PROPOSED NIAGARA HISTORICAL SOCIETY MUSEUM ADDITION
43 CASTLEREAGH STREET, NIAGARA-ON-THE-LAKE

STORM WATER MANAGEMENT DESIGN BRIEF
NEW DEVELOPMENT DRAINAGE SYSTEM

REV 1 – February 23, 2026

PREPARED BY:

HALLEX ENGINEERING LTD.

HALLEX PROJECT #251023

HALLEX NIAGARA
4999 VICTORIA AVENUE
NIAGARA FALLS, ON L2E 4C9

HALLEX HAMILTON
745 SOUTH SERVICE ROAD, UNIT 205
STONEY CREEK, ON L8E 5Z2

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1. PRE-DEVELOPMENT CONDITIONS

1.1 LOCATION

The proposed Niagara Historical Society Museum Addition will take place in two recently merged properties: the Niagara-on-the-Lake Museum at 43 Castlereagh Street and a former residential property at 25 Castlereagh Street, known as the Museum Annex. This development is located at the northwest corner of the Davy Street and Castlereagh Street intersection in the Town of Niagara-on-the-Lake, ON.

1.2 DRAINAGE PATTERN

The current drainage path for the site consists of overland sheet flow to the existing 375mm municipal storm sewer at Davy Street and partly of overland sheet flow to Castlereagh Street and to the northerly property. The proposed stormwater management controls will ensure the storm flows are controlled to the pre-development flow rate to the existing municipal storm sewer at Davy Street.

2. PROPOSED WORK

2.1 GRADING

The objective of the design is to utilize the existing natural slope and achieve the minimum and maximum slopes in the grading of the proposed surfaces. This will ensure the surface not only drains as per the design, but is not too steep. The grading of the site also ensures that the storm water flow will mostly drain through the onsite drainage system for storm water quantity and quality controls. The proposed drainage system onsite has been designed according to the five and one-hundred-year storm event as per the Town of Niagara-on-the-Lake intensity-duration-frequency curve.

2.2 DRAINAGE

The proposed design requires 156.5 metres of storm sewer piping, ONE precast catch basin, three precast catch basin maintenance holes, three area drains, a Hydroguard HG4 oil and grit separator and a cast-in-place concrete stormwater management tank.

3. DESIGN CONSIDERATIONS

3.1 SITE DRAINAGE

3.1.1 Pre-Development

A. Peak Runoff

The total drainage area for the proposed development is 0.276 hectares with an existing runoff coefficient of 0.47 based on the existing roof, concrete, gravel and grass surfaces.

The time of concentration is determined to be 10 minutes to the start of the existing drainage system as required by the Town of Niagara-on-the-Lake municipal standards.

Using the Rational Method, the peak flow rates are $Q = \frac{CiA}{360}$

Subcatchment	Description	Draining to	Area, ha	Tc, min
Area.1	Sheet	Davy Street	0.053	10
Area.2	Sheet	Castlereagh Street	0.115	10
Area.3	Sheet	North Property	0.108	10
5-year Storm	**A,ha**	**C**	**i,mm/h**	**Q, L/s**
Area.1	0.053	0.50	90	6.6
Area.2	0.115	0.58	90	16.6
Area.3	0.108	0.35	90	9.5
TOTAL	**0.276**	**0.47**	**90**	**32.7**
100-year Storm	**A,ha**	**C**	**i,mm/h**	**Q, L/s**
Area.1	0.053	0.50	144	10.6
Area.2	0.115	0.58	144	26.6
Area.3	0.108	0.35	144	15.3
TOTAL	**0.170**	**0.47**	**144**	**52.5**

Therefore, the total pre-development flow for the subject site is 32.7L/s for the five-year storm and 52.5L/s for the one-hundred-year storm event, as outlined in Exhibit #1 and #2 at the end of this report.

B. Quantity

There is no known storm quantity control measure in place for the pre-development condition.

C. Quality

There is no known storm quality control measure in place for the pre-development condition.

3.1.2 Post-Development

A. Peak Runoff

The proposed Niagara Historical Society Museum Addition consists of the construction of an addition to the existing building along with concrete, pavers and grass surface areas. The resulting runoff coefficient in the post-development condition of the site is 0.55.

The proposed development will drain through the proposed onsite storm drainage system and shall discharge to the existing 375mm municipal storm sewer at Davy Street as per the existing site condition. Part of the site will continue to drain directly to Davy Street, and part of the site will continue to drain to the North Property similar to the pre-development condition.

The site's storm sewer pipes are designed according to the 5-year minor storm. Utilizing the minimum recommended time of concentration of 10 minutes, the time for storm water to flow from the farthest drainage area to the municipal storm sewer at Davy Street, as outlined in Exhibit #1, is calculated to be 11.80 minutes.

Using the Rational Method, the peak flow rates are as follows:

Subcatchment	**Description**	**Draining to**	**Area, ha**	**Tc, min**
Area.1	Sheet	Davy Street	0.018	10
Area.2	Sheet	North Property	0.011	10
Prop. Sewer	Sewer	Street	0.155	10
5-year Storm	**A,ha**	**C**	***i*,mm/h**	**Q, L/s**
Area.1	0.018	0.60	90	2.7
Area.2	0.011	0.70	90	1.9
Prop. Sewer	0.247	0.54	82	31.9
TOTAL	**0.276**	**0.55**	**90**	**36.5**
100-year Storm	**A,ha**	**C**	***i*,mm/h**	**Q, L/s**
Area.1	0.018	0.60	144	4.3
Area.2	0.011	0.70	144	3.1
Prop. Sewer	0.247	0.54	132	51.2
TOTAL	**0.276**	**0.55**	**144**	**58.5**

Therefore, the total post-development flow for the subject site is 36.5L/s for the five-year storm and 58.5L/s for the one-hundred-year storm event. The flows and other design information are contained in Exhibit #3 for the five-year storm and Exhibit #4 for the one-hundred-year storm at the end of the design brief.

B. Quantity

The post-development storm water runoff to the existing 375mm municipal storm sewer at Davy Street is higher than the pre-development runoff. As such, storm water detention is required to ensure that the existing municipal sewer does not surcharge as a result of the proposed development.

Stormwater quantity controls for the site will be achieved by utilizing a 50mm diameter orifice plate at the outlet side of CBMH.4. The orifice plate will ensure the post-development runoff is controlled to the pre-development runoff rate for the five and one-hundred-year storm event. The resulting 39m^3 volume generated from the five-year storm and 64m^3 from the one-hundred-year storm will be fully contained within the proposed underground stormwater management tank.

Since such a small orifice hole is required to maintain the pre-development runoff rate, a hooded outlet complete with a screen is suggested. This will prevent any large objects from clogging the orifice.

The following table summarizes the pre-development flow rates, the post-development uncontrolled flow rates and the post-development-controlled flow rates for the subject site:

	Pre- Development Flow Rate (L/s)	**Post- Development Uncontrolled Flow Rate (L/s)**	**Post- Development Controlled Flow Rate (L/s)**
5-year Storm			
Area.1	6.6	2.7	2.7
Area.2	16.6	1.9	1.9
Area.3	9.5	N/A	N/A
Prop. Sewer	N/A	31.9	3.8
TOTAL	**32.7**	**36.5**	**8.4**
100-year Storm			
Area.1	10.6	4.3	4.3
Area.2	26.6	3.1	3.1
Area.3	15.3	N/A	N/A
Prop. Sewer	N/A	51.2	4.8
TOTAL	**52.5**	**58.5**	**12.2**

The orifice plate and subsequent storage volume for the detained flow are indicated in Exhibit #5 for the five - year storm and Exhibit #6 for the one-hundred-year storm at the end of the design brief.

C. Quality

The storm water collected in the proposed development passes through a Hydroguard HG4, which achieves a total suspended solids removal of at least 98%. This value is greater than the required 'Normal' treatment of 70% as indicated in the MOE Stormwater Management Planning and Design Manual, dated March 2003 (refer to Chapter 3: Environmental Design Criteria, Section 3.3.1.1. Level of Protection). The design calculations from the manufacturer as well as the drawings for the unit are included in Appendix 'A' of this report.

D. Maintenance Recommendations

The storm sewer system includes pipes, catch basins, maintenance holes, the oil/grit separator and underground storage tank. It is important to regularly inspect the elements to ensure that storm water is flowing as originally designed. Debris and sediment commonly clog the system and reduce the overall effectiveness.

The following maintenance and inspection tasks should be done:

1. Inspect the inlet pipes and outlet pipes for structural integrity. (Annually) Check inlet/ outlet pipes for structural integrity to ensure they aren't crumbling or broken.
2. Conduct routine inspections for trash or other debris that may be blocking the inlet and outlet pipes. (Monthly and after rain events) Remove all trash and debris.

3. Inspect and clean the storm sewer system (Every 5 years or as needed). Catchbasins to be inspected annually and debris removed when the debris reaches a depth of ½ from the bottom of the sump to the bottom of the pipe.
4. Inspect for sediment accumulation at pipes (Semi-annually and after rain events). It is important to clean out sediment that might be restricting water flow.
5. Do not dump any materials in the storm sewer system.
6. Inspect the Hydroguard Oil/Grit Separator (Annually). Procedures for inspection are provided in the Hydroguard Owner's Manual. A vacuum truck is to be used for maintenance of the Hydroguard.
7. Inspect the concrete stormwqater management tank (Annually).

4. CONCLUSION

The aforementioned calculations and recommendations for the storm drainage system are based on the current design for the site as of writing this report.

We trust this report meets your approval. Please contact the undersigned should you have any questions or comments.

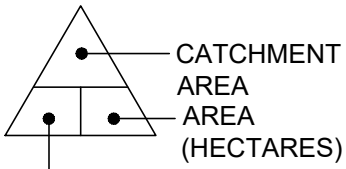
Yours truly,

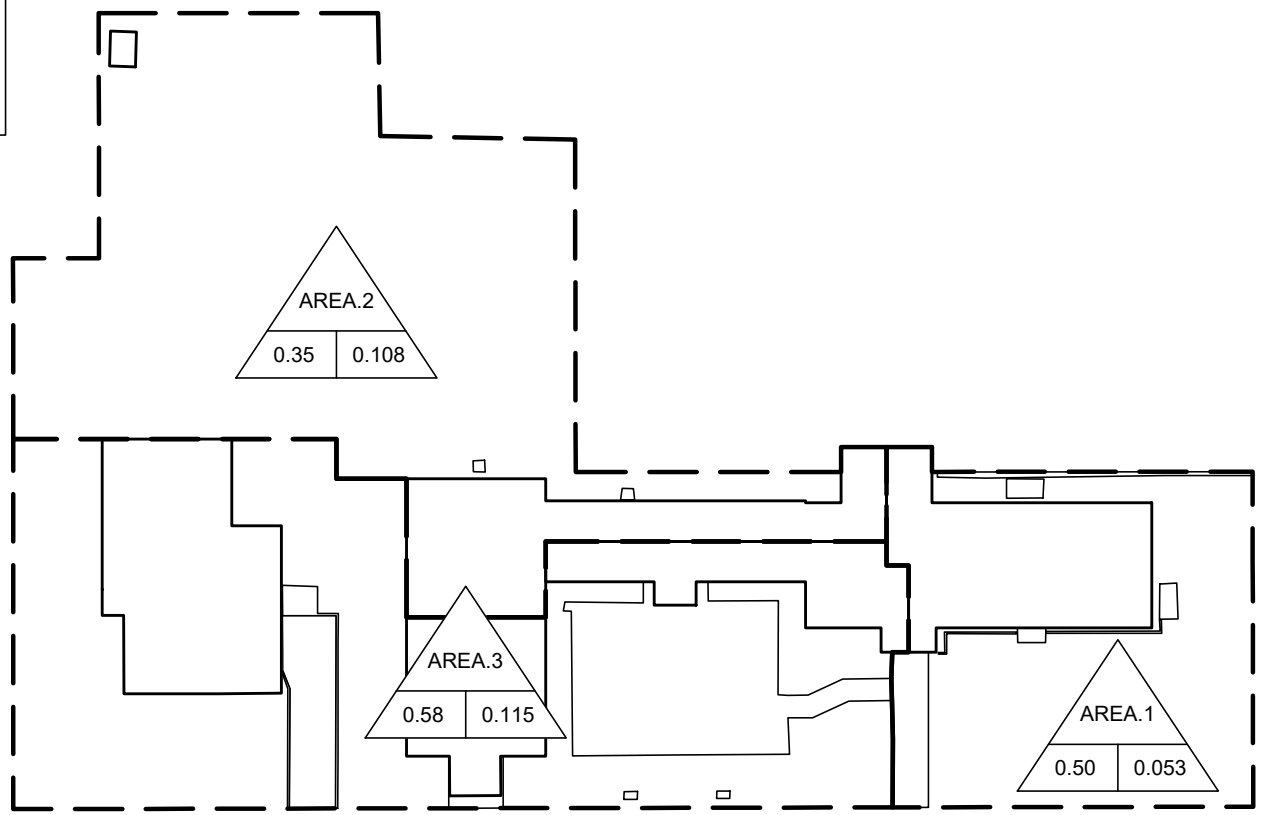
HALLEX ENGINEERING LTD

Jim Halucha, P.Eng
Civil/Structural Engineer

Mustafa Abdullaiev, B.Eng
Civil Designer

LEGEND





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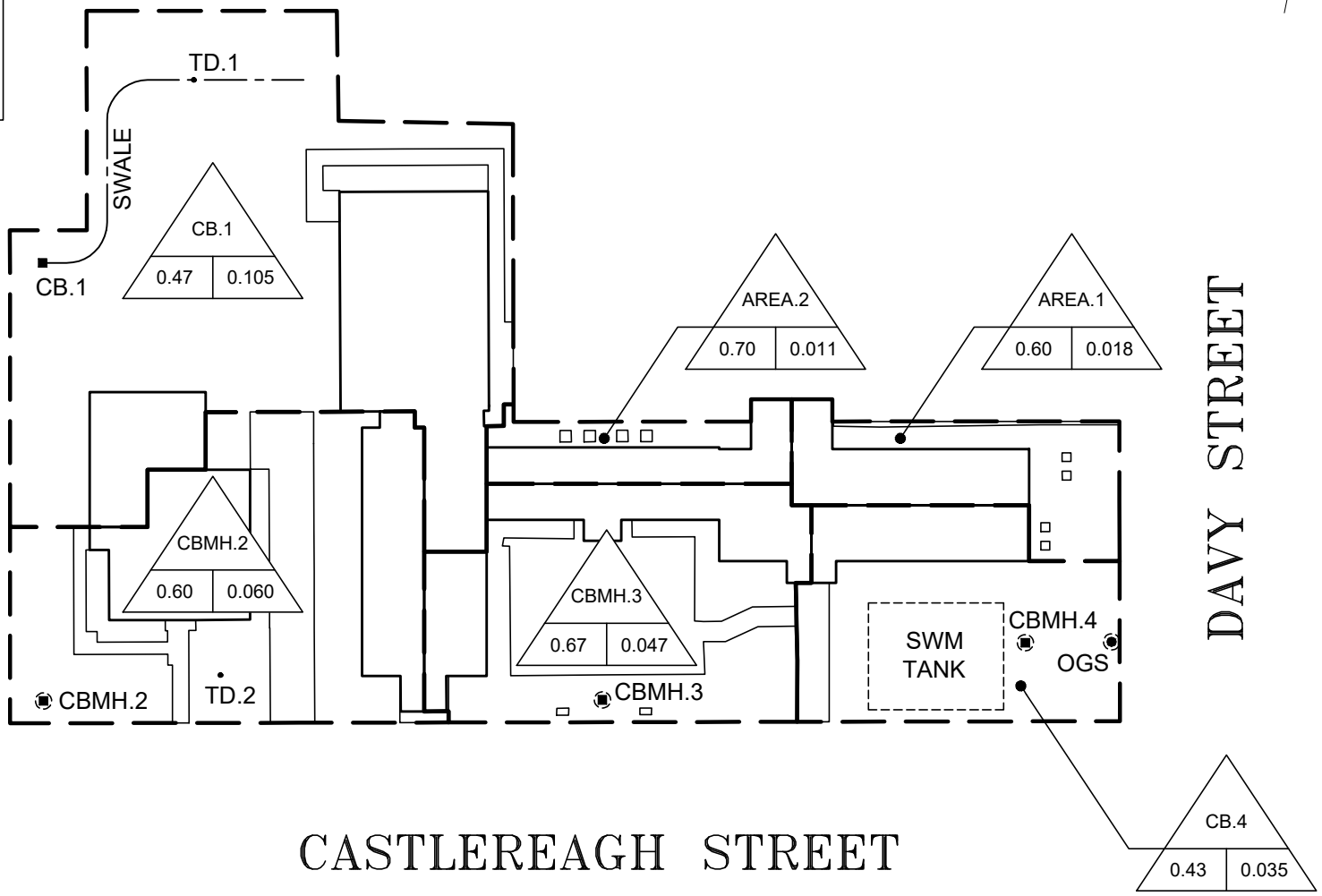
PROJECT:
NIAGARA HISTORICAL SOCIETY
MUSEUM ADDITION. NOTL, ON

SHEET TITLE:
PRE-DEVELOPMENT
CATCHMENT AREA PLAN

SCALE: 1:500	JOB NUMBER: 251023
DATE: 2026/01/21	ISSUED FOR: APPROVAL
DRAWN BY: MA	DWG CSK1 REV. 1
DESIGNED BY: MA	
CHECKED BY: AI	

LEGEND

CATCHMENT AREA
AREA (HECTARES)
AVERAGE RUNOFF COEFFICIENT



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PROJECT:
NIAGARA HISTORICAL SOCIETY
MUSEUM ADDITION. NOTL, ON

SHEET TITLE:
POST-DEVELOPMENT
CATCHMENT AREA PLAN

SCALE: 1:500	JOB NUMBER: 251023
DATE: 2026/02/23	ISSUED FOR: APPROVAL
DRAWN BY: MA	DWG CSK2 REV. 3
DESIGNED BY: MA	
CHECKED BY: AI	

Niagara Historical Society Museum Addition
Exhibit #1 - 5 Year Pre - Development Calculations

2026-02-23
Job: 251023

MUNICIPALITY: **NOTL**

manning's n = 0.013 Conc Pipe
0.013 PVC Pipe
0.024 Corr. Stl Pipe

Rainfall Intensity Values = A= 664.000
B= 4.700
C= 0.744

Location			Length of Pipe	Area		Flow Time		Rainfall Intensity	Unit rate of Runoff	Design Flows	
Pipe	From Node	To Node		Incre-ment	Cum Total	To Upper	In Sectio			Cum Flow	Cum Flow
			(m)	(ha)	(ha)	(min)	(min)	mm/hr	m^3/ha*day	(m^3/d)	(m^3/s)
1	**Area.1**	**Street.1**	**N/A**	**0.053**	**0.053**	**10.00**	**N/A**	**90**	**64717**	**568.4**	**0.0066**
Roof	-	-	-	0.015	-	-	-	-	20493.6	307.4	-
Paved	-	-	-	0.004	-	-	-	-	19415.0	77.7	-
Grass	-	-	-	0.034	-	-	-	-	5393.1	183.4	-
2	**Area.2**	**Prpty.1**	**N/A**	**0.108**	**0.108**	**10.00**	**N/A**	**90**	**64717**	**824.1**	**0.0095**
Roof	-	-	-	0.016	-	-	-	-	20493.6	327.9	-
Paved	-	-	-	0.000	-	-	-	-	19415.0	0.0	-
Gravel	-	-	-	0.000	-	-	-	-	12943.3	0.0	-
Grass	-	-	-	0.092	-	-	-	-	5393.1	496.2	-
3	**Area.3**	**Street.2**	**N/A**	**0.115**	**0.115**	**10.00**	**N/A**	**90**	**64717**	**1432.4**	**0.0166**
Roof	-	-	-	0.036	-	-	-	-	20493.6	737.8	-
Grass	-	-	-	0.058	-	-	-	-	5393.1	312.8	-

Run-off Coefficients Used:

Roof Structure	C =	0.95
Paved Surface	C =	0.90
Gravel Surface	C =	0.60
Perm. Paver	C =	0.30
Grass Surface	C =	0.25

Velocity Range:

Minimum Velocity =	0.75	m/s
Maximum Velocity =	6.00	m/s

Time of Concentration = 10 min

Niagara Historical Society Museum Addition
Exhibit #2 - 100 Year Pre - Development Calculations

MUNICIPALITY: **NOTL**

manning's n = 0.013 Conc Pipe
0.013 PVC Pipe
0.024 Corr. Stl Pipe

Rainfall Intensity Values = A= 980.000
B= 3.700
C= 0.732

Location			Length of Pipe	Area		Flow Time		Rainfall Intensity	Unit rate of Runoff	Design Flows	
Pipe	From Node	To Node		Incre-ment	Cum Total	To Upper	In Sectio			Cum Flow	Cum Flow
			(m)	(ha)	(ha)	(min)	(min)	mm/hr	m^3/ha*day	(m^3/d)	(m^3/s)
1	**Area.1**	**Street.1**	**N/A**	**0.053**	**0.053**	**10.00**	**N/A**	**144**	**103867**	**912.3**	**0.0106**
Roof	-	-	-	0.015	-	-	-	-	32891.3	493.4	-
Paved	-	-	-	0.004	-	-	-	-	31160.2	124.6	-
Grass	-	-	-	0.034	-	-	-	-	8655.6	294.3	-
2	**Area.2**	**Prpty.1**	**N/A**	**0.108**	**0.108**	**10.00**	**N/A**	**144**	**103867**	**1322.6**	**0.0153**
Roof	-	-	-	0.016	-	-	-	-	32891.3	526.3	-
Paved	-	-	-	0.000	-	-	-	-	31160.2	0.0	-
Gravel	-	-	-	0.000	-	-	-	-	20773.5	0.0	-
Grass	-	-	-	0.092	-	-	-	-	8655.6	796.3	-
3	**Area.3**	**Street.2**	**N/A**	**0.115**	**0.115**	**10.00**	**N/A**	**144**	**103867**	**2298.9**	**0.0266**
Roof	-	-	-	0.036	-	-	-	-	32891.3	1184.1	-
Grass	-	-	-	0.058	-	-	-	-	8655.6	502.0	-

Run-off Coefficients Used:

Roof Structure	C =	0.95
Paved Surface	C =	0.90
Gravel Surface	C =	0.60
Perm. Paver	C =	0.30
Grass Surface	C =	0.25

Velocity Range:

Minimum Velocity = 0.75 m/s
Maximum Velocity = 6.00 m/s

Time of Concentration = 10 min

Niagara Historical Society Museum Addition
Exhibit #3 - 5 Year Post - Development Calculations

MUNICIPALITY: **NOTL**

Rainfall Intensity Values = A= 664.000, B= 4.700, C= 0.744

manning's n = 0.013 PVC Pipe, 0.013 Conc Pipe, 0.024 Corr. Stl Pipe, 0.035 Grass Swale

Location			Length of Pipe	Area		Flow Time		Rainfall Intensity	Unit rate of Runoff	Design Flows		Flow Control	Sewer/Channel Design				Invert Elevations	
Pipe	From Node	To Node		Incre-ment	Cum Total	To Upper	In Section			Cum Flow	Cum Flow		Slope	Capacity Full	Velocity Full	*Dia/ Depth	Up-stream	Down-stream
			(m)	(ha)	(ha)	(min)	(min)	mm/hr	m^3/ha*day	(m^3/d)	(m^3/s)	(m^3/s)	(m/m)	(m^3/s)	(m/s)	(m)	(m)	(m)
1	**Area 1**	**Street 1**	**N/A**	**0.018**	**0.018**	**10.00**	**N/A**	**90**	**45302**	**231.9**	**0.0027**	**0.0027**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Roof	-	-	-	0.008	-	-	-	-	20493.6	163.9	-	-	-	-	-	-	-	-
Paved	-	-	-	0.001	-	-	-	-	19415.0	19.4	-	-	-	-	-	-	-	-
Grass	-	-	-	0.009	-	-	-	-	5393.1	48.5	-	-	-	-	-	-	-	-
2	**Area 2**	**Prpty 1**	**N/A**	**0.011**	**0.011**	**10.00**	**N/A**	**90**	**25887**	**165.0**	**0.0019**	**0.0019**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Roof	-	-	-	0.007	-	-	-	-	20493.6	143.5	-	-	-	-	-	-	-	-
Grass	-	-	-	0.004	-	-	-	-	5393.1	21.6	-	-	-	-	-	-	-	-
3	**CB. 1**	**CBMH. 2**	**31.5**	**0.105**	**0.105**	**10.00**	**0.61**	**90**	**45302**	**1074.3**	**0.0124**	**0.0124**	**0.0070**	**0.0274**	**0.8735**	**0.200**	**86.92**	**86.69**
Roof	-	-	-	0.029	-	-	-	-	20493.6	594.3	-	-	-	-	-	-	-	-
Paved	-	-	-	0.005	-	-	-	-	19415.0	97.1	-	-	-	-	-	-	-	-
Grass	-	-	-	0.071	-	-	-	-	5393.1	382.9	-	-	-	-	-	-	-	-
4	**CBMH. 2**	**CBMH. 3**	**40.1**	**0.060**	**0.165**	**10.61**	**0.77**	**87**	**43952**	**1830.9**	**0.0212**	**0.0212**	**0.0070**	**0.0274**	**0.8735**	**0.200**	**86.63**	**86.34**
Roof	-	-	-	0.020	-	-	-	-	19883.0	397.7	-	-	-	-	-	-	-	-
Paved	-	-	-	0.011	-	-	-	-	18836.5	207.2	-	-	-	-	-	-	-	-
Grass	-	-	-	0.029	-	-	-	-	5232.4	151.7	-	-	-	-	-	-	-	-
5	**CBMH. 3**	**Tank. 1**	**19**	**0.047**	**0.212**	**11.38**	**0.31**	**84**	**42376**	**2462.5**	**0.0285**	**0.0285**	**0.0100**	**0.0328**	**1.0440**	**0.200**	**86.34**	**86.15**
Roof	-	-	-	0.014	-	-	-	-	19170.2	268.4	-	-	-	-	-	-	-	-
Paved	-	-	-	0.015	-	-	-	-	18161.2	272.4	-	-	-	-	-	-	-	-
Grass	-	-	-	0.018	-	-	-	-	5044.8	90.8	-	-	-	-	-	-	-	-
6	**Tank. 1**	**CBMH. 4**	**1**	**0.000**	**0.212**	**11.69**	**0.02**	**83**	**0**	**2462.5**	**0.0285**	**0.0285**	**0.0100**	**0.0328**	**1.0440**	**0.200**	**86.15**	**86.14**
7	**CBMH. 4**	**OGS 1**	**5.2**	**0.035**	**0.247**	**11.71**	**0.09**	**83**	**41741**	**2759.7**	**0.0319**	**0.0038**	**0.0100**	**0.0328**	**1.0440**	**0.200**	**86.14**	**86.08**
Roof	-	-	-	0.007	-	-	-	-	18882.6	132.2	-	-	-	-	-	-	-	-
Paved	-	-	-	0.002	-	-	-	-	17888.8	35.8	-	-	-	-	-	-	-	-
Grass	-	-	-	0.026	-	-	-	-	4969.1	129.2	-	-	-	-	-	-	-	-
8	**OGS 1**	**Street 1**	**12.8**	**0.000**	**0.247**	**11.80**	**0.21**	**82**	**0**	**2759.7**	**0.0319**	**0.0038**	**0.0100**	**0.0328**	**1.0440**	**0.200**	**86.08**	**85.95**

Run-off Coefficients Used:

Roof Structure	C =	0.95
Paved Surface	C =	0.90
Gravel Surface	C =	0.60
Grass Surface	C =	0.25

Velocity Range:

Minimum Velocity =	0.75	m/s
Maximum Velocity =	6.00	m/s

Time of Concentration:

Time of Concentration = 10 min

HALLEX CIVIL ENGINEERING LTD.

Niagara Historical Society Museum Addition
Exhibit #4 - 100 Year Post - Development Calculations

2026-02-23
Job: 251023

MUNICIPALITY: **NOTL**

Rainfall Intensity Values = A= 980.000, B= 3.700, C= 0.732

manning's n = 0.013 PVC Pipe; 0.013 Conc Pipe; 0.024 Corr. Stl Pipe; 0.035 Grass Swale

Location			Length of Pipe	Area		Flow Time		Rainfall Intensity	Unit rate of Runoff	Design Flows		Flow Control	Sewer/Channel Design				Invert Elevations	
Pipe	From Node	To Node		Incre-ment	Cum Total	To Upper	In Section			Cum Flow	Cum Flow		Slope	Capacity Full	Velocity Full	*Dia/ Depth	Up-stream	Down-stream
			(m)	(ha)	(ha)	(min)	(min)	mm/hr	m^3/ha*day	(m^3/d)	(m^3/s)	(m^3/s)	(m/m)	(m^3/s)	(m/s)	(m)	(m)	(m)
1	**Area 1**	**Street 1**	**N/A**	**0.018**	**0.018**	**10.00**	**N/A**	**144**	**72707**	**372.2**	**0.0043**	**0.0043**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Roof	-	-	-	0.008	-	-	-	-	32891.3	263.1	-	-	-	-	-	-	-	-
Paved	-	-	-	0.001	-	-	-	-	31160.2	31.2	-	-	-	-	-	-	-	-
Grass	-	-	-	0.009	-	-	-	-	8655.6	77.9	-	-	-	-	-	-	-	-
2	**Area 2**	**Prpty 1**	**N/A**	**0.011**	**0.011**	**10.00**	**N/A**	**144**	**41547**	**264.9**	**0.0031**	**0.0031**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Roof	-	-	-	0.007	-	-	-	-	32891.3	230.2	-	-	-	-	-	-	-	-
Grass	-	-	-	0.004	-	-	-	-	8655.6	34.6	-	-	-	-	-	-	-	-
3	**CB. 1**	**CBMH. 2**	**31.5**	**0.105**	**0.105**	**10.00**	**0.61**	**144**	**72707**	**1724.2**	**0.0200**	**0.0200**	**0.0070**	**0.0274**	**0.8735**	**0.200**	**86.92**	**86.69**
Roof	-	-	-	0.029	-	-	-	-	32891.3	953.8	-	-	-	-	-	-	-	-
Paved	-	-	-	0.005	-	-	-	-	31160.2	155.8	-	-	-	-	-	-	-	-
Grass	-	-	-	0.071	-	-	-	-	8655.6	614.5	-	-	-	-	-	-	-	-
4	**CBMH. 2**	**CBMH. 3**	**40.1**	**0.060**	**0.165**	**10.61**	**0.77**	**140**	**70425**	**2936.5**	**0.0340**	**0.0340**	**0.0070**	**0.0274**	**0.8735**	**0.200**	**86.63**	**86.34**
Roof	-	-	-	0.020	-	-	-	-	31859.0	637.2	-	-	-	-	-	-	-	-
Paved	-	-	-	0.011	-	-	-	-	30182.3	332.0	-	-	-	-	-	-	-	-
Grass	-	-	-	0.029	-	-	-	-	8384.0	243.1	-	-	-	-	-	-	-	-
5	**CBMH. 3**	**Tank. 1**	**19**	**0.047**	**0.212**	**11.38**	**0.31**	**134**	**67775**	**3946.7**	**0.0457**	**0.0457**	**0.0100**	**0.0328**	**1.0440**	**0.200**	**86.34**	**86.15**
Roof	-	-	-	0.014	-	-	-	-	30659.9	429.2	-	-	-	-	-	-	-	-
Paved	-	-	-	0.015	-	-	-	-	29046.2	435.7	-	-	-	-	-	-	-	-
Grass	-	-	-	0.018	-	-	-	-	8068.4	145.2	-	-	-	-	-	-	-	-
6	**Tank. 1**	**CBMH. 4**	**1**	**0.000**	**0.212**	**11.69**	**0.02**	**132**	**0**	**3946.7**	**0.0457**	**0.0457**	**0.0100**	**0.0328**	**1.0440**	**0.200**	**86.15**	**86.14**
7	**CBMH. 4**	**OGS 1**	**5.2**	**0.035**	**0.247**	**11.71**	**0.09**	**132**	**66709**	**4421.6**	**0.0512**	**0.0048**	**0.0100**	**0.0328**	**1.0440**	**0.200**	**86.14**	**86.08**
Roof	-	-	-	0.007	-	-	-	-	30177.9	211.2	-	-	-	-	-	-	-	-
Paved	-	-	-	0.002	-	-	-	-	28589.6	57.2	-	-	-	-	-	-	-	-
Grass	-	-	-	0.026	-	-	-	-	7941.6	206.5	-	-	-	-	-	-	-	-
8	**OGS 1**	**Street 1**	**12.8**	**0.000**	**0.247**	**11.80**	**0.21**	**132**	**0**	**4421.6**	**0.0512**	**0.0048**	**0.0100**	**0.0328**	**1.0440**	**0.200**	**86.08**	**85.95**

Run-off Coefficients Used:

Roof Structure	C =	0.95
Paved Surface	C =	0.90
Gravel Surface	C =	0.60
Grass Surface	C =	0.25

Velocity Range:

Minimum Velocity =	0.75	m/s
Maximum Velocity =	6.00	m/s

Time of Concentration:

Time of Concentration = 10 min

Niagara Historical Society Museum Addition
Exhibit #5 - 5 Year Orifice Plate and Storage Volume Calcs

2026-02-23
Job: 251023

Site Data

Site Discharge	Flow	Flow to Davy Street	Adj. Flow (w/o Surface Runoff)	Total Storm Volume
	(m^3/s)	(m^3/s)	(m^3/s)	(m^3)
Pre - Develop.	0.0327	0.0066	0.0039	
Post - Develop.	0.0365	0.0346	0.0319	39.0

Control Node Data

Outlet Pipe	Storm Control Node	Outlet Pipe Size	Outlet Invert Elev.	Elev. @ Orifice
		(m)	(m)	(m)
7	CBMH. 4	0.200	86.14	86.17

* Volume calculated using SWMM 5.1 modelling software in accordance with the flow rate for actual size of the orifice.

Storm Retention Elevation 86.65 m
Head Height 0.48 m

Storm Retention Elev. Check **86.65 m**

Cast-in-Place Concrete Tank Storage

Model #	Length	Width	Height	Storage Volume
	(m)	(m)	(m)	(m^3)
CIP	10.00	7.90	0.50	39.5
Total				**39.5**

Total Storage = **39.5 m^3** **Required Storage Achieved**

Orifice Diameter Calculation (A=Q/(Cd*sqrt(2*g*h)))

Coefficient of Discharge	Cd =	0.62	(sharp)	0.62	Sharp Orifice coefficient of discharge
Allowable Flow Rate	Q =	0.0039	m^3/s	0.80	Tube coefficient of discharge
Force of Gravity	g =	9.81	m/s/s		
Head Height	h =	0.48	m		
Dia of Max. Orifice	dia =	50.93	mm	Use - 50	mm

Flow Rate for Actual Size of Hole (Q=Cd*A*sqrt(2*g*h))

Area of Orifice	A =	0.0020	m^2
Flow Rate through Orifice	Q =	0.0038	m^3/s

Niagara Historical Society Museum Addition
Exhibit #6 - 100 Year Orifice Plate and Storage Volume Calcs

2026-02-23
Job: 251023

Site Data

Site Discharge	Flow	Flow to Davy Street	Adj. Flow (w/o Surface Runoff)	Total Storm Volume
	(m^3/s)	(m^3/s)	(m^3/s)	(m^3)
Pre - Develop.	0.0525	0.0106	0.0063	
Post - Develop.	0.0585	0.0555	0.0512	64.0

Control Node Data

Outlet Pipe	Storm Control Node	Outlet Pipe Size	Outlet Invert Elev.	Elev. @ Orifice
		(m)	(m)	(m)
7	CBMH. 4	0.200	86.14	86.17

* Volume calculated using SWMM 5.1 modelling software in accordance with the flow rate for actual size of the orifice.

Storm Retention Elevation 86.96 m
Head Height 0.80 m

Storm Retention Elev. Check **86.96 m**

Cast-in-Place Concrete Tank Storage

Model #	Length	Width	Height	Storage Volume
	(m)	(m)	(m)	(m^3)
CIP	10.00	7.90	0.81	64.0
Total				**64.0**

Total Storage = 64.0 m^3 **Required Storage Achieved**

Orifice Diameter Calculation (A=Q/(Cd*sqrt(2*g*h)))

Coefficient of Discharge	Cd =	0.62	(sharp)	0.62	Sharp Orifice coefficient of discharge
Allowable Flow Rate	Q =	0.0063	m^3/s	0.80	Tube coefficient of discharge
Force of Gravity	g =	9.81	m/s/s		
Head Height	h =	0.80	m		
Dia of Max. Orifice	dia =	57.02	mm	Use - 50	mm

Flow Rate for Actual Size of Hole (Q=Cd*A*sqrt(2*g*h))

Area of Orifice	A =	0.0020	m^2
Flow Rate through Orifice	Q =	0.0048	m^3/s

APPENDIX ‘A’

Hydroguard HG4

Sizing Calculations and Schematic

Hydroworks Sizing Summary

Niagara Historical Society Museum Addition
43 Castlereagh St, NOTL

05-27-2021

Recommended Size: HG 4

A Hydroguard HG 4 is recommended to provide 70 % annual TSS removal based on a drainage area of .16 (ha) with an imperviousness of 70 % and St. Catherines A, Ontario rainfall for the 20 um to 2000 um particle size distribution.

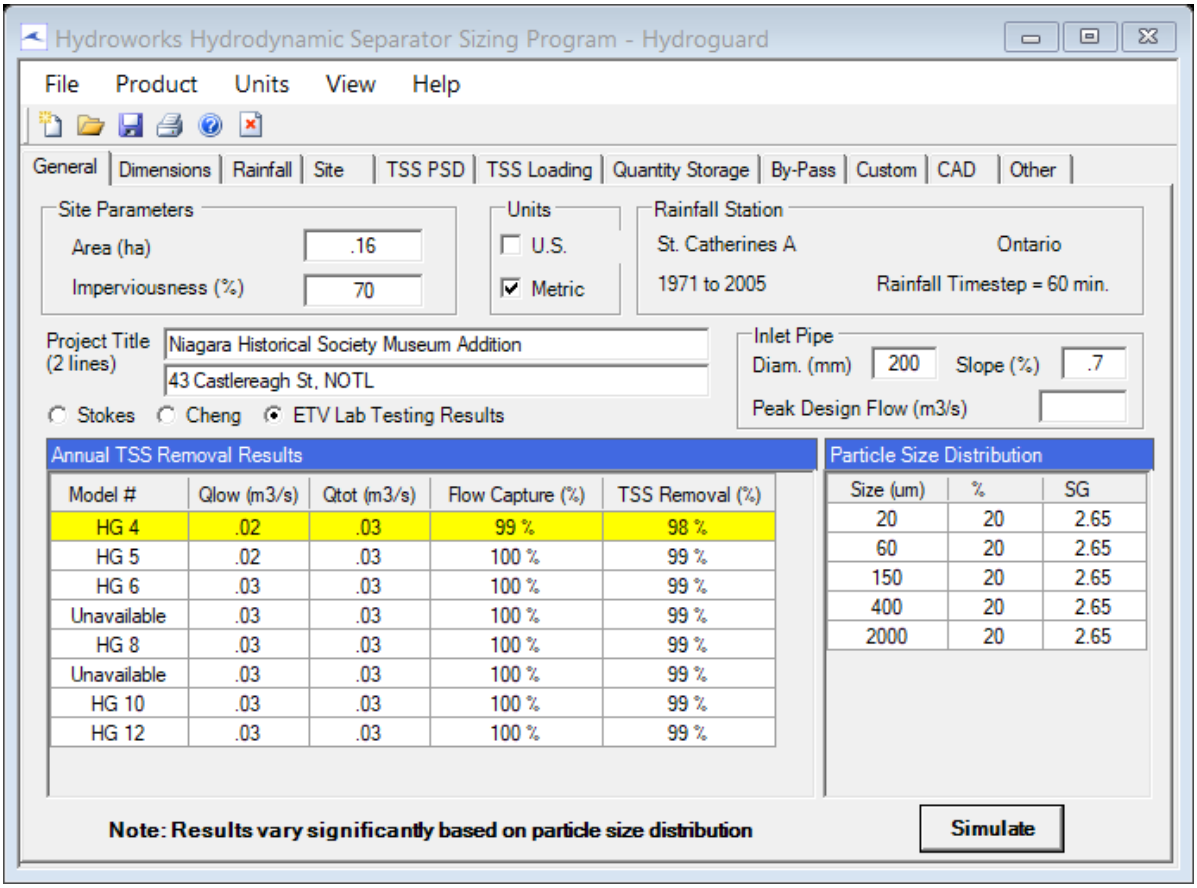
The recommended Hydroguard HG 4 treats 99 % of the annual runoff and provides 98 % annual TSS removal for the St. Catherines A rainfall records and 20 um to 2000 um particle size distribution.

The Hydroguard has a headloss coefficient (K) of 1.6. Since a peak flow was not specified, headloss was calculated using the full pipe flow of .03 (m3/s) for the given 200 (mm) pipe diameter at .7% slope. The headloss was calculated to be 62 (mm) based on a flow depth of 200 (mm) (full pipe flow).

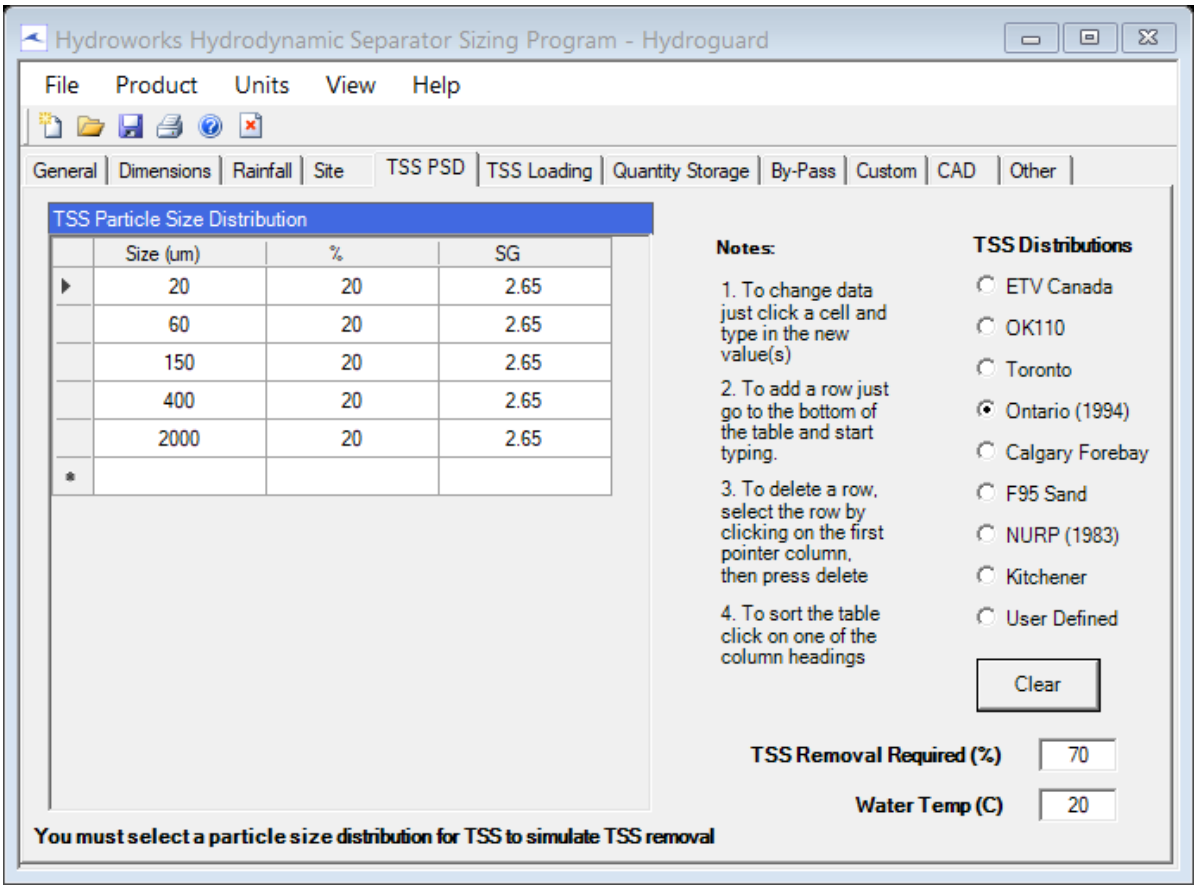
This summary report provides the main parameters that were used for sizing. These parameters are shown on the summary tables and graphs provided in this report.

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.

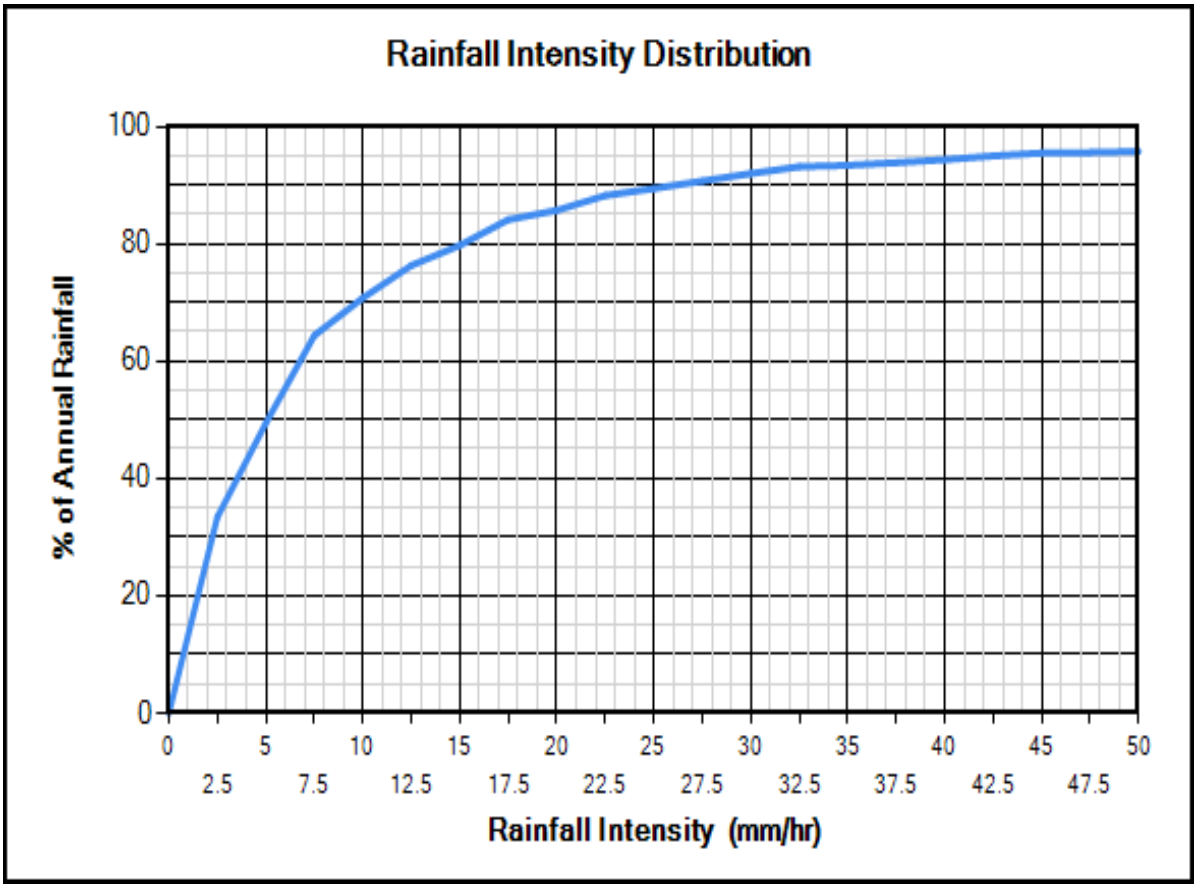
TSS Removal Sizing Summary



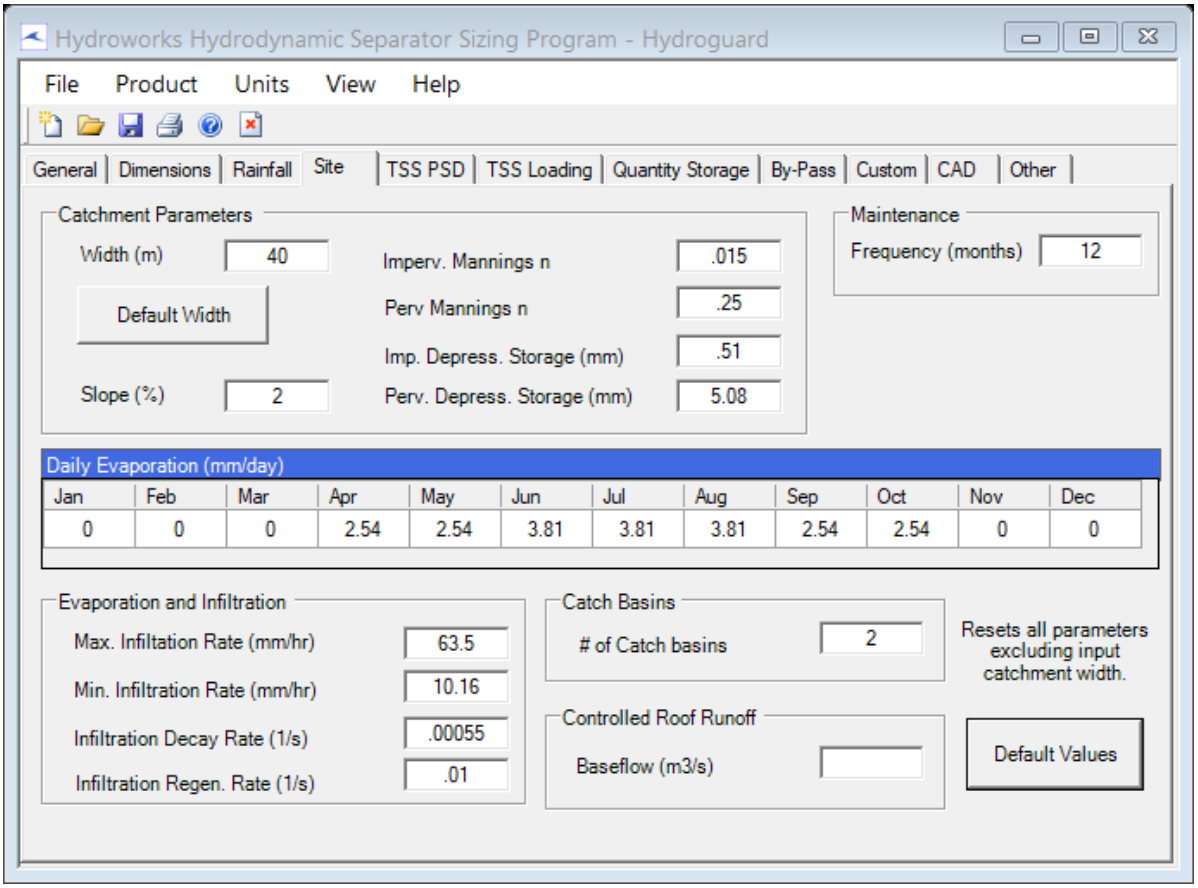
TSS Particle Size Distribution



Rainfall Station - St. Catherines A, Ontario(1971 to 2005)



Site Physical Characteristics



Dimensions And Capacities

Hydroworks Hydrodynamic Separator Sizing Program - Hydroguard

File Product Units View Help

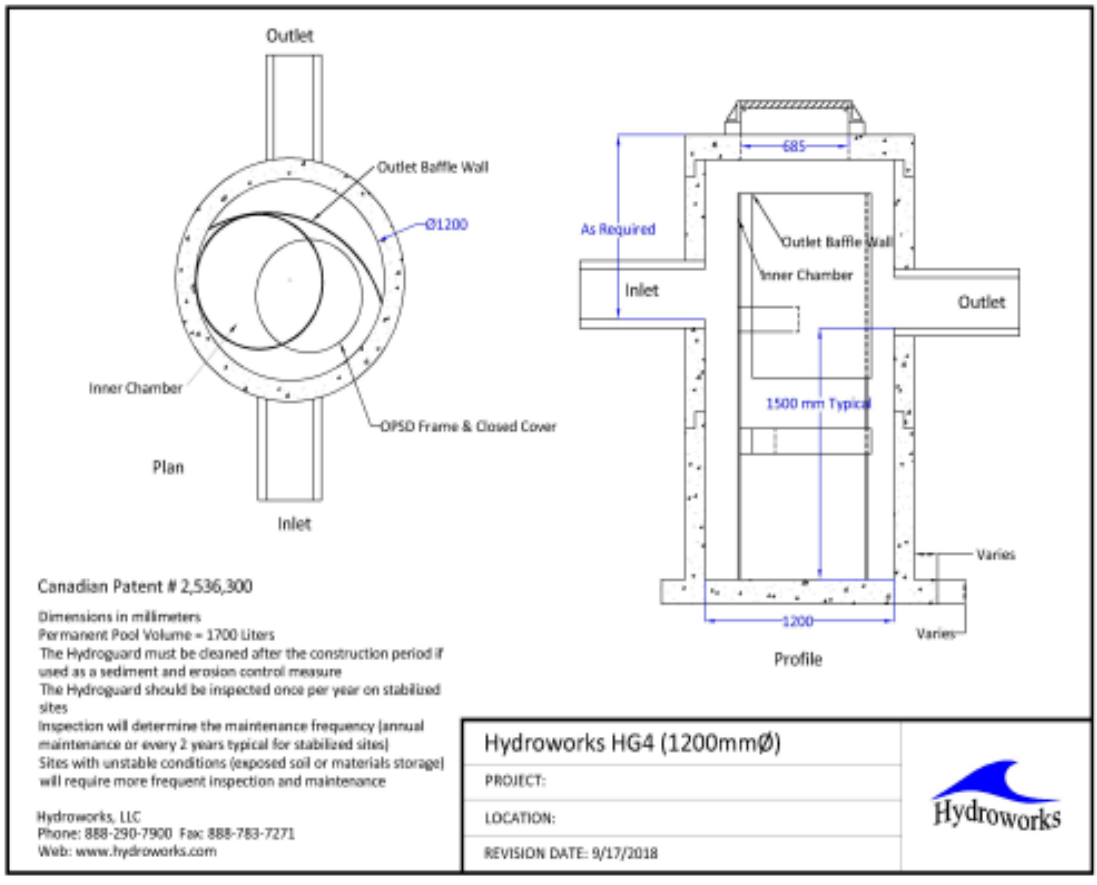
General | Dimensions | Rainfall | Site | TSS PSD | TSS Loading | Quantity Storage | By-Pass | Custom | CAD | Other

Dimensions and Capacities

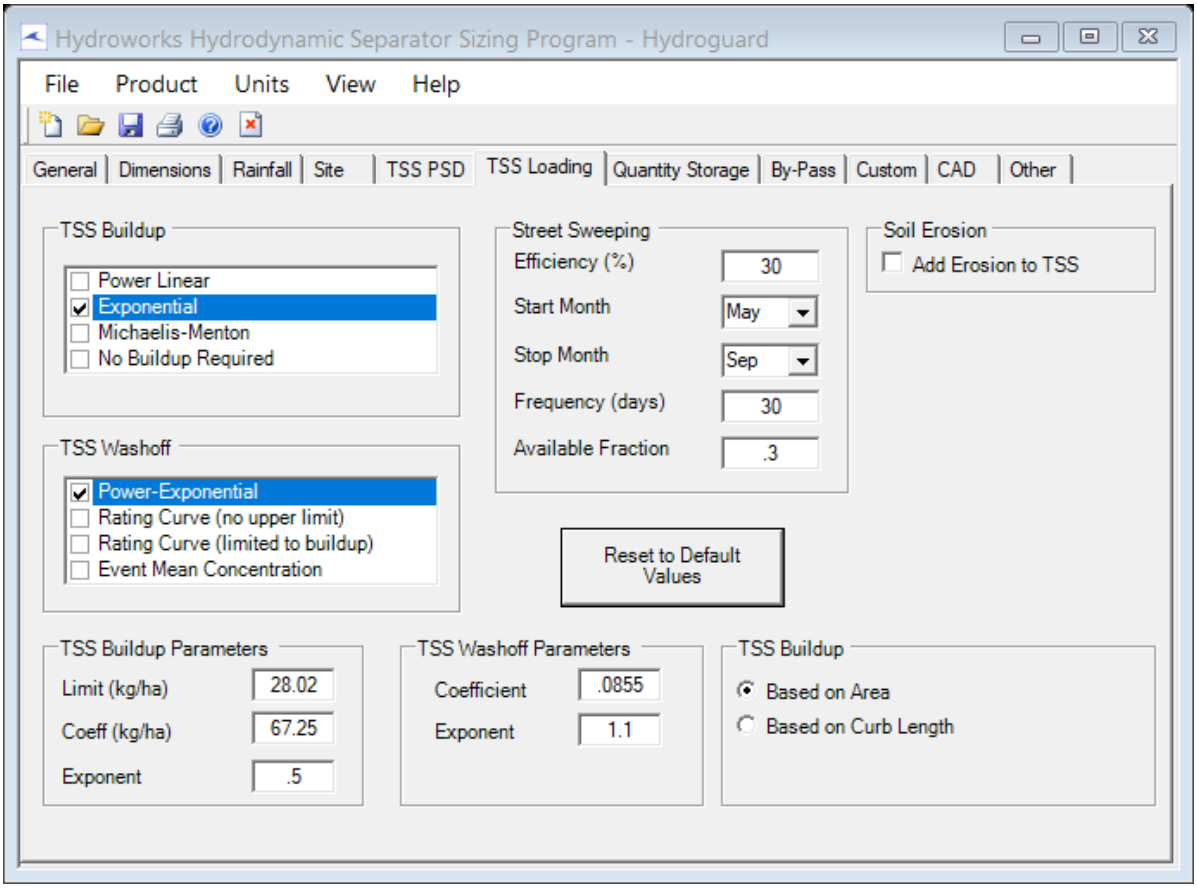
Model	Diam. (m)	Depth (m)	Float. Vol. (L)	Sediment Vol. (m3)	Total Vol. (m3)
HG 4	1.22	1.52	278	1.2	1.8
HG 5	1.52	1.68	504	2.1	3
HG 6	1.83	1.83	833	3.3	4.8
Unavailable	2.13	1.98	1270	4.8	7.1
HG 8	2.44	2.13	1853	6.8	10
Unavailable	2.74	2.44	2686	9.9	14.4
HG 10	3.05	2.74	3619	14.1	20
HG 12	3.66	3.35	6672	24.9	35.2

Depth = Depth from outlet invert to inside bottom of tank

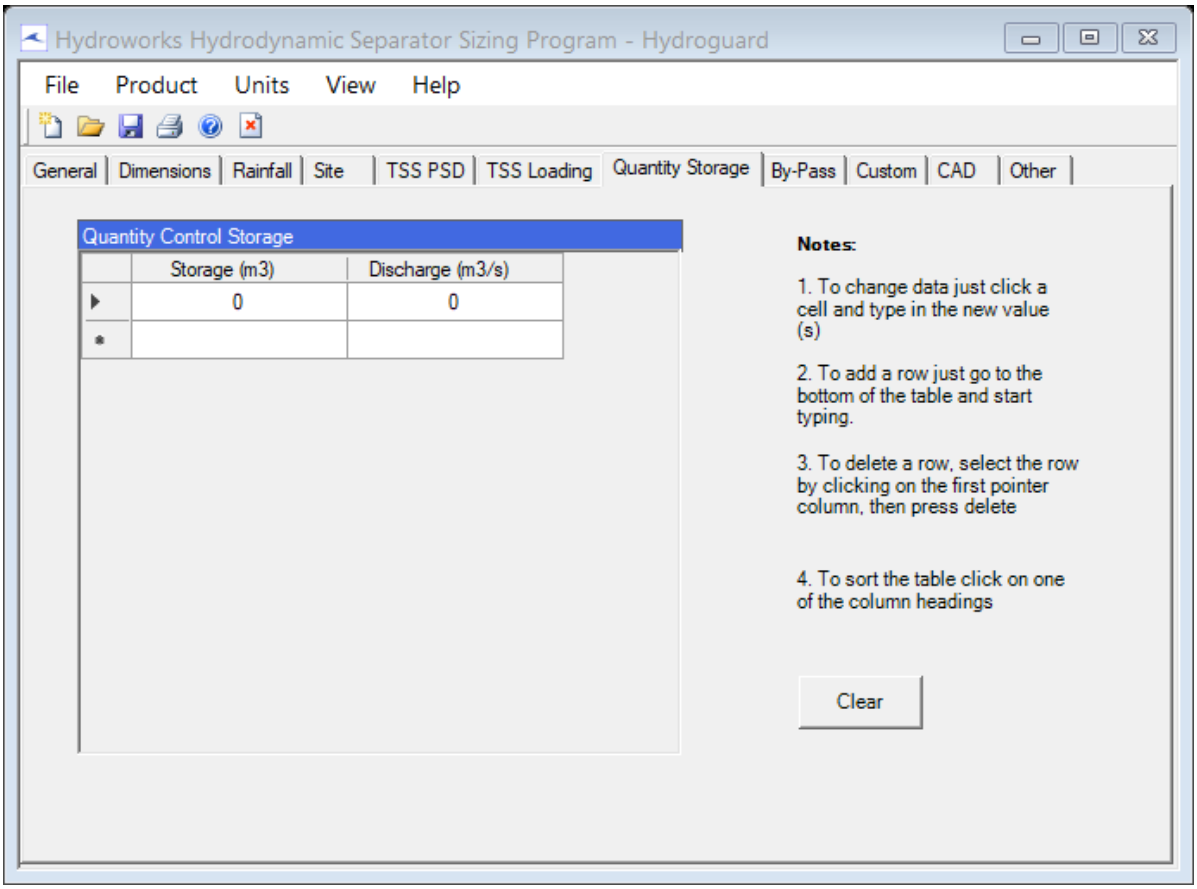
Generic HG 4 CAD Drawing



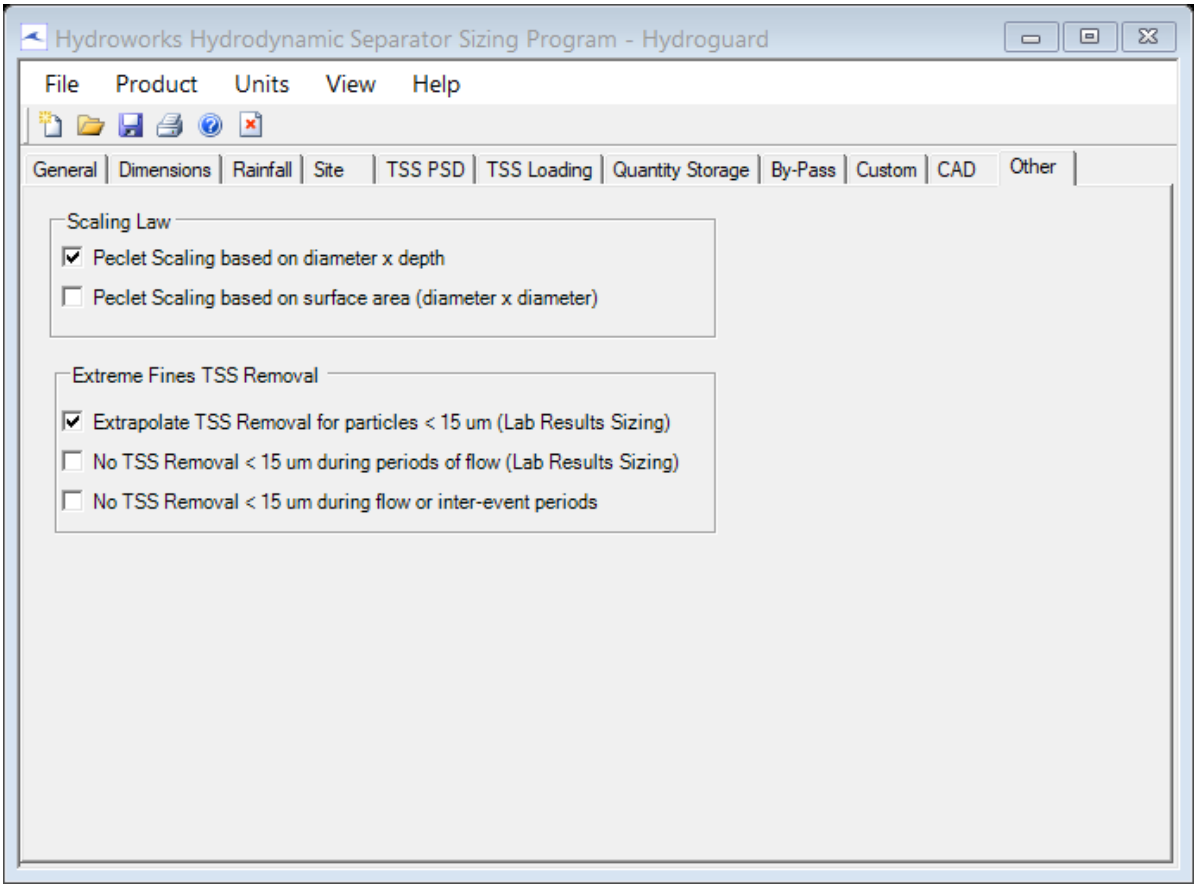
TSS Buildup And Washoff



Upstream Quantity Storage



Other Parameters



Hydroworks Sizing Program - Version 5.0

APPENDIX ‘B’

EPA SWMM v5.1

Output File

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.015)

Historical Museum, 5yr Storm

****
Element Count
****
Number of rain gages 1
Number of subcatchments ... 1
Number of nodes 2
Number of links 1
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
1	3hrChicago5yr_R0.46	INTENSITY	5 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
POST	0.28	60.60	54.60	1.5000	1	Storage

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
DavySt_POST	OUTFALL	100.00	0.00	0.0	
Storage	STORAGE	101.00	1.00	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
Outlet	Storage	DavySt_POST	ORIFICE			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****
Flow Units ..... LPS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... NO
  Groundwater ..... NO
  Flow Routing ..... YES
  Ponding Allowed ..... NO
  Water Quality ..... NO
Infiltration Method ..... CURVE_NUMBER
Flow Routing Method ..... DYNWAVE
Surcharge Method ..... EXTRAN
Starting Date 08/08/2014 00:00:00
Ending Date 08/08/2014 06:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Wet Time Step 00:05:00
Dry Time Step 01:00:00
Routing Time Step ..... 30.00 sec
Variable Time Step ..... YES

Maximum Trials 8
Number of Threads 1
Head Tolerance ..... 0.001524 m

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	0.011	38.537
Evaporation Loss	0.000	0.000
Infiltration Loss	0.005	17.206
Surface Runoff	0.006	20.496
Final Storage	0.000	0.907
Continuity Error (%)	-0.187	

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.006	0.057
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.004	0.041
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.002	0.016
Continuity Error (%)	0.000	

Time-Step Critical Elements

None

Highest Flow Instability Indexes

All links are stable.

Routing Time Step Summary

Minimum Time Step	:	29.50 sec
Average Time Step	:	29.96 sec
Maximum Time Step	:	30.00 sec
Percent in Steady State	:	0.00
Average Iterations per Step	:	2.00
Percent Not Converging	:	0.00
Time Step Frequencies	:	
30.000 - 13.228 sec	:	100.00 %
13.228 - 5.833 sec	:	0.00 %
5.833 - 2.572 sec	:	0.00 %
2.572 - 1.134 sec	:	0.00 %
1.134 - 0.500 sec	:	0.00 %

Subcatchment Runoff Summary

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
POST	38.54	0.00	0.00	17.21	20.50	0.00	20.50	0.06	36.06	0.532

Node Depth Summary

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
DavySt_POST	OUTFALL	0.00	0.00	100.00	0 00:00	0.00
Storage	STORAGE	0.03	0.06	101.06	0 02:02	0.06

Node Inflow Summary

Node	Type	Maximum Lateral Inflow LPS	Maximum Total Inflow LPS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
DavySt_POST	OUTFALL	0.00	3.80	0 02:03	0	0.0408	0.000
Storage	STORAGE	36.06	36.06	0 01:30	0.0566	0.0566	-0.004

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow LPS
Storage	0.022	3	0	0	0.039	6	0 02:02	3.80

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow LPS	Max Flow LPS	Total Volume 10^6 ltr
DavySt_POST	89.32	2.11	3.80	0.041
System	89.32	2.11	3.80	0.041

****
Link Flow Summary
****

Link	Type	Maximum |Flow| LPS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
Outlet	ORIFICE	3.80	0 02:03			0.28

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Mon Feb 23 11:50:48 2026
Analysis ended on: Mon Feb 23 11:50:48 2026
Total elapsed time: < 1 sec

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.015)

Historical Museum, 100yr Storm

****
Element Count
****
Number of rain gages 1
Number of subcatchments ... 1
Number of nodes 2
Number of links 1
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
1	3hrChicago100yr_R0.46	INTENSITY	5 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
POST	0.28	60.60	54.60	1.5000	1	Storage

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
DavySt_POST	OUTFALL	100.00	0.00	0.0	
Storage	STORAGE	101.00	1.00	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
Outlet	Storage	DavySt_POST	ORIFICE			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****
Flow Units ..... LPS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... NO
  Groundwater ..... NO
  Flow Routing ..... YES
  Ponding Allowed ..... NO
  Water Quality ..... NO
Infiltration Method ..... CURVE_NUMBER
Flow Routing Method ..... DYNWAVE
Surcharge Method ..... EXTRAN
Starting Date 08/08/2014 00:00:00
Ending Date 08/08/2014 06:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Wet Time Step 00:05:00
Dry Time Step 01:00:00
Routing Time Step ..... 30.00 sec
Variable Time Step ..... YES

Maximum Trials 8
Number of Threads 1
Head Tolerance ..... 0.001524 m

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	0.017	60.011
Evaporation Loss	0.000	0.000
Infiltration Loss	0.007	26.767
Surface Runoff	0.009	32.237
Final Storage	0.000	1.095
Continuity Error (%)	-0.146	

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.009	0.089
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.006	0.056
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.003	0.033
Continuity Error (%)	0.000	

Time-Step Critical Elements

None

Highest Flow Instability Indexes

All links are stable.

Routing Time Step Summary

Minimum Time Step	:	29.50 sec
Average Time Step	:	29.96 sec
Maximum Time Step	:	30.00 sec
Percent in Steady State	:	0.00
Average Iterations per Step	:	2.00
Percent Not Converging	:	0.00
Time Step Frequencies	:	
30.000 - 13.228 sec	:	100.00 %
13.228 - 5.833 sec	:	0.00 %
5.833 - 2.572 sec	:	0.00 %
2.572 - 1.134 sec	:	0.00 %
1.134 - 0.500 sec	:	0.00 %

Subcatchment Runoff Summary

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
POST	60.01	0.00	0.00	26.77	32.24	0.00	32.24	0.09	56.28	0.537

Node Depth Summary

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
DavySt_POST	OUTFALL	0.00	0.00	100.00	0 00:00	0.00
Storage	STORAGE	0.06	0.09	101.09	0 02:12	0.09

Node Inflow Summary

Node	Type	Maximum Lateral Inflow LPS	Maximum Total Inflow LPS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
DavySt_POST	OUTFALL	0.00	4.80	0 02:13	0	0.0565	0.000
Storage	STORAGE	56.28	56.28	0 01:30	0.089	0.089	-0.003

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow LPS
Storage	0.040	6	0	0	0.064	9	0 02:12	4.80

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow LPS	Max Flow LPS	Total Volume 10^6 ltr
DavySt_POST	91.26	2.86	4.80	0.056
System	91.26	2.86	4.80	0.056

****
Link Flow Summary
****

Link	Type	Maximum |Flow| LPS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
Outlet	ORIFICE	4.80	0 02:13			0.77

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Mon Feb 23 11:54:19 2026
Analysis ended on: Mon Feb 23 11:54:19 2026
Total elapsed time: < 1 sec