8	**0.80**
Site	373.0	

Post

		C-Value
Drainage Area #:	201	
Roof/Building Area (m²):	335.0	0.95
Asphalt/Conc. Area (m²):	390.0	0.90
Interlocking Brick Area (m²):I	48.0	0.80
Grass Area - Pervious (m²):	97.0	0.25
Total Area (m²):	870.0	0.84
Impervious	773.0	**0.89**
Pervious	97.0	**0.11**
Site	870.0	

Post

		C-Value
Drainage Area #:	202	
Roof/Building Area (m²):	0.0	0.95
Asphalt/Conc. Area (m²):	35.0	0.90
Interlocking Brick Area (m²):I	0.0	0.80
Grass Area - Pervious (m²):	245.0	0.25
Total Area (m²):	280.0	0.33
Impervious	35.0	**0.13**
Pervious	245.0	**0.88**
Site	280.0	

Post

		C-Value
Drainage Area #:	203	
Roof/Building Area (m²):	0.0	0.95
Asphalt/Conc. Area (m²):	0.0	0.90
Interlocking Brick Area (m²):I	0.0	0.80
Grass Area - Pervious (m²):	21.6	0.25
Total Area (m²):	21.6	0.25
Impervious	0.0	**0.00**
Pervious	21.6	**1.00**
Site	21.6	

130 Cornwall
Oakville, Ontario

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STAGE-STORAGE-DISCHARGE CALCULATIONS

Catchment 201

Outlet Device No. 1 (Quantity)

Type:	Orifice Plate
Diameter (mm)	**140**
Area (m^2)	0.01539
Invert Elev. (m)	95.97
C/L Elev. (m)	96.04
Disch. Coeff. (C_d)	0.6
Discharge (Q) =	$C_d A (2 g H)^{0.5}$
Number of Orifices:	1

		SWM Tank Volumes						Outlet No. 1	
	Elevation m	Area m^2	Tank Incremental Volume	Additional Incremental Underground	Additional Incremental Surface m^3	Cumulative Volume m^3	Active Storage Volume m^3	H m	Discharge m^3/s
Orifice Invert	95.97	0	0	0.0	0	0	0	0.000	0.0000
Bottom of Tank	95.17	10	0	0.0	0	0	0	0.000	0.0000
0.3m Deep	95.47	10	3	0.0	0	3	0	0.000	0.0000
0.6m Deep	95.77	10	3	0.0	0	6	0	0.000	0.0000
Pipe Inlet	96.08	10	3	0.0	0	9	0	0.040	0.0082
1.20m Deep	96.37	10	3	0.0	0	12	3	0.330	0.0235
Top of Tank	96.53	10	2	0.0	0	13	4	0.490	0.0286

2-Year Storm - Modified Rational Method

Stormwater Storage Volume

Determination of required storage volume under proposed conditions to control the 100-year proposed conditions runoff to the allowable release rate. Storage volume calculated using the Modified Rational Method.

Storm Rainfall Information	
City/Town/Region:	**Oakville**
Return Period:	**2** Years
A =	**725.000**
B =	**4.800**
C=	**0.808**
Tc =	**10** minutes
	600 seconds

Area of site being investigated (ha) =	**0.09**	(Lot Area)
Composite Runoff Coeff. (C) =	**0.84**	(Post-development "C")
Release Rate - Q_{ALLOW} (m^3/s) =	**0.015**	(Allowable discharge)

Flows from Lot area calculated from area indicated above

Roof flows (Q_{ROOF}) added in as a constant flow rate into the orifice controlled system (if applicable)

Duration (T_D)		Rainfall Intensity		Post-Development Runoff			Runoff Volume	Release Volume	Storage Volume
				Site	Roof	Total "Q_{POST}"			
(min)	(sec)	(mm/hr)	(m/s)	(m^3/s)	(m^3/s)	(m^3)	(m^3)	(m^3)	(m^3)
5	300	114.664	0.0000319	0.024	0.0	0.0241	7.22	6.75	0.47
10	600	82.180	0.0000228	0.017	0.0	0.0173	10.35	9.00	1.35
15	900	64.958	0.0000180	0.014	0.0	0.0136	12.28	11.25	1.03
20	1200	54.153	0.0000150	0.011	0.0	0.0114	13.65	13.50	0.15
25	1500	46.684	0.0000130	0.010	0.0	0.0098	14.71	15.75	-1.04
30	1800	41.185	0.0000114	0.009	0.0	0.0086	15.57	18.00	-2.43
35	2100	36.952	0.0000103	0.008	0.0	0.0078	16.30	20.25	-3.95
40	2400	33.582	0.0000093	0.007	0.0	0.0071	16.93	22.50	-5.57
45	2700	30.830	0.0000086	0.006	0.0	0.0065	17.48	24.75	-7.27
50	3000	28.537	0.0000079	0.006	0.0	0.0060	17.98	27.00	-9.02
55	3300	26.593	0.0000074	0.006	0.0	0.0056	18.43	29.25	-10.82
60	3600	24.922	0.0000069	0.005	0.0	0.0052	18.84	31.50	-12.66
65	3900	23.469	0.0000065	0.005	0.0	0.0049	19.22	33.75	-14.53
70	4200	22.193	0.0000062	0.005	0.0	0.0047	19.57	36.00	-16.43
75	4500	21.063	0.0000059	0.004	0.0	0.0044	19.90	38.25	-18.35
80	4800	20.054	0.0000056	0.004	0.0	0.0042	20.21	40.50	-20.29
85	5100	19.147	0.0000053	0.004	0.0	0.0040	20.51	42.75	-22.24
90	5400	18.326	0.0000051	0.004	0.0	0.0038	20.78	45.00	-24.22
95	5700	17.581	0.0000049	0.004	0.0	0.0037	21.04	47.25	-26.21
100	6000	16.900	0.0000047	0.004	0.0	0.0035	21.29	49.50	-28.21
105	6300	16.275	0.0000045	0.003	0.0	0.0034	21.53	51.75	-30.22
110	6600	15.700	0.0000044	0.003	0.0	0.0033	21.76	54.00	-32.24
115	6900	15.169	0.0000042	0.003	0.0	0.0032	21.98	56.25	-34.27
120	7200	14.676	0.0000041	0.003	0.0	0.0031	22.19	58.50	-36.31

Max. required storage volume = 1.35 m^3

Q_{POST} = (C i A) x 10000 m^2/ha (Rational Method)

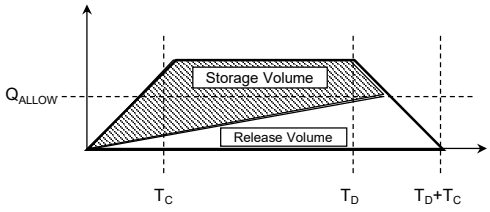
Runoff Volume = Area under trapezoidal hydrograph

= $(T_D - T_C)Q_{POST} + (T_C\ Q_{POST})$

Release Volume = Area under triangular outflow hydrograph

= ½ $(T_D + T_C)\ Q_{ALLOW}$

Storage Volume = Runoff Volume - Release Volume



5-Year Storm - Modified Rational Method

Stormwater Storage Volume

Determination of required storage volume under proposed conditions to control the 100-year proposed conditions runoff to the allowable release rate. Storage volume calculated using the Modified Rational Method.

Storm Rainfall Information	
City/Town/Region:	**Oakville**
Return Period:	**5** Years
A =	**1170.000**
B =	**5.800**
C=	**0.843**
Tc =	**10** minutes
	600 seconds

Area of site being investigated (ha) =	**0.09**	(Lot Area)
Composite Runoff Coeff. (C) =	**0.84**	(Post-development "C")
Release Rate - Q_{ALLOW} (m^3/s) =	**0.0200**	(Allowable discharge)

Flows from Lot area calculated from area indicated above

Roof flows (Q_{ROOF}) added in as a constant flow rate into the orifice controlled system (if applicable)

Duration (T_D)		Rainfall Intensity		Post-Development Runoff			Runoff Volume	Release Volume	Storage Volume
				Site	Roof	Total "Q_{POST}"			
(min)	(sec)	(mm/hr)	(m/s)	(m^3/s)	(m^3/s)	(m^3)	(m^3)	(m^3)	(m^3)
5	300	157.402	0.0000437	0.033	0.0	0.0331	9.92	9.00	0.92
10	600	114.214	0.0000317	0.024	0.0	0.0240	14.39	12.00	2.39
15	900	90.585	0.0000252	0.019	0.0	0.0190	17.12	15.00	2.12
20	1200	75.542	0.0000210	0.016	0.0	0.0159	19.04	18.00	1.04
25	1500	65.064	0.0000181	0.014	0.0	0.0137	20.50	21.00	-0.50
30	1800	57.314	0.0000159	0.012	0.0	0.0120	21.66	24.00	-2.34
35	2100	51.333	0.0000143	0.011	0.0	0.0108	22.64	27.00	-4.36
40	2400	46.567	0.0000129	0.010	0.0	0.0098	23.47	30.00	-6.53
45	2700	42.672	0.0000119	0.009	0.0	0.0090	24.20	33.00	-8.80
50	3000	39.425	0.0000110	0.008	0.0	0.0083	24.84	36.00	-11.16
55	3300	36.674	0.0000102	0.008	0.0	0.0077	25.41	39.00	-13.59
60	3600	34.310	0.0000095	0.007	0.0	0.0072	25.94	42.00	-16.06
65	3900	32.256	0.0000090	0.007	0.0	0.0068	26.42	45.00	-18.58
70	4200	30.453	0.0000085	0.006	0.0	0.0064	26.86	48.00	-21.14
75	4500	28.856	0.0000080	0.006	0.0	0.0061	27.27	51.00	-23.73
80	4800	27.432	0.0000076	0.006	0.0	0.0058	27.65	54.00	-26.35
85	5100	26.153	0.0000073	0.005	0.0	0.0055	28.01	57.00	-28.99
90	5400	24.997	0.0000069	0.005	0.0	0.0052	28.35	60.00	-31.65
95	5700	23.948	0.0000067	0.005	0.0	0.0050	28.67	63.00	-34.33
100	6000	22.990	0.0000064	0.005	0.0	0.0048	28.97	66.00	-37.03
105	6300	22.113	0.0000061	0.005	0.0	0.0046	29.25	69.00	-39.75
110	6600	21.305	0.0000059	0.004	0.0	0.0045	29.53	72.00	-42.47
115	6900	20.559	0.0000057	0.004	0.0	0.0043	29.79	75.00	-45.21
120	7200	19.868	0.0000055	0.004	0.0	0.0042	30.04	78.00	-47.96

Max. required storage volume = 2.39 m^3

Q_{POST} = (C i A) x 10000 m^2/ha (Rational Method)

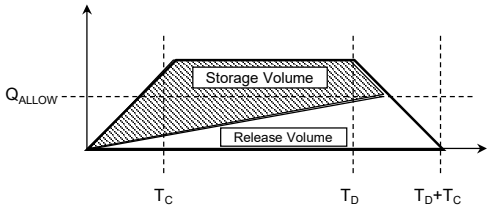
Runoff Volume = Area under trapezoidal hydrograph

= $(T_D - T_C)Q_{POST} + (T_C\ Q_{POST})$

Release Volume = Area under triangular outflow hydrograph

= ½ $(T_D + T_C)\ Q_{ALLOW}$

Storage Volume = Runoff Volume - Release Volume



10-Year Storm - Modified Rational Method

Stormwater Storage Volume

Determination of required storage volume under proposed conditions to control the 100-year proposed conditions runoff to the allowable release rate. Storage volume calculated using the Modified Rational Method.

Storm Rainfall Information	
City/Town/Region:	**Oakville**
Return Period:	**10** Years
A =	**1400.000**
B =	**5.800**
C=	**0.848**
Tc =	**10** minutes
	600 seconds

Area of site being investigated (ha) =	**0.09**	(Lot Area)
Composite Runoff Coeff. (C) =	**0.84**	(Post-development "C")
Release Rate - Q_{ALLOW} (m^3/s) =	**0.028**	(Allowable discharge)

Flows from Lot area calculated from area indicated above

Roof flows (Q_{ROOF}) added in as a constant flow rate into the orifice controlled system (if applicable)

Duration (T_D)		Rainfall Intensity		Post-Development Runoff			Runoff Volume	Release Volume	Storage Volume
				Site	Roof	Total "Q_{POST}"			
(min)	(sec)	(mm/hr)	(m/s)	(m^3/s)	(m^3/s)	(m^3)	(m^3)	(m^3)	(m^3)
5	300	186.116	0.0000517	0.039	0.0	0.0391	11.73	12.60	-0.87
10	600	134.793	0.0000374	0.028	0.0	0.0283	16.98	16.80	0.18
15	900	106.760	0.0000297	0.022	0.0	0.0224	20.18	21.00	-0.82
20	1200	88.935	0.0000247	0.019	0.0	0.0187	22.41	25.20	-2.79
25	1500	76.531	0.0000213	0.016	0.0	0.0161	24.11	29.40	-5.29
30	1800	67.365	0.0000187	0.014	0.0	0.0141	25.46	33.60	-8.14
35	2100	60.296	0.0000167	0.013	0.0	0.0127	26.59	37.80	-11.21
40	2400	54.666	0.0000152	0.011	0.0	0.0115	27.55	42.00	-14.45
45	2700	50.067	0.0000139	0.011	0.0	0.0105	28.39	46.20	-17.81
50	3000	46.236	0.0000128	0.010	0.0	0.0097	29.13	50.40	-21.27
55	3300	42.991	0.0000119	0.009	0.0	0.0090	29.79	54.60	-24.81
60	3600	40.204	0.0000112	0.008	0.0	0.0084	30.39	58.80	-28.41
65	3900	37.783	0.0000105	0.008	0.0	0.0079	30.94	63.00	-32.06
70	4200	35.659	0.0000099	0.007	0.0	0.0075	31.45	67.20	-35.75
75	4500	33.779	0.0000094	0.007	0.0	0.0071	31.92	71.40	-39.48
80	4800	32.102	0.0000089	0.007	0.0	0.0067	32.36	75.60	-43.24
85	5100	30.596	0.0000085	0.006	0.0	0.0064	32.77	79.80	-47.03
90	5400	29.237	0.0000081	0.006	0.0	0.0061	33.15	84.00	-50.85
95	5700	28.002	0.0000078	0.006	0.0	0.0059	33.52	88.20	-54.68
100	6000	26.876	0.0000075	0.006	0.0	0.0056	33.86	92.40	-58.54
105	6300	25.844	0.0000072	0.005	0.0	0.0054	34.19	96.60	-62.41
110	6600	24.894	0.0000069	0.005	0.0	0.0052	34.50	100.80	-66.30
115	6900	24.018	0.0000067	0.005	0.0	0.0050	34.80	105.00	-70.20
120	7200	23.206	0.0000064	0.005	0.0	0.0049	35.09	109.20	-74.11

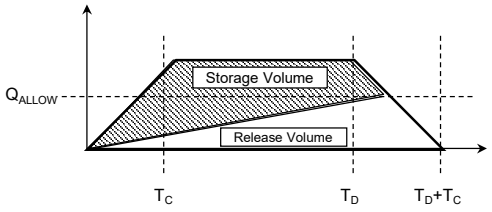
Max. required storage volume = 0.18 m^3

Q_{POST} = (C i A) x 10000 m^2/ha (Rational Method)

Runoff Volume = Area under trapezoidal hydrograph
= $(T_D - T_C)Q_{POST} + (T_C Q_{POST})$

Release Volume = Area under triangular outflow hydrograph
= ½ $(T_D + T_C)$ Q_{ALLOW}

Storage Volume = Runoff Volume - Release Volume



25-Year Storm - Modified Rational Method

Stormwater Storage Volume

Determination of required storage volume under proposed conditions to control the 100-year proposed conditions runoff to the allowable release rate. Storage volume calculated using the Modified Rational Method.

Storm Rainfall Information	
City/Town/Region:	**Oakville**
Return Period:	**25** Years
A =	**1680.000**
B =	**5.600**
C=	**0.851**
Tc =	**10** minutes
	600 seconds

Area of site being investigated (ha) =	**0.09**	(Lot Area)
Composite Runoff Coeff. (C) =	**0.84**	(Post-development "C")
Release Rate - Q_{ALLOW} (m^3/s) =	**0.034**	(Allowable discharge)

Flows from Lot area calculated from area indicated above

Roof flows (Q_{ROOF}) added in as a constant flow rate into the orifice controlled system (if applicable)

Duration (T_D)		Rainfall Intensity		Post-Development Runoff			Runoff Volume	Release Volume	Storage Volume
				Site	Roof	Total "Q_{POST}"			
(min)	(sec)	(mm/hr)	(m/s)	(m^3/s)	(m^3/s)	(m^3)	(m^3)	(m^3)	(m^3)
5	300	225.307	0.0000626	0.047	0.0	0.0473	14.19	15.35	-1.15
10	600	162.166	0.0000450	0.034	0.0	0.0341	20.43	20.46	-0.03
15	900	128.000	0.0000356	0.027	0.0	0.0269	24.19	25.58	-1.38
20	1200	106.389	0.0000296	0.022	0.0	0.0223	26.81	30.69	-3.88
25	1500	91.403	0.0000254	0.019	0.0	0.0192	28.79	35.81	-7.01
30	1800	80.357	0.0000223	0.017	0.0	0.0169	30.38	40.92	-10.54
35	2100	71.854	0.0000200	0.015	0.0	0.0151	31.69	46.04	-14.35
40	2400	65.092	0.0000181	0.014	0.0	0.0137	32.81	51.15	-18.34
45	2700	59.577	0.0000165	0.013	0.0	0.0125	33.78	56.27	-22.48
50	3000	54.986	0.0000153	0.012	0.0	0.0115	34.64	61.38	-26.74
55	3300	51.100	0.0000142	0.011	0.0	0.0107	35.41	66.50	-31.08
60	3600	47.767	0.0000133	0.010	0.0	0.0100	36.11	71.61	-35.50
65	3900	44.872	0.0000125	0.009	0.0	0.0094	36.75	76.73	-39.97
70	4200	42.334	0.0000118	0.009	0.0	0.0089	37.34	81.84	-44.50
75	4500	40.088	0.0000111	0.008	0.0	0.0084	37.88	86.96	-49.07
80	4800	38.087	0.0000106	0.008	0.0	0.0080	38.39	92.07	-53.68
85	5100	36.291	0.0000101	0.008	0.0	0.0076	38.87	97.19	-58.32
90	5400	34.669	0.0000096	0.007	0.0	0.0073	39.31	102.30	-62.99
95	5700	33.197	0.0000092	0.007	0.0	0.0070	39.74	107.42	-67.68
100	6000	31.855	0.0000088	0.007	0.0	0.0067	40.14	112.53	-72.39
105	6300	30.625	0.0000085	0.006	0.0	0.0064	40.52	117.65	-77.13
110	6600	29.494	0.0000082	0.006	0.0	0.0062	40.88	122.76	-81.88
115	6900	28.450	0.0000079	0.006	0.0	0.0060	41.22	127.88	-86.65
120	7200	27.483	0.0000076	0.006	0.0	0.0058	41.55	132.99	-91.44

Max. required storage volume = -0.03 m^3

Q_{POST} = (C i A) x 10000 m^2/ha (Rational Method)

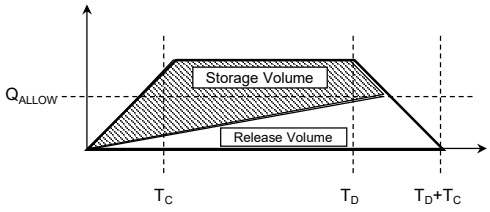
Runoff Volume = Area under trapezoidal hydrograph

= $(T_D - T_C)Q_{POST} + (T_C Q_{POST})$

Release Volume = Area under triangular outflow hydrograph

= ½ $(T_D + T_C)$ Q_{ALLOW}

Storage Volume = Runoff Volume - Release Volume



50-Year Storm - Modified Rational Method

Stormwater Storage Volume

Determination of required storage volume under proposed conditions to control the 100-year proposed conditions runoff to the allowable release rate. Storage volume calculated using the Modified Rational Method.

Storm Rainfall Information	
City/Town/Region:	**Oakville**
Return Period:	**50** Years
A =	**1960.000**
B =	**5.800**
C=	**0.861**
Tc =	**10** minutes
	600 seconds

Area of site being investigated (ha) =	**0.09**	(Lot Area)
Composite Runoff Coeff. (C) =	**0.84**	(Post-development "C")
Release Rate - Q_{ALLOW} (m^3/s) =	**0.038**	(Allowable discharge)

Flows from Lot area calculated from area indicated above

Roof flows (Q_{ROOF}) added in as a constant flow rate into the orifice controlled system (if applicable)

Duration (T_D)		Rainfall Intensity		Post-Development Runoff			Runoff Volume	Release Volume	Storage Volume
				Site	Roof	Total "Q_{POST}"			
(min)	(sec)	(mm/hr)	(m/s)	(m^3/s)	(m^3/s)	(m^3)	(m^3)	(m^3)	(m^3)
5	300	252.626	0.0000702	0.053	0.0	0.0531	15.92	17.10	-1.18
10	600	182.059	0.0000506	0.038	0.0	0.0382	22.94	22.80	0.14
15	900	143.682	0.0000399	0.030	0.0	0.0302	27.16	28.50	-1.34
20	1200	119.358	0.0000332	0.025	0.0	0.0251	30.08	34.20	-4.12
25	1500	102.474	0.0000285	0.022	0.0	0.0215	32.28	39.90	-7.62
30	1800	90.025	0.0000250	0.019	0.0	0.0189	34.03	45.60	-11.57
35	2100	80.441	0.0000223	0.017	0.0	0.0169	35.47	51.30	-15.83
40	2400	72.820	0.0000202	0.015	0.0	0.0153	36.70	57.00	-20.30
45	2700	66.605	0.0000185	0.014	0.0	0.0140	37.77	62.70	-24.93
50	3000	61.433	0.0000171	0.013	0.0	0.0129	38.70	68.40	-29.70
55	3300	57.058	0.0000158	0.012	0.0	0.0120	39.54	74.10	-34.56
60	3600	53.304	0.0000148	0.011	0.0	0.0112	40.30	79.80	-39.50
65	3900	50.047	0.0000139	0.011	0.0	0.0105	40.99	85.50	-44.51
70	4200	47.191	0.0000131	0.010	0.0	0.0099	41.62	91.20	-49.58
75	4500	44.666	0.0000124	0.009	0.0	0.0094	42.21	96.90	-54.69
80	4800	42.415	0.0000118	0.009	0.0	0.0089	42.75	102.60	-59.85
85	5100	40.397	0.0000112	0.008	0.0	0.0085	43.26	108.30	-65.04
90	5400	38.575	0.0000107	0.008	0.0	0.0081	43.74	114.00	-70.26
95	5700	36.921	0.0000103	0.008	0.0	0.0078	44.19	119.70	-75.51
100	6000	35.414	0.0000098	0.007	0.0	0.0074	44.62	125.40	-80.78
105	6300	34.034	0.0000095	0.007	0.0	0.0071	45.03	131.10	-86.07
110	6600	32.764	0.0000091	0.007	0.0	0.0069	45.41	136.80	-91.39
115	6900	31.593	0.0000088	0.007	0.0	0.0066	45.78	142.50	-96.72
120	7200	30.509	0.0000085	0.006	0.0	0.0064	46.13	148.20	-102.07

Max. required storage volume = 0.14 m^3

Q_{POST} = (C i A) x 10000 m^2/ha (Rational Method)

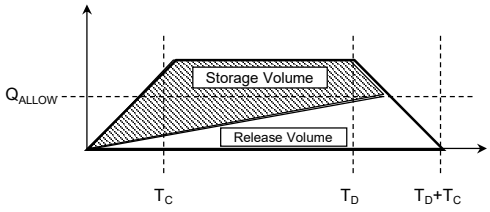
Runoff Volume = Area under trapezoidal hydrograph

= $(T_D - T_C)Q_{POST} + (T_C\ Q_{POST})$

Release Volume = Area under triangular outflow hydrograph

= ½ $(T_D + T_C)\ Q_{ALLOW}$

Storage Volume = Runoff Volume - Release Volume



100-Year Storm - Modified Rational Method

Stormwater Storage Volume

Determination of required storage volume under proposed conditions to control the 100-year proposed conditions runoff to the allowable release rate. Storage volume calculated using the Modified Rational Method.

Storm Rainfall Information	
City/Town/Region:	**Oakville**
Return Period:	**100** Years
A =	**2150.000**
B =	**5.700**
C=	**0.861**
Tc =	**10** minutes
	600 seconds

Area of site being investigated (ha) =	**0.09**	(Lot Area)
Composite Runoff Coeff. (C) =	**0.84**	(Post development "C")
Release Rate - Q_{ALLOW} (m^3/s) =	**0.0422**	(Allowable discharge)

Flows from Lot area calculated from area indicated above

Roof flows (Q_{ROOF}) added in as a constant flow rate into the orifice controlled system (if applicable)

Duration (T_D)		Rainfall Intensity		Post-Development Runoff			Runoff Volume	Release Volume	Storage Volume
				Site	Roof	Total "Q_{POST}"			
(min)	(sec)	(mm/hr)	(m/s)	(m^3/s)	(m^3/s)	(m^3)	(m^3)	(m^3)	(m^3)
5	300	279.344	0.0000776	0.059	0.0	0.0587	17.60	18.99	-1.39
10	600	200.802	0.0000558	0.042	0.0	0.0422	25.30	25.32	-0.02
15	900	158.266	0.0000440	0.033	0.0	0.0332	29.91	31.65	-1.74
20	1200	131.367	0.0000365	0.028	0.0	0.0276	33.10	37.98	-4.88
25	1500	112.723	0.0000313	0.024	0.0	0.0237	35.51	44.31	-8.80
30	1800	98.990	0.0000275	0.021	0.0	0.0208	37.42	50.64	-13.22
35	2100	88.426	0.0000246	0.019	0.0	0.0186	39.00	56.97	-17.97
40	2400	80.030	0.0000222	0.017	0.0	0.0168	40.33	63.30	-22.97
45	2700	73.186	0.0000203	0.015	0.0	0.0154	41.50	69.63	-28.13
50	3000	67.493	0.0000187	0.014	0.0	0.0142	42.52	75.96	-33.44
55	3300	62.678	0.0000174	0.013	0.0	0.0132	43.44	82.29	-38.85
60	3600	58.548	0.0000163	0.012	0.0	0.0123	44.26	88.62	-44.36
65	3900	54.965	0.0000153	0.012	0.0	0.0115	45.02	94.95	-49.93
70	4200	51.825	0.0000144	0.011	0.0	0.0109	45.71	101.28	-55.57
75	4500	49.048	0.0000136	0.010	0.0	0.0103	46.35	107.61	-61.26
80	4800	46.574	0.0000129	0.010	0.0	0.0098	46.95	113.94	-66.99
85	5100	44.355	0.0000123	0.009	0.0	0.0093	47.50	120.27	-72.77
90	5400	42.352	0.0000118	0.009	0.0	0.0089	48.03	126.60	-78.57
95	5700	40.535	0.0000113	0.009	0.0	0.0085	48.52	132.93	-84.41
100	6000	38.879	0.0000108	0.008	0.0	0.0082	48.99	139.26	-90.27
105	6300	37.362	0.0000104	0.008	0.0	0.0078	49.43	145.59	-96.16
110	6600	35.967	0.0000100	0.008	0.0	0.0076	49.85	151.92	-102.07
115	6900	34.681	0.0000096	0.007	0.0	0.0073	50.25	158.25	-108.00
120	7200	33.490	0.0000093	0.007	0.0	0.0070	50.64	164.58	-113.94

Max. required storage volume = -0.02 m^3

Q_{POST} = (C i A) x 10000 m^2/ha (Rational Method)

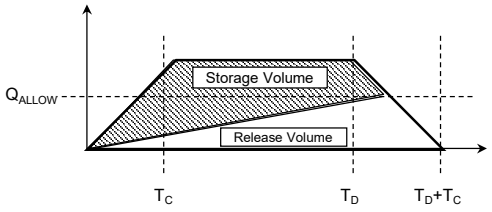
Runoff Volume = Area under trapezoidal hydrograph

= $(T_D - T_C)Q_{POST} + (T_C Q_{POST})$

Release Volume = Area under triangular outflow hydrograph

= ½ $(T_D + T_C)$ Q_{ALLOW}

Storage Volume = Runoff Volume - Release Volume



APPENDIX B
QUALITY CONTROL INFORMATION

Hydroworks Sizing Summary

130 Cornwall
Oakville, Ontario

12-16-2022

Recommended Size: HS 4

A HydroStorm HS 4 is recommended to provide 80 % annual TSS removal based on a drainage area of 0.09 (ha) with an imperviousness of 89 % and Hamilton RBG, Ontario rainfall for the ETV Canada particle size distribution.

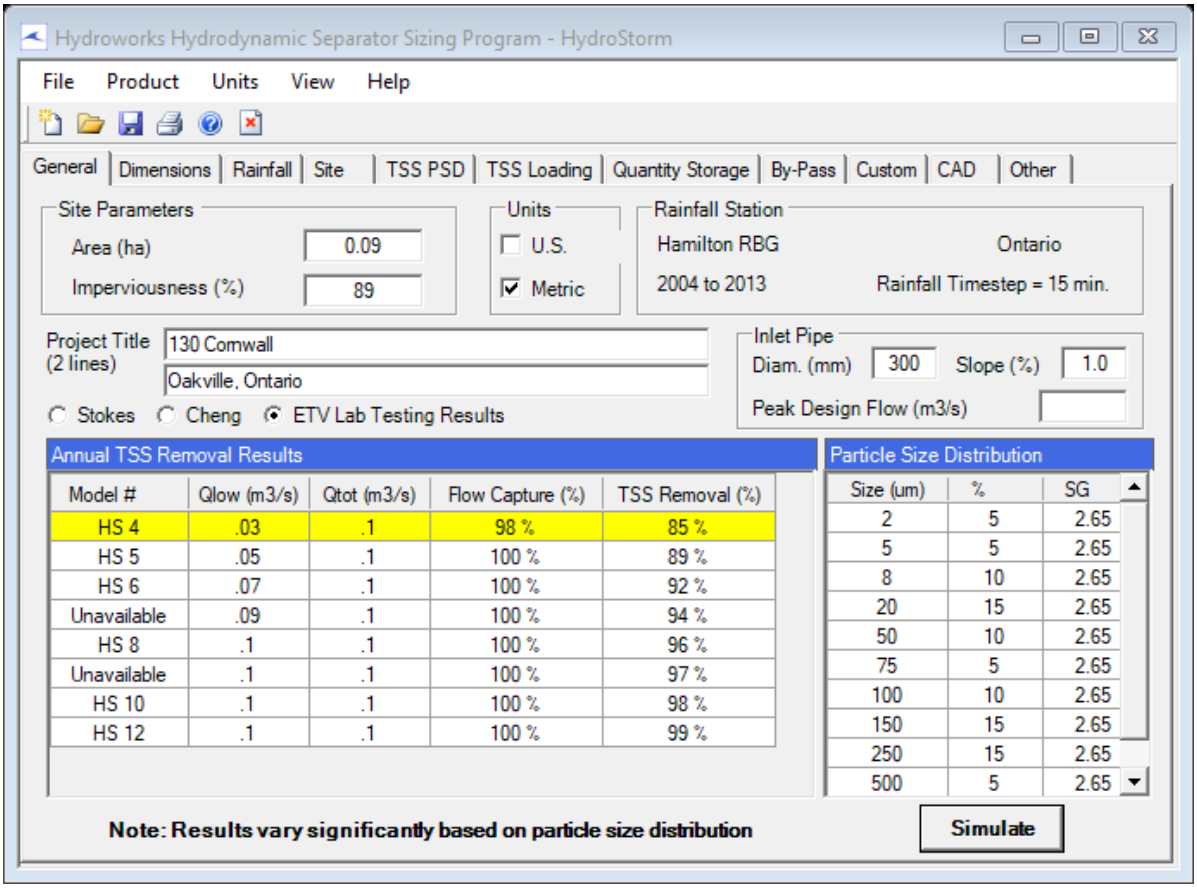
The recommended HydroStorm HS 4 treats 98 % of the annual runoff and provides 85 % annual TSS removal for the Hamilton RBG rainfall records and ETV Canada particle size distribution.

The HydroStorm has a headloss coefficient (K) of 1.04. Since a peak flow was not specified, headloss was calculated using the full pipe flow of .1 (m3/s) for the given 300 (mm) pipe diameter at 1% slope. The headloss was calculated to be 99 (mm) based on a flow depth of 300 (mm) (full pipe flow).

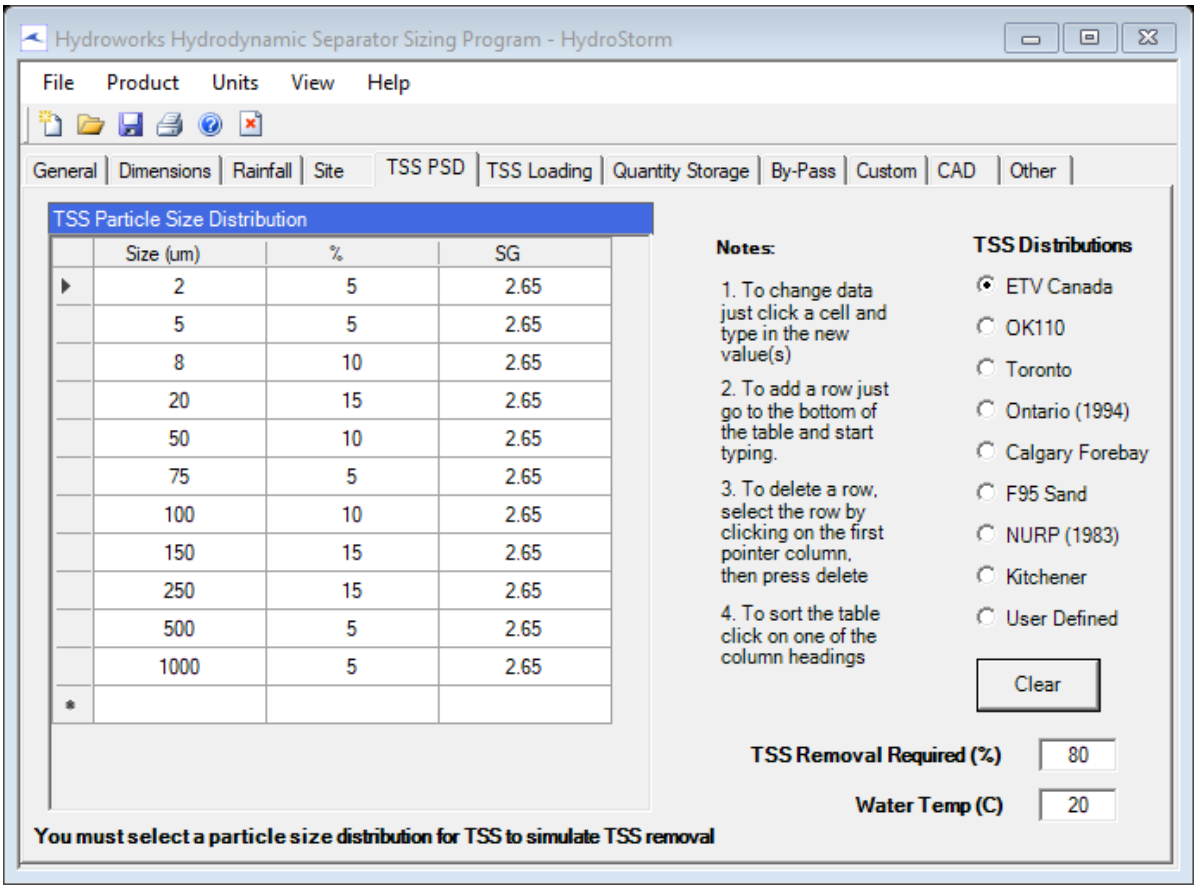
This summary report provides the main parameters that were used for sizing. These parameters are shown on the summary tables and graphs provided in this report.

If you have any questions regarding this sizing summary please do not hesitate to contact Hydroworks at 888-290-7900 or email us at support@hydroworks.com.

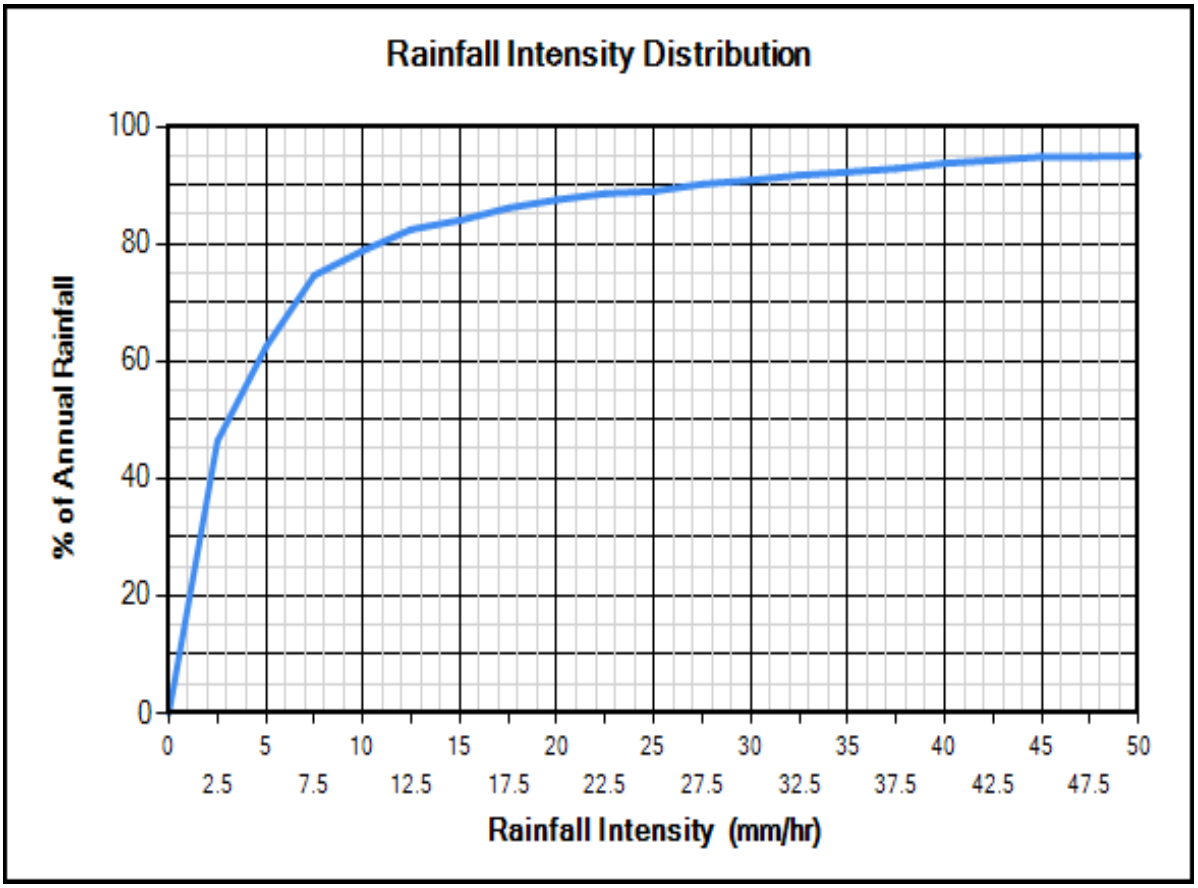
TSS Removal Sizing Summary



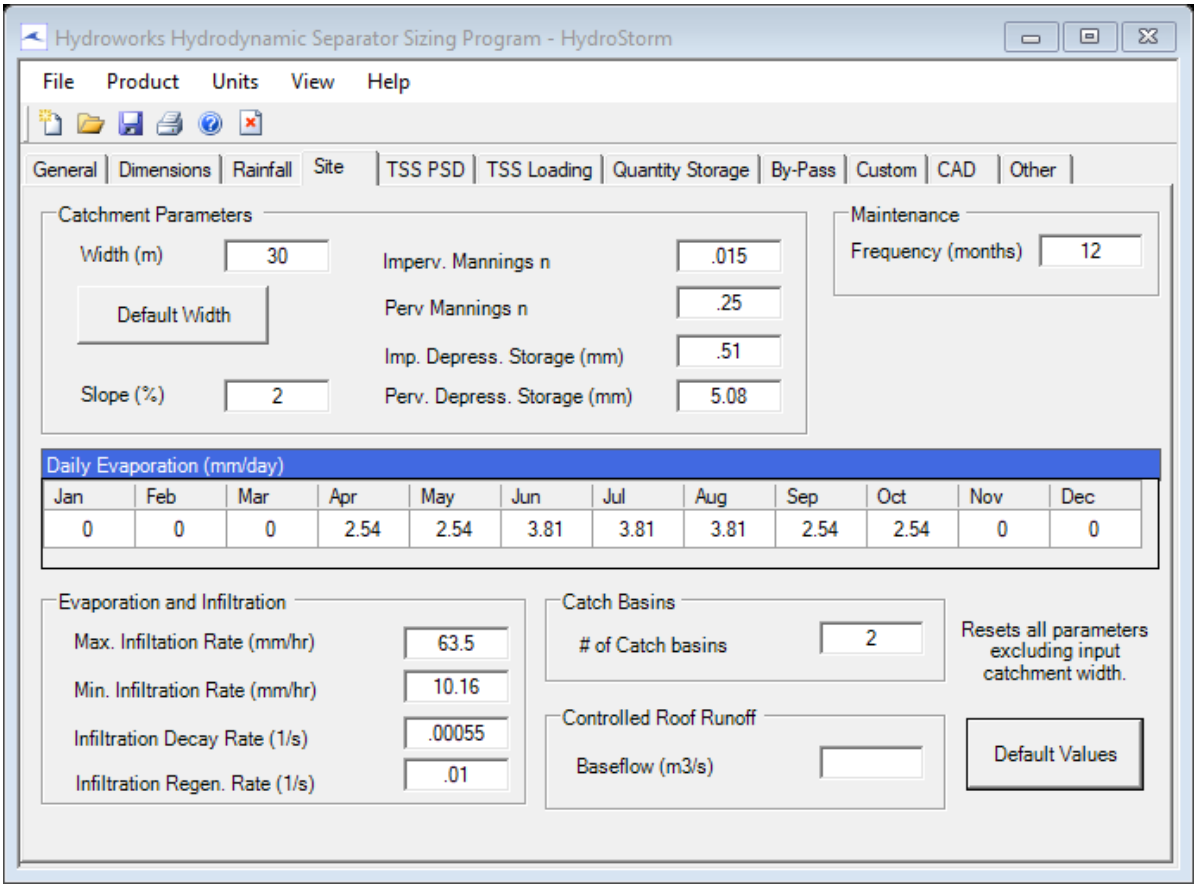
TSS Particle Size Distribution



Rainfall Station - Hamilton RBG, Ontario(2004 to 2013)



Site Physical Characteristics



Dimensions And Capacities

Hydroworks Hydrodynamic Separator Sizing Program - HydroStorm

File Product Units View Help

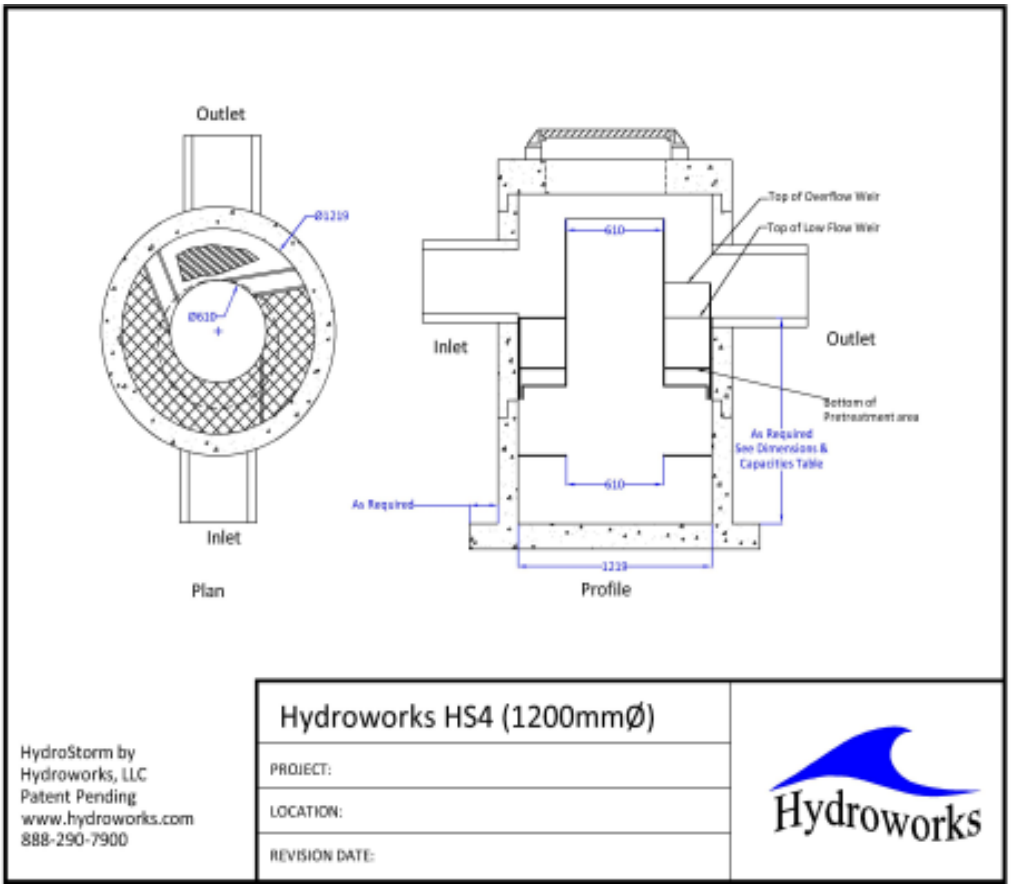
General | Dimensions | Rainfall | Site | TSS PSD | TSS Loading | Quantity Storage | By-Pass | Custom | CAD | Other

Dimensions and Capacities

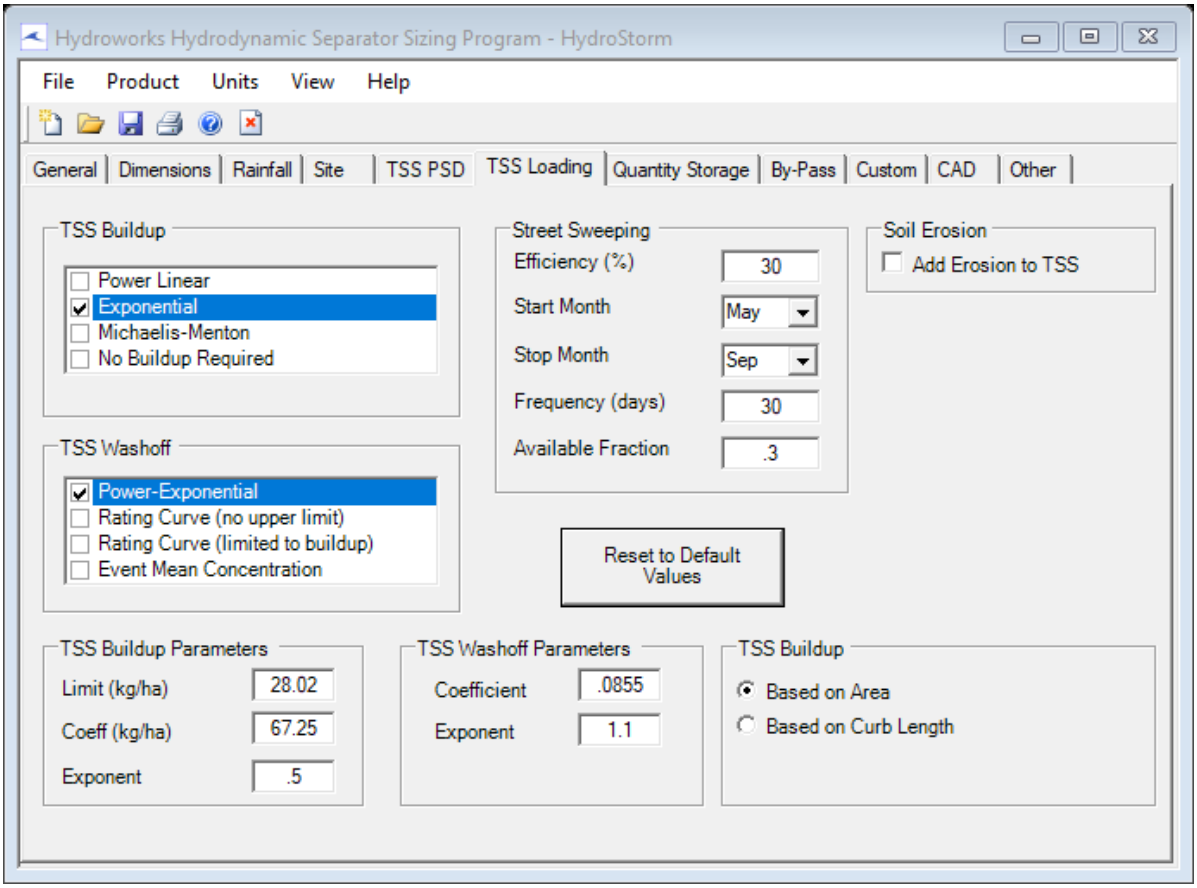
Model	Diam. (m)	Depth (m)	Float. Vol. (L)	Sediment Vol. (m3)	Total Vol. (m3)
HS 4	1.22	1.22	381	0.9	1.4
HS 5	1.52	1.52	642	1.8	2.8
HS 6	1.83	1.83	1041	3.2	4.8
HS 7	2.13	1.98	1575	4.6	7.1
HS 8	2.44	2.13	2354	6.3	10
HS 9	2.74	2.44	3242	9.3	14.4
HS 10	3.05	2.74	4327	13.2	20
HS 12	3.66	3.35	7164	23.8	35.2

Depth = Depth from outlet invert to inside bottom of tank

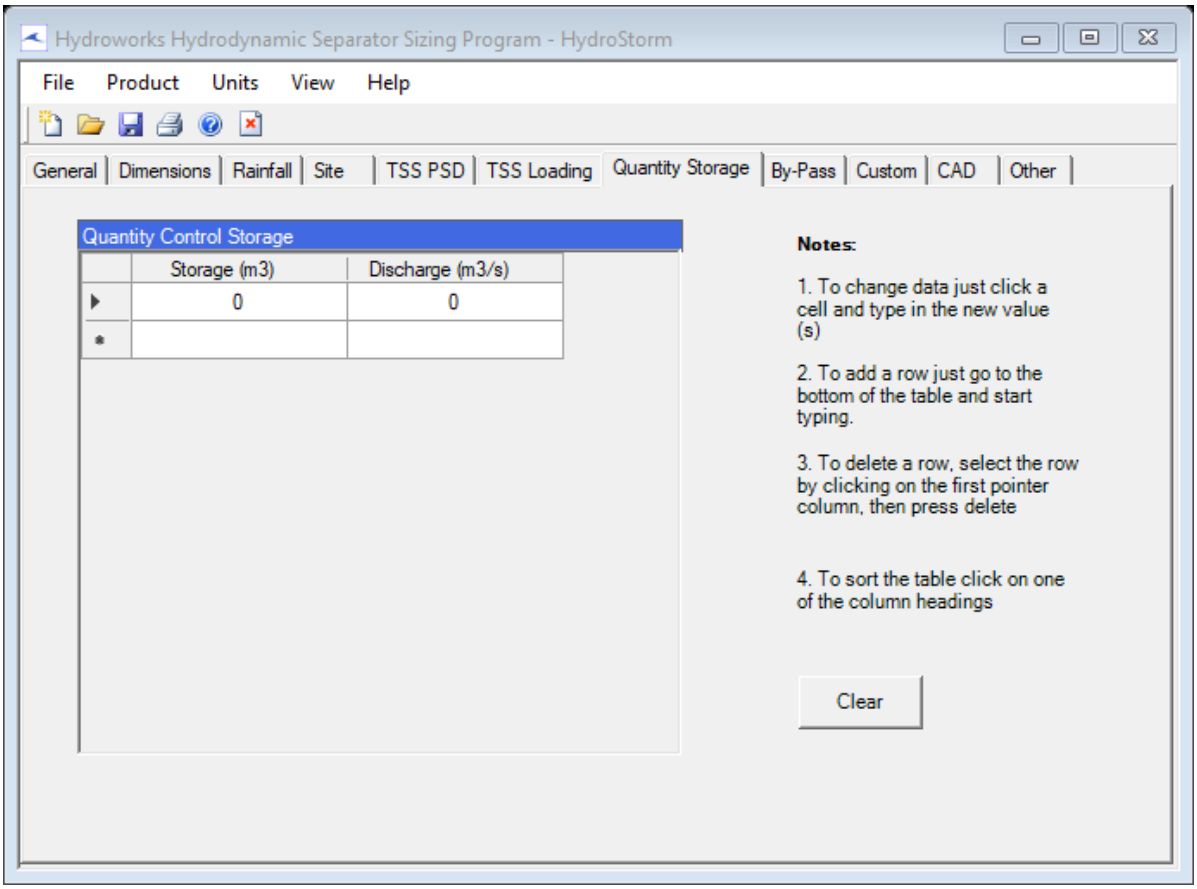
Generic HS 4 CAD Drawing



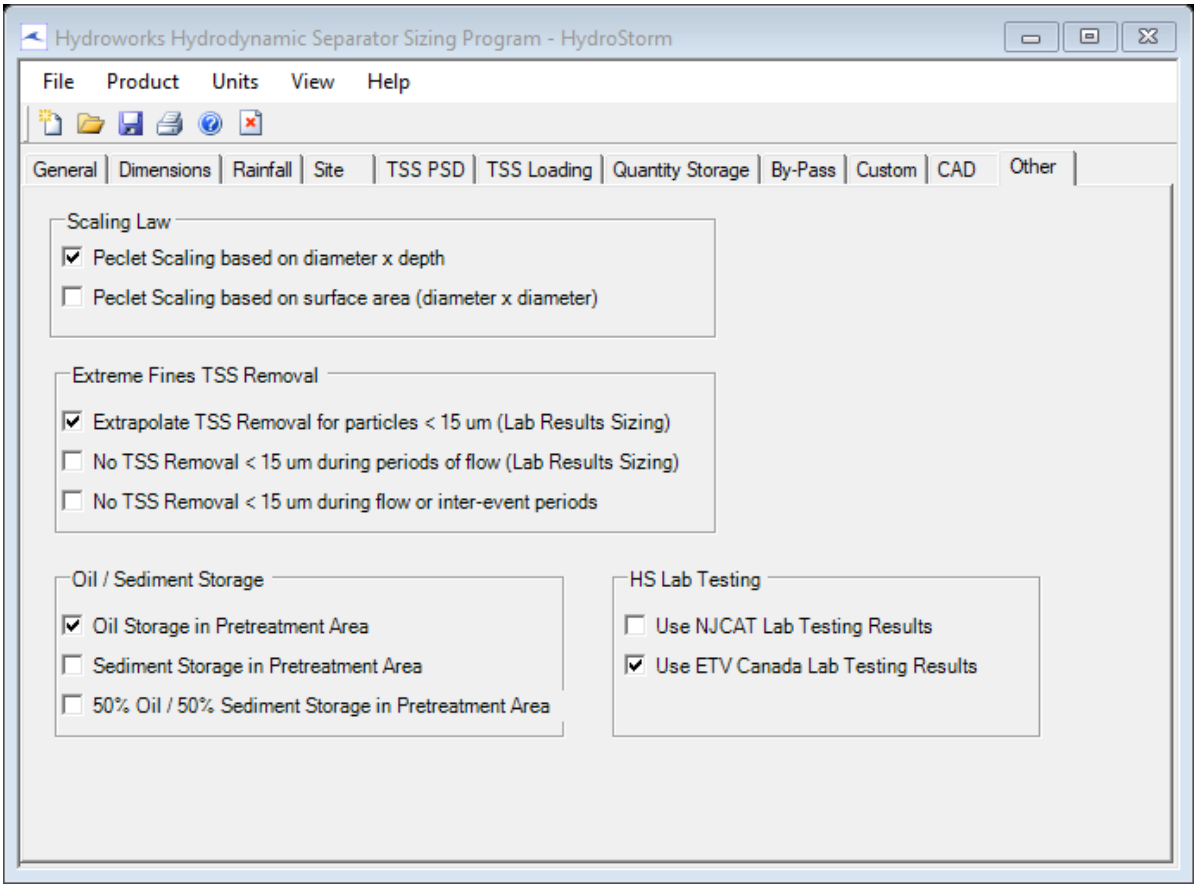
TSS Buildup And Washoff



Upstream Quantity Storage



Other Parameters



Hydroworks Sizing Program - Version 5.0

Hydroworks® HydroStorm

Operations & Maintenance Manual

Version 1.0

Please call Hydroworks at 888-290-7900 or email us at support@hydroworks.com if you have any questions regarding the Inspection Checklist. Please fax a copy of the completed checklist to Hydroworks at 888-783-7271 for our records.

Introduction

The HydroStorm is a state of the art hydrodynamic separator. Hydrodynamic separators remove solids, debris and lighter than water (oil, trash, floating debris) pollutants from stormwater. Hydrodynamic separators and other water quality measures are mandated by regulatory agencies (Town/City, State, Federal Government) to protect storm water quality from pollution generated by urban development (traffic, people) as part of new development permitting requirements.

As storm water treatment structures fill up with pollutants they become less and less effective in removing new pollution. Therefore, it is important that storm water treatment structures be maintained on a regular basis to ensure that they are operating at optimum performance. The HydroStorm is no different in this regard and this manual has been assembled to provide the owner/operator with the necessary information to inspect and coordinate maintenance of their HydroStorm.

Hydroworks® HydroStorm Operation

The Hydroworks HydroStorm (HS) separator is a unique hydrodynamic by-pass separator. It incorporates a protected submerged pretreatment zone to collect larger solids, a treatment tank to remove finer solids, and a dual set of weirs to create a high flow bypass. High flows are conveyed directly to the outlet and do not enter the treatment area, however, the submerged pretreatment area still allows removal of coarse solids during high flows.

Under normal or low flows, water enters an inlet area with a horizontal grate. The area underneath the grate is submerged with openings to the main treatment area of the separator. Coarse solids fall through the grate and are either trapped in the pretreatment area or conveyed into the main treatment area depending on the flow rate. Fines are transported into the main treatment area. Openings and weirs in the pretreatment area allow entry of water and solids into the main treatment area and cause water to rotate in the main treatment area creating a vortex motion. Water in the main treatment area is forced to rise along the walls of the separator to discharge from the treatment area to the downstream pipe.

The vortex motion forces solids and floatables to the middle of the inner chamber. Floatables are trapped since the inlet to the treatment area is submerged. The design maximizes the retention of settled solids since solids are forced to the center of the inner chamber by the vortex motion of water while water must flow up the walls of the separator to discharge into the downstream pipe.

A set of high flow weirs near the outlet pipe create a high flow bypass over both the pretreatment area and main treatment chamber. The rate of flow into the treatment area is regulated by the number and size of openings into the treatment chamber and the height of by-pass weirs. High flows flow over the weirs directly to the outlet pipe preventing the scour and resuspension of any fines collected in the treatment chamber.

A central access tube is located in the structure to provide access for cleaning. The arrangement of the inlet area and bypass weirs near the outlet pipe facilitate the use of multiple inlet pipes.

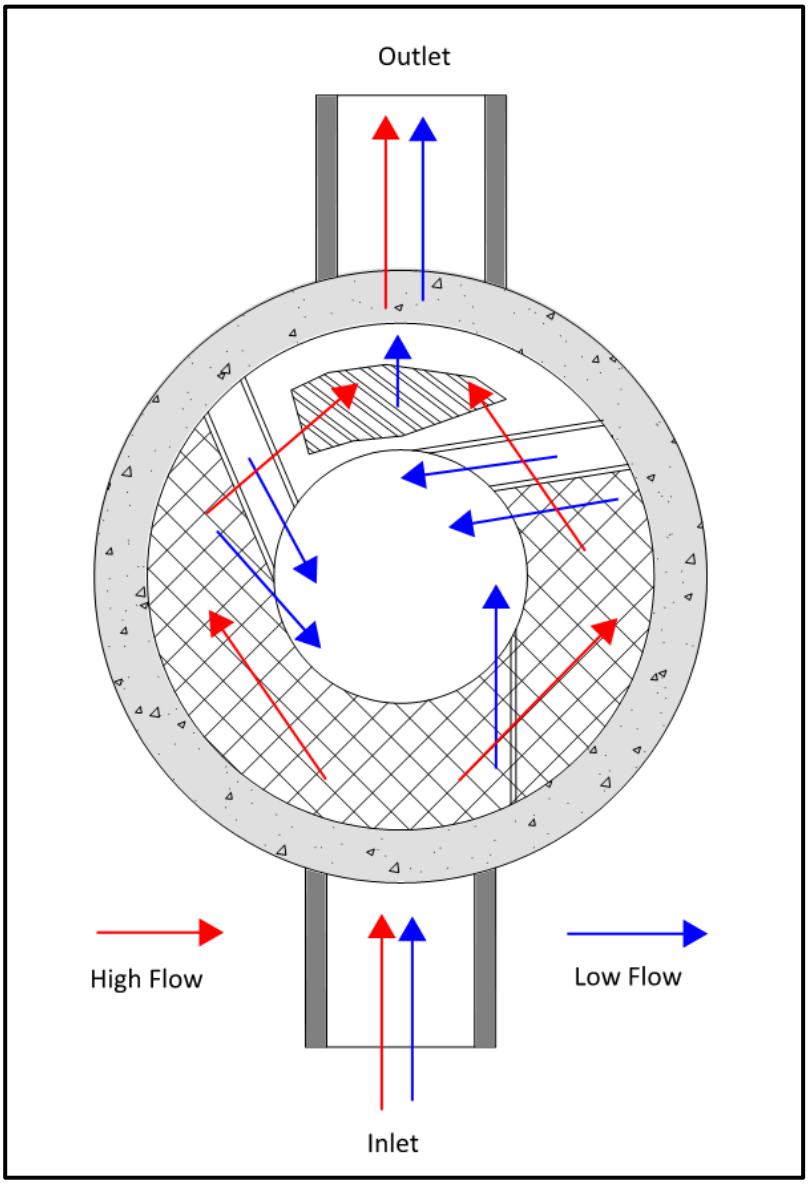


Figure 1. Hydroworks HydroStorm Operation – Plan View

Figure 2 is a profile view of the HydroStorm separator showing the flow patterns for low and high flows.

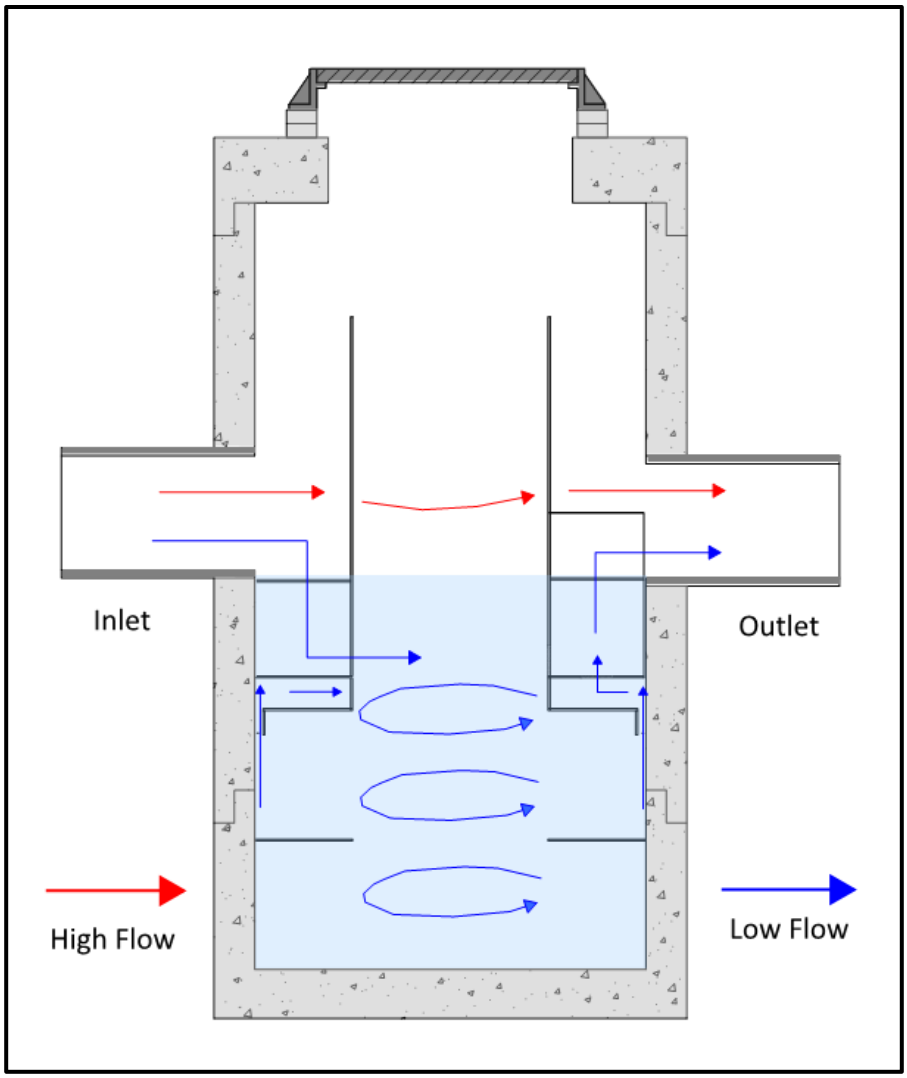


Figure 2. Hydroworks HydroStorm Operation – Profile View

The HS 4i is an inlet version of the HS 4 separator. There is a catch-basin grate on top of the HS 4i. A funnel sits sits underneath the grate on the frame and directs the water to the inlet side of the separator to ensure all lows flows are properly treated. The whole funnel is removed for inspection and cleaning.

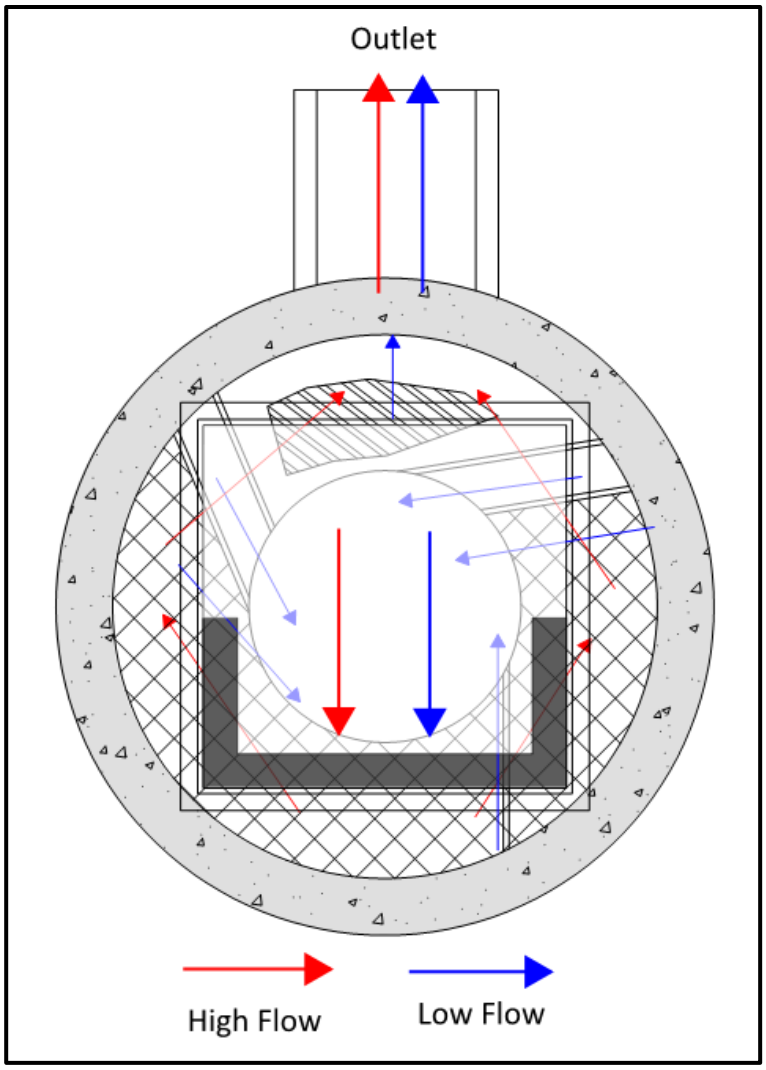


Figure 3. Hydroworks HS 4i Funnel

Inspection

Procedure

Floatables

A visual inspection can be conducted for floatables by removing the covers and looking down into the center access tube of the separator. Separators with an inlet grate (HS 4i or custom separator) will have a plastic funnel located under the grate that must be removed from the frame prior to inspection or maintenance. If you are missing a funnel please contact Hydroworks at the numbers provided at the end of this document.

Hydroworks

TSS/Sediment

Inspection for TSS build-up can be conducted using a Sludge Judge®, Core Pro®, AccuSludge® or equivalent sampling device that allows the measurement of the depth of TSS/sediment in the unit. These devices typically have a ball valve at the bottom of the tube that allows water and TSS to flow into the tube when lowering the tube into the unit. Once the unit touches the bottom of the device, it is quickly pulled upward such that the water and TSS in the tube forces the ball valve closed allowing the user to see a full core of water/TSS in the unit. The unit should be inspected for TSS through each of the access covers. Several readings (2 or 3) should be made at each access cover to ensure that an accurate TSS depth measurement is recorded.

Frequency

Construction Period

The HydroStorm separator should be inspected every four weeks and after every large storm (over 0.5" (12.5 mm) of rain) during the construction period.

Post-Construction Period

The Hydroworks HydroStorm separator should be inspected during the first year of operation for normal stabilized sites (grassed or paved areas). If the unit is subject to oil spills or runoff from unstabilized (storage piles, exposed soils) areas the HydroStorm separator should be inspected more frequently (4 times per year). The initial annual inspection will indicate the required future frequency of inspection and maintenance if the unit was maintained after the construction period.

Reporting

Reports should be prepared as part of each inspection and include the following information:

1. Date of inspection
2. GPS coordinates of Hydroworks unit
3. Time since last rainfall
4. Date of last inspection
5. Installation deficiencies (missing parts, incorrect installation of parts)
6. Structural deficiencies (concrete cracks, broken parts)
7. Operational deficiencies (leaks, blockages)
8. Presence of oil sheen or depth of oil layer
9. Estimate of depth/volume of floatables (trash, leaves) captured
10. Sediment depth measured
11. Recommendations for any repairs and/or maintenance for the unit
12. Estimation of time before maintenance is required if not required at time of inspection

A sample inspection checklist is provided at the end of this manual.

Maintenance

Procedure

The Hydroworks HydroStorm unit is typically maintained using a vacuum truck. There are numerous companies that can maintain the HydroStorm separator. Maintenance with a vacuum truck involves removing all of the water and sediment together. The water is then separated from the sediment on the truck or at the disposal facility.

A central access opening (24” or greater) is provided to the gain access to the lower treatment tank of the unit. This is the primary location to maintain by vacuum truck. The pretreatment area can also be vacuumed and/or flushed into the lower treatment tank of the separator for cleaning via the central access once the water level is lowered below the pretreatment floor.

In instances where a vacuum truck is not available other maintenance methods (i.e. clamshell bucket) can be used, but they will be less effective. If a clamshell bucket is used the water must be decanted prior to cleaning since the sediment is under water and typically fine in nature. Disposal of the water will depend on local requirements. Disposal options for the decanted water may include:

1. Discharge into a nearby sanitary sewer manhole
2. Discharge into a nearby LID practice (grassed swale, bioretention)
3. Discharge through a filter bag into a downstream storm drain connection

The local municipality should be consulted for the allowable disposal options for both water and sediments prior to any maintenance operation. Once the water is decanted the sediment can be removed with the clamshell bucket.

Disposal of the contents of the separator depend on local requirements. Maintenance of a Hydroworks HydroStorm unit will typically take 1 to 2 hours based on a vacuum truck and longer for other cleaning methods (i.e. clamshell bucket).

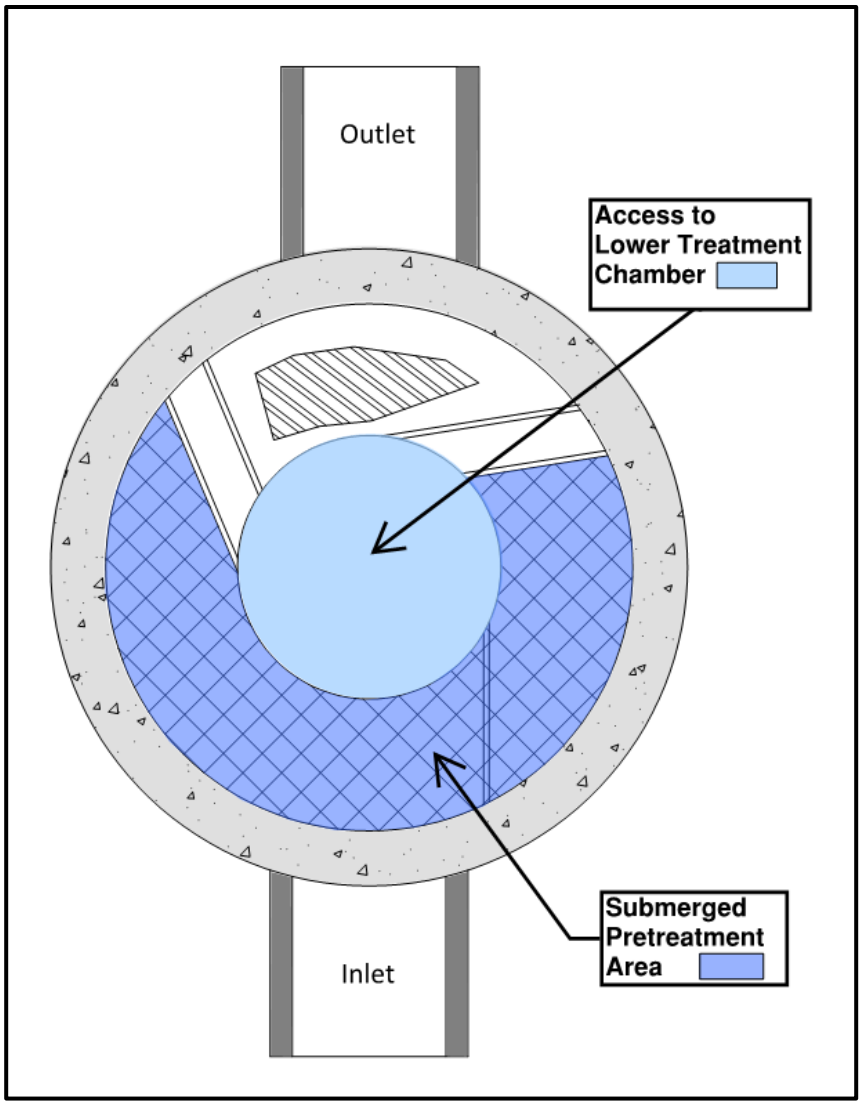


Figure 3. Maintenance Access

Frequency

Construction Period

A HydroStorm separator can fill with construction sediment quickly during the construction period. The HydroStorm must be maintained during the construction period when the depth of TSS/sediment reaches 24” (600 mm). It must also be maintained during the construction period if there is an appreciable depth of oil in the unit (more than a sheen) or if floatables other than oil cover over 50% of the area of the separator

The HydroStorm separator should be maintained at the end of the construction period, prior to operation for the post-construction period.

Post-Construction Period

The HydroStorm was independently tested by Alden Research Laboratory in 2017. A HydroStorm HS 4 was tested for scour with a 50% sediment depth of 0.5 ft. Therefore, maintenance for sediment accumulation is required if the depth of sediment is 1 ft or greater in separators with standard water (sump) depths (Table 1).

There will be designs with increased sediment storage based on specifications or site-specific criteria. A measurement of the total water depth in the separator through the central access tube should be taken and compared to water depth given in Table 1. The standard water depth from Table 1 should be subtracted from the measured water depth and the resulting extra depth should be added to the 1 ft to determine the site-specific sediment maintenance depth for that separator.

For example, if the measured water depth in the HS-7 is 7 feet, then the sediment maintenance depth for that HS-7 is 2 ft (= 1 + 7 – 6) and the separator does not need to be cleaned for sediment accumulation until the measure sediment depth is 2 ft.

The HydroStorm separator must also be maintained if there is an appreciable depth of oil in the unit (more than a sheen) or if floatables other than oil cover over 50% of the water surface of the separator.

Table 1 Standard Dimensions for Hydroworks HydroStorm Models

Model	Diameter (ft)	Total Water Depth (ft)	Sediment Maintenance Depth for Table 1 Total Water Depth(ft)
HS-3	3	3	1
HS-4	4	4	1
HS-5	5	4	1
HS-6	6	4	1
HS-7	7	6	1
HS-8	8	7	1
HS-9	9	7.5	1
HS-10	10	8	1
HS-11	11	9	1
HS-12	12	9.5	1

HYDROSTORM INSPECTION SHEET

Date _____
Date of Last Inspection _____

Site _____
City _____
State _____
Owner _____

GPS Coordinates _____

Date of last rainfall _____

Site Characteristics	**Yes**	**No**
Soil erosion evident	☐	☐
Exposed material storage on site	☐	☐
Large exposure to leaf litter (lots of trees)	☐	☐
High traffic (vehicle) area	☐	☐

HydroStorm	**Yes**	**No**
Obstructions in the inlet or outlet	☐ *	☐
Missing internal components	☐ **	☐
Improperly installed inlet or outlet pipes	☐ ***	☐
Internal component damage (cracked, broken, loose pieces)	☐ **	☐
Floating debris in the separator (oil, leaves, trash)	☐	☐
Large debris visible in the separator	☐ *	☐
Concrete cracks/deficiencies	☐ ***	☐
Exposed rebar	☐ **	☐
Water seepage (water level not at outlet pipe invert)	☐ ***	☐

Water level depth below outlet pipe invert _____“

Routine Measurements

Floating debris depth	**< 0.5” (13mm)**	☐	**>0.5” 13mm)**	☐ *
Floating debris coverage	**< 50% of surface area**	☐	**> 50% surface area**	☐ *
Sludge depth	**< 12” (300mm)**	☐	**> 12” (300mm)**	☐ ****

* Maintenance required
** Repairs required
*** Further investigation is required

Hydroworks

Other Comments:

Hydroworks

Hydroworks® HydroStorm

One Year Limited Warranty

Hydroworks, LLC warrants, to the purchaser and subsequent owner(s) during the warranty period subject to the terms and conditions hereof, the Hydroworks HydroStorm to be free from defects in material and workmanship under normal use and service, when properly installed, used, inspected and maintained in accordance with Hydroworks written instructions, for the period of the warranty. The standard warranty period is 1 year.

The warranty period begins once the separator has been manufactured and is available for delivery. Any components determined to be defective, either by failure or by inspection, in material and workmanship will be repaired, replaced or remanufactured at Hydroworks' option provided, however, that by doing so Hydroworks, LLC will not be obligated to replace an entire insert or concrete section, or the complete unit. This warranty does not cover shipping charges, damages, labor, any costs incurred to obtain access to the unit, any costs to repair/replace any surface treatment/cover after repair/replacement, or other charges that may occur due to product failure, repair or replacement.

This warranty does not apply to any material that has been disassembled or modified without prior approval of Hydroworks, LLC, that has been subjected to misuse, misapplication, neglect, alteration, accident or act of God, or that has not been installed, inspected, operated or maintained in accordance with Hydroworks, LLC instructions and is in lieu of all other warranties expressed or implied. Hydroworks, LLC does not authorize any representative or other person to expand or otherwise modify this limited warranty.

The owner shall provide Hydroworks, LLC with written notice of any alleged defect in material or workmanship including a detailed description of the alleged defect upon discovery of the defect. Hydroworks, LLC should be contacted at 136 Central Ave., Clark, NJ 07066 or any other address as supplied by Hydroworks, LLC. (888-290-7900).

This limited warranty is exclusive. There are no other warranties, express or implied, or merchantability or fitness for a particular purpose and none shall be created whether under the uniform commercial code, custom or usage in the industry or the course of dealings between the parties. Hydroworks, LLC will replace any goods that are defective under this warranty as the sole and exclusive remedy for breach of this warranty.

Subject to the foregoing, all conditions, warranties, terms, undertakings or liabilities (including liability as to negligence), expressed or implied, and howsoever arising, as to the condition, suitability, fitness, safety, or title to the Hydroworks HydroStorm are hereby negated and excluded and Hydroworks, LLC gives and makes no such representation, warranty or undertaking except as expressly set forth herein. Under no circumstances shall Hydroworks, LLC be liable to the Purchaser or to any third party for product liability claims; claims arising from the design, shipment, or installation of the HydroStorm, or the cost of other goods or services related to the purchase and installation of the HydroStorm. For this Limited Warranty to apply, the HydroStorm must be installed in accordance with all site conditions required by state and local codes; all other applicable laws; and Hydroworks' written installation instructions.

Hydroworks, LLC expressly disclaims liability for special, consequential or incidental damages (even if it has been advised of the possibility of the same) or breach of expressed or implied warranty. Hydroworks, LLC shall not be liable for penalties or liquidated damages, including loss of production and profits; labor and materials; overhead costs; or other loss or expense incurred by the purchaser or any third party. Specifically excluded from limited warranty coverage are damages to the HydroStorm arising from ordinary wear and tear; alteration, accident, misuse, abuse or neglect; improper maintenance, failure of the product due to improper installation of the concrete sections or improper sizing; or any other event not caused by Hydroworks, LLC. This limited warranty represents Hydroworks' sole liability to the purchaser for claims related to the HydroStorm, whether the claim is based upon contract, tort, or other legal basis.

Average Annual Sediment Removal Rates (%) using a CB Shield (based on ETV Sediment - 1 to 1000 micron Particle Size Distribution)

Area to CB (ha)	Imperviousness[1] (%)					
	20%	35%	50%	65%	80%	100%
0.02	57%	57%	57%	57%	56%	56%
0.05	56%	56%	56%	55%	55%	54%
0.10	56%	55%	54%	53%	52%	51%
0.20	54%	53%	51%	49%	48%	46%
0.30	53%	50%	48%	46%	45%	43%
0.40	51%	48%	46%	44%	42%	40%
0.50	50%	47%	44%	42%	40%	38%
0.60	49%	45%	43%	40%	39%	36%

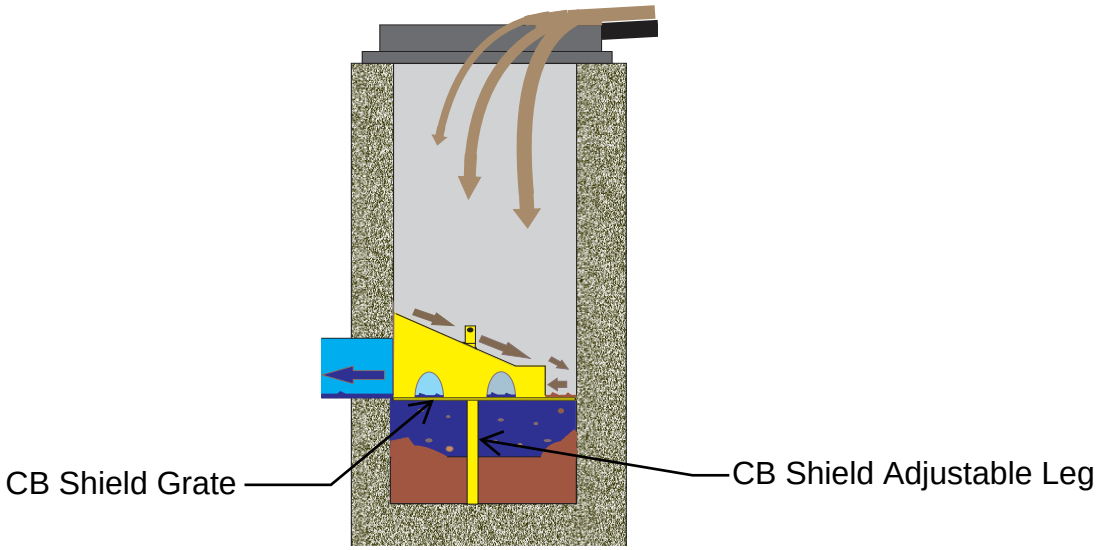
Notes:

1. Runoff Coefficient 'C' is approximately equal to 0.05 + 0.9*Impervious Fraction.
2. Above chart is based on long term continuous hydrologic analysis of Toronto, Ontario (Bloor St) rainfall data.
3. Assumes 0.6 m sump in CB and that maintenance is performed (i.e. CB cleaning) when required by sediment/pollutant build-up or otherwise.
4. See accompanying chart for suggested maintenance scheduling - AND - get CB Shield Inc. to monitor it for you in field.
5. Sediment/Pollutant removal rates based on third party certified laboratory testing using ETV sediment (PSD analysis available on request).
6. See additional discussion regarding scour protection from CB Shield during more infrequent runoff events.

CB Shield Operations Manual

Installing CB Shield

It is important the catch basin frame and cover is aligned properly with the catch basin below
If it is misaligned it may be difficult to install the CB Shield insert
Determine the depth of the sump (i.e. the distance from the invert of the outlet pipe to the bottom of the catch basin). If the catch basin is in service the sump depth will be the depth of the water. The grate section of the CB Shield insert should be the same elevation as the water depth in the sump.



Adjust the leg of the CB Shield to achieve the appropriate elevation
The CB Shield is lowered into place with the rope attached to the top of the leg. The high side of the sloped plate should face the wall with the outlet pipe. (The incoming water should be directed to the wall furthest from the outlet)
The flexible plastic skirt around the outer edges of the CB Shield insert may interfere with some misaligned frame and grates. If so a slice can be cut into the skirt with a utility knife at the point of interference.
Make sure the grate is at the desired level or remove CB Shield and re-adjust the leg length.

Inspecting a CB Shield Enhanced Catch Basin

Open grate
A lifting rope is attached to the top of the centered leg of the CB Shield insert. Lift and remove the insert.
Inspect CB Shield for any possible damage. Quite often leaves will accumulate on the grate. This can actually improve the Shield's ability to capture sediment and assist in preventing leave litter from being washed down stream.
Use a Sludge Judge to measure the sediment depth in 4 - 6 locations of the sump.
If the sediment depth is 300mm – 600mm deep it is recommended that the unit be cleaned.

Cleaning a CB Shield Enhanced Catch Basin

Open grate and remove CB Shield with lift rope.
Clean catch basin as usual with a Vacuum truck.
Clean CB Shield (if needed) and re-install into catch basin.
If there is any significant damage to a CB Shield please send a picture and its location to CB Shield Inc. (info@cbshield.com).

APPENDIX C
FIRE FLOW ANALYSIS INFORMATION

FIRE FLOW DEMAND REQUIREMENTS - FIRE UNDERWRITERS SURVEY (FUS GUIDELINES)

Project Number: **20052A**
Project Name: **130 Cornwall Road**
Date: **June 06/22**

Fire flow demands for the FUS method is based on information and guidance provided in "Water Supply for Public Protection" (Fire Underwriters Survey, 1999).

An estimate of the fire flow required is given by the following formula:

$$F = 220\,C\sqrt{A} \qquad \textbf{(1)}$$

where:

F = the required fire flow in litres per minute
C = coefficient related to the type of construction
= 1.5 for wood frame construction (structure essentially all combustible).
= 1.0 for ordinary construction (brick or other masonry walls, combustible floor and interior)
= 0.8 for non-combustible construction (unprotected metal structural components, masonry or metal walls)
= 0.6 for fire-resistive construction (fully protected frame, floors, roof)
A = Total floor area in square metres

	Building Area				(1)		(2)			(3)		(4)		Final Adjusted Fire Flow	
Building / Location	Footprint Area (m^2)	# of Storeys	**Total GFA (m^2)**	Type of Construction	***Fire Flow "F"*** (l/min)	(l/s)	***Occupancy*** %	Adjustment (l/min)	**Adjusted Fire Flow (l/min)**	***Sprinkler*** %	Adjustment (l/min)	***Exposure*** %	Adjustment (l/min)	**(l/min)**	**(l/s)**
Residential Building	**335**	**5**	**1675**	**0.8**	7000	116.7	**-15**	-1050.0	**5950.0**	**0**	0.0	0	0.0	**6000**	**100**

(2) Occupancy

Non-Combustible	-25%
Limited Combustible	-15%
Combustible	No charge
Free Burning	15%
Rapid Burning	25%

Note: Building Area includes all 10 storeys

(3) Sprinkler

Minimum credit for systems designed to NFPA 13 is 30%.

If the domestic and fire services are supplied by the same municipal water system, then take an additional 10%.

If the sprinkler system is fully supervised (ie. annunciator panel that alerts the Fire Dept., such as a school), then an additional 10% can be taken. Maximum credit = 50%.

(4) Exposure

0 to 3m	25%	
3.1 to 10m	20%	Calculate for all
10.1 to 20m	15%	sides. Maximum
20.1 to 30m	10%	charge shall not
30.1 to 45m	5%	exceed 75%

Side	Exposure (m)	Charge (%)
North =	**>45**	**0**
South =	**>45**	**0**
East =	**>45**	**0**
West =	**>45**	**0**
Total Expoure =		***0***