S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

Functional Servicing & Stormwater Management Report

150 Mohawk Road East

CITY OF HAMILTON

Effort Trust

Revised: May 2023
July 2022

SLA File: 22025

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1.0 INTRODUCTION AND BACKGROUND

1.1 OVERVIEW

S. Llewellyn & Associates Limited was retained by Effort Trust to provide Consulting Engineering services for the proposed development at 150 Mohawk Road East in the City of Hamilton (see Figure 1.0 for location plan). The west side of property currently consists of landscaped areas, an outdoor swimming pool, and parking structure; The east side of the property consists of a 12-storey residential building, and asphalt and landscaped areas. The east side of the property is to remain in the existing condition and the west side of the property is to be redeveloped. The property is bound by Mohawk Road to the north, existing residential areas to the south and east, and Upper Wellington Street to the east.

The proposed development consists of a residential building with 161 units, surface level asphalt parking, underground parking, as well as concrete pathways and landscaped areas. There is an existing underground parking garage that is proposed to be demolished.

This Functional Servicing and Stormwater Management Report will provide information on the proposed servicing and grading scheme for the development. Please refer to the Preliminary Engineering plans and Site Plan prepared by S. Llewellyn & Associates Limited and KNYMH Inc. for additional information.

1.2 BACKGROUND INFORMATION

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

Ref. 1: *Comprehensive Development Guidelines and Financial Policies Manual*, City of Hamilton (2019).

Ref. 2: MOE Stormwater Management Practices Planning and Design Manual (Ministry of Environment, March 2003)

Ref. 3: Engineering Guidelines for Servicing Land under Development Applications (City of Hamilton, December 2012)

Ref. 4: City of Hamilton Criteria and Guidelines for Stormwater Management Infrastructure (September 2007)

Ref. 5: City of Hamilton Storm Drainage Policy (2004)

Ref. 6: Erosion & Sediment Control Guidelines for Urban Construction (December 2006)

Figure 1.0 – Location Plan

2.0 STORMWATER MANAGEMENT

The following stormwater management (SWM) criteria will be applied to the site, in accordance with the City of Hamilton requirements:

Quantity Control

The Stormwater discharge rate from the 100-year event from the proposed site shall be controlled to the discharge rate of the 2-year storm in the existing condition.

Quality Control

The stormwater runoff from the proposed condition 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 City of Hamilton.

2.1 EXISTING CONDITIONS

Under existing conditions, the property consists of a 12-storey apartment building, parking structure, asphalt parking lot, concrete pathways, and landscaped areas. The site is bound by Mohawk Road East to the north, Upper Wellington Street to the east, and existing residential lands to the south and west.

In the existing conditions there is an existing 600mmø storm sewer and a 375mmø combined sewer located north of the site flowing west along Mohawk Road East, as well as an existing 300mmø storm sewer flowing south along Upper Wellington Street.

Four catchment areas, Catchment 101, 101-A, 102, and 103, have been identified in the existing condition. Catchment 101 represents discharge from the site to the existing 375mmø combined sewer on Mohawk Road East via the existing catch basins and storm sewers on site. Catchment 101-A represents discharge from the site to the existing 375mmø combined sewer on Mohawk Road East that is within the development area, however, will remain unchanged in the post development condition. Discharge directed to Mohawk Road East from the subject site is located within a catchment area with a runoff coefficient of 0.60. Catchment 102 represents uncontrolled discharge from the site to Upper Wellington Street. Catchment 103 represents uncontrolled discharge from the site to existing residential lands south of the subject site. See Table 2.1 below and the Existing Condition Drainage Area Plan in Appendix A for details.

Table 2.1 – Existing Conditions Catchment Areas

Catchment ID	Description	Area (ha)	Percent Impervious	Run-off Coefficient
101	To Mohawk Road East	0.68	61%	0.60
101-A	To Mohawk Road East	0.11	87%	0.81
102	To Upper Wellington Street	0.05	0%	0.25
103	To South Existing Residential Lands	0.04	0%	0.25

The allowable discharge from the site was calculated using the Rational Method based on the above runoff coefficient (C) and the City of Hamilton storm intensities at a time of concentration of 10 minutes (Tc=10min). An example of the 2-year calculation for Catchment 101 is shown below and a summary can be found in Table 2.2.

$Q_{2\text{-yr (Catchment 101)}}$ = 2.78CiA=2.78(0.60)(74.10mm/hr)(1.16ha)
= ***54.3 l/s (0.0543 m^3/s)***

Table 2.2 – Allowable Stormwater Discharge

Storm Event	Catchment 101 Discharge (m^3/s)
2-Yr Event	**0.0840**
5-Yr Event	0.1168
10-Yr Event	0.1386
25-Yr Event	0.1656
50-Yr Event	0.1866
100-Yr Event	0.2061

2.2 PROPOSED CONDITIONS

Under proposed conditions, the development is comprised of an 11-storey residential building, underground parking, surface parking, and podium parking level while maintaining the existing residential building and infrastructure on the east side of the site. The development includes asphalt parking/roadways, concrete curbing, sidewalk and landscaped areas.

It is proposed to service the site with a private storm sewer system, designed and constructed in accordance with the City of Hamilton standards.

Four catchment areas, Catchment 201, 202, 203, and 204, have been identified in the proposed conditions. Catchment 201 represents the controlled discharge from the proposed development directed to the existing 600mmø storm sewer located on Mohawk Road East via the proposed private 300mmø storm service. Catchment 202 represents uncontrolled drainage from the proposed development direct to existing catchbasins within the Mohawk Road East right-of-way. Catchment 203 represents the uncontrolled discharge from the proposed development directed to the existing residential lands south of the subject site. Catchment 204 represents the uncontrolled discharge from the proposed development captured by proposed and existing catchbasins and directed to the existing 600mmø storm sewer located on Mohawk Road East via the proposed private 300mmø storm sewer. See Table 2.3 and the Post-Development Storm Drainage Area Plan in Appendix A for details.

Table 2.3 – Proposed Condition Catchment Areas

Catchment ID	Description	Area (ha)	% Impervious	Runoff Coeff. (C)
201	Controlled to Mohawk Road East	0.66	87%	0.87
202	Uncontrolled to Mohawk Road East	0.03	14%	0.34
203	Uncontrolled to South Existing Residential Lands	0.04	0%	0.25
204	Uncontrolled to Mohawk Road East via existing infrastructure	0.11	89%	0.83

2.3 WATER QUANTITY CONTROL

It is proposed to apply quantity control measures to the runoff from Catchment 201 by means of a 155mmø orifice plate at the south invert of MH2 to restrict the discharge from the site to the discharge of the 2-year storm event. Discharge from Catchment 204 will not be controlled since there only is an increase of 2% in imperviousness over a 1100.0m^2 area from Catchment 101-A, therefore, the additional flows to the existing storm sewer from Catchment 204 are considered negligible.

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 a cast-in-place stormwater storage tank within the underground parking garage.

Details of the proposed storage can be found on the Site Servicing Plan. The stage-storage-discharge characteristics can be seen in Table 2.4 and Appendix A for details.

Table 2.4 – Proposed Condition Stage-Storage-Discharge (Catchment 201)			
Elevation (m)	Total Storage (m^3)	Active Storage (m^3)	Discharge (m^3/s)
205.95 (Bottom of Tank)	0	0	0.0000
206.00 (Outlet Pipe Invert)	5	0	0.0000
206.45 (0.50m Deep)	48	43	0.0334
206.95 (1.0m Deep)	96	91	0.0487
207.45 (1.50m Deep)	144	139	0.0602
207.95 (2.0m Deep)	192	187	0.0699
208.45 (Top of Tank)	240	235	0.0784

The maximum discharge rates were calculated using the Rational Method based on the proposed condition runoff coefficients for the 2-year to 100-year storm events. Additionally, the 2-year to 100-year storage volumes for Catchment 201 were calculated using the Modified Rational Method (MRM). 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 (To Mohawk Road East)					
Storm Event	Catchment 201 Discharge (m^3/s) (Controlled Mohawk Road E)*	Catchment 202 Discharge (m^3/s) (Uncontrolled to Mohawk Road E)	Total Discharge to Mohawk Road E	Catchment 101 Allowable Discharge (m^3/s)	Storage (m^3)
2-Year	<0.0758	0.0021	<0.0779	0.0840	29.0
5-Year	<0.0758	0.0029	<0.0787		72.0
10-Year	<0.0758	0.0035	<0.0973		105.0
25-Year	<0.0758	0.0041	<0.0799		149.0
50-Year	<0.0758	0.0047	<0.0805		182.0
100-Year	0.0758	0.0052	0.0810		220.0

The 100-year discharge from Catchment 201 was used to determine the required storage in the 100-yr event and estimate the required storage in all lesser storm events. Since all lesser storm events would produce a lesser discharge and required storage than estimated in Table 2.5, the proposed 235.0m^3 stormwater tank will provide adequate stormwater storage for all storm events.

This analysis determined the following:

- The proposed conditions discharge rate will not exceed the allowable pre-development discharge rate (0.0840 m^3/s) for all storm events up to and including the 100-year event for flows directed to Mohawk Road East, with the installation of a 155mmø orifice plate on the south invert of MH2.

- The proposed development will require 220.0 m^3 of stormwater storage during the 100-year event, which can be accommodated with the proposed cast-in-place stormwater storage tank, having an active storage volume 235.0m^3.

2.4 WATER QUALITY CONTROL

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

The proposed development is required to achieve an “Enhanced” (80% TSS removal) level of water quality protection. To achieve this criteria, discharge from Catchment 201 and 204 will be subject to a treatment train that consists of ADS Flexstorm Pure Permanent Inlet Filters, CB Sheilds, and a HydroStorm oil/grit separator before ultimately discharging to the existing storm sewer system along Mohawk Road East.

ADS Flexstorm Pure Permanent Inlet Filters have been proposed within the proposed area drains in the asphalt parking lot. The installation of the ADS Flexstorm Pure Permanent Inlet Filters will contribute to the removal of TSS and the capture of floatables within the catchbasins. The units also provide scour protection and reduce the resuspension of solids during heavy rain events which would otherwise enter the storm system. The technical information regarding the ADS Flexstorm Pure Permanent Inlet Filters can be found in Appendix B.

CB Shields have been proposed within the proposed catch basins in the asphalt parking lot. It was determined that the CB Shields will provide an average of 52% TSS removal of the ETV particle size distribution. See CB Shield design sheets in Appendix B for sizing information.

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 HS10 will provide 84% TSS removal and 99% average annual runoff treatment. See HydroStorm unit sizing procedures in Appendix B for details.

With the combination of the proposed HydroStorm Unit and the ADS Flexstorm Pure Permanent Inlet Filters, the requirements for an “Enhanced” level of quality control for the site will be satisfied.

HydroStorm units and ADS Inlet Filters require regular inspection and maintenance as per the manufacture’s specifications to ensure the unit operates properly. See the Maintenance Manuals in Appendix B for details.

2.5 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 proposed catchbasins as well as the nearby existing catchbasins to ensure that no untreated runoff enters the existing conveyance system;
- Stabilize all disturbed or landscaped areas with hydro seeding/sodding to minimize the opportunity for erosion.

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, vegetation, etc.) with follow up reports to the governing municipality; and
- The developer and/or their 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

In the existing condition there is an existing 375mmø combined sewer flowing west along Mohawk Road East and an existing 250mmø sanitary sewer flowing south along Upper Wellington Street.

3.2 SANITARY DEMAND

The proposed development consists of constructing a 11-storey residential building, resulting in a total of 161 residential units.

Table 3.1 summarizes the sanitary sewer discharge rates for the residential development. Wastewater generation for the site was calculated based on Table 8.2.1.3.A – Residential Occupancies of the 2020 Ontario Plumbing Code.

Table 3.1 – Proposed Sanitary Sewer Discharge	
Occupancy Type:	
One-bedroom dwelling	750 l/day x 120 units **= 90,000 l/day**
Two-bedroom dwelling	1100 l/day x 41 units **= 45,100 l/day**
Waste Generated (l/day):	**135,100**
Total Wastewater Estimate (l/s):	**1.56**

Based on the above, the estimate of sanitary demand for the residential development is:
1.56 L/s

3.3 PROPOSED SANITARY SERVICING AND CAPACITY ANALYSIS

The proposed residential site will be serviced by a 250mmø sanitary sewer, designed and constructed in accordance with the City of Hamilton standards. Drainage from this sewer will discharge to the existing 375mmø combined sewer located on Mohawk Road East.

The minimum grade of the proposed 250mmø sanitary sewer will be 2.0%. At this minimum grade, the proposed sanitary sewer will have a capacity of 0.084 m^3/s (84 l/s). Therefore, the proposed 250mmø sanitary sewer at 2.0% grade is adequately sized to service the proposed development.

4.0 DOMESTIC AND FIRE WATER SUPPLY SERVICING

4.1 EXISTING CONDITIONS

The existing municipal water distribution system consists of a 300mmø watermain located north of the site on Mohawk Road East and a 300mmø watermain located east of the site on Upper Wellington Street. The watermains intersect at the junction of Upper Wellington Street and Mohawk Road East. There are two existing municipal fire hydrants near the site, one located on Mohawk Road East and the other on Upper Wellington Street.

4.2 DOMESTIC WATER DEMAND

The following is an estimate of the water usage for the proposed development. Water usage for the site was calculated based on the “Fixture Unit Method” as per Table 7.6.3.2.A. forming part of sentences 7.6.3.1(1) to (3) and 7.6.3.4.(2), (3) and (5) of the 2020 Ontario Building Code. See Table 4.1 and Table 4.2 for fixture unit (FU) calculations. Fixture unit calculations will be confirmed upon completion of the Water Usage Assessment, which will be prepared as part of the Site Plan Approval process.

Table 4.1 - Fixture Unit Calculations			
Component	FU/ Fixture	No. of Units	Total FU
Dishwasher, domestic	1.4	161	225.4
Lavatory (8.3L/min or less) (Private)	0.7		112.7
Sink, kitchen, domestic (8.3L/min or less) (Private)	1.0		161.0
Water Closet (6 LPF or less with flush tank) (Private)	2.2		354.2
Shower head, 9.5 L/min or less per head	1.4		225.4
Clothes Washer (3.5kg)	1.4		225.4
		Total FU:	**1,304.1**

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 = 1,304.1 FU

Water Usage: 211 IGPM (15.98 L/s)

4.3 FIRE FLOW DEMAND

Fire flow demands for development are governed by a number of guidelines and criteria, such as the Ontario Building Code (OBC), various codes and standards published by the National Fire Protection Association (NFPA) and most recently, the Target Available Fire Flows provided by the City of Hamilton.

The proposed development consists of constructing an 11-storey residential building, resulting in a total of 161 residential units. Existing hydrants within proximity of the site are located on Mohawk Road East and Upper Wellington Street. No additional hydrants will be proposed for this development.

The fire flow for this building was determined to be the greater of the OBC fire flow calculation (OBC section A-3.2.5.7) or the City of Hamilton Target Available Fire Flow. The result of the OBC fire flow calculation was a minimum flow rate of 9000 L/min (150 L/sec) (see attached OBC fire flow calculation sheet). This is less than the City of Hamilton target available fire flow of 150 l/s for Residential use with more than 3 units see City of Hamilton Target Flows (Policy PW19096) attached. Therefore, the minimum required fire flow for this site is **150 l/sec**. See Appendix C for fire flow calculations.

The following hydrant flow test data for the public fire hydrants in closest proximity to the proposed development has been analyzed to determine if the municipal system adjacent to the subject site is adequate to provide the required fire flow, with a minimum pressure of 20 psi. Table 4.2 and 4.3 summarize the hydrant flow data made available by the City of Hamilton database and Vipond Inc, respectively:

Table 4.2 – Hydrant Flow Data (City of Hamilton)	
Hydrant ID	**HC29H001**
Location	147 Mohawk Road E
Test Date	9/19/17 8:22:26 PM
Static Pressure	88 psi
Residual Pressure During Test Flow	86 psi
Test Flow Rate	1310 IGPM (99.26 l/s)
Theoretical Flow @ 20 psi	**8796 IGPM (666.46 l/s)**

Table 4.3 – Hydrant Flow Data (Vipond Inc.)	
Hydrant ID	**HC35H005**
Location	Upper Wellington Street
Test Date	May 9, 2023 1:00PM
Static Pressure	92 psi
Residual Pressure During Test No. 1	87 psi
Residual Pressure During Test No. 2	82 psi
Test Flow Rate During Test No. 1	1460 USGPM (92.11 l/s)
Test Flow Rate During Test No. 2	2470 USGPM (155.83 l/s)
Theoretical Flow @ 20 psi	**7200 IGPM (454.2 l/s)**

Based on the above hydrant flow test data, the theoretical maximum available flow rate is **454.2 l/s**, while the maximum required fire flow for the proposed development is only **150 l/s**.

Therefore, based on the above analysis, the third party conducted hydrant flow test confirms that the existing municipal water distribution system will have the capacity and pressure required to adequately service the subject land.

4.4 PROPOSED WATER SERVICING AND ANALYSIS

Proposed water servicing for the site consists of connecting a 150mmø water service from the existing 300mmø watermain located on Mohawk Road East. The proposed 150mmø water service will provide domestic and fire water service for the proposed residential development. Water services for the site are to be designed and constructed in accordance with City of Hamilton standards.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the information provided herein, it is concluded that the proposed development at 150 Mohawk Road East can be constructed to meet the requirements of the City of Hamilton. Therefore, it is recommended that:

- The development be graded and serviced in accordance with the Preliminary Grading & Servicing Plans prepared by S. Llewellyn & Associates Limited;
- A 155mmø orifice plate be installed as per the Preliminary Site Servicing Plan and this report to provide adequate quantity control;
- An cast-in-place 240m^3 stormwater storage tank be installed as per the Preliminary Site Servicing Plan to provide stormwater storage;
- A HydroStorm HS10 oil/grit separator, CB Shields, and ADS Flexstorm Pure Permanent Inlet Filters be installed as per the Preliminary Site Servicing Plan and this report to provide efficient stormwater quality control;
- Erosion and sediment controls be installed as described in this report to meet City of Hamilton requirements;

We trust the information enclosed herein is satisfactory. Should you have any questions please 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

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MOHAWK ROAD EAST

UPPER WELLINGTON STREET

101
0.68
61
0.60

101-A
0.11
87
0.81

102
0.05
100
0.25

103
0.04
100
0.25

LEGEND:

- CATCHMENT AREA BOUNDARY
- 101 / 0.018 / 100 / 0.90 — DRAINAGE AREA ID, DRAINAGE AREA (ha), PERCENT IMPERVIOUS, RUNOFF COEFFICIENT
- EXISTING DIRECTION OF DRAINAGE

FIGURE 1.0
PRE-DEVELOPMENT STORM DRAINAGE AREA PLAN

SCALE: 1:600

PROJECT: 150 MOHAWK ROAD EAST
PROJECT No.: 22025

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MOHAWK ROAD EAST

UPPER WELLINGTON STREET

202
0.03
14
0.34

201
0.66
87
0.83

204
0.11
89
0.83

203
0.04
100
0.25

LEGEND:

CATCHMENT AREA BOUNDARY

101
0.04
25
0.41

DRAINAGE AREA ID
DRAINAGE AREA (ha)
PERCENT IMPERVIOUS
RUNOFF COEFFICIENT

FIGURE 2.0
POST-DEVELOPMENT STORM DRAINAGE AREA PLAN

SCALE: 1:600

PROJECT: 150 MOHAWK ROAD E
PROJECT No.: 22025

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STAGE-STORAGE-DISCHARGE CALCULATIONS

Catchment 201

Outlet Device No. 1 (Quantity)

Type:	Orifice Plate
Diameter (mm)	**155**
Area (m^2)	0.01887
Invert Elev. (m)	205.93
C/L Elev. (m)	206.01
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	205.93	0	0	0.0	0	0	0	0.000	0.0000
Bottom of Tank	205.95	96	0	0.0	0	0	0	0.000	0.0000
Tank Invert	206.00	96	5	0.0	0	5	0	0.000	0.0000
0.5m Deep	206.45	96	43	0.0	0	48	43	0.442	0.0334
1.0m Deep	206.95	96	48	0.0	0	96	91	0.942	0.0487
1.5m Deep	207.45	96	48	0.0	0	144	139	1.443	0.0602
2.0m Deep	207.95	96	48	0.0	0	192	187	1.943	0.0699
Top of Tank	208.45	96	48	0.0	0	240	235	2.443	0.0784

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:	**Hamilton**
Return Period:	**2** Years
A =	**646.000**
B =	**6.000**
C=	**0.781**
Tc =	**10** minutes
	600 seconds

Area of site being investigated (ha) =	**0.66**	(Lot Area)
Composite Runoff Coeff. (C) =	**0.87**	(Post-development "C")
Release Rate - Q_{ALLOW} (m^3/s) =	**0.0758**	(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	99.290	0.0000276	0.158	0.0	0.1584	47.51	34.11	13.40
10	600	74.099	0.0000206	0.118	0.0	0.1182	70.91	45.48	25.43
15	900	59.921	0.0000166	0.096	0.0	0.0956	86.02	56.85	29.17
20	1200	50.715	0.0000141	0.081	0.0	0.0809	97.07	68.22	28.85
25	1500	44.206	0.0000123	0.071	0.0	0.0705	105.76	79.59	26.17
30	1800	39.333	0.0000109	0.063	0.0	0.0627	112.93	90.96	21.97
35	2100	35.534	0.0000099	0.057	0.0	0.0567	119.02	102.33	16.69
40	2400	32.480	0.0000090	0.052	0.0	0.0518	124.33	113.70	10.63
45	2700	29.965	0.0000083	0.048	0.0	0.0478	129.05	125.07	3.98
50	3000	27.855	0.0000077	0.044	0.0	0.0444	133.28	136.44	-3.16
55	3300	26.055	0.0000072	0.042	0.0	0.0416	137.14	147.81	-10.67
60	3600	24.500	0.0000068	0.039	0.0	0.0391	140.68	159.18	-18.50
65	3900	23.142	0.0000064	0.037	0.0	0.0369	143.95	170.55	-26.60
70	4200	21.944	0.0000061	0.035	0.0	0.0350	147.00	181.92	-34.92
75	4500	20.879	0.0000058	0.033	0.0	0.0333	149.86	193.29	-43.43
80	4800	19.925	0.0000055	0.032	0.0	0.0318	152.54	204.66	-52.12
85	5100	19.064	0.0000053	0.030	0.0	0.0304	155.08	216.03	-60.95
90	5400	18.284	0.0000051	0.029	0.0	0.0292	157.48	227.40	-69.92
95	5700	17.573	0.0000049	0.028	0.0	0.0280	159.77	238.77	-79.00
100	6000	16.923	0.0000047	0.027	0.0	0.0270	161.95	250.14	-88.19
105	6300	16.324	0.0000045	0.026	0.0	0.0260	164.03	261.51	-97.48
110	6600	15.772	0.0000044	0.025	0.0	0.0252	166.03	272.88	-106.85
115	6900	15.261	0.0000042	0.024	0.0	0.0243	167.95	284.25	-116.30
120	7200	14.786	0.0000041	0.024	0.0	0.0236	169.80	295.62	-125.82

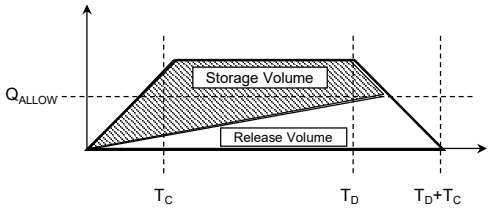
Max. required storage volume = 29.17 m^3

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:	**Hamilton**
Return Period:	**5** Years
A =	**1049.500**
B =	**8.000**
C=	**0.803**
Tc =	**10** minutes
	600 seconds

Area of site being investigated (ha) =	**0.66**	(Lot Area)
Composite Runoff Coeff. (C) =	**0.87**	(Post-development "C")
Release Rate - Q_{ALLOW} (m^3/s) =	**0.0758**	(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	133.809	0.0000372	0.213	0.0	0.2134	64.03	34.11	29.92
10	600	103.038	0.0000286	0.164	0.0	0.1643	98.61	45.48	53.13
15	900	84.628	0.0000235	0.135	0.0	0.1350	121.48	56.85	64.63
20	1200	72.263	0.0000201	0.115	0.0	0.1153	138.31	68.22	70.09
25	1500	63.331	0.0000176	0.101	0.0	0.1010	151.52	79.59	71.93
30	1800	56.548	0.0000157	0.090	0.0	0.0902	162.35	90.96	71.39
35	2100	51.204	0.0000142	0.082	0.0	0.0817	171.51	102.33	69.18
40	2400	46.875	0.0000130	0.075	0.0	0.0748	179.44	113.70	65.74
45	2700	43.290	0.0000120	0.069	0.0	0.0690	186.43	125.07	61.36
50	3000	40.267	0.0000112	0.064	0.0	0.0642	192.68	136.44	56.24
55	3300	37.680	0.0000105	0.060	0.0	0.0601	198.33	147.81	50.52
60	3600	35.439	0.0000098	0.057	0.0	0.0565	203.49	159.18	44.31
65	3900	33.476	0.0000093	0.053	0.0	0.0534	208.24	170.55	37.69
70	4200	31.742	0.0000088	0.051	0.0	0.0506	212.64	181.92	30.72
75	4500	30.197	0.0000084	0.048	0.0	0.0482	216.74	193.29	23.45
80	4800	28.811	0.0000080	0.046	0.0	0.0460	220.58	204.66	15.92
85	5100	27.561	0.0000077	0.044	0.0	0.0440	224.19	216.03	8.16
90	5400	26.426	0.0000073	0.042	0.0	0.0421	227.61	227.40	0.21
95	5700	25.391	0.0000071	0.040	0.0	0.0405	230.84	238.77	-7.93
100	6000	24.442	0.0000068	0.039	0.0	0.0390	233.91	250.14	-16.23
105	6300	23.570	0.0000065	0.038	0.0	0.0376	236.84	261.51	-24.67
110	6600	22.765	0.0000063	0.036	0.0	0.0363	239.64	272.88	-33.24
115	6900	22.019	0.0000061	0.035	0.0	0.0351	242.33	284.25	-41.92
120	7200	21.325	0.0000059	0.034	0.0	0.0340	244.90	295.62	-50.72

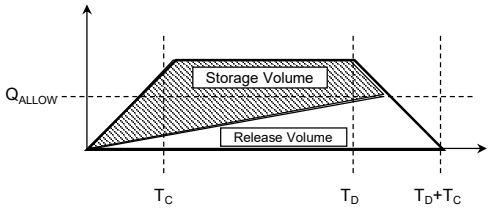
Max. required storage volume = 71.93 m^3

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:	**Hamilton**
Return Period:	**10** Years
A =	**1343.700**
B =	**9.000**
C=	**0.814**
Tc =	**10** minutes
	600 seconds

Area of site being investigated (ha) =	**0.66**	(Lot Area)
Composite Runoff Coeff. (C) =	**0.87**	(Post-development "C")
Release Rate - Q_{ALLOW} (m^3/s) =	**0.0758**	(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	156.803	0.0000436	0.250	0.0	0.2501	75.03	34.11	40.92
10	600	122.292	0.0000340	0.195	0.0	0.1951	117.03	45.48	71.55
15	900	101.114	0.0000281	0.161	0.0	0.1613	145.15	56.85	88.30
20	1200	86.678	0.0000241	0.138	0.0	0.1383	165.90	68.22	97.68
25	1500	76.152	0.0000212	0.121	0.0	0.1215	182.19	79.59	102.60
30	1800	68.104	0.0000189	0.109	0.0	0.1086	195.53	90.96	104.57
35	2100	61.735	0.0000171	0.098	0.0	0.0985	206.78	102.33	104.45
40	2400	56.557	0.0000157	0.090	0.0	0.0902	216.50	113.70	102.80
45	2700	52.256	0.0000145	0.083	0.0	0.0833	225.04	125.07	99.97
50	3000	48.622	0.0000135	0.078	0.0	0.0776	232.65	136.44	96.21
55	3300	45.506	0.0000126	0.073	0.0	0.0726	239.52	147.81	91.71
60	3600	42.803	0.0000119	0.068	0.0	0.0683	245.78	159.18	86.60
65	3900	40.434	0.0000112	0.064	0.0	0.0645	251.52	170.55	80.97
70	4200	38.338	0.0000106	0.061	0.0	0.0611	256.83	181.92	74.91
75	4500	36.470	0.0000101	0.058	0.0	0.0582	261.77	193.29	68.48
80	4800	34.794	0.0000097	0.055	0.0	0.0555	266.38	204.66	61.72
85	5100	33.279	0.0000092	0.053	0.0	0.0531	270.71	216.03	54.68
90	5400	31.905	0.0000089	0.051	0.0	0.0509	274.80	227.40	47.40
95	5700	30.650	0.0000085	0.049	0.0	0.0489	278.66	238.77	39.89
100	6000	29.501	0.0000082	0.047	0.0	0.0471	282.32	250.14	32.18
105	6300	28.443	0.0000079	0.045	0.0	0.0454	285.81	261.51	24.30
110	6600	27.467	0.0000076	0.044	0.0	0.0438	289.14	272.88	16.26
115	6900	26.562	0.0000074	0.042	0.0	0.0424	292.33	284.25	8.08
120	7200	25.721	0.0000071	0.041	0.0	0.0410	295.38	295.62	-0.24

Max. required storage volume = 104.57 m^3

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

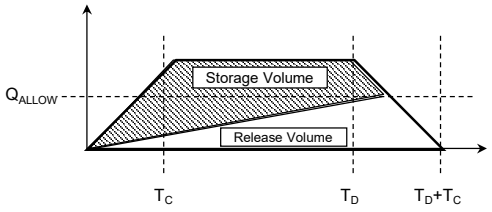
Runoff Volume = Area under trapezoidal hydrograph

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

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:	**Hamilton**
Return Period:	**25** Years
A =	**1719.500**
B =	**10.000**
C=	**0.823**
Tc =	**10** minutes
	600 seconds

Area of site being investigated (ha) =	**0.66**	(Lot Area)
Composite Runoff Coeff. (C) =	**0.87**	(Post-development "C")
Release Rate - Q_{ALLOW} (m^3/s) =	**0.0758**	(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	185.131	0.0000514	0.295	0.0	0.2953	88.59	34.11	54.48
10	600	146.101	0.0000406	0.233	0.0	0.2330	139.82	45.48	94.34
15	900	121.590	0.0000338	0.194	0.0	0.1939	174.54	56.85	117.69
20	1200	104.648	0.0000291	0.167	0.0	0.1669	200.30	68.22	132.08
25	1500	92.179	0.0000256	0.147	0.0	0.1470	220.54	79.59	140.95
30	1800	82.586	0.0000229	0.132	0.0	0.1317	237.10	90.96	146.14
35	2100	74.956	0.0000208	0.120	0.0	0.1196	251.07	102.33	148.74
40	2400	68.731	0.0000191	0.110	0.0	0.1096	263.10	113.70	149.40
45	2700	63.545	0.0000177	0.101	0.0	0.1014	273.66	125.07	148.59
50	3000	59.154	0.0000164	0.094	0.0	0.0944	283.05	136.44	146.61
55	3300	55.383	0.0000154	0.088	0.0	0.0883	291.51	147.81	143.70
60	3600	52.106	0.0000145	0.083	0.0	0.0831	299.19	159.18	140.01
65	3900	49.230	0.0000137	0.079	0.0	0.0785	306.23	170.55	135.68
70	4200	46.683	0.0000130	0.074	0.0	0.0745	312.73	181.92	130.81
75	4500	44.411	0.0000123	0.071	0.0	0.0708	318.76	193.29	125.47
80	4800	42.370	0.0000118	0.068	0.0	0.0676	324.39	204.66	119.73
85	5100	40.526	0.0000113	0.065	0.0	0.0646	329.66	216.03	113.63
90	5400	38.851	0.0000108	0.062	0.0	0.0620	334.62	227.40	107.22
95	5700	37.322	0.0000104	0.060	0.0	0.0595	339.31	238.77	100.54
100	6000	35.920	0.0000100	0.057	0.0	0.0573	343.75	250.14	93.61
105	6300	34.630	0.0000096	0.055	0.0	0.0552	347.98	261.51	86.47
110	6600	33.438	0.0000093	0.053	0.0	0.0533	352.00	272.88	79.12
115	6900	32.333	0.0000090	0.052	0.0	0.0516	355.84	284.25	71.59
120	7200	31.306	0.0000087	0.050	0.0	0.0499	359.52	295.62	63.90

Max. required storage volume = 149.40 m^3

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

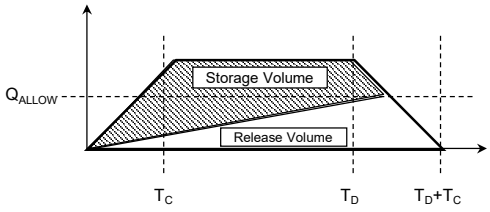
Runoff Volume = Area under trapezoidal hydrograph

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

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:	**Hamilton**
Return Period:	**50** Years
A =	**1954.800**
B =	**10.000**
C=	**0.826**
Tc =	**10** minutes
	600 seconds

Area of site being investigated (ha) =	**0.66**	(Lot Area)
Composite Runoff Coeff. (C) =	**0.87**	(Post-development "C")
Release Rate - Q_{ALLOW} (m^3/s) =	**0.0758**	(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	208.762	0.0000580	0.333	0.0	0.3330	99.89	34.11	65.78
10	600	164.608	0.0000457	0.263	0.0	0.2626	157.53	45.48	112.05
15	900	136.900	0.0000380	0.218	0.0	0.2184	196.52	56.85	139.67
20	1200	117.761	0.0000327	0.188	0.0	0.1878	225.39	68.22	157.17
25	1500	103.682	0.0000288	0.165	0.0	0.1654	248.06	79.59	168.47
30	1800	92.854	0.0000258	0.148	0.0	0.1481	266.58	90.96	175.62
35	2100	84.246	0.0000234	0.134	0.0	0.1344	282.18	102.33	179.85
40	2400	77.224	0.0000215	0.123	0.0	0.1232	295.61	113.70	181.91
45	2700	71.378	0.0000198	0.114	0.0	0.1138	307.39	125.07	182.32
50	3000	66.428	0.0000185	0.106	0.0	0.1060	317.86	136.44	181.42
55	3300	62.178	0.0000173	0.099	0.0	0.0992	327.27	147.81	179.46
60	3600	58.486	0.0000162	0.093	0.0	0.0933	335.83	159.18	176.65
65	3900	55.246	0.0000153	0.088	0.0	0.0881	343.66	170.55	173.11
70	4200	52.378	0.0000145	0.084	0.0	0.0835	350.88	181.92	168.96
75	4500	49.820	0.0000138	0.079	0.0	0.0795	357.58	193.29	164.29
80	4800	47.522	0.0000132	0.076	0.0	0.0758	363.83	204.66	159.17
85	5100	45.447	0.0000126	0.072	0.0	0.0725	369.69	216.03	153.66
90	5400	43.561	0.0000121	0.069	0.0	0.0695	375.19	227.40	147.79
95	5700	41.841	0.0000116	0.067	0.0	0.0667	380.40	238.77	141.63
100	6000	40.264	0.0000112	0.064	0.0	0.0642	385.32	250.14	135.18
105	6300	38.812	0.0000108	0.062	0.0	0.0619	390.00	261.51	128.49
110	6600	37.471	0.0000104	0.060	0.0	0.0598	394.46	272.88	121.58
115	6900	36.229	0.0000101	0.058	0.0	0.0578	398.72	284.25	114.47
120	7200	35.074	0.0000097	0.056	0.0	0.0559	402.79	295.62	107.17

Max. required storage volume = 182.32 m^3

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

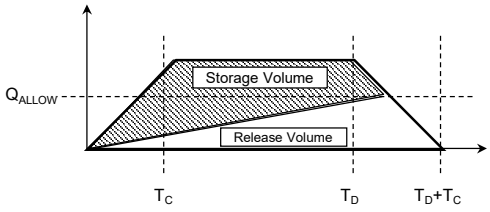
Runoff Volume = Area under trapezoidal hydrograph

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

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:	**Hamilton**
Return Period:	**100** Years
A =	**2317.400**
B =	**11.000**
C=	**0.836**
Tc =	**10** minutes
	600 seconds

Area of site being investigated (ha) =	**0.66**	(Lot Area)
Composite Runoff Coeff. (C) =	**0.87**	(Post development "C")
Release Rate - Q_{ALLOW} (m^3/s) =	**0.0758**	(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	228.222	0.0000634	0.364	0.0	0.3640	109.20	34.11	75.09
10	600	181.813	0.0000505	0.290	0.0	0.2900	174.00	45.48	128.52
15	900	152.084	0.0000422	0.243	0.0	0.2426	218.32	56.85	161.47
20	1200	131.287	0.0000365	0.209	0.0	0.2094	251.28	68.22	183.06
25	1500	115.860	0.0000322	0.185	0.0	0.1848	277.19	79.59	197.60
30	1800	103.923	0.0000289	0.166	0.0	0.1658	298.36	90.96	207.40
35	2100	94.392	0.0000262	0.151	0.0	0.1506	316.17	102.33	213.84
40	2400	86.591	0.0000241	0.138	0.0	0.1381	331.47	113.70	217.77
45	2700	80.078	0.0000222	0.128	0.0	0.1277	344.86	125.07	219.79
50	3000	74.553	0.0000207	0.119	0.0	0.1189	356.74	136.44	220.30
55	3300	69.801	0.0000194	0.111	0.0	0.1113	367.40	147.81	219.59
60	3600	65.667	0.0000182	0.105	0.0	0.1047	377.06	159.18	217.88
65	3900	62.036	0.0000172	0.099	0.0	0.0989	385.89	170.55	215.34
70	4200	58.818	0.0000163	0.094	0.0	0.0938	394.02	181.92	212.10
75	4500	55.945	0.0000155	0.089	0.0	0.0892	401.54	193.29	208.25
80	4800	53.363	0.0000148	0.085	0.0	0.0851	408.55	204.66	203.89
85	5100	51.030	0.0000142	0.081	0.0	0.0814	415.10	216.03	199.07
90	5400	48.909	0.0000136	0.078	0.0	0.0780	421.25	227.40	193.85
95	5700	46.973	0.0000130	0.075	0.0	0.0749	427.05	238.77	188.28
100	6000	45.197	0.0000126	0.072	0.0	0.0721	432.54	250.14	182.40
105	6300	43.563	0.0000121	0.069	0.0	0.0695	437.74	261.51	176.23
110	6600	42.053	0.0000117	0.067	0.0	0.0671	442.69	272.88	169.81
115	6900	40.653	0.0000113	0.065	0.0	0.0648	447.41	284.25	163.16
120	7200	39.352	0.0000109	0.063	0.0	0.0628	451.91	295.62	156.29

Max. required storage volume = 220.30 m^3

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

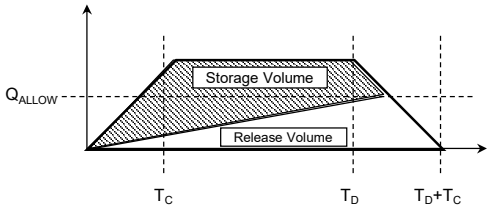
Runoff Volume = Area under trapezoidal hydrograph

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

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

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%

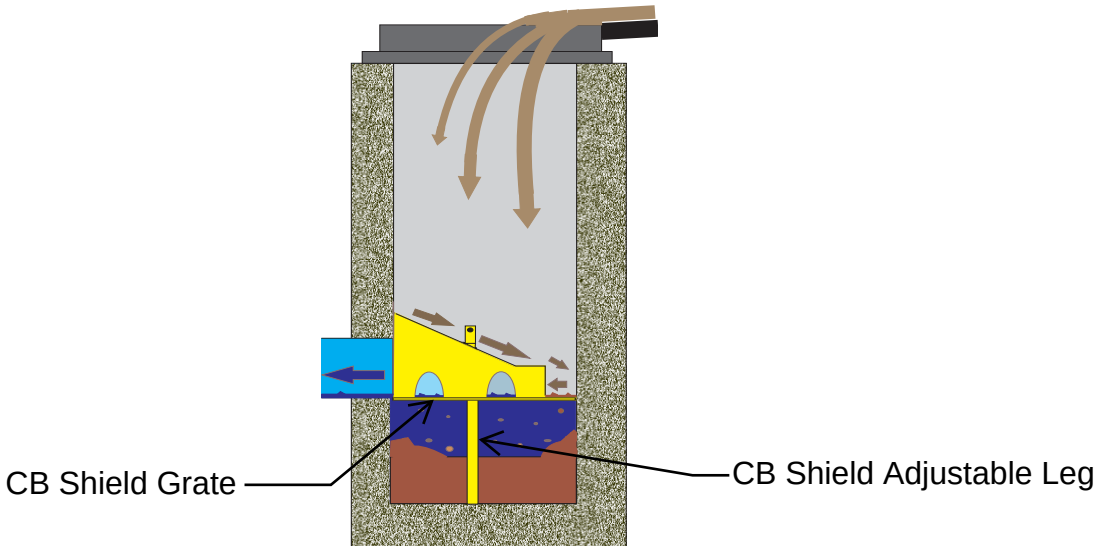
Notes:

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).

Hydroworks Sizing Summary

150 Mohawk Road East
Hamilton, Ontario

07-11-2022

Recommended Size: HS 10

A HydroStorm HS 10 is recommended to provide 80 % annual TSS removal based on a drainage area of 0.77 (ha) with an imperviousness of 88 % and Hamilton Airport, Ontario rainfall for the ETV Canada particle size distribution.

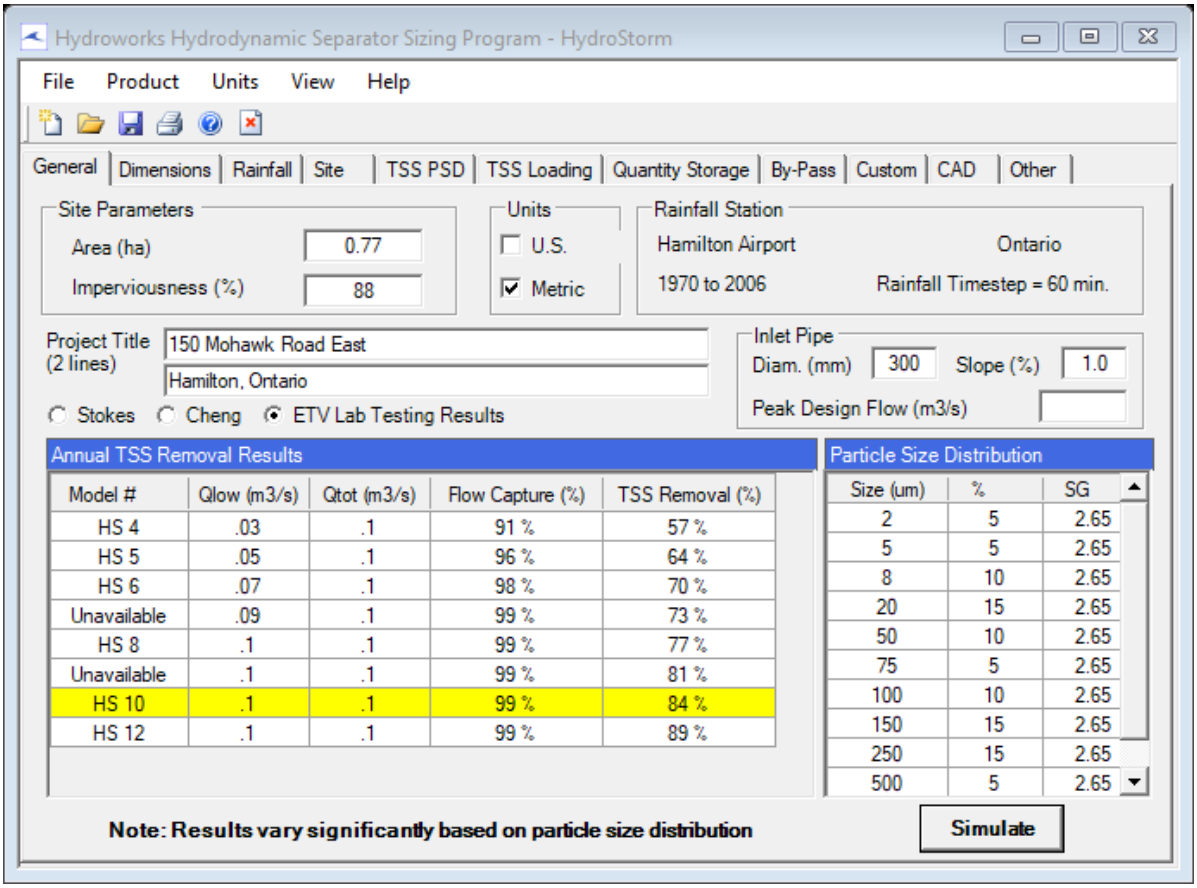
The recommended HydroStorm HS 10 treats 99 % of the annual runoff and provides 84 % annual TSS removal for the Hamilton Airport rainfall records and ETV Canada particle size distribution.

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).

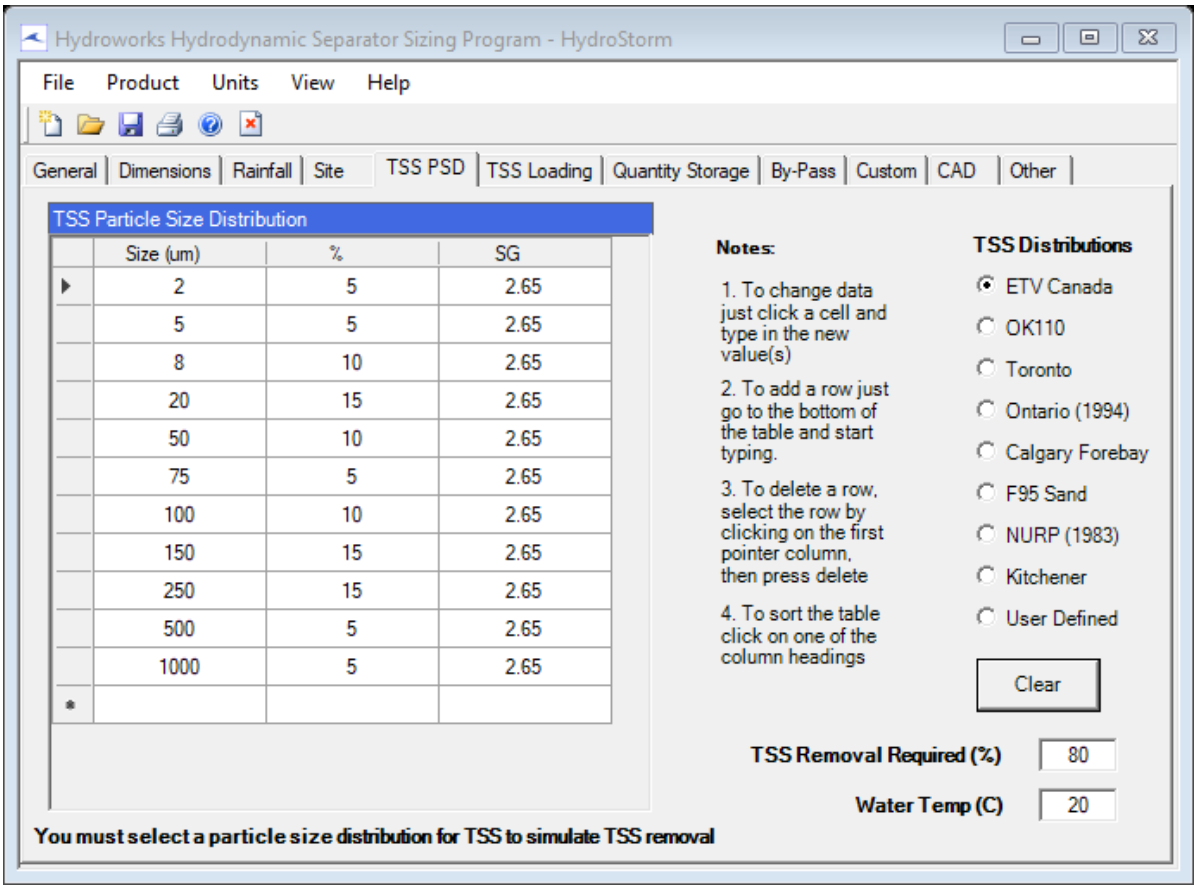
This summary report provides the main parameters that were used for sizing. These parameters are shown on the summary tables and graphs provided in this report.

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.

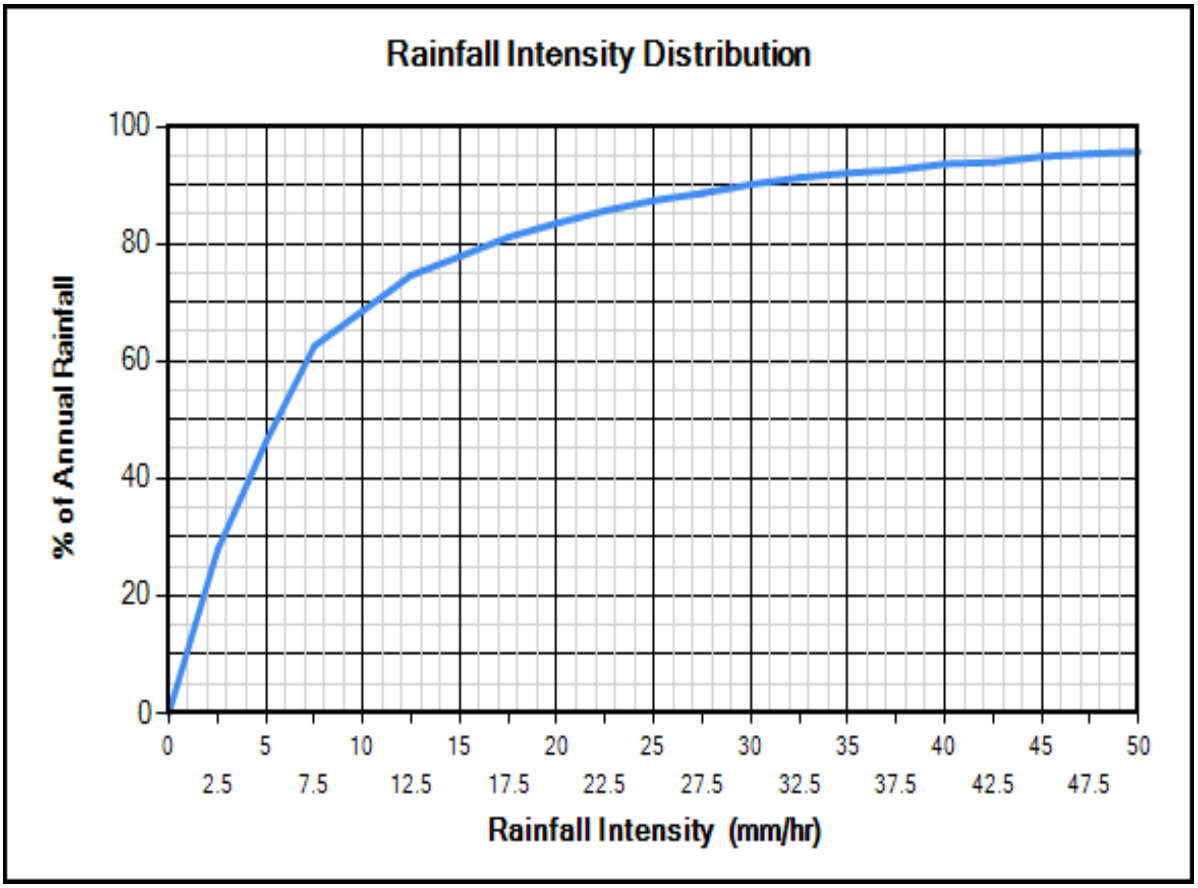
TSS Removal Sizing Summary



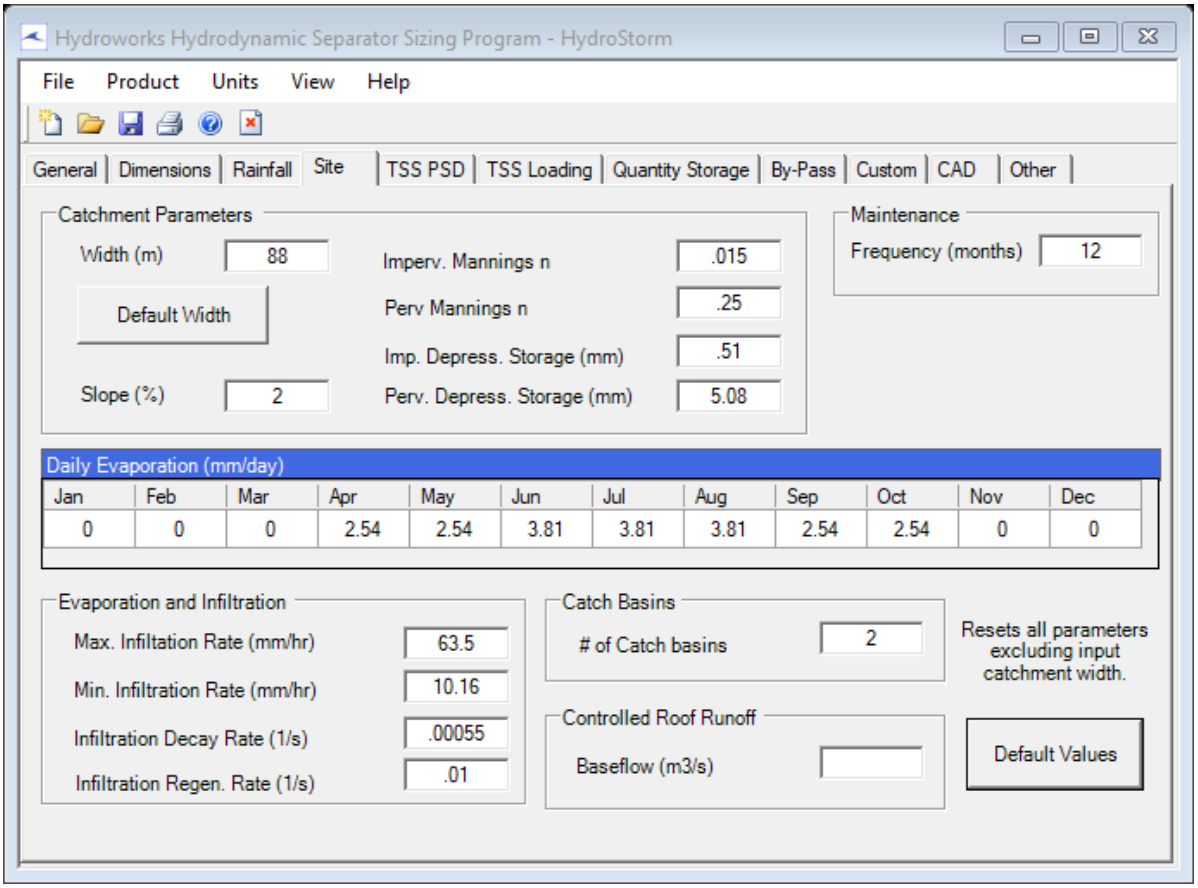
TSS Particle Size Distribution



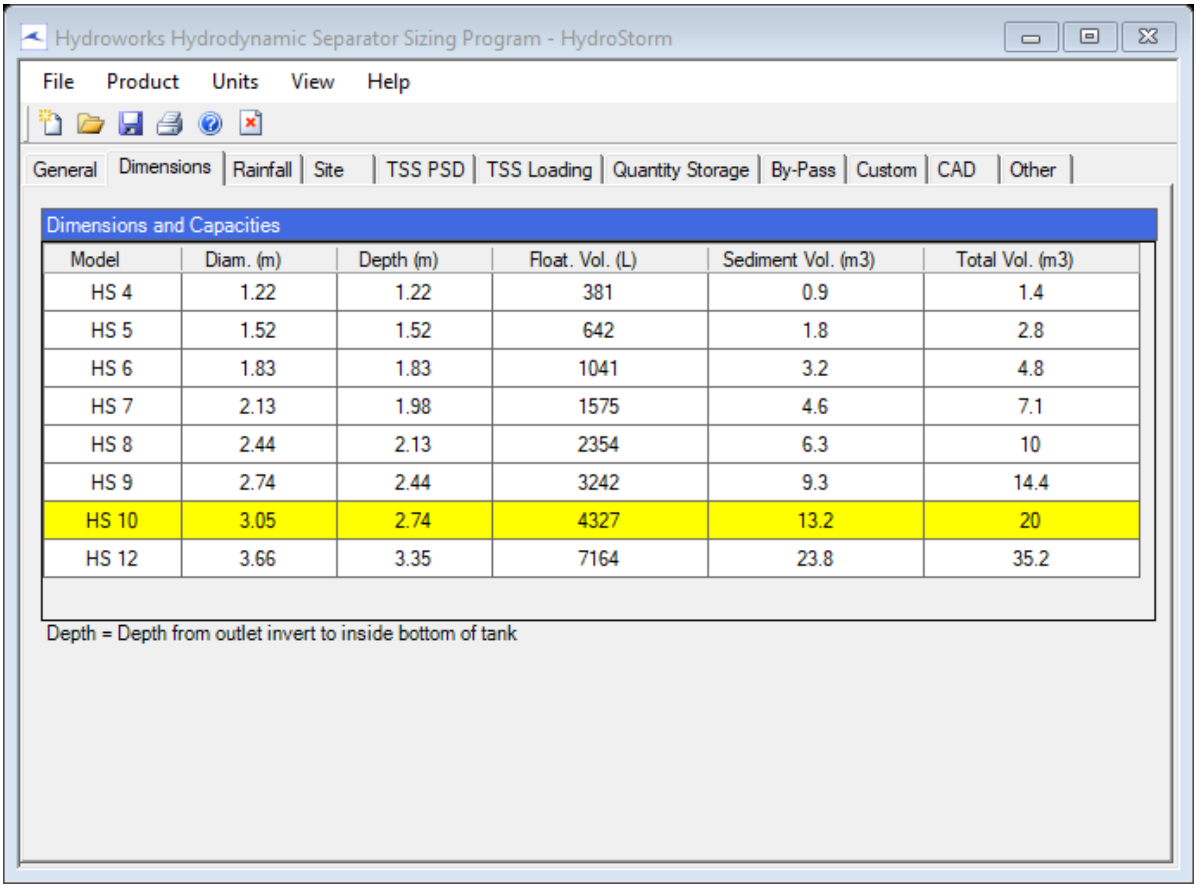
Rainfall Station - Hamilton Airport, Ontario(1970 to 2006)



Site Physical Characteristics



Dimensions And Capacities

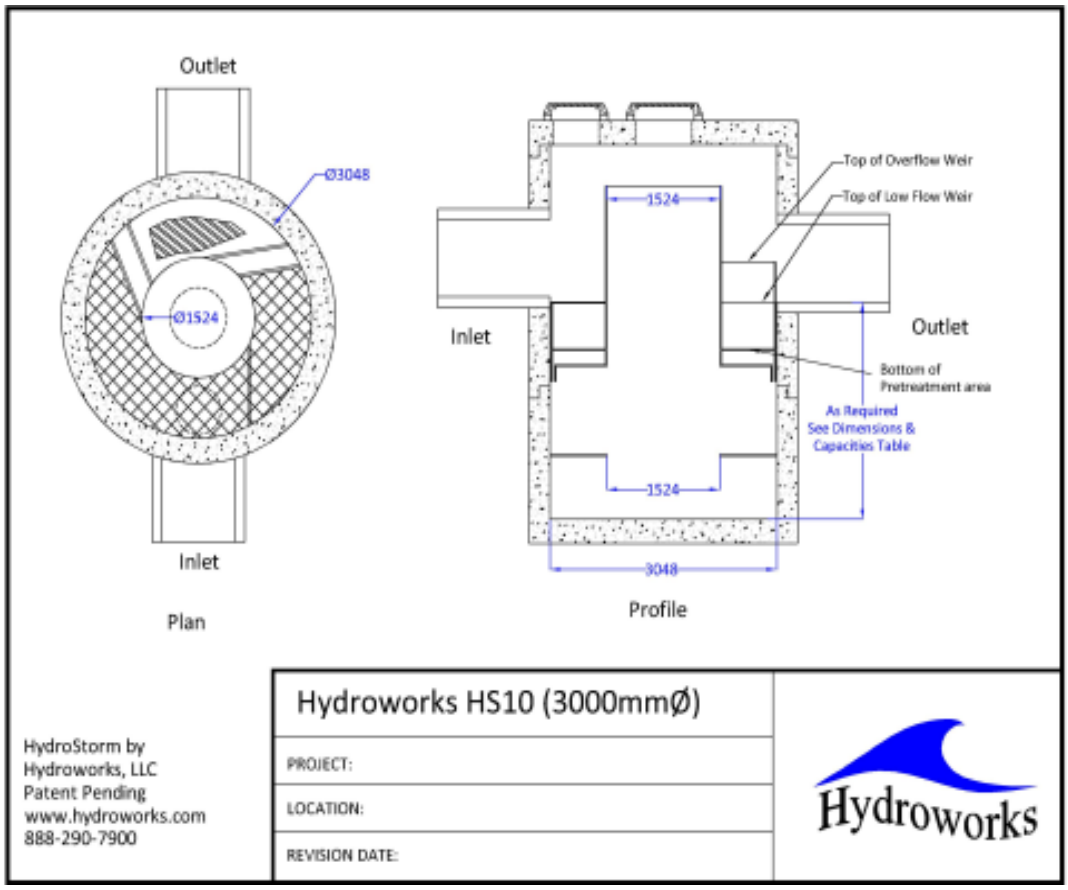


Dimensions and Capacities

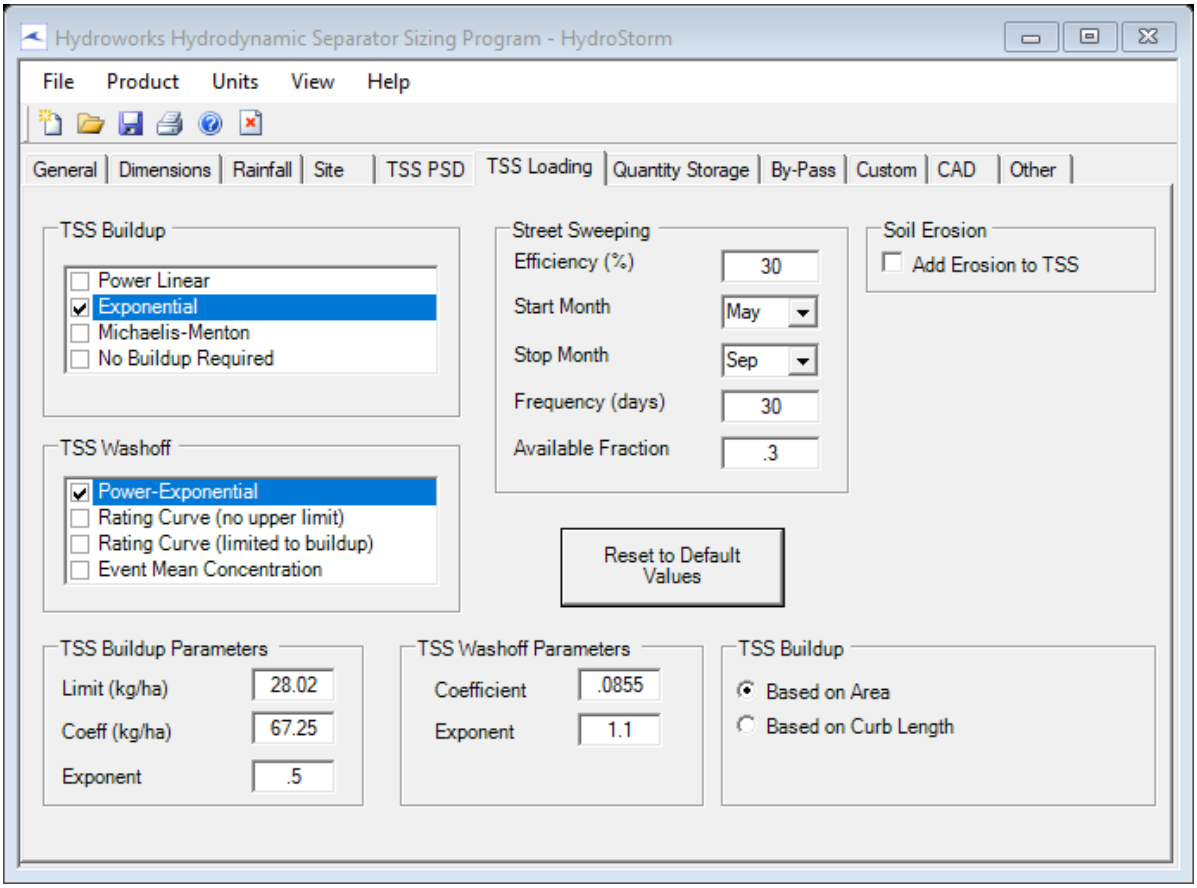
Model	Diam. (m)	Depth (m)	Float. Vol. (L)	Sediment Vol. (m3)	Total Vol. (m3)
HS 4	1.22	1.22	381	0.9	1.4
HS 5	1.52	1.52	642	1.8	2.8
HS 6	1.83	1.83	1041	3.2	4.8
HS 7	2.13	1.98	1575	4.6	7.1
HS 8	2.44	2.13	2354	6.3	10
HS 9	2.74	2.44	3242	9.3	14.4
HS 10	3.05	2.74	4327	13.2	20
HS 12	3.66	3.35	7164	23.8	35.2

Depth = Depth from outlet invert to inside bottom of tank

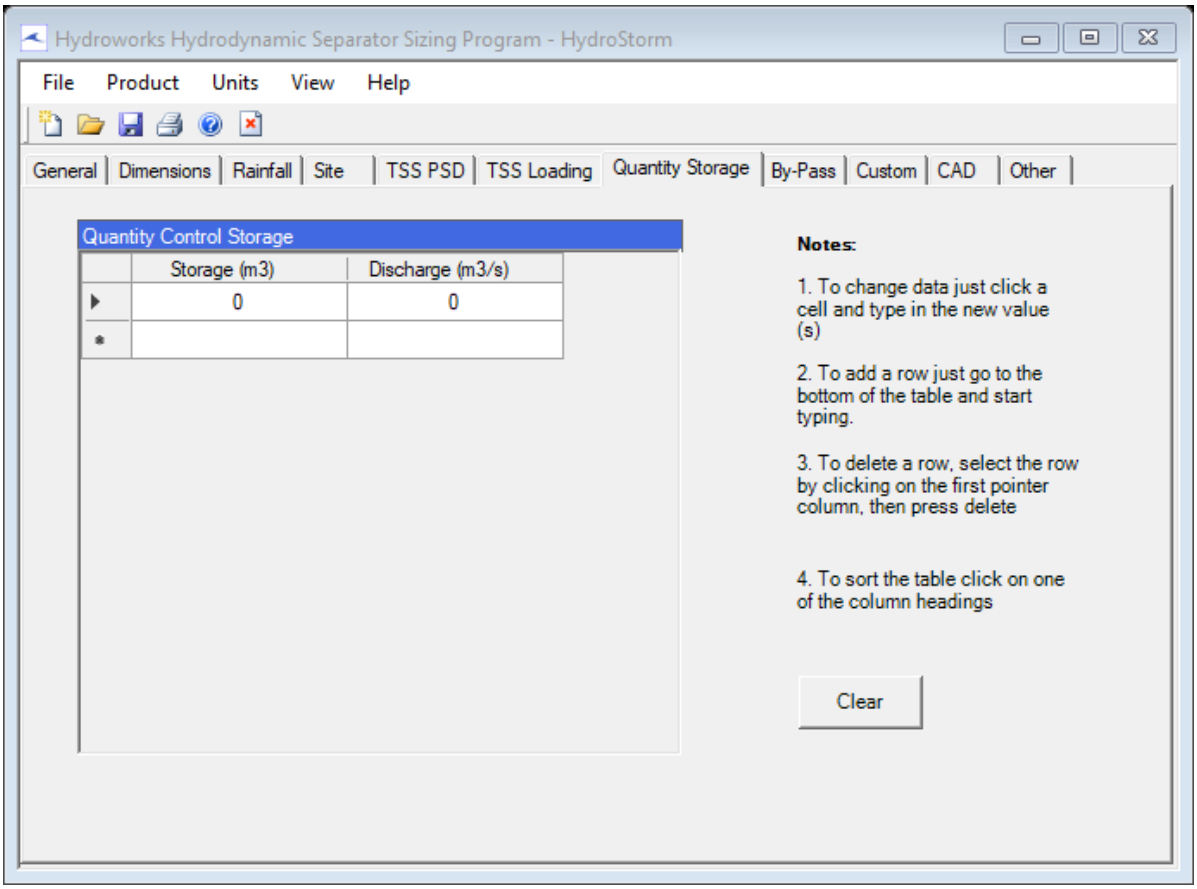
Generic HS 10 CAD Drawing



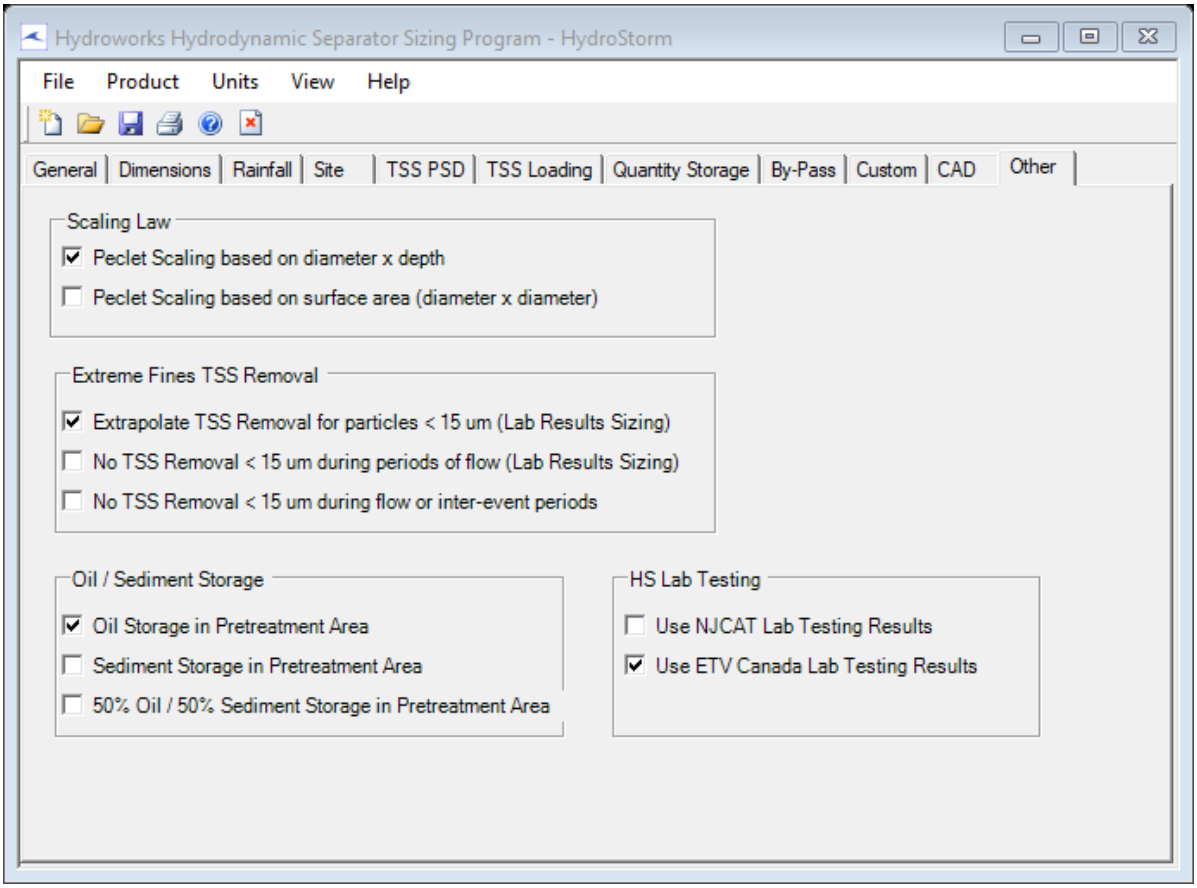
TSS Buildup And Washoff



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.

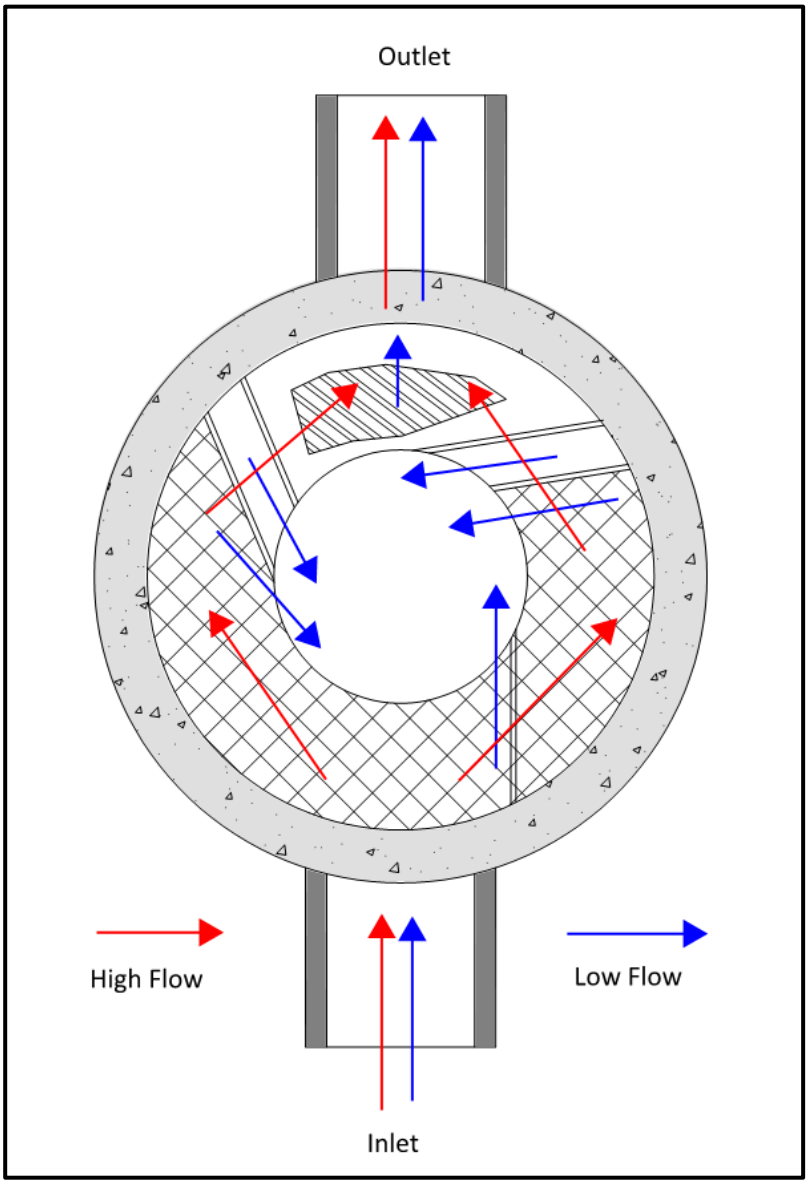


Figure 1. Hydroworks HydroStorm Operation – Plan View

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

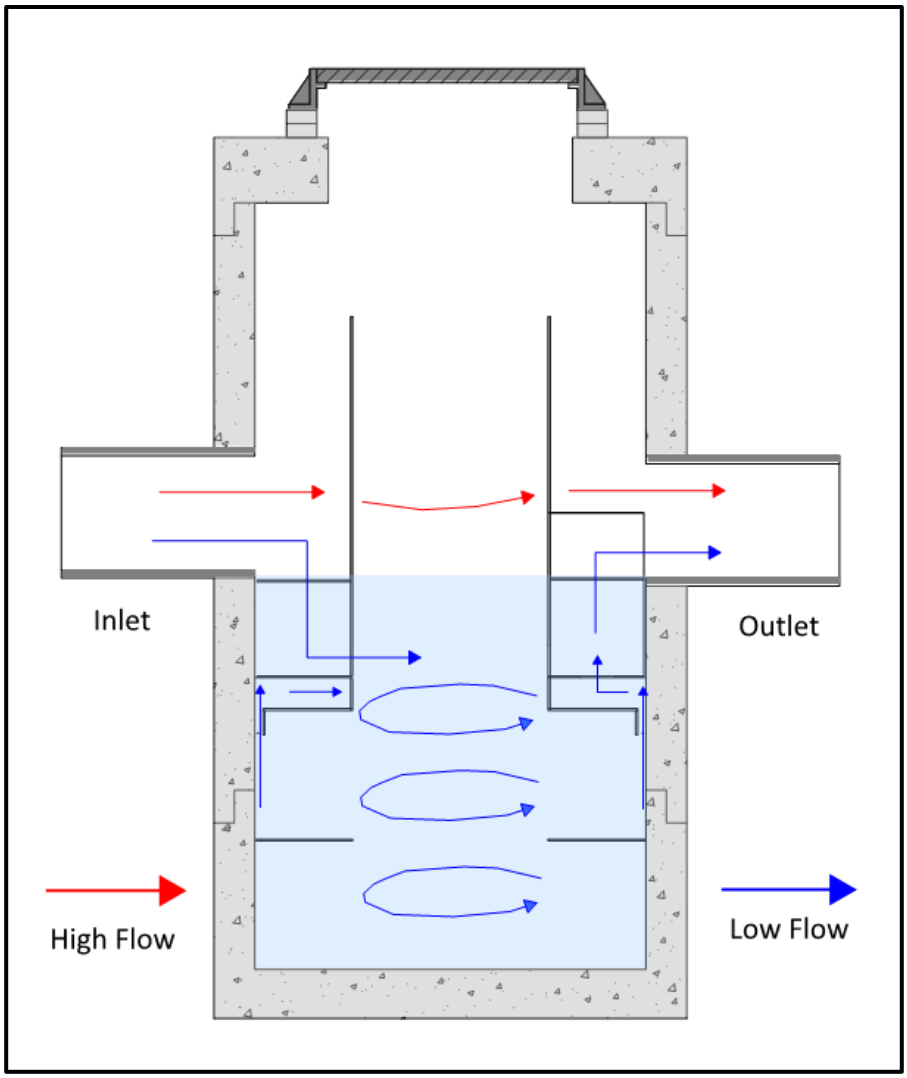


Figure 2. Hydroworks HydroStorm Operation – Profile View

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.

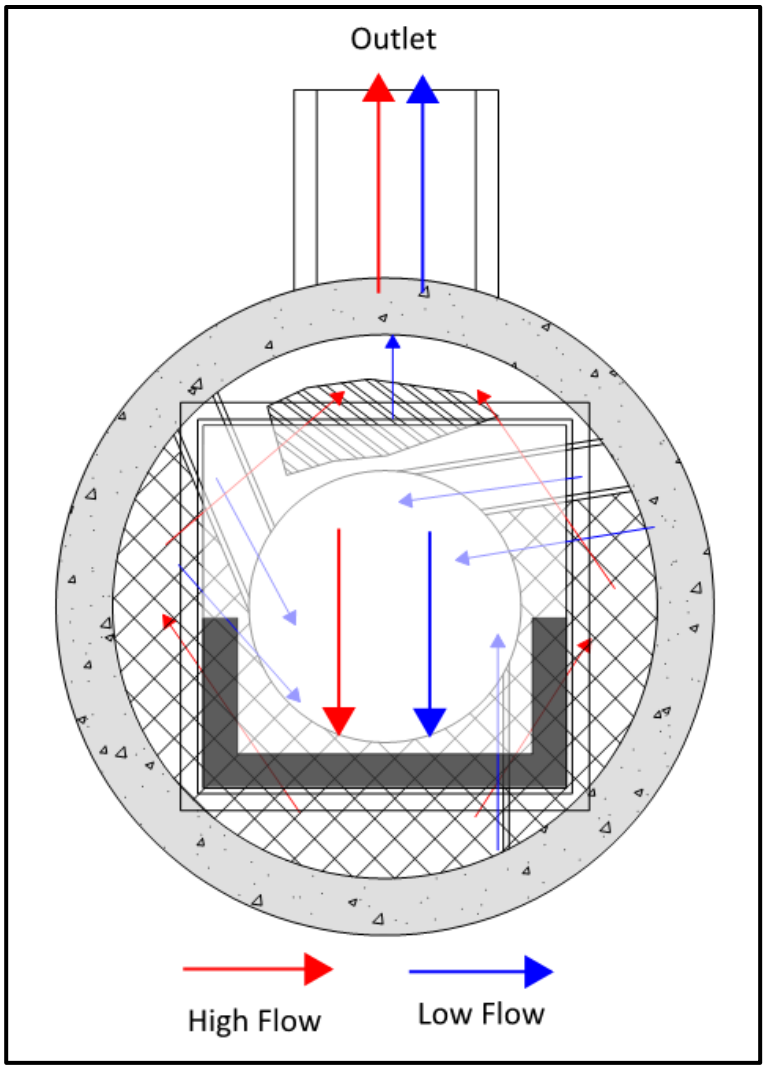


Figure 3. Hydroworks HS 4i Funnel

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).

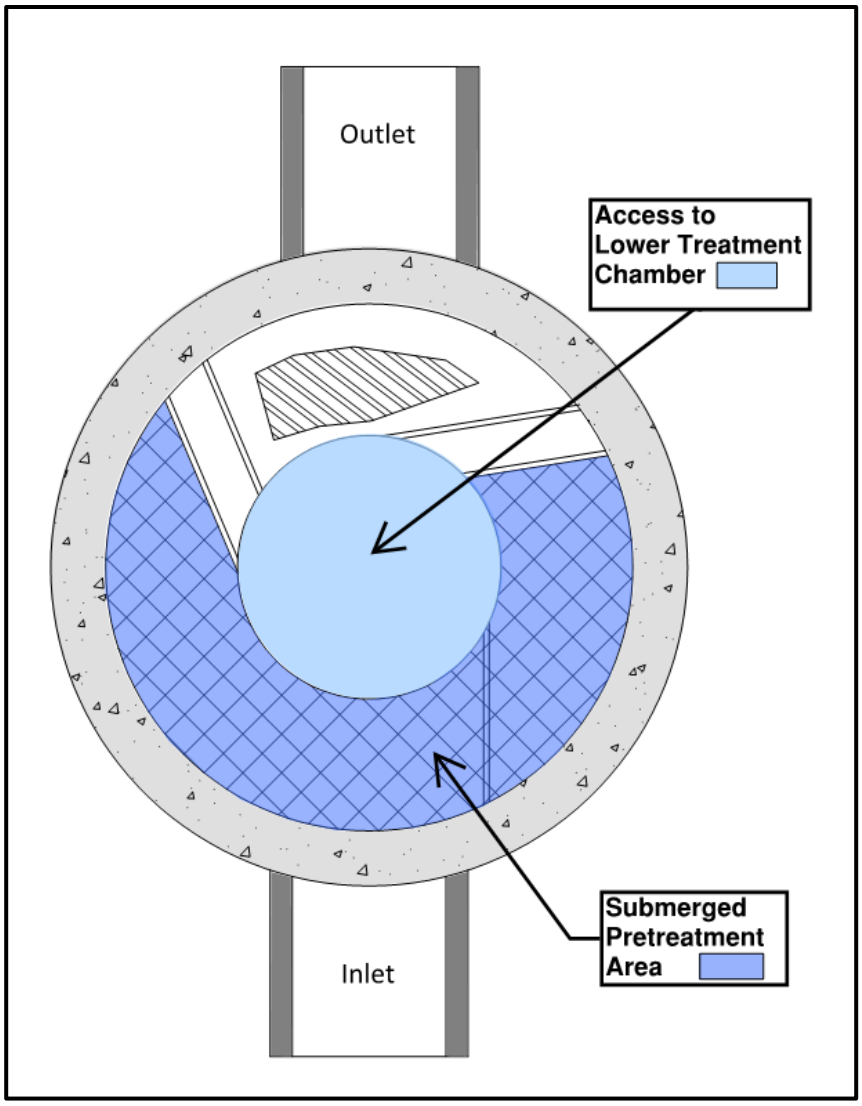


Figure 3. Maintenance Access

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.

APPENDIX C
FIRE FLOW ANALYSIS

OBC FIRE FLOW WATER SUPPLY

S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

Project: **150 Mohawk Road East**
Project Number: 22025
Date: Jul-22

Type of Development: **Residential (Greater than 3 Units)**

Required Fire Water Supply (Q) per OBC: **$Q = K\ V\ S_{tot}$** *(OBC Tables and Figures attached)*

Where:

Q = Minimim supply of water in litres
K = Water suppy coefficient from Table 1
V = total building volume in cubic meters
S_{tot} = total of spatial coefficient values from property line exposures on all sides

$S_{tot} = 1.0 + [S_{side1} + S_{side2} + S_{side3} + ...]$ from Figure 1. Max. 2.0

Water Supply Coefficient (K)

Building Group/Division Classification: **C (Residential occupancy, building that exceeds 600m^2)**

From Table 1, **K =** **16**

Building Volume (V)

Calculations for worst case building - Building C

Building Footprint Area: **1500** m^2
Building Height: **33** m
Building Volume (V): ***105000*** **m^3**

Spatial Coefficient (S)

See Figure 1 for Spatial Coefficients

Side	Dist (m)	S_{coeff}
North	>10m	0
South	>10m	0
East	>10m	0
West	5	0.5
	Total	0.5

Therefore, S_{tot} = **1.5**

Required Water Supply

$Q = K\ V\ S_{tot}$ = 2520000 L

From Table 2, the minimum required water supply flow rate = ***9000*** ***l/min*** ***or*** 150 l/s

City of Hamilton Target flow for Residential (Greater than 3 Units) = **150** **l/s <-- governs**

OBC Tables and Figures

Table 1

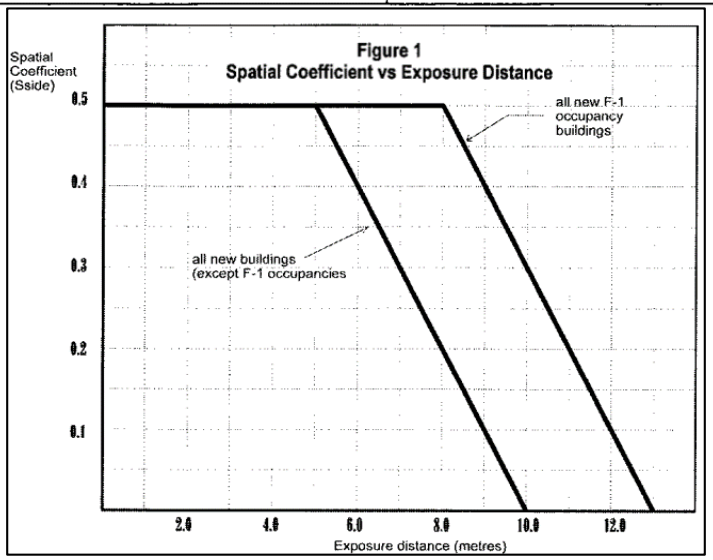
Water Supply Coefficient - K

Type of Construction	Classification by Group or Division in Accordance with Table 3.1.2.1. of the Building Code				
	A-2 B-1 B-2 B-3 C D	A-4 F-3	A-1 A-3	E F-2	F-1
Building is of noncombustible construction with fire separations and fire-resistance ratings provided in accordance with Subsection 3.2.2., including loadbearing walls, columns and arches.	10	12	14	17	23
Building is of noncombustible construction or of heavy timber construction conforming to Article 3.1.4.6. Floor assemblies are fire separations but with no fire-resistance rating. Roof assemblies, mezzanines, loadbearing walls, columns and arches do not have a fire-resistance rating.	16	19	22	27	37
Building is of combustible construction with fire separations and fire-resistance ratings provided in accordance with Subsection 3.2.2., including loadbearing walls, columns and arches. Noncombustible construction may be used in lieu of fire-resistance rating where permitted in Subsection 3.2.2.	18	22	25	31	41
Building is of combustible construction. Floor assemblies are fire separations but with no fire-resistance rating. Roof assemblies, mezzanines, loadbearing walls, columns and arches do not have a fire-resistance rating.	23	28	32	39	53
Column 1	2	3	4	5	6

Table 2

Part 3 Buildings under the Building Code	Required Minimum Water Supply Flow Rate, L/min
One-storey building with building area not exceeding 600 m²	1 800
All other buildings	2 700 (if Q ≤ 108 000 L)(1) 3 600 (if Q > 108 000 L and ≤ 135 000 L)(1) 4 500 (if Q > 135 000 L and ≤ 162 000 L)(1) 5 400 (if Q > 162 000 L and ≤ 190 000 L)(1) 6 300 (if Q > 190 000 L and ≤ 270 000 L)(1) 9 000 (if Q > 270 000 L)(1)

Figure 1
Spatial Coefficient vs Exposure Distance



City of Hamilton Target Flows (Policy PW19096)

Table 1: Target Available Fire Flow

Land Use	Target AFF (L/s)
Commercial	150
Small ICI (<1,800 m^2)'	100
Industrial	250
Institutional	150
Residential Multi (greater than 3 units)	150
Residential Medium (3 or less units)	125
Residential Single	75
Residential Single (Dead End)	50

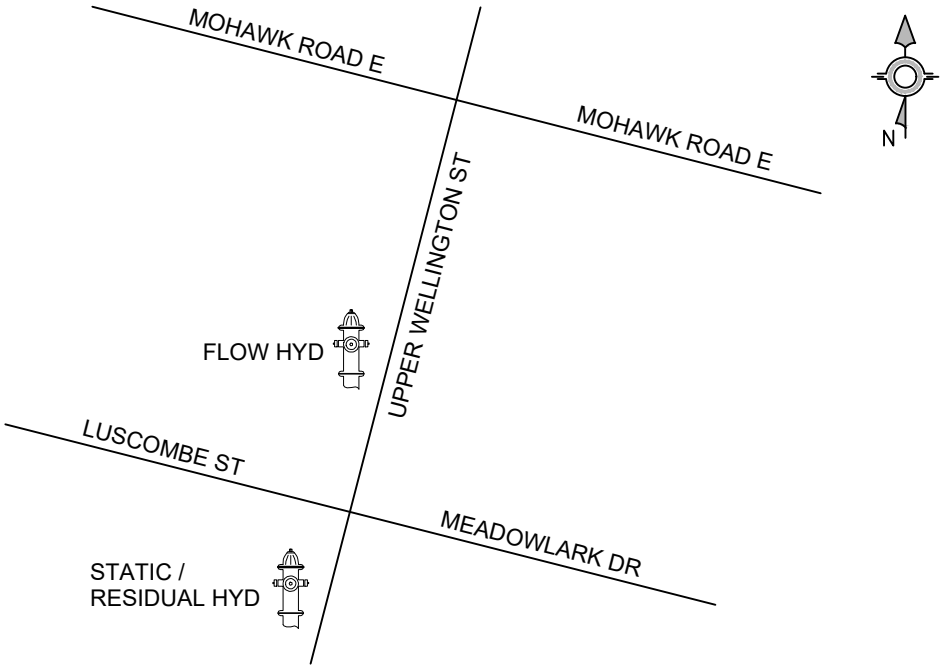
FIRST FOR FIRE PROTECTION
VIPOND INC
est. 1945

FLOW TEST RESULTS

DATE : MAY 9, 2023 TIME : 1:00 PM

LOCATION : 150 MOHAWK ROAD EAST
HAMILTON, ONTARIO

TEST BY : VIPOND & P.U.C.



STATIC PRESSURE : 92

TEST NO.	NO. OF NOZZLES	NOZZLE DIAMETER (INCHES)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	DISCHARGE (U.S.GPM)
1	1	2-1/2"	87	76	1460
2	2	2-1/2", 2-1/2"	82	54,54	2470

FIRST FOR FIRE PROTECTION
VIPOND INC
est. 1945

150 MOHAWK ROAD EAST		PREPARED BY :	JOHN LUCES
HAMILTON, ONTARIO		OFFICE :	STONEY CREEK
		TEST BY :	VIPOND & P.U.C.
		DATE :	MAY 9, 2023 1:00 PM

STATIC : 92 PSI
87 PSI @ 1460 GPM
82 PSI @ 2470 GPM