PROPOSED ORANGEVILLE FIRE STATION DEVELOPMENT
10 COMMERCE ROAD, ORANGEVILLE

STORM WATER MANAGEMENT DESIGN BRIEF
NEW DEVELOPMENT DRAINAGE SYSTEM

REV 5 – August 22, 2025

PREPARED BY:

HALLEX ENGINEERING LTD.

HALLEX PROJECT #220705

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NIAGARA FALLS, ON L2E 4C9

HALLEX HAMILTON
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1. PRE-DEVELOPMENT CONDITIONS

1.1 LOCATION

The proposed Fire Station development is located at 10 Commerce Road, which is south of the Commerce Road and Centennial Road intersection in the Town of Orangeville, ON.

1.2 DRAINAGE PATTERN

The current drainage path for the site consists of overland sheet flow to the existing 600mm municipal storm sewer at Centennial Road. Given the development will take place on the entire site, the proposed stormwater management controls will ensure the one-hundred-year post development flow rate is controlled to the five-year pre-development flow rate to the existing municipal sewer at Centennial Road.

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 granular and asphalt 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 events as per the Town of Orangeville intensity-duration-frequency curve.

2.2 DRAINAGE

The proposed design requires 260.5 metres of storm sewer piping, 81.1 meters of bioretention swale, 75.5 meters of V-swale, three precast catch basin, seven precast maintenance holes, a double ditch inlet catch basin maintenance hole, a HydroStorm HS12 oil and grit separator and 368 Xerxes Model S-22 underground storage chambers.

3. DESIGN CONSIDERATIONS

3.1 PRE-DEVELOPMENT

3.1.1 Peak Runoff

The total drainage area for the development is 1.990 hectares with an existing runoff coefficient of 0.27 based on the existing grass and paved 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 Orangeville 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	Centennial Road	1.990	10
5-year Storm	**A,ha**	**C**	**i,mm/h**	**Q, L/s**
Area.1	1.990	0.27	96	142.5

Therefore, the total pre-development flow for the subject site is 142.5L/s for the five-year storm.

3.1.2 Quantity

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

3.1.3 Quality

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

3.2 POST-DEVELOPMENT SITE DRAINAGE

3.2.1 Peak Runoff

The proposed Fire Station development consists of the construction of a new building, asphalt laneway & parking areas, gravel areas and grass areas. The resulting runoff coefficient in the post-development condition of the site is 0.61.

The proposed development will drain through the proposed onsite storm drainage system and shall discharge to the existing 600mm municipal storm sewer at Centennial Road Street as per the existing site condition. Part of the site will continue to drain directly to Centennial Road, via sheet flow, similar to the pre-development condition.

The proposed sewer system is designed to convey the runoff from hard surfaces (pavement and concrete) and gravel and grass surfaces sloped towards the proposed CB’s and CBMH’s all across the site. Additionally, the proposed sewer will pick up flows from the building roof. As the roof design consists mostly of a flat roof, a direct connection to the sewer is proposed to convey flows, while the small portion of sloped roofs will discharge to grade through downspouts towards permeable surfaces.

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 Centennial Road, as outlined in Exhibit #1, is calculated to be 12.97 minutes.

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

Subcatchment	**Description**	**Draining to**	**Area, ha**	**Tc, min**
Area.1	Sheet	Centennial Road	0.354	10
Prop. Sewer	Sewer	Centennial Road	1.636	10
5-year Storm	**A,ha**	**C**	***i*,mm/h**	**Q, L/s**
Area.1	0.354	0.39	96	37.4
Prop. Sewer	1.636	0.66	96	249.2
TOTAL	**1.990**	**0.61**	**96**	**286.6**
100-year Storm	**A,ha**	**C**	***i*,mm/h**	**Q, L/s**
Area.1	0.354	0.39	152	59.3
Prop. Sewer	1.636	0.65	152	394.7
TOTAL	**1.990**	**0.61**	**152**	**454.0**

Therefore, the total post-development flow for the subject site is 286.6L/s for the five-year storm and 454.0L/s for the one-hundred-year storm. The flows and other design information are contained in Exhibit #1 for the five -year storm and Exhibit #2 for the one-hundred-year storm at the end of the design brief.

3.2.2 Quantity

The post-development storm water runoff to the existing 600mm municipal storm sewer at Centennial Road 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 175mm diameter orifice plate at the outlet side of MH.10. The orifice plate will ensure the one-hundred-year post-development runoff is controlled to the five-year pre-development flow rate. The resulting 356m^3 volume generated from the one-hundred-year storm will be contained within the proposed Xerxes Model S-22 underground storage chambers.

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:

	5-Year Pre- Development Flow Rate (L/s)	**100-Year Post- Development Uncontrolled Flow Rate (L/s)**	**100-Year Post- Development Controlled Flow Rate (L/s)**
5-year Storm			
Area.1	142.5	59.3	59.3
Prop. Sewer	N/A	394.7	81.8
TOTAL	**142.5**	**454.0**	**141.1**

The orifice plate sizing and subsequent storage volume for the detained flow are indicated in Exhibit #3 for the one-hundred-year storm at the end of the design brief.

3.2.3 Quality

The storm water collected in the proposed development passes through a HydroStorm HS12, which achieves a total suspended solids removal of at least 80%. This value is equal to the required 'enhanced' treatment of 80% 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.

Additionally, a bioretention swale is proposed for the development to convey runoff from grass, gravel and asphalt surfaces to the proposed storm sewer on-site. The bioretention swale has been designed in accordance with section 4.8 of the 'Low Impact Development Stormwater Management Planning and Design Guide', to support storm water conveyance and quality enhancement.

3.2.4 LID implementation and suitability

A geotechnical investigation was carried out at the subject site to confirm the soil conditions, provide geotechnical recommendations, and assess the suitability of the proposed LID features. The results of the Geotechnical Investigation, Field Infiltration Test, and Water Balance Analysis, prepared by Fisher Engineering on July 25th and 26th, 2024, were reviewed to determine the impact of the proposed LID features considering the site conditions.

The proposed bioretention swale will be located adjacent to areas of brown/reddish-brown silt and clayey silt near BH31 and BH103. These boreholes showed no signs of groundwater during the investigation. However, the soils were classified as clayey and of low permeability. As such, the swale is not intended to serve as the primary infiltration system but as a supportive measure to provide water quality treatment and temporary surface storage, while conveying runoff to the proposed storm sewer.

Similarly, The proposed Xerxes S-22 chambers will be located in an area of brown/reddish-brown silt/clayey silt (BH10) and silty sand to sandy silt (BH8). While groundwater was encountered at BH9 and BH12, these boreholes are outside the footprint of the proposed chambers, meanwhile, at BH8 and BH10, soils were dry, and no groundwater was encountered, indicating no major interference with the chamber installation or functioning. Given the low permeability of the soils at BH10 and adjacent areas, the chambers are not expected to operate as primary infiltration system but rather as a supporting retention system, while the storm sewer discharges to the municipal sewer at the 5-year-storm pre-development flow rate.

Furthermore, Infiltration testing was carried out at the southwest corner of the site, at the outdoor training area, to assess the infiltration capabilities of this gravel area, that contributes most of the flow directed to the bioretention swale. The results of the Fisher Engineering testing indicate that the underlying native soils might be suitable for the construction of infiltration facilities, especially, at TH1, while TH2 to TH4 present lower infiltration capacities based on the minimum 15mm/hr infiltration rate required as per the MOE guidelines. As a result, minor infiltration will occur at the gravel area before conveying to the bioretention swale, but efforts to improve the drainage and depress the higher water levels of some areas of the site, will be made through grading and drainage modifications, as noted in section 4 of the Infiltration Report prepared by Fisher Engineering.

Overall, both the bioretention swale and the underground chamber system are supportive mechanisms of the proposed stormwater management system. Their function is to provide storage, conveyance, and water quality in conjunction with the storm sewer infrastructure, instead of main mechanisms to discharge runoff. The primary outlet for stormwater discharge, will be the proposed storm sewer to the municipal storm sewer on Centennial Road at the proposed 5-year-storm pre-development flow rate.

Additionally, to mitigate the hydrological effects of the proposed development and the increase in the number of impervious surfaces, 833 cubic meters of storage have been retained on site and will dissipate through infiltration. The volume will be stored within the proposed Xerxes underground storage chambers below the outlet elevation and within the bio-retention swale along the Northwest property line. The water balance calculations can be found in Exhibit #4 at the end of this report.

3.2.5 Maintenance Recommendations

The storm sewer system includes pipes, catchbasins, maintenance holes, swales, the oil/grit separator and underground storage chambers. 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 HydroStorm Oil/Grit Separator (Annually). Procedures for inspection are provided in the HydroStorm Owner's Manual. A vacuum truck is to be used for maintenance of the HydroStorm.
7. Inspect the Xerxes Model S-22 chambers (Annually). Procedures for inspection are provided in the Triton Stormwater Solutions Main Header Row Operation and Maintenance Manual. A vacuum truck is to be used for maintenance of the Triton chamber system.

4. CONCLUSION

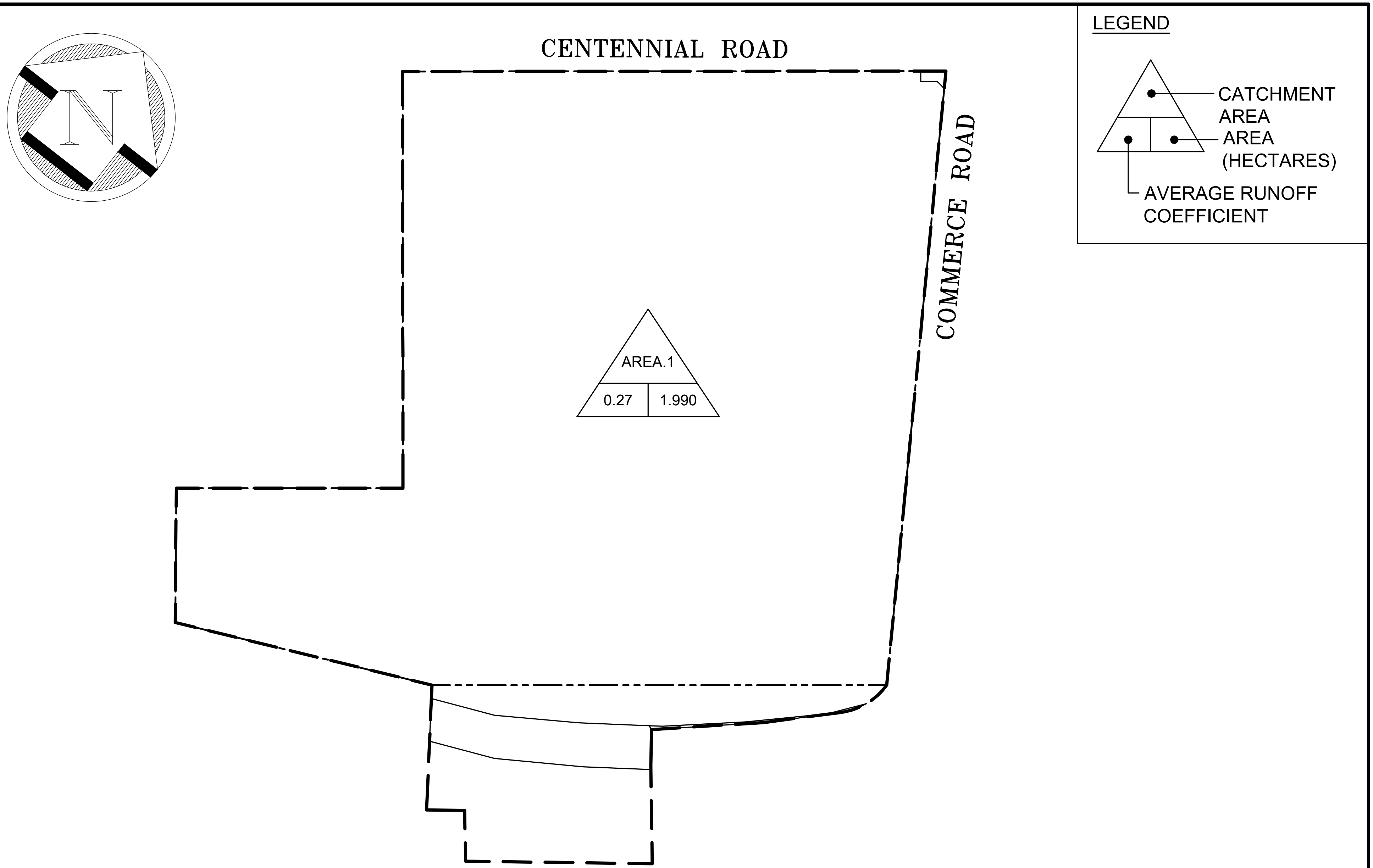
The aforementioned calculations and recommendations for the storm drainage system are based on the current design for the site as of writing this report.

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

Anthony Infurna, C.E.T., rcji
Project Manager



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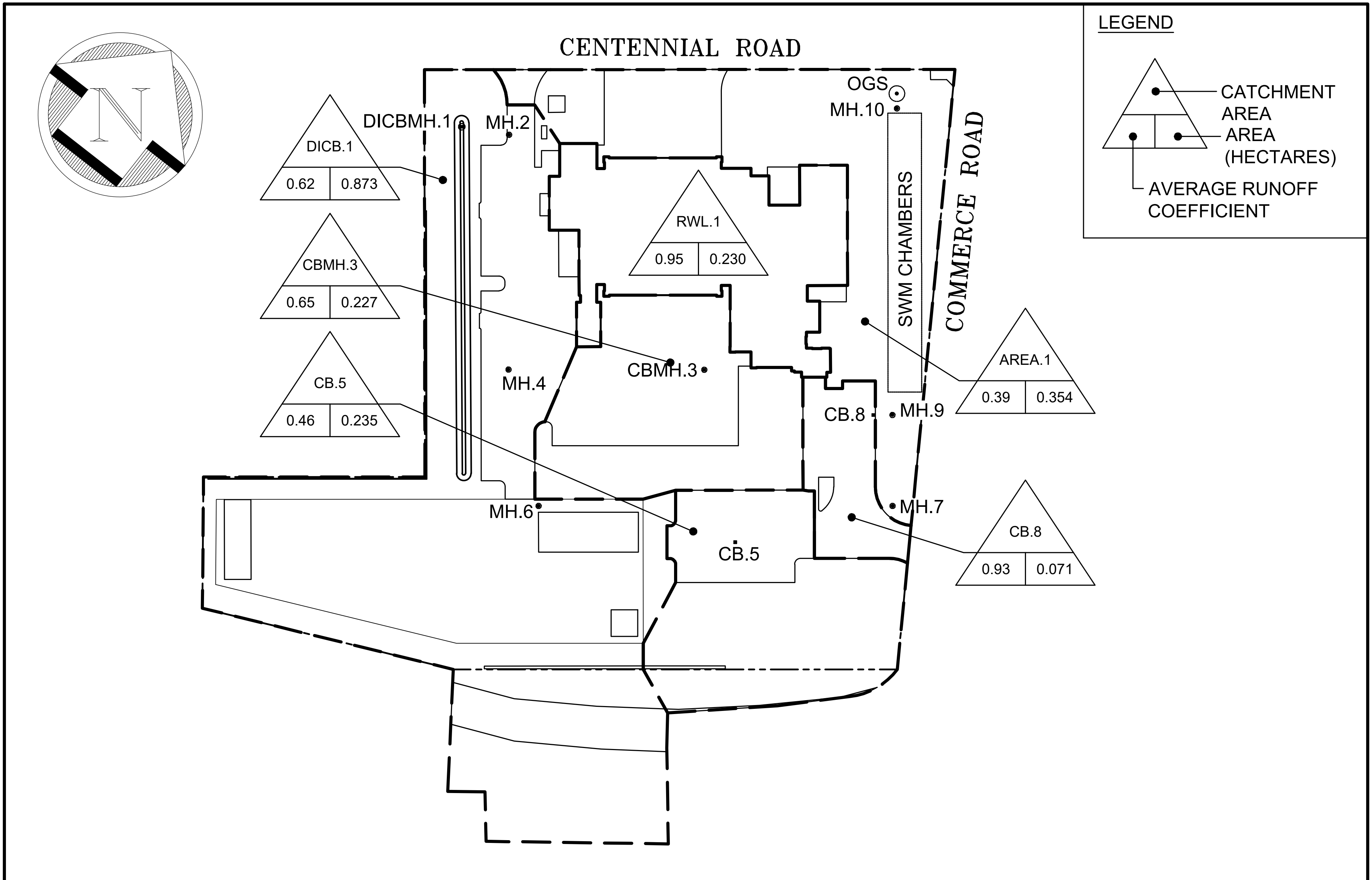
PROJECT: PROPOSED ORANGEVILLE FIRE STATION
10 COMMERCE ROAD, ORANGEVILLE, ON

SHEET TITLE: PRE-DEVELOPMENT CATCHMENT AREA PLAN

DATE: 2025/06/24
SCALE: 1:1200
DR. BY: MA
CH. BY: AI /JH
JOB No.: 220705
DWG. CSK1
REV. 2



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PROJECT:
PROPOSED ORANGEVILLE FIRE STATION
10 COMMERCE ROAD, ORANGEVILLE, ON

SHEET TITLE:
POST-DEVELOPMENT CATCHMENT AREA PLAN

DATE: 2025/06/24
SCALE: 1:1200
DR. BY: MA
CH. BY: AI /JH
JOB No.: 220705
DWG. CSK2
REV. 2

Proposed Orangeville Fire Station
Exhibit #1 - 5 Year Post - Development Calculations

MUNICIPALITY: **Orangeville**

Rainfall Intensity Values =
A= 1166.822
B= 11.326
C= 0.816

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**	**Prpty 1**	**N/A**	**0.354**	**0.354**	**10.00**	**N/A**	**96**	**27670**	**3235.1**	**0.0374**	**0.0374**	**0.1000**	**N/A**	**N/A**	**0.100**	**N/A**	**N/A**
Paved	-	-	-	0.074	-	-	-	-	21905.3	1621.0	-	-	-	-	-	-	-	-
Grass	-	-	-	0.280	-	-	-	-	5764.6	1614.1	-	-	-	-	-	-	-	-
2	**DI CB. 1**	**MH. 2**	**10.7**	**0.873**	**0.873**	**10.00**	**0.14**	**96**	**47269**	**12484.9**	**0.1445**	**0.1445**	**0.0070**	**0.1467**	**1.3282**	**0.375**	**449.14**	**449.06**
Paved	-	-	-	0.226	-	-	-	-	21905.3	4950.6	-	-	-	-	-	-	-	-
Gravel	-	-	-	0.275	-	-	-	-	19599.5	5389.9	-	-	-	-	-	-	-	-
Grass	-	-	-	0.372	-	-	-	-	5764.6	2144.4	-	-	-	-	-	-	-	-
3	**MH. 2**	**MH. 4**	**62.5**	**0.000**	**0.873**	**10.14**	**1.07**	**96**	**0**	**12484.9**	**0.1445**	**0.1445**	**0.0030**	**0.1562**	**0.9819**	**0.450**	**449.00**	**448.81**
4	**CB. 3**	**MH. 4**	**28.2**	**0.000**	**0.000**	**10.00**	**0.55**	**96**	**0**	**0.0**	**0.0000**	**0.0000**	**0.0050**	**0.0420**	**0.8566**	**0.250**	**449.02**	**448.87**
5	**MH. 4**	**MH. 6**	**23.2**	**0.000**	**0.873**	**11.21**	**0.40**	**92**	**0**	**12484.9**	**0.1445**	**0.1445**	**0.0030**	**0.1562**	**0.9819**	**0.450**	**448.81**	**448.74**
6	**CB. 5**	**MH. 6**	**8**	**0.235**	**0.235**	**10.00**	**0.13**	**96**	**27670**	**2484.5**	**0.0288**	**0.0288**	**0.0100**	**0.0328**	**1.0440**	**0.200**	**449.09**	**449.01**
Paved	-	-	-	0.070	-	-	-	-	21905.3	1533.4	-	-	-	-	-	-	-	-
Grass	-	-	-	0.165	-	-	-	-	5764.6	951.2	-	-	-	-	-	-	-	-
7	**MH. 6**	**MH. 7**	**63.6**	**0.000**	**1.108**	**11.61**	**0.94**	**91**	**0**	**14969.4**	**0.1733**	**0.1733**	**0.0040**	**0.1803**	**1.1338**	**0.450**	**448.68**	**448.42**
8	**MH. 7**	**MH. 9**	**19.6**	**0.000**	**1.108**	**12.55**	**0.29**	**88**	**0**	**14969.4**	**0.1733**	**0.1733**	**0.0040**	**0.1803**	**1.1338**	**0.450**	**448.36**	**448.28**
9	**CB. 8**	**MH. 9**	**3.5**	**0.071**	**0.071**	**10.00**	**0.06**	**96**	**27670**	**1523.0**	**0.0176**	**0.0176**	**0.0100**	**0.0328**	**1.0440**	**0.200**	**448.38**	**448.34**
Paved	-	-	-	0.069	-	-	-	-	21905.3	1511.5	-	-	-	-	-	-	-	-
Grass	-	-	-	0.002	-	-	-	-	5764.6	11.5	-	-	-	-	-	-	-	-
10	**MH. 9**	**CHMBR 1**	**5.8**	**0.000**	**1.179**	**12.84**	**0.08**	**87**	**0**	**16492.4**	**0.1909**	**0.1909**	**0.0050**	**0.2016**	**1.2676**	**0.450**	**448.28**	**448.25**
11	**RWL. 1**	**MH. 10**	**1.1**	**0.230**	**0.230**	**10.00**	**0.02**	**96**	**21905**	**5038.2**	**0.0583**	**0.0583**	**0.0100**	**0.0595**	**1.2115**	**0.250**	**448.90**	**448.88**
Roof	-	-	-	0.230	-	-	-	-	21905.3	5038.2	-	-	-	-	-	-	-	-
12	**MH. 10**	**CHMBR 1**	**23.9**	**0.000**	**0.230**	**10.02**	**0.33**	**96**	**0**	**5038.2**	**0.0583**	**0.0583**	**0.0100**	**0.0595**	**1.2115**	**0.250**	**448.82**	**448.58**
13	**CHMBR 1**	**MH. 11**	**1.8**	**0.000**	**1.409**	**12.92**	**0.03**	**87**	**0**	**21530.6**	**0.2492**	**0.2492**	**0.0050**	**0.3041**	**1.4048**	**0.525**	**448.25**	**448.24**
14	**MH. 11**	**OGS 1**	**1**	**0.000**	**1.409**	**12.95**	**0.02**	**86**	**0**	**21530.6**	**0.2492**	**0.2492**	**0.0050**	**0.3041**	**1.4048**	**0.525**	**448.21**	**448.20**
15	**OGS 1**	**Street 1**	**7.6**	**0.000**	**1.409**	**12.97**	**0.09**	**86**	**0**	**21530.6**	**0.2492**	**0.2492**	**0.0110**	**0.1014**	**1.4348**	**0.300**	**448.20**	**448.12**

Run-off Coefficients Used:

Roof Structure C = 0.95
Paved Surface C = 0.95
Gravel Surface C = 0.85
Grass Surface C = 0.25

Velocity Range:

Minimum Velocity = 0.60 m/s
Maximum Velocity = 6.00 m/s

Time of Concentration:

Time of Concentration = 10 min

Proposed Orangeville Fire Station
Exhibit #2 - 100 Year Post - Development Calculations

MUNICIPALITY: **Orangeville**

Rainfall Intensity Values = A= 4338.383, B= 27.408, C= 0.925

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**	**Prpty 1**	**N/A**	**0.354**	**0.354**	**10.00**	**N/A**	**152**	**43826**	**5123.9**	**0.0593**	**0.0593**	**0.1000**	**N/A**	**N/A**	**0.100**	**N/A**	**N/A**
Paved	-	-	-	0.074	-	-	-	-	34695.3	2567.5	-	-	-	-	-	-	-	-
Grass	-	-	-	0.280	-	-	-	-	9130.3	2556.5	-	-	-	-	-	-	-	-
2	**DI CB. 1**	**MH. 2**	**10.7**	**0.873**	**0.873**	**10.00**	**0.14**	**152**	**74869**	**19774.5**	**0.2289**	**0.2289**	**0.0070**	**0.1467**	**1.3282**	**0.375**	**449.14**	**449.06**
Paved	-	-	-	0.226	-	-	-	-	34695.3	7841.1	-	-	-	-	-	-	-	-
Gravel	-	-	-	0.275	-	-	-	-	31043.2	8536.9	-	-	-	-	-	-	-	-
Grass	-	-	-	0.372	-	-	-	-	9130.3	3396.5	-	-	-	-	-	-	-	-
3	**MH. 2**	**MH. 4**	**62.5**	**0.000**	**0.873**	**10.14**	**1.07**	**152**	**0**	**19774.5**	**0.2289**	**0.2289**	**0.0030**	**0.1562**	**0.9819**	**0.450**	**449.00**	**448.81**
4	**CB. 3**	**MH. 4**	**28.2**	**0.000**	**0.000**	**10.00**	**0.55**	**152**	**0**	**0.0**	**0.0000**	**0.0000**	**0.0050**	**0.0420**	**0.8566**	**0.250**	**449.02**	**448.87**
5	**MH. 4**	**MH. 6**	**23.2**	**0.000**	**0.873**	**11.21**	**0.40**	**148**	**0**	**19774.5**	**0.2289**	**0.2289**	**0.0030**	**0.1562**	**0.9819**	**0.450**	**448.81**	**448.74**
6	**CB. 5**	**MH. 6**	**8**	**0.235**	**0.235**	**10.00**	**0.13**	**152**	**43826**	**3935.2**	**0.0455**	**0.0455**	**0.0100**	**0.0328**	**1.0440**	**0.200**	**449.09**	**449.01**
Paved	-	-	-	0.070	-	-	-	-	34695.3	2428.7	-	-	-	-	-	-	-	-
Grass	-	-	-	0.165	-	-	-	-	9130.3	1506.5	-	-	-	-	-	-	-	-
7	**MH. 6**	**MH. 7**	**63.6**	**0.000**	**1.108**	**11.61**	**0.94**	**146**	**0**	**23709.7**	**0.2744**	**0.2744**	**0.0040**	**0.1803**	**1.1338**	**0.450**	**448.68**	**448.42**
8	**MH. 7**	**MH. 9**	**19.6**	**0.000**	**1.108**	**12.55**	**0.29**	**143**	**0**	**23709.7**	**0.2744**	**0.2744**	**0.0040**	**0.1803**	**1.1338**	**0.450**	**448.36**	**448.28**
9	**CB. 8**	**MH. 9**	**3.5**	**0.071**	**0.071**	**10.00**	**0.06**	**152**	**43826**	**2412.2**	**0.0279**	**0.0279**	**0.0100**	**0.0328**	**1.0440**	**0.200**	**448.38**	**448.34**
Paved	-	-	-	0.069	-	-	-	-	34695.3	2394.0	-	-	-	-	-	-	-	-
Grass	-	-	-	0.002	-	-	-	-	9130.3	18.3	-	-	-	-	-	-	-	-
10	**MH. 9**	**CHMBR 1**	**5.8**	**0.000**	**1.179**	**12.84**	**0.08**	**142**	**0**	**26121.9**	**0.3023**	**0.3023**	**0.0050**	**0.2016**	**1.2676**	**0.450**	**448.28**	**448.25**
11	**RWL. 1**	**MH. 10**	**1.1**	**0.230**	**0.230**	**10.00**	**0.02**	**152**	**34695**	**7979.9**	**0.0924**	**0.0924**	**0.0100**	**0.0595**	**1.2115**	**0.250**	**448.90**	**448.88**
Roof	-	-	-	0.230	-	-	-	-	34695.3	7979.9	-	-	-	-	-	-	-	-
12	**MH. 10**	**CHMBR 1**	**23.9**	**0.000**	**0.230**	**10.02**	**0.33**	**152**	**0**	**7979.9**	**0.0924**	**0.0924**	**0.0100**	**0.0595**	**1.2115**	**0.250**	**448.82**	**448.58**
13	**CHMBR 1**	**MH. 11**	**1.8**	**0.000**	**1.409**	**12.92**	**0.03**	**142**	**0**	**34101.8**	**0.3947**	**0.3947**	**0.0050**	**0.3041**	**1.4048**	**0.525**	**448.25**	**448.24**
14	**MH. 11**	**OGS 1**	**1**	**0.000**	**1.409**	**12.95**	**0.02**	**142**	**0**	**34101.8**	**0.3947**	**0.0818**	**0.0050**	**0.3041**	**1.4048**	**0.525**	**448.21**	**448.20**
15	**OGS 1**	**Street 1**	**7.6**	**0.000**	**1.409**	**12.97**	**0.09**	**142**	**0**	**34101.8**	**0.3947**	**0.0818**	**0.0110**	**0.1014**	**1.4348**	**0.300**	**448.20**	**448.12**

Run-off Coefficients Used:

Roof Structure	C =	0.95
Paved Surface	C =	0.95
Gravel Surface	C =	0.85
Grass Surface	C =	0.25

Velocity Range:

Minimum Velocity = 0.60 m/s
Maximum Velocity = 6.00 m/s

Time of Concentration:

Time of Concentration = 10 min

Proposed Orangeville Fire Station
Exhibit #3 - 100 Year Orifice Plate and Storage Volume Calcs

Site Data

Site Discharge	Flow	Adj. Flow (w/o Surface Runoff)	Total Storm Volume
	(m^3/s)	(m^3/s)	(m^3)
5YR - Pre - Develop.	0.1425	0.0832	
100YR - Post - Develop.	0.4540	0.3947	356.0

Control Node Data

Outlet Pipe	Storm Control Node	Outlet Pipe Size	Outlet Invert Elev.	Elev. @ Orifice
		(m)	(m)	(m)
14	MH. 11	0.525	448.21	448.30

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

Head Height 1.53 m **<u>Storm Retention Elev. Check</u>** **<u>449.83 m</u>**

Triton System Storage

Model #	# of Chambers	Storage Volume
		(m^3)
S-22	368	377.0

<u>Total Storage =</u> **<u>377.0 m^3</u>** **<u>Required Storage Achieved</u>**

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 =	0.0832	m^3/s	0.80	Tube coefficient of discharge
Force of Gravity	g =	9.81	m/s/s		
Head Height	h =	1.53	m		
Dia of Max. Orifice	dia =	176.55	mm	Use -	175 mm

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

Area of Orifice	A =	0.0241	m^2
Flow Rate through Orifice	Q =	0.0818	m^3/s

Proposed Orangeville Fire Station
Exhibit #4 - Water Balance and Storage Volume Calcs

On Site Storage - Storm Chambers		
Area of S-22 Chamber Bed	493.2	m^2
S-22 Chamber Outlet Elevation	448.25	m
Groundwater elevation	442.80	m
Required Storage as per Geotech	833.0	m^3
Proposed Stone Depth	2.88	m
Proposed Bottom of Stone Elevation	445.37	m
Storage below elevation 448.25	568.2	m^3

* Given the groundwater has not been observed within the boreholes in the area adjacent to the underground Chamber System, the end of deepest borehole is considered as a groundwater elevation.

* Volume includes 40% stone void

On Site Storage - Bioretention Swale		
Area of Bioretention Swale	474.6	m^2
Bottom of Choking Layer Elevation	448.82	m
Groundwater elevation	447.38	m
Required Storage as per Geotech	833.0	m^3
Proposed Stone Depth	1.40	m
Proposed Bottom of Stone Elevation	447.42	m
Storage below elevation 448.82	265.8	m^3

* Volume includes 40% stone void

Total Storage = 833.9 m^3 Required Storage Achieved

T-Time	T_t=	10	min/cm
Infiltration Rate	i=	24	mm/hr
Void Ratio	V_r=	0.4	
Time to Drain	T_s=	48	hr
Max Reservoir Depth	Dr_{max}=	2.88	m

* Percolation Time and Infiltration Rate are based on Fisher Engineering Report FG24-14044, dated July 26, 2024. Used factor of safety FS=2.5

* Given the designed depths of the granular storages are less than the maximum required reservoir depth, the requred storm volume will therefore drain in less than 48 hours.

APPENDIX 'A'

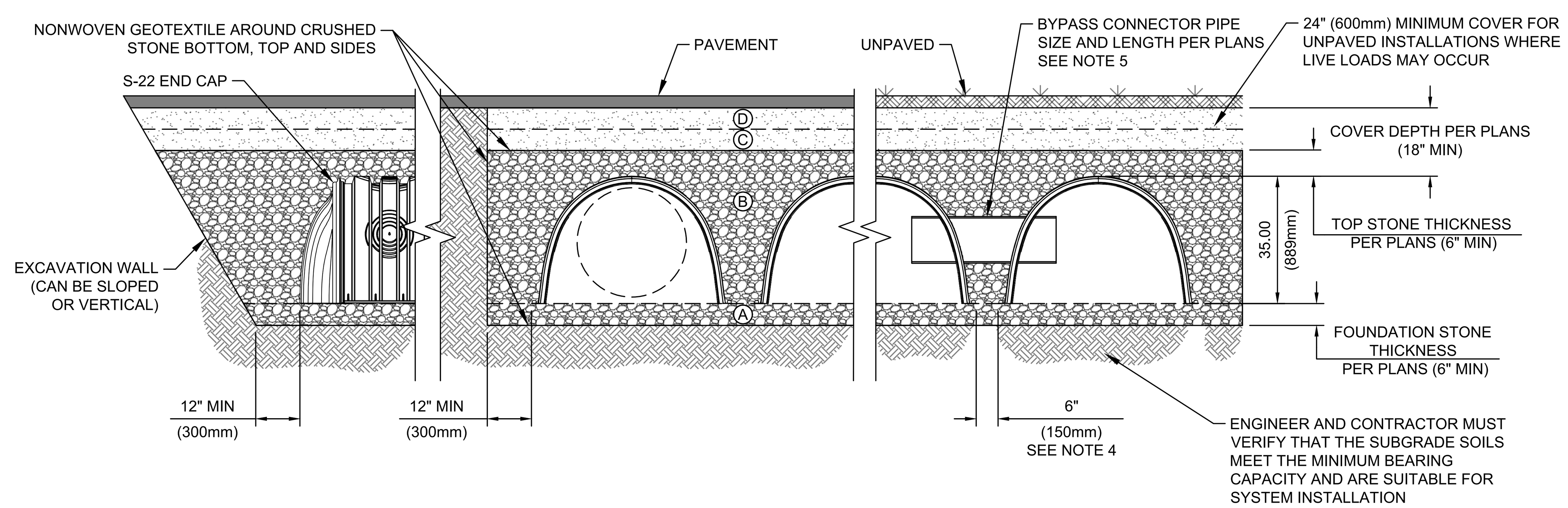
Xerxes Hydrochain Underground Storage Chambers

O&M Manual

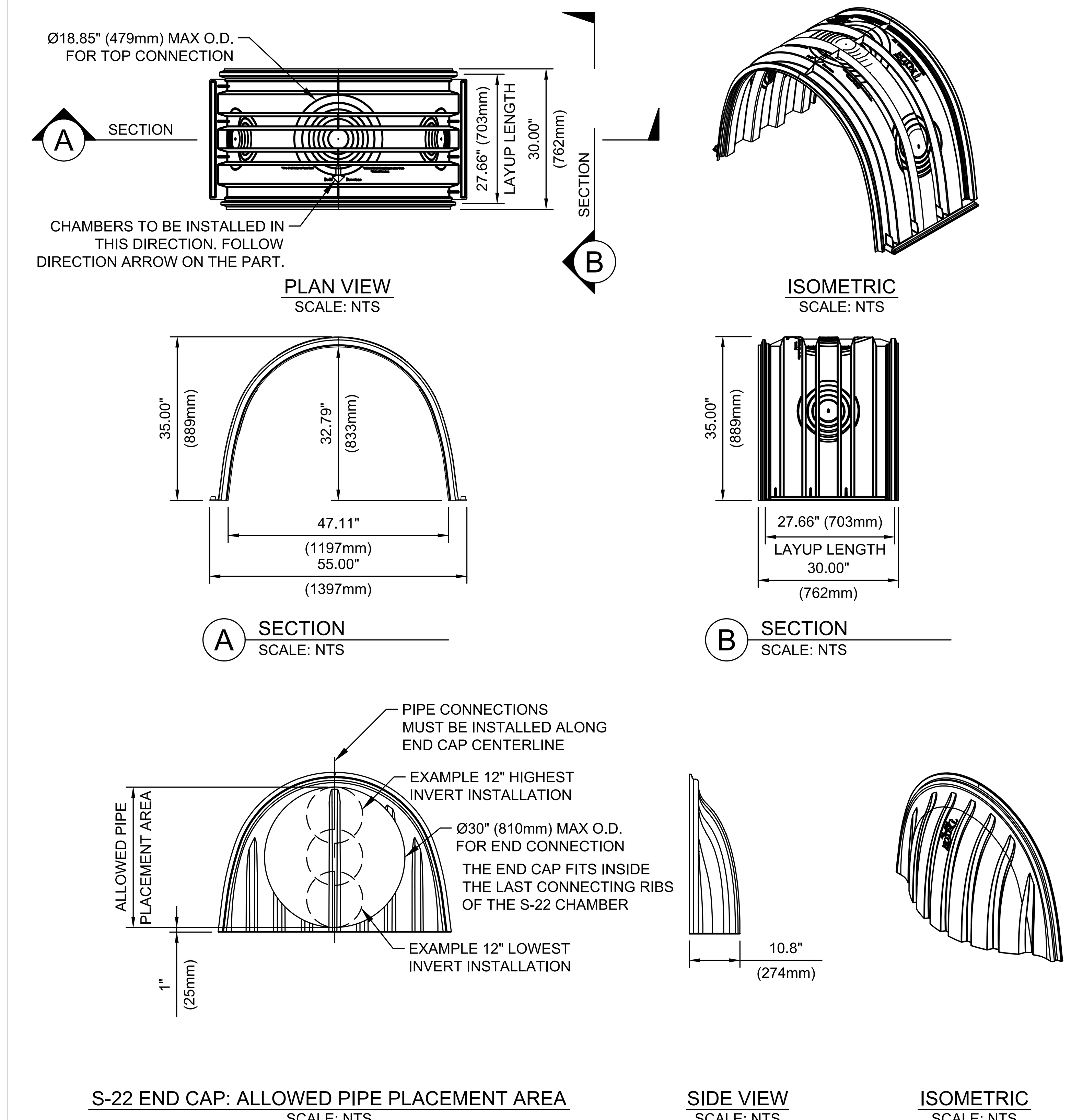
CHAMBER STANDARD FILL MATERIALS

	MATERIAL LOCATION	DESCRIPTION	AASHTO M43 DESIGNATION	COMPACT/DENSITY REQUIREMENT
D	FILL MATERIAL FROM 18" (450mm) ABOVE CHAMBER TO GRADE	ANY SOIL/ROCK MATERIALS, NATIVE SOILS OR PER ENGINEER'S PLANS. CHECK PLANS FOR PAVEMENT SUBGRADE REQUIREMENTS.	PER PLANS	PREPARE PER ENGINEER'S PLANS. PAVED INSTALLATIONS MAY HAVE STRINGENT MATERIAL AND PREPARATION REQUIREMENTS.
C	FILL MATERIAL FOR 6" (150mm) TO 18" (450mm) ABOVE THE CHAMBER AND 24" (600mm) FOR UNPAVED INSTALLATIONS	GRANULAR WELL-GRADED SOIL/AGGREGATE MIXTURES, <35% FINES. MOST PAVEMENT SUB-BASE MATERIALS CAN BE USED IN LIEU OF THIS LAYER	3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10 M145: A-1, A-2, A-3	COMPACT IN MAXIMUM 6" (150mm) LIFTS. SEE NOTES.
B	EMBEDMENT AND TOP STONE	3/8" - 2" (8-50mm) CLEAN, CRUSHED, ANGULAR STONE	3, 357, 4, 467, 5, 56, 57	NO COMPACTION REQUIRED.
A	FOUNDATION STONE	3/8" - 2" (8-50mm) CLEAN, CRUSHED, ANGULAR STONE	3, 357, 4, 467, 5, 56, 57	PLATE COMPACT OR ROLL. SEE NOTES.

NOTES:
1. INSTALL CHAMBERS AND END CAPS IN ACCORDANCE WITH SITE SPECIFIC PLANS, HYDROCHAIN INSTALLATION MANUAL AND SUPPLEMENTAL DOCUMENTS. REFERENCE THE QR CODE BELOW FOR PRODUCT DOCUMENTS.
2. THE LISTED AASHTO DESIGNATIONS ARE FOR GRADATIONS ONLY. THE STONE MUST ALSO BE CLEAN, CRUSHED, AND ANGULAR.
3. AS AN ALTERNATE TO PROCTOR TESTING AND FIELD DENSITY MEASUREMENTS ON OPEN GRADED STONE, COMPACTION REQUIREMENTS ARE MET WHEN STONE IS PLACED AND COMPACTED IN 6" (150mm) MAXIMUM LIFTS USING TWO FULL PASSES WITH A VIBRATORY COMPACTOR.
4. SPACERS ARE REQUIRED TO CONNECT PERPENDICULAR CHAMBER ROWS WITH 6" SPACING, SEE S-22 SPACER DETAIL.
5. EXTEND CROSS CONNECTION PIPES INTO THE CHAMBER BY A LENGTH EQUAL OR GREATER THAN 1/2 THE PIPE O.D.



S-22 CHAMBER CROSS SECTION



S-22 CHAMBER AND END CAP

S-22 CHAMBER PROPERTIES

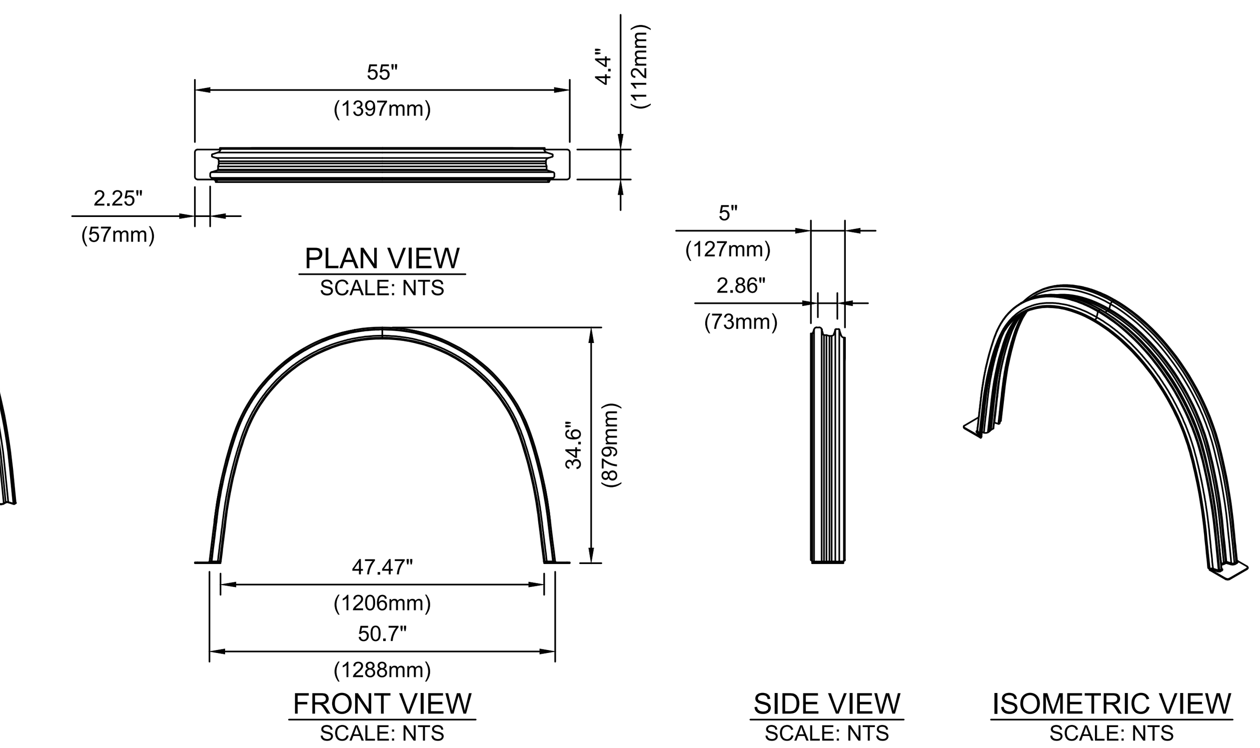
NOMINAL DIMENSIONS (LAYUP LENGTH × WIDTH × HEIGHT)	27.66" × 55.00" × 35.00" (703mm × 1397mm × 889mm)
BARE CHAMBER STORAGE	21.57 CUBIC FEET (0.611 CUBIC METERS)
*MIN INSTALLED STORAGE	31.30 CUBIC FEET (0.886 CUBIC METERS)
CHAMBER WEIGHT	28 LBS (12.701 KG)
STORAGE PER LINEAR UNIT WITHOUT STONE	9.36 FT³/FT (0.869 M³/M)
STORAGE PER LINEAR UNIT WITH STONE	13.58 FT³/FT (1.261 M³/M)

*ASSUMING A MIN OF 6" (150mm) STONE ABOVE AND BELOW AND 6" (150mm) BETWEEN ROWS WITH 40% STONE POROSITY (DOES NOT INCLUDE 12" (300mm) PERIMETER STONE VOLUME)

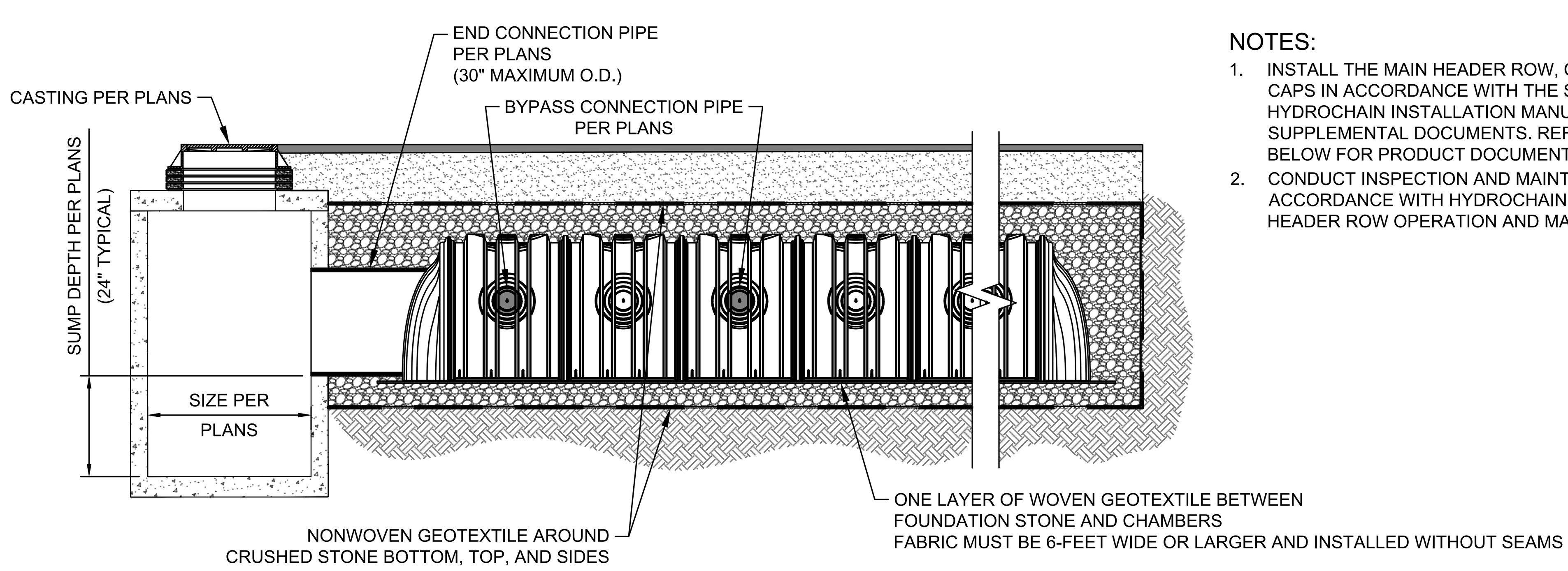
S-22 END CAP PROPERTIES

NOMINAL DIMENSIONS (LAYUP LENGTH × WIDTH × HEIGHT)	10.8" × 49.9" × 34.16" (274mm × 1267mm × 868mm)
BARE END CAP STORAGE	3.98 CUBIC FEET (0.113 CUBIC METERS)
*MIN INSTALLED STORAGE	9.56 CUBIC FEET (0.271 CUBIC METERS)

*ASSUMING A MIN OF 6" (150mm) STONE ABOVE AND BELOW AND 6" (150mm) BETWEEN ROWS WITH 40% STONE POROSITY (DOES NOT INCLUDE 12" (300mm) PERIMETER STONE VOLUME)

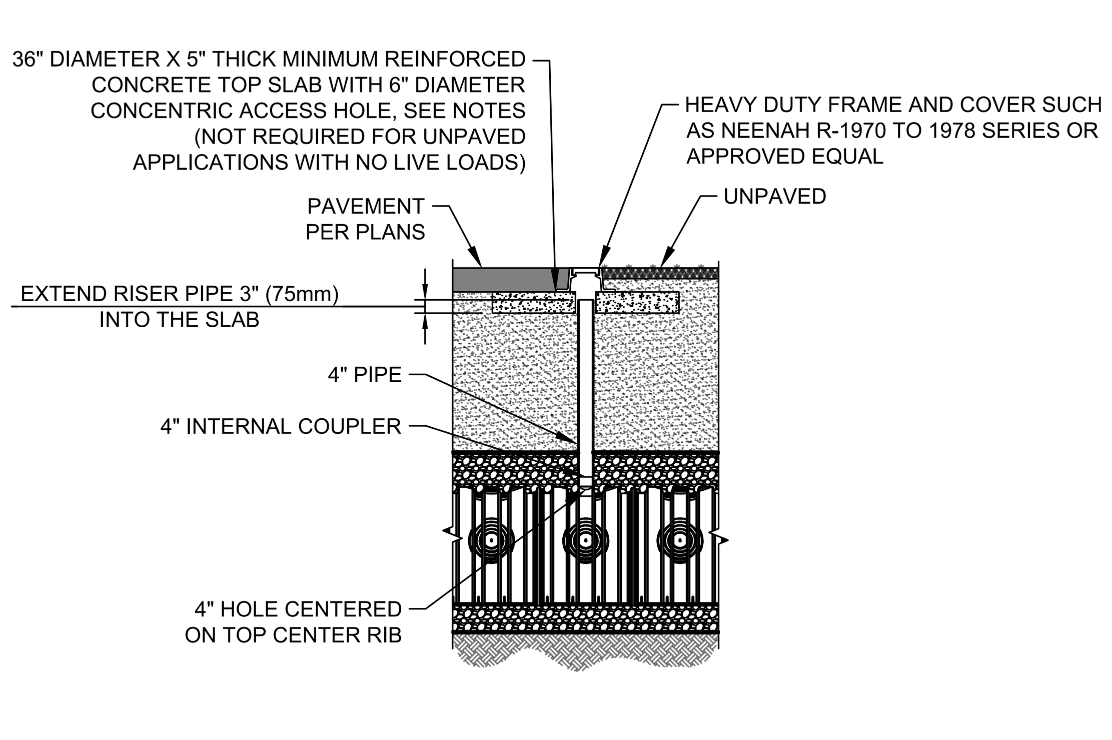


S-22 SPACER

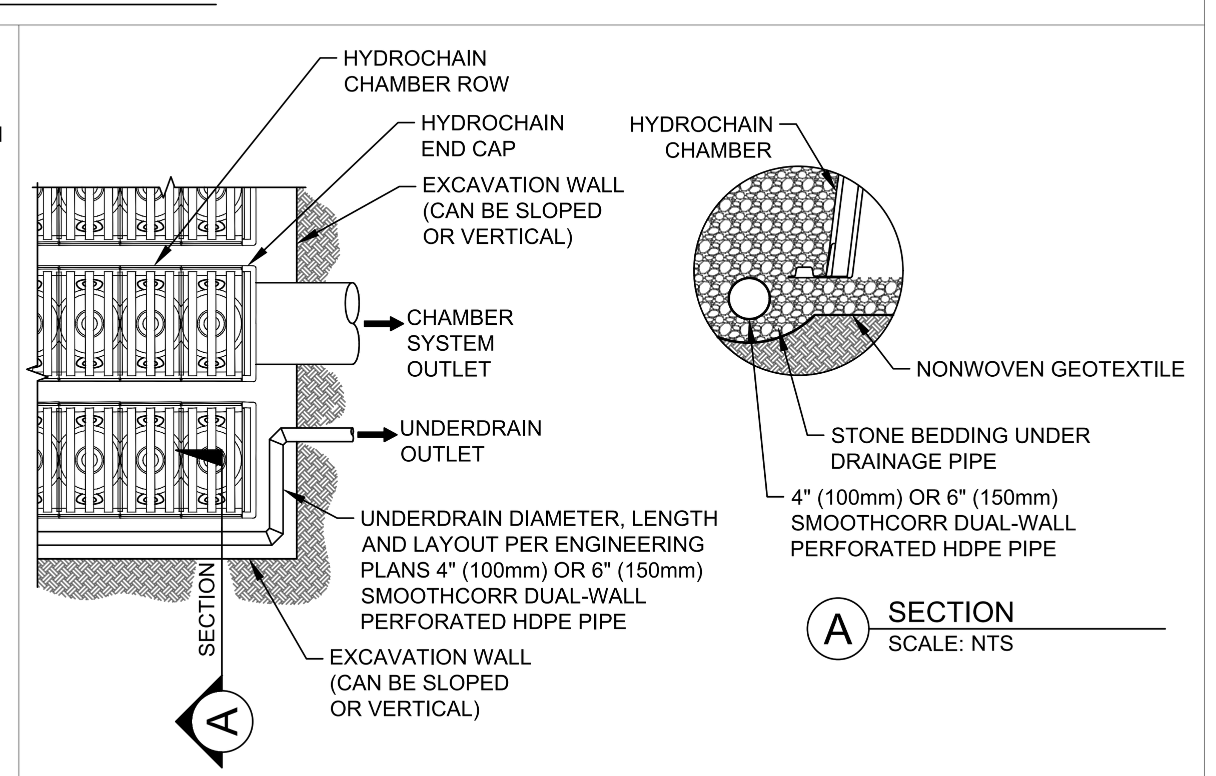


NOTES:
1. INSTALL THE MAIN HEADER ROW, CHAMBERS, AND END CAPS IN ACCORDANCE WITH THE SITE SPECIFIC PLANS, HYDROCHAIN INSTALLATION MANUAL AND SUPPLEMENTAL DOCUMENTS. REFERENCE THE QR CODE BELOW FOR PRODUCT DOCUMENTS.
2. CONDUCT INSPECTION AND MAINTENANCE IN ACCORDANCE WITH HYDROCHAIN CHAMBER MAIN HEADER ROW OPERATION AND MAINTENANCE MANUAL.

S-22 CHAMBER CROSS SECTION



S-22 4-INCH INSPECTION PORT



UNDERDRAIN DETAIL

GENERAL

1. CHAMBERS MUST BE XERXES® HYDROCHAIN™ S-22. ONLY CHAMBERS APPROVED BY THE SITE DESIGN ENGINEER ARE PERMITTED.
2. CHAMBERS MUST BE MANUFACTURED BY COMPRESSION MOLDING OF FIBERGLASS REINFORCED COMPOSITE.
3. CHAMBERS MUST BE EVALUATED AND TESTED TO MEET OR EXCEED THE STANDARDS IN ASTM F2418 STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS.
4. CHAMBERS MUST BE ARCH-SHAPED AND HAVE AN OPEN BOTTOM. CHAMBER ROWS MUST BE CONTINUOUS, UNOBSTRUCTED, AND WITHOUT INTERNAL SUPPORT THAT WOULD IMPEDE FLOW OR LIMIT ACCESS FOR INSPECTION AND MAINTENANCE.
5. THE INSTALLED CHAMBER SYSTEM MUST BE DESIGNED TO MEET THE LOAD REQUIREMENTS OF ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS" FOR:

   A. INSTANTANEOUS LIVE LOAD FROM AASHTO DESIGN TRUCK AT MINIMUM COVER
   B. MAXIMUM DEAD LOAD (100-YEAR)
   C. 1-WEEK AASHTO DESIGN TRUCK LOAD AT MINIMUM COVER
6. THE INSTALLED CHAMBER SYSTEM MUST BE DESIGNED TO MEET THE LOAD REQUIREMENTS OF AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, SPECIFICATION 12.12 FOR:

   A. LONG-DURATION DEAD LOADS
   B. SHORT-DURATION LIVE LOADS WITH IMPACT AND MULTIPLE VEHICLE PRESENCE
7. CHAMBERS MUST HAVE AN ARCH STIFFNESS CONSTANT (ASC) ≥ 700 LBS/FT/% PER ASTM F2418, SECTION 6.2.8 AND MAINTAIN STIFFNESS THROUGH TEMPERATURE RANGES OF -40 DEGREES FAHRENHEIT TO 180 DEGREES FAHRENHEIT.
8. THE CHAMBER MUST INTERCONNECT USING AN OVERLAPPING CORRUGATION JOINT.
9. THE STORMWATER CHAMBER SYSTEM SHALL INCORPORATE A MAIN HEADER ROW FOR STORMWATER TREATMENT AND SYSTEM MAINTENANCE WHICH HAS BEEN TESTED TO A MINIMUM OF 80% OF TSS REMOVAL FOLLOWING NJCAT TESTING PROTOCOLS.
10. CHAMBERS AND END CAPS MUST BE PRODUCED AT AN ISO 9001 CERTIFIED MANUFACTURING FACILITY.

INSTALLATION

1. INSTALLATION MUST NOT START UNTIL A PRE-CONSTRUCTION MEETING HAS BEEN HELD WITH THE MANUFACTURER'S REPRESENTATIVE AND THE INSTALLERS.
2. INSTALLATION MUST BE IN ACCORDANCE WITH THE CONSTRUCTION PLANS AND HYDROCHAIN™ INSTALLATION MANUAL.
3. BACKFILLING OVER CHAMBERS MUST NOT BE DONE WITH A DOZER OR AN EXCAVATOR LOCATED OVER THE CHAMBERS. SEE THE INSTALLATION MANUAL FOR MAXIMUM EQUIPMENT LOADS BASED ON THE DEPTH OF COVER OVER THE CHAMBERS. RECOMMENDED BACKFILL METHODS INCLUDE:

   A. USING A STONE SHOOTER LOCATED OFF THE CHAMBER BED.
   B. BACKFILLING WHILE PLACING ROWS USING AN EXCAVATOR ON THE FOUNDATION STONE OR SUBGRADE.
   C. BACKFILLING FROM OUTSIDE THE EXCAVATION USING A LONG BOOM EXCAVATOR.
4. THE FOUNDATION STONE MUST BE LEVELED AND COMPACTED BEFORE PLACING CHAMBERS.
5. JOINTS BETWEEN CHAMBERS MUST BE PROPERLY SEATED BEFORE PLACING STONE.
6. A MINIMUM 6-INCH (150 MM) SPACING MUST BE MAINTAINED BETWEEN CHAMBER ROWS.
7. EMBEDMENT STONE SURROUNDING CHAMBERS MUST BE CLEAN, CRUSHED, ANGULAR STONE MEASURING 3/4-2 INCHES (20-50 MM).
8. ANY DISCREPANCIES WITH CHAMBER FOUNDATION BEARING CAPACITIES MUST BE REPORTED TO THE SITE ENGINEER.
9. IT IS RECOMMENDED TO INSTALL EROSION AND SEDIMENT CONTROL MEASURES TO PROTECT THE STORMWATER SYSTEM DURING ALL PHASES OF CONSTRUCTION.

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HYDROCHAIN™
S-22 STANDARD DETAILS

DATE	04/09/2024	SHEET 1	OF 1

XS-006082

HydroChain™ Chamber Main Header Row Manual

Operation & Maintenance

INTRODUCTION

An important component of any Stormwater Pollution Prevention Plan is inspection and maintenance. The Main Header Row™ is a patent pending technique to cost-effectively enhance total suspended solids removal and provide easy access for inspection and maintenance.

MAIN HEADER ROW™

The Main Header Row is comprised of a row of any chambers that sit upon the woven geotextile barrier (see **Figure 1**) or sediment floor is connected to a closely located manhole for easy access.

At the end of the Main Header Row there can be an optional Sump Basin Assembly (shown as item 3 in **Figure 2**) to help collect and contain any sediment that will be flushed out of the Main Header Row during a rain event or during a maintenance cleaning. The sump basin assembly can then be accessed from above via a manhole or up to a 33" diameter stand pipe.

The Main Header Row feeds the distribution rows (shown as item 4 in **Figure 2**) via a feed or distribution pipe. The Feed pipe is at an elevated invert height so the water in the Main Header Row has to rise to this invert height before flowing into the distribution rows thus capturing the sediments in the Main Header Row. The Main Header Row is then protecting the distribution chamber row storage areas of any sediment accumulation. This allows for preserving the infiltration rate of the area where the distribution rows are installed thus allowing the system to perform at the rate that the system was designed for. The geotextile barrier or sediment floor is designed to prevent scouring of the underlying stone and to collect sediments from infiltrating into the ground under the Main Header Row. The geotextile barrier or sediment floor is installed with the chambers so they will remain intact during very high flow events and during high pressure cleaning.

The Main Header Row is typically designed to capture the "first flush" and offers the versatility to be sized on a volume basis or flow-rate basis. An upstream manhole not only provides access to the Main Header Row but typically includes a high flow outlet such that stormwater flow rates or volumes that exceed the capacity of the Main Header Row can overflow into the surrounding stone and/or discharge through a manifold to the other chambers.

The Main Header Row may also be part of a treatment train. By treating stormwater prior to entry into the Main Header Row system, the service life can be extended and pollutants such as hydrocarbons can be captured. Pretreatment best management practices can be as simple as deep sump catch basins, oil-water separators or can be innovative stormwater treatment devices.

Figure 1.

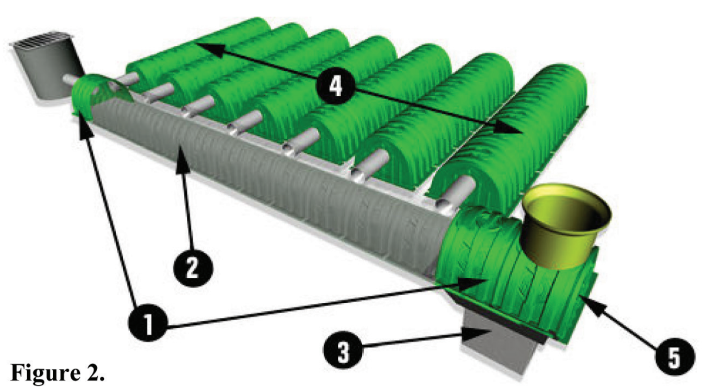


Figure 2.

The design of the treatment train and selection of pretreatment devices by the design engineer are often driven by regulatory requirements. Whether pretreatment is used or not, the Main Header Row is recommended as an effective means to minimize maintenance requirements and maintenance costs.

TREATMENT TRAIN INSPECTION AND MAINTENANCE

We recommend treatment train inlet system has three tiers of treatment upstream of the chambers. It is recommended that inspection and maintenance (I&M) be initiated at the furthest upstream treatment tier and continue downstream as necessary. The following I&M procedures follow this approach providing I&M information in the following order:

Tier 1- Pretreatment (BMP)

Tier 2 - Main Header Row

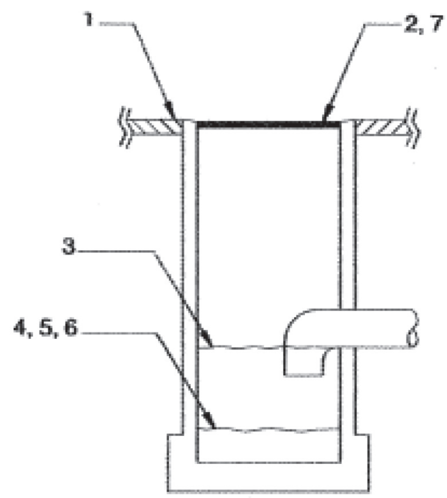
Tier 3 - Eccentric Pipe Header System – This option is not needed when using the chamber system because the Main Header Row eliminates the need for a pipe header system.

Catch Basin/Manholes I&M

Typically a stormwater system will have catch basins and manholes upstream of the detention/retention system. In some cases these may be the only pretreatment devices. Regular I&M of catch basins and manholes should be scheduled and performed as part of a site's routine maintenance plan.

Step-by-Step Maintenance Procedures

1). Inspect catch basins and manholes upstream of the chambers for sediment.
2). Remove grate or cover.
3). Skim off oils and floatables.
4). Using a stadia rod, measure the depth of sediment
5). If sediment is at a depth greater than 8" proceed to step 6. If not, proceed to step 7.
6). Vacuum or manually remove sediment .
7). Replace grate.
8). Record depth & date and schedule next inspection.



PreTreatment Device I&M

Manufacturer's I&M procedures should be followed for proprietary pretreatment devices such as baffle boxes, swirl concentrators, oil-water separators, and filtration units. Table below provides some general guidelines but is not a substitute for a manufacturer's specific instructions.

SEDIMENT CONTROL INSPECTION	INSPECTION*	MAINTENANCE**
Main Header Row	Annually	JetVac-Culvert Cleaning Nozzle or High-Pressure Hose
Sediment Basin	Bi-Annually or after large storm event	Excavate sediment
Catch Basin Sump	Bi-Annually	Excavate, pump or vacuum
Sediment Structure	Bi-Annually	Excavate, pump or vacuum
Catch Basin Filter Bags	After all storm events	Clean and/or replace filter bags
Porous Pavement	Quarterly	Sweep Pavement
Pipe Header Design	Quarterly	Excavate, pump or vacuum
Water Quality Inlet	Quarterly	Excavate, pump or vacuum
Filter Pucks	Bi-Annually	Clean and/or replace filter media in pucks

Main Header Row™ Inspection

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

At a minimum, we recommend annual inspections. The Main Header Row should be inspected every 6 months for the first year of operation. For subsequent years, the inspection should be adjusted based upon previous observation of sedi-ment deposition.

The Main Header Row incorporates a combination of standard manhole(s) and strategically located inspection ports (as needed). The inspection ports allow for easy access to the system from the surface, eliminating the need to perform a confined space entry for inspection purposes.If upon visual inspection it is found that sediment has accumulated, a stadia rod should be inserted to determine the depth of sediment. When the average depth of sediment exceeds 8" inches in the bottom of the Sump Basin and or if there is 3" throughout the length of the Main Header Row, clean-out of the Sump Basin and Main Header Row should be performed.

Main Header Row™ Maintenance

The Main Header Row was designed to reduce the cost of periodic maintenance. By confining sediments to just one row, costs are dramatically reduced by eliminating the need to clean out each row of the entire storage bed. If inspection indicates the potential need for maintenance, access is provided via a manhole(s) located on the end(s) of the Main Header Row for cleanout. If entry into the manhole is required, please follow local and OSHA rules for a confined-space entries. The inside dimensions of the Main Header Row Chambers are 34” tall by 48” wide.

Maintenance is accomplished by removing the sediment that has built up in the Sump Basin by using a standard vacuum truck as shown to the right. The Main Header Row sys-tem was designed to allow for easy access to the Sump Basin via a manhole/inspection port up to a 33” diameter pipe. There is no need for a special process to clean out the Sump Basin and the Main Header Row but they can be cleaned using a JetVac process or can be cleaned by using a water tank truck or fire truck equipped with a hose to flush the sediment to the Sump Basin if so desired. To use a water tanker or fire truck simply insert the hose into the upstream catch basin struc-ture and flush the sediment to the end of the main header row where the Sump Basin is located. If the Sump Basin is located close to the inlet, then vacuum out the sediment first and then back flush the Main Header Row back into the Sump Basin.

NOTE: The JetVac or high-pressure hose process shall only be performed on the Main Header Row where the woven geotextile barrier or sediment floor has been installed and only if there is 3” of sediment throughout the length of the Main Header Row.

Main Header Row™ Step-by-Step Maintenance Procedures

Step 1. Inspect Sump Basin and Main Header Row for Sediment

A. Inspection ports (if present)

- **i.** Remove lid from floor box frame.
- **ii.** Remove cap from inspection riser.
- **iii.** Using a flashlight and stadia rod, measure depth of sediment in the Sump Basin and record results on maintenance log.
- **iv.** If sediment is at or above 11-inch depth, proceed to Step 2. If not, proceed to step 3.

B. All Main Header Rows

- **i.** Remove cover from manhole at upstream end of Main Header Row.
- **ii.** Using a flashlight, inspect the Main Header Row through outlet pipe and through each distribution pipe that is connected in between the Main Header Row and the distribution row of chambers.
- **iii.** If sediment is at or above the 11" mark in the sump bin, proceed to Step 2.

1. Be sure to have proper footing when entering into Main Header Row.

2. Follow OSHA regulations for confined space entry if entering Main Header Row. If not, proceed to Step 3.

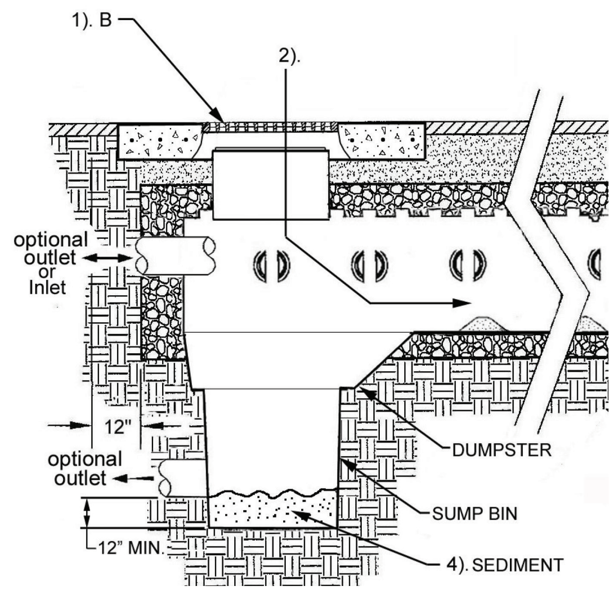
Step 2. Clean out the Sump Basin with a vacuum truck

A. Remove any secondary filtration media that may be installed in the sump basin.

B. Vacuum Sump Basin as required.

Step 3. Replace all caps, lids, and covers. Record observations and actions.

Step 4. Inspect & clean catch basins and manholes upstream of the chamber system.



Sample

Date	Stadia Rod Readings		Sediment Depth (1)-(2)	Observations/Actions	Inspector
	Fixed point to chamber bottom (1)	Fixed point to chamber top (2)			
4/11/2007	9.7 ft.	None		New installation. Fixed point is J1 frame at grade	KET
10/21/2007		9.6	0.1 ft.	Very little sediment in system - No maintenance required	GKT
4/11/2008		9.4	0.3 ft.	Very little sediment in system - No maintenance required	CMM
7/25/2009		9.1	0.6 ft.	Some debris/sediment is visible in sump basin assembly but not interfering with outlet	LEJ
7/20/2010		8.7	1.0 ft.	Some debris/sediment is visible in sump basin assembly - maintenance is due	DLC
8/20/2010	9.7 ft.		0	System has cleaned and vacuumed - very easy system to clean	NAT

APPENDIX ‘B’

HydroStorm HS12

Sizing Calculations, Schematic and O&M Manual

Hydroworks Sizing Summary

Orangeville Fire Station

10 Commerce Rd, Orangeville

05-13-2025

Recommended Size: HydroStorm HS 12

Hydroworks Sizing Program Version 5.8.5

A HydroStorm HS 12 is recommended to provide 80 % annual TSS removal based on a drainage area of 1.63 (ha) with an imperviousness of 65 % and Toronto Central, Ontario rainfall for the ETV particle size distribution.

The recommended HydroStorm HS 12 treats 99 % of the annual runoff and provides 81 % annual TSS removal for the Toronto Central rainfall records and ETV particle size distribution.

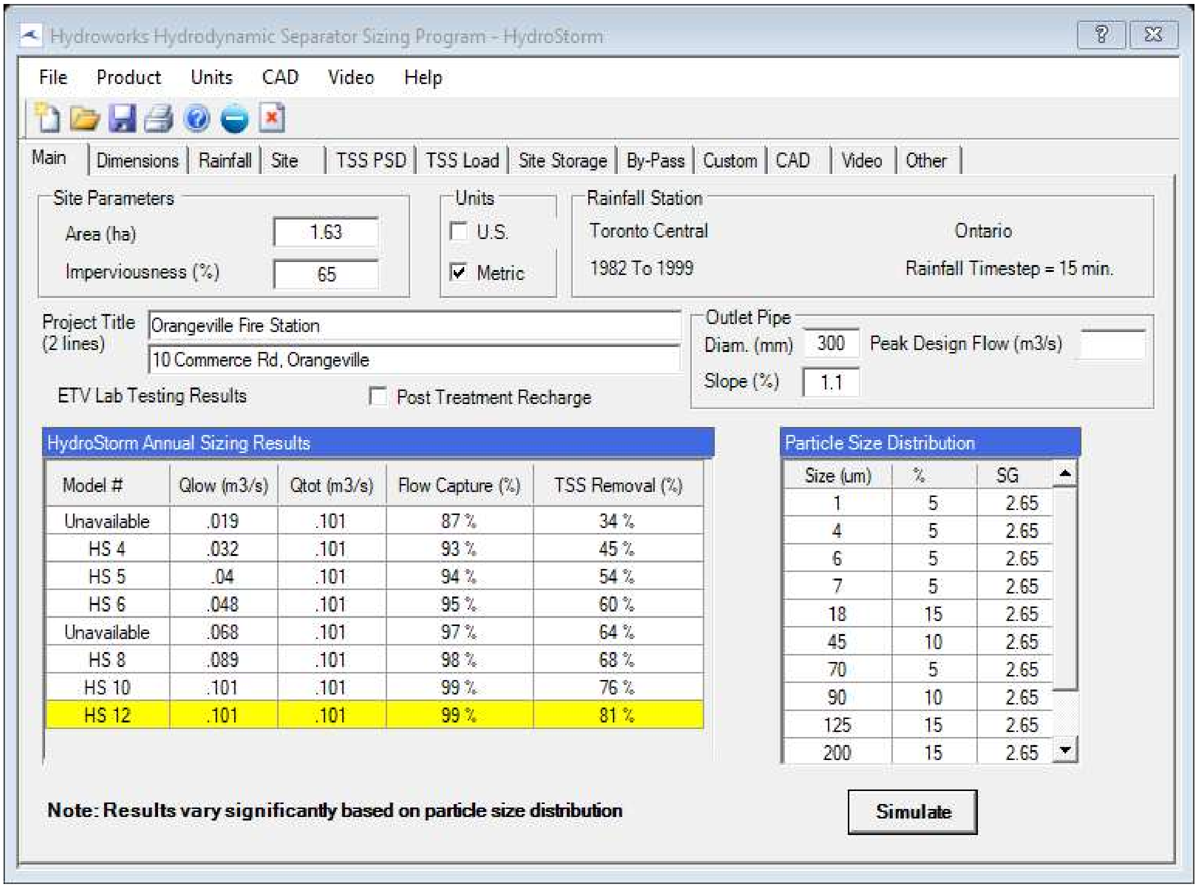
The HydroStorm has a headloss coefficient (K) of 1.04. Since a peak flow was not specified, headloss was calculated using the full pipe flow of .1 (m3/s) for the given 300 (mm) pipe diameter at 1.1% slope. The headloss was calculated to be 109 (mm) based on a flow depth of 300 (mm) (full pipe flow).

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.

The sizing program is for sizing purposes only and does not address any site specific parameters such as hydraulic gradeline, tailwater submergence, groundwater, soils bearing capacity, etc. Headloss calculations are not a hydraulic gradeline calculation since this requires a starting water level and an analysis of the entire system downstream of the HydroStorm .

TSS Removal Sizing Summary



Hydroworks Hydrodynamic Separator Sizing Program - HydroStorm

File Product Units CAD Video Help

Main | Dimensions | Rainfall | Site | TSS PSD | TSS Load | Site Storage | By-Pass | Custom | CAD | Video | Other

Site Parameters
Area (ha) 1.63
Imperviousness (%) 65

Units
☐ U.S.
☑ Metric

Rainfall Station
Toronto Central Ontario
1982 To 1999 Rainfall Timestep = 15 min.

Project Title (2 lines) Orangeville Fire Station
10 Commerce Rd, Orangeville

Outlet Pipe
Diam. (mm) 300 Peak Design Flow (m3/s)
Slope (%) 1.1

ETV Lab Testing Results ☐ Post Treatment Recharge

HydroStorm Annual Sizing Results

Model #	Qlow (m3/s)	Qtot (m3/s)	Flow Capture (%)	TSS Removal (%)
Unavailable	.019	.101	87 %	34 %
HS 4	.032	.101	93 %	45 %
HS 5	.04	.101	94 %	54 %
HS 6	.048	.101	95 %	60 %
Unavailable	.068	.101	97 %	64 %
HS 8	.089	.101	98 %	68 %
HS 10	.101	.101	99 %	76 %
HS 12	.101	.101	99 %	81 %

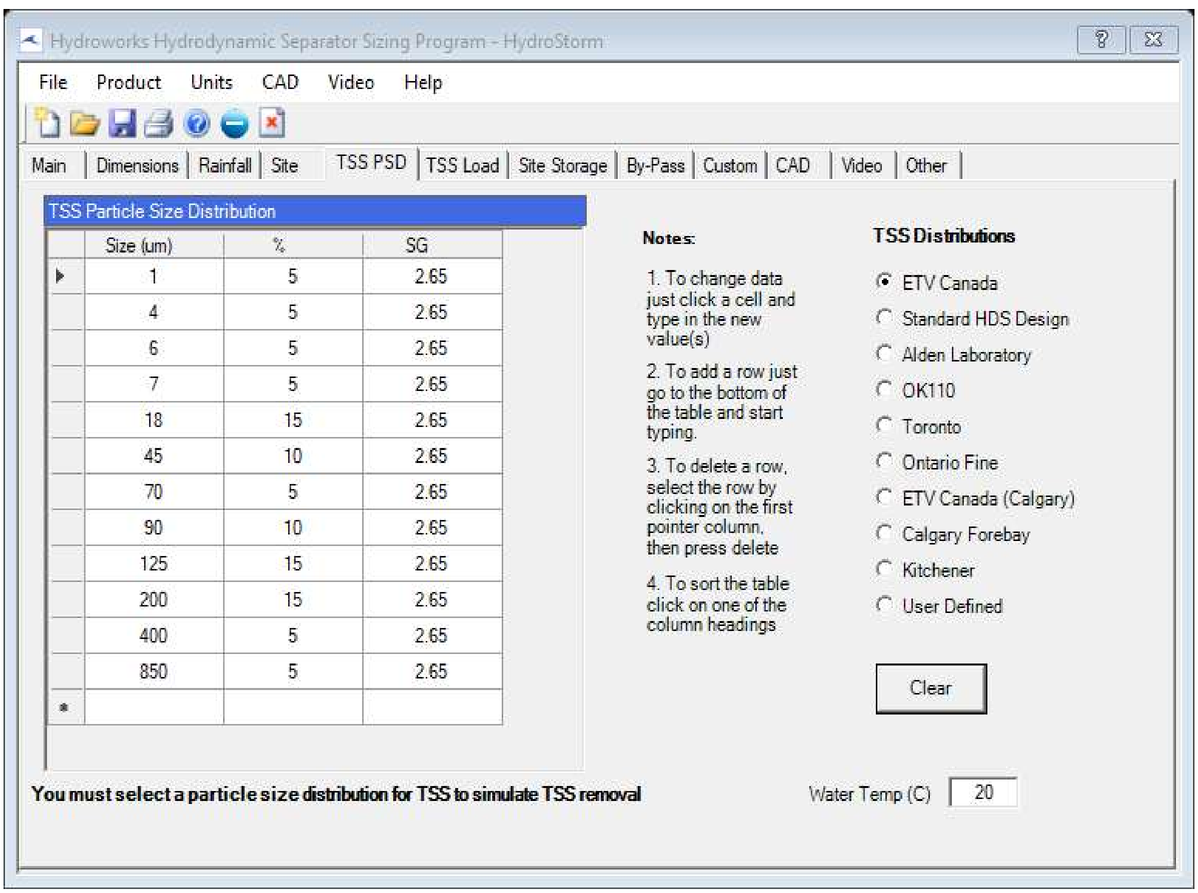
Particle Size Distribution

Size (um)	%	SG
1	5	2.65
4	5	2.65
6	5	2.65
7	5	2.65
18	15	2.65
45	10	2.65
70	5	2.65
90	10	2.65
125	15	2.65
200	15	2.65

Note: Results vary significantly based on particle size distribution

Simulate

TSS Particle Size Distribution



Hydroworks Hydrodynamic Separator Sizing Program - HydroStorm

File Product Units CAD Video Help

Main | Dimensions | Rainfall | Site | TSS PSD | TSS Load | Site Storage | By-Pass | Custom | CAD | Video | Other

TSS Particle Size Distribution

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7	5	2.65
18	15	2.65
45	10	2.65
70	5	2.65
90	10	2.65
125	15	2.65
200	15	2.65
400	5	2.65
850	5	2.65

Notes:

1. To change data just click a cell and type in the new value(s)
2. To add a row just go to the bottom of the table and start typing.
3. To delete a row, select the row by clicking on the first pointer column, then press delete
4. To sort the table click on one of the column headings

TSS Distributions

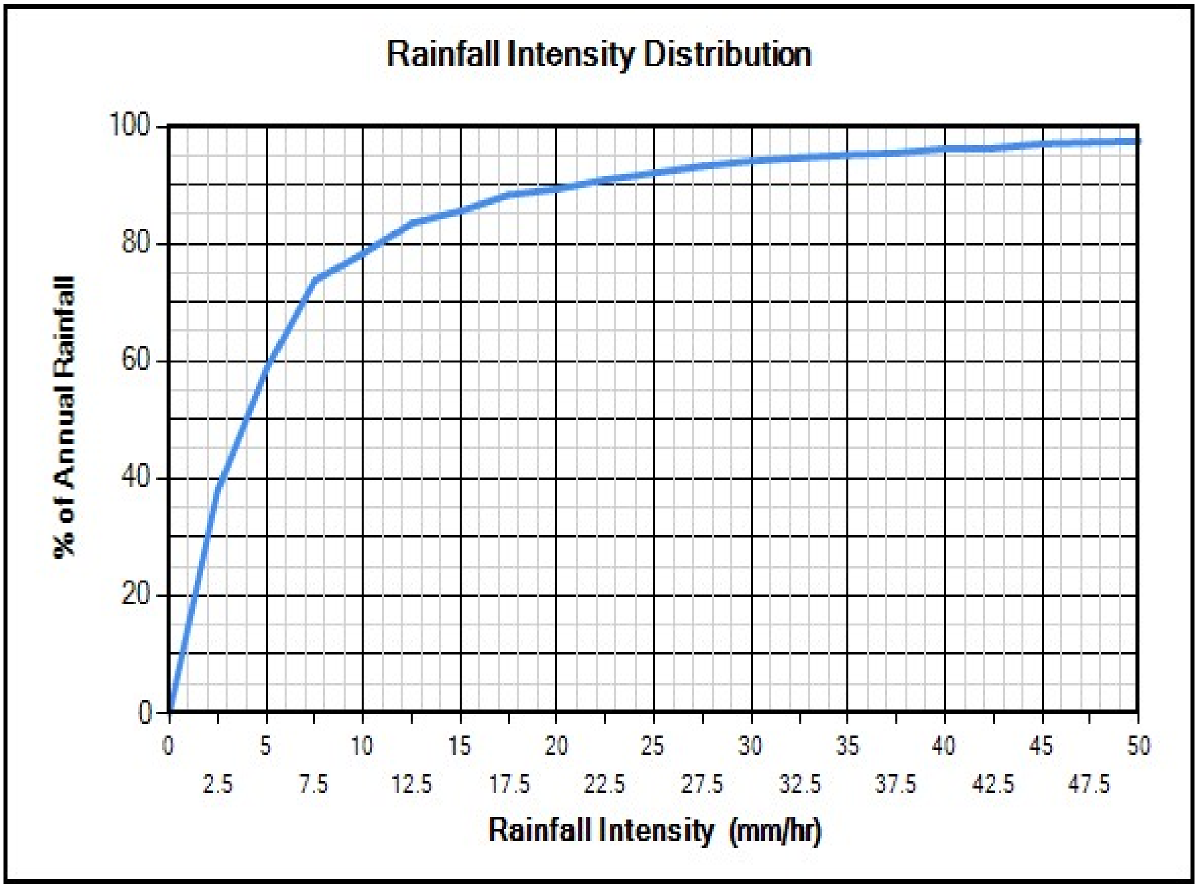
- (•) ETV Canada
- ( ) Standard HDS Design
- ( ) Alden Laboratory
- ( ) OK110
- ( ) Toronto
- ( ) Ontario Fine
- ( ) ETV Canada (Calgary)
- ( ) Calgary Forebay
- ( ) Kitchener
- ( ) User Defined

Clear

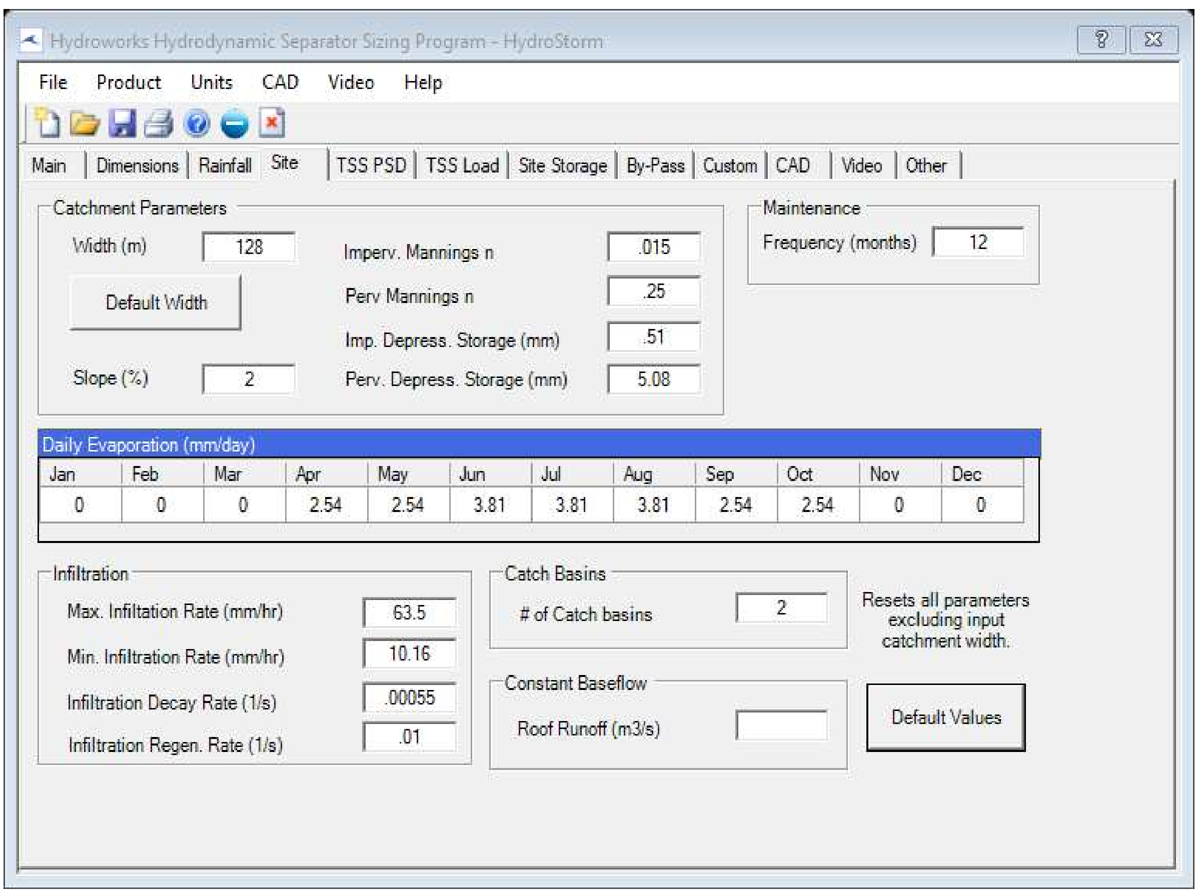
You must select a particle size distribution for TSS to simulate TSS removal

Water Temp (C) 20

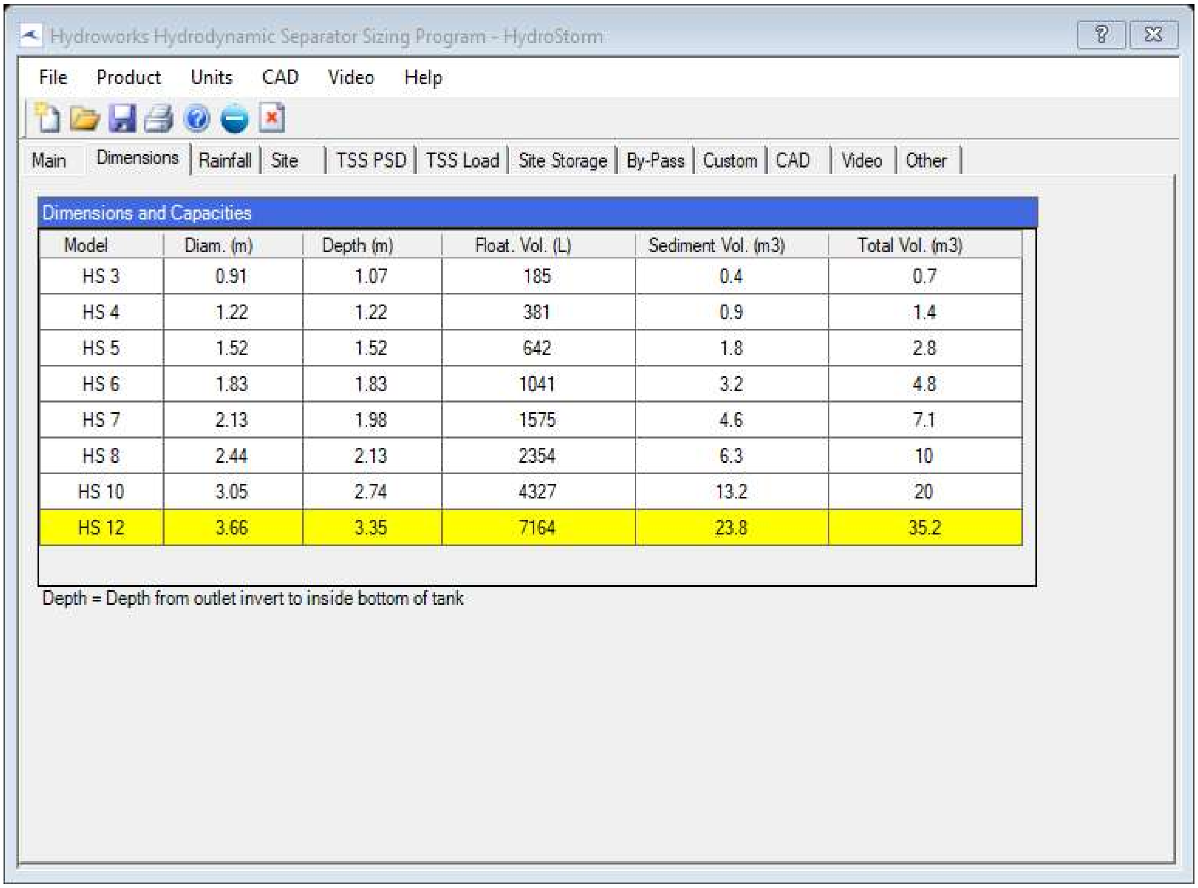
Rainfall Station - Toronto Central, Ontario(1982 To 1999)



Site Physical Characteristics



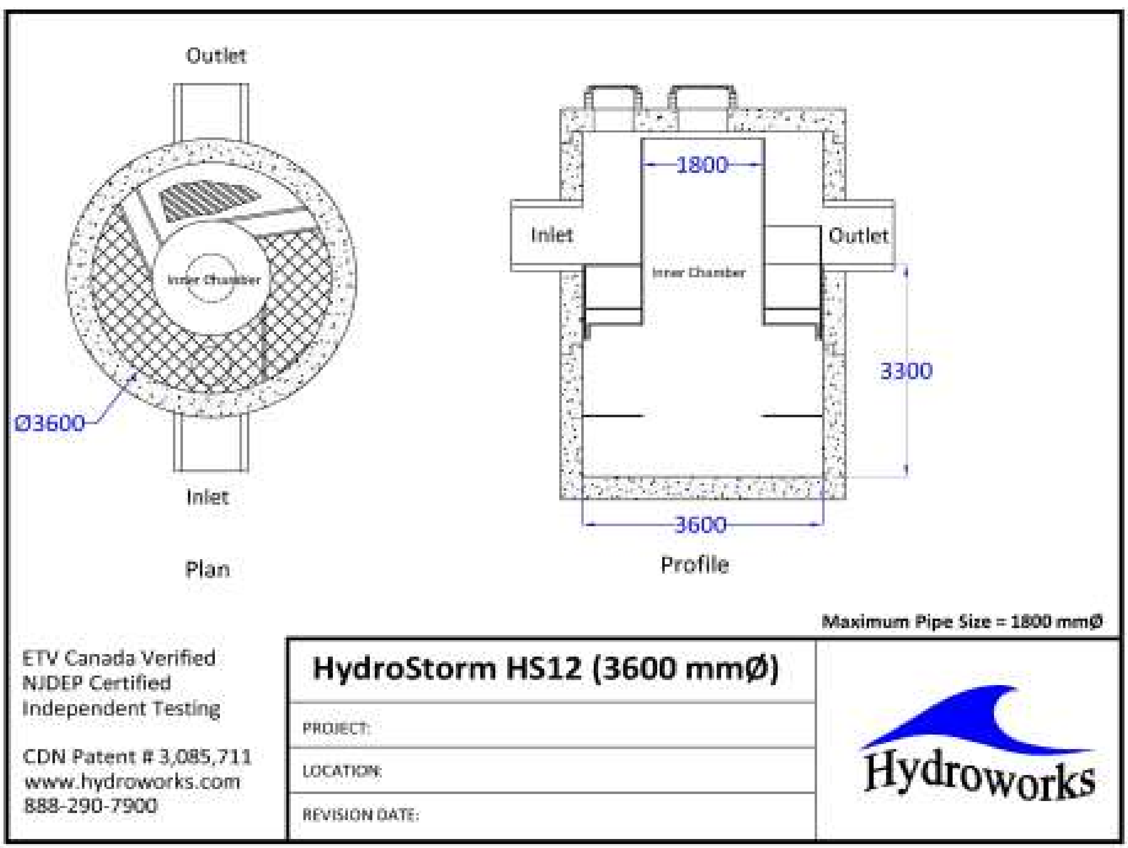
Dimensions And Capacities



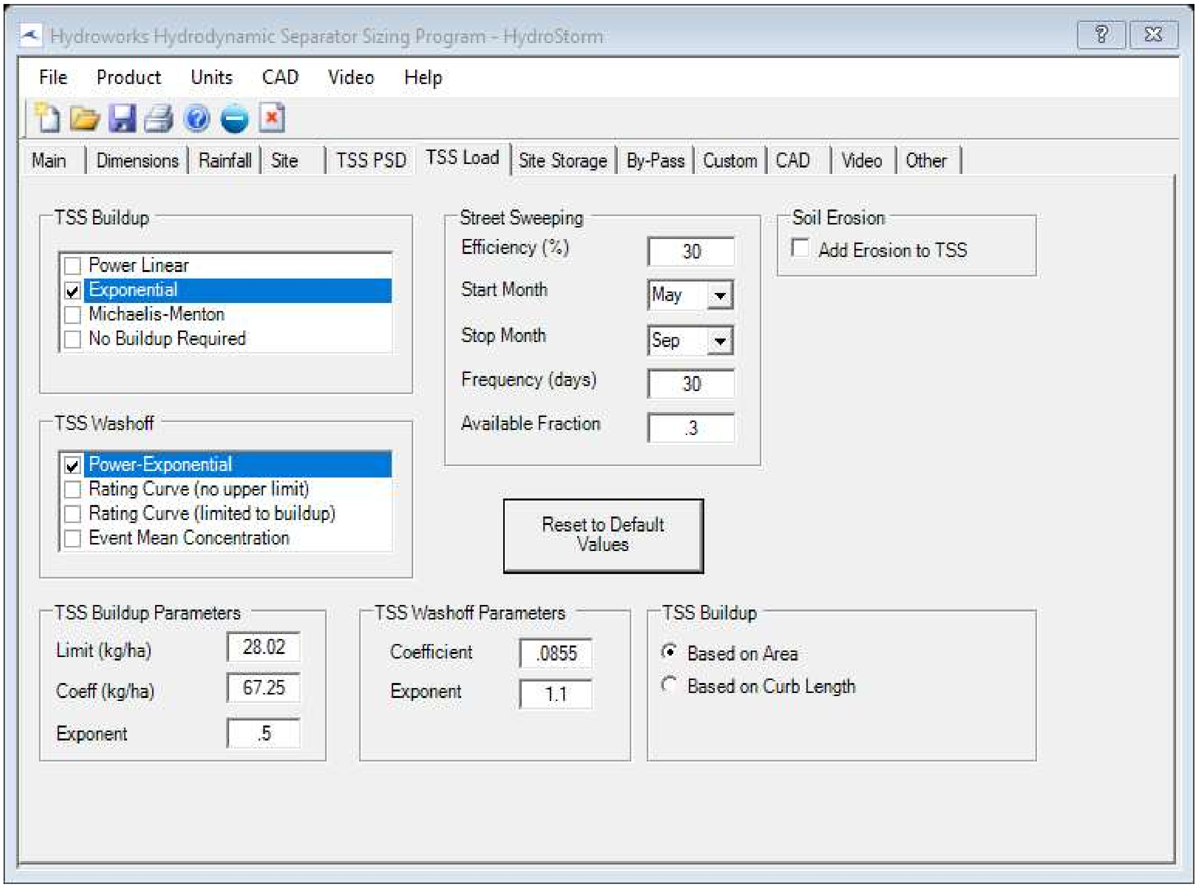
Model	Diam. (m)	Depth (m)	Float. Vol. (L)	Sediment Vol. (m3)	Total Vol. (m3)
HS 3	0.91	1.07	185	0.4	0.7
HS 4	1.22	1.22	381	0.9	1.4
HS 5	1.52	1.52	642	1.8	2.8
HS 6	1.83	1.83	1041	3.2	4.8
HS 7	2.13	1.98	1575	4.6	7.1
HS 8	2.44	2.13	2354	6.3	10
HS 10	3.05	2.74	4327	13.2	20
HS 12	3.66	3.35	7164	23.8	35.2

Depth = Depth from outlet invert to inside bottom of tank

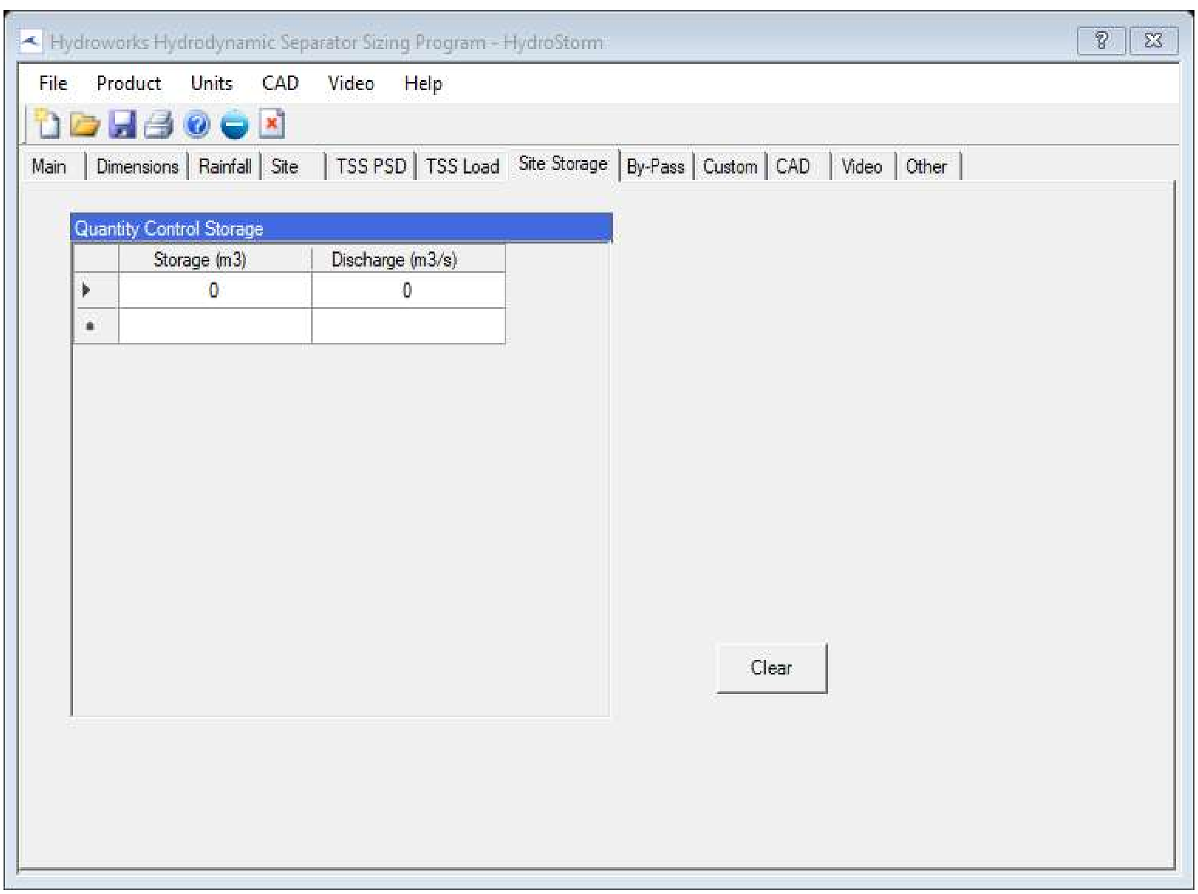
Generic HS 12 CAD Drawing



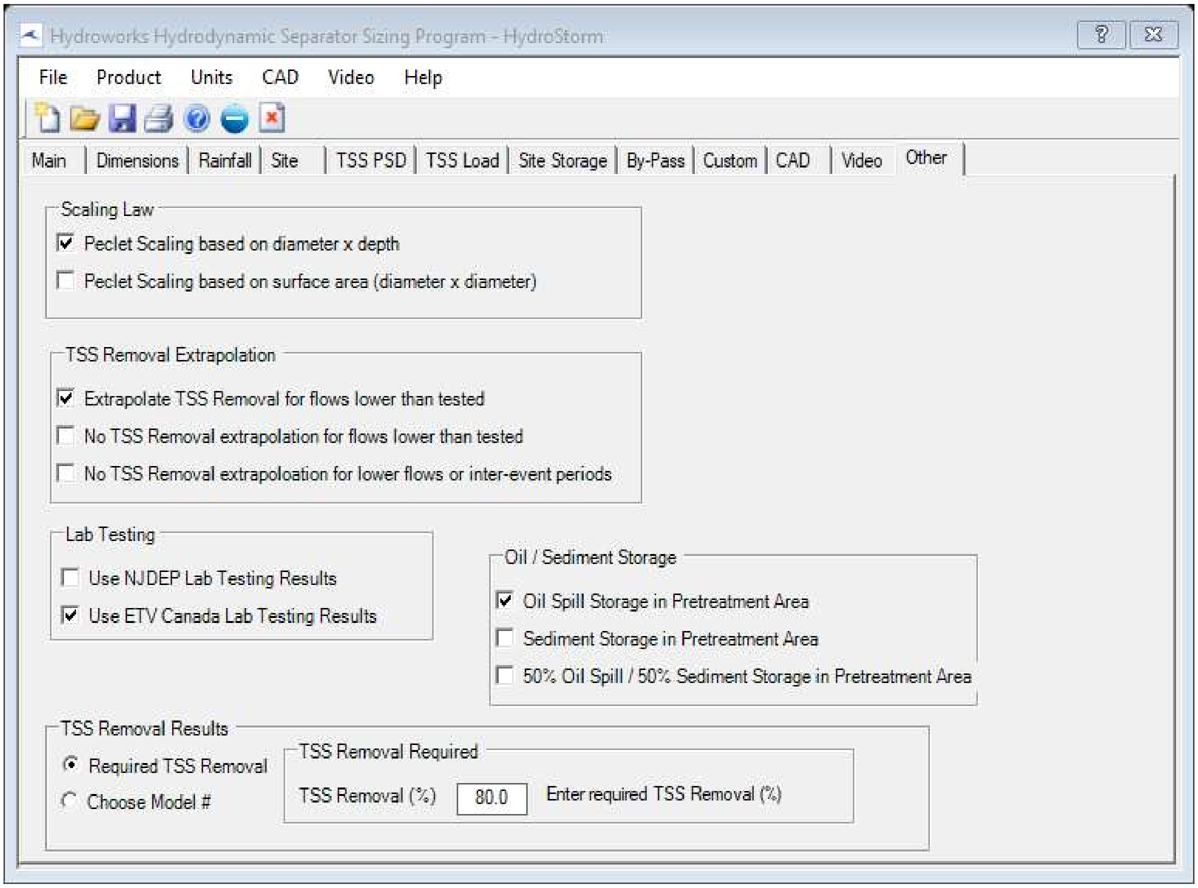
TSS Buildup And Washoff



Upstream Quantity Storage



Other Parameters



Flagged Issues

None

Hydroworks Sizing Program - Version 5.8.5

1-800-290-7900
www.hydroworks.com

Hydroworks® HydroStorm

Operations & Maintenance Manual

Version 1.2

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

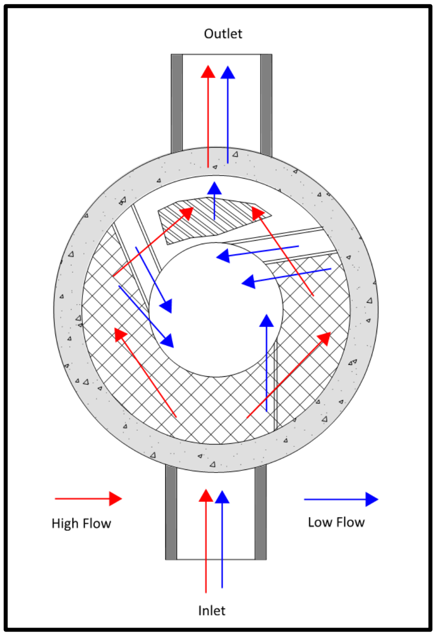


Figure 1. Hydroworks HydroStorm Operation – Plan View

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

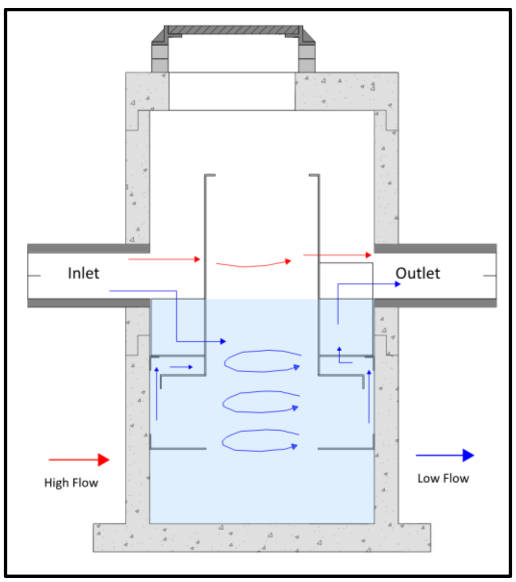


Figure 2. Hydroworks HydroStorm Operation – Profile View

Hydroworks

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.

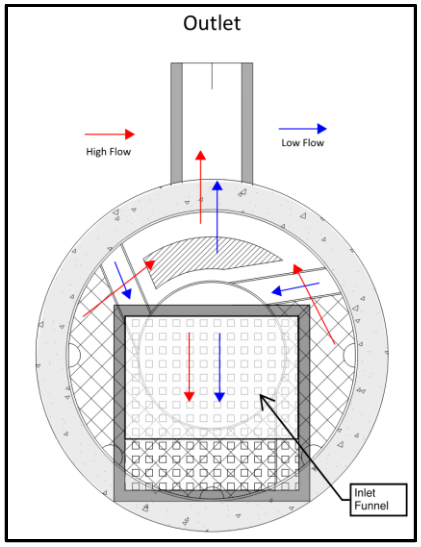


Figure 3. Hydroworks HS 4i Funnel

Construction Materials

The inner chamber and outlet baffle are made out of a copolymer plastic. The shell of the structure is pre-cast concrete. Pre-cast concrete is readily accepted by all municipalities since it has the following advantages:

- long service life
- ease of installation (less dependent on backfill (contractor proficiency) for structural integrity)
- concrete structures are designed for both anti-buoyancy and traffic loading without any field requirements (such as structural loading slabs in traffic areas and anti-buoyancy slabs to prevent groundwater uplift).
- low maintenance requirements

Hydroworks HS Separator Dimensions and Capacities

The HS separator is manufactured in a variety of sizes from 4 ft inside diameter to 12 ft inside diameter as shown in Table 1. Larger sizes may not be available in all areas. Please check with Hydroworks to ensure availability of the larger model sizes.

Table 1. Hydroworks HS Separator Dimensions*					
Model	Structure Inside Diam. (SID) (mm)	Structure Depth (mm)*	Sediment/ Sinking Trash Volume (L)	Oil/Floating Trash Volume (L)	Permanent Pool Wet Volume (L)
HS 3	900	1050	420	150	700
HS 4	1200	1200	845	355	1420
HS 5	1500	1500	1695	620	2775
HS 6	1800	1800	3110	1020	4800
HS 7	2100	1950	4530	1550	7080
HS 8	2400	2100	6225	2325	9960
HS 9	2700	2400	9200	3195	14410
HS 10	3000	2700	13025	4275	20015
HS 12	3600	3000	20525	7095	30535

*Dimensions vary with project requirements

The volumes provided in Table 1 for oil and sediment are to full capacity and not indicative of recommended depths/volumes for maintenance.

Headloss

Any water quality system implemented in a storm drain network will create headloss in the system. In general, depending on the configuration of the by-pass, systems designed to treat high flows or all of the flow will have a higher headloss impact on the storm drain network than systems that by-pass high flows.

The headloss created by the HS separator was measured in an independent laboratory (Alden Research Laboratory) for a full-scale HS 4. The K value (h = K v2/(2g)) for headloss calculations was determined to be 1.04 as shown in Figure 3.

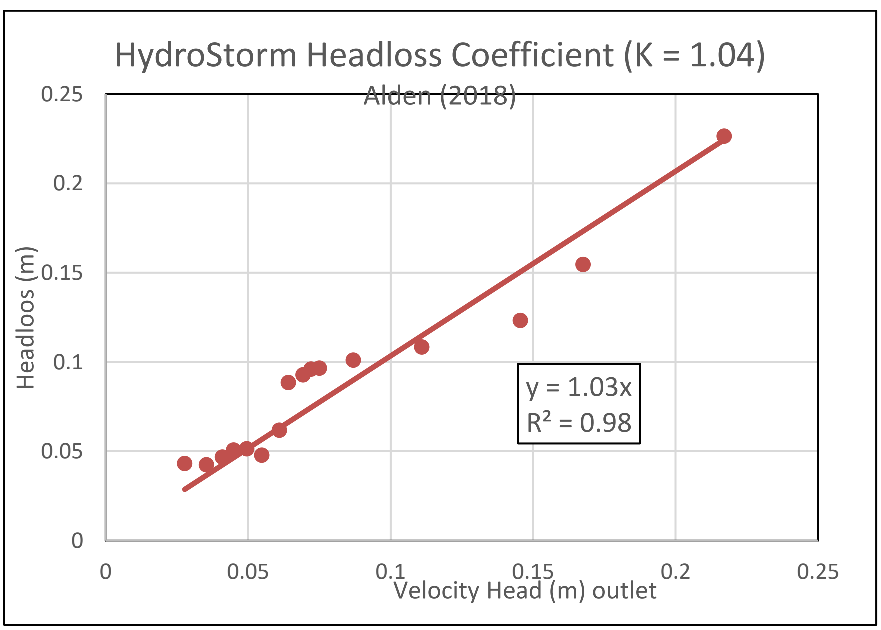


Figure 3. HydroStorm Headloss K Factor (1.04)

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.

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" (600 mm) 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.

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).

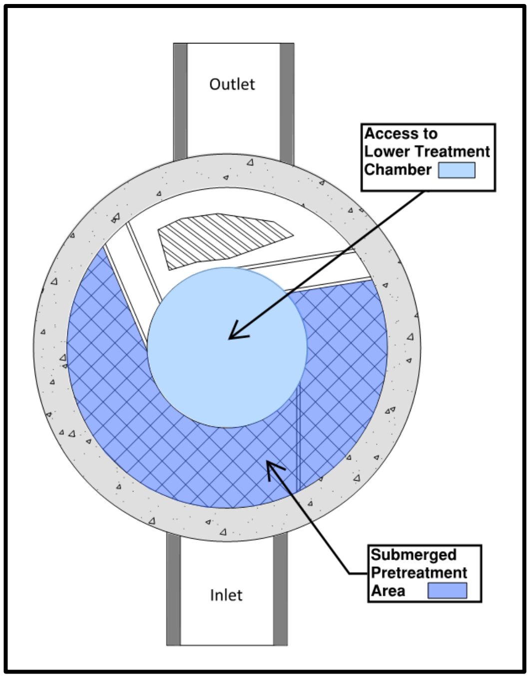


Figure 3. Maintenance Access

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.(150 mm). The sump depths given in Table 1 are scaled larger than required based on standard scaling requirements (NJDEP, ETV Canada). Accordingly maintenance depths for units larger than the HS 4 will be larger than 300 mm.

There will be designs with increased sediment storage based on specifications or site-specific criteria. A measurement of the total depth in the separator through the central access tube should be taken and compared to sump depth given in Table 1.

The standard sump depth from Table 1 should be subtracted from the measured depth and the resulting extra depth should be added to the values given in Table 2 to determine the site-specific sediment maintenance depth for that separator.

For example, if the measured sump depth in the HS-7 is 7.5 feet, then the sediment maintenance depth for that HS-7 is 2.25 ft (= 0.5 + 1.75) and the separator does not need to be cleaned for sediment accumulation until the measure sediment depth is 2.25 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 2 Standard Maintenance Depths for HydroStorm Models

Model	Diameter ft (mm)	Sediment Maintenance Depth for Total Water Depth ft (mm)*
HS-3	3 (900)	1 (300)
HS-4	4 (1200)	1 (300)
HS-5	5 (1500)	1.75 (530)
HS-6	6 (1800)	2 (610)
HS-7	7 (2100)	1.75 (535)
HS-8	8 (2400)	1.5 (465)
HS-9	9 (2700)	1.75 (540)
HS-10	10 (3000)	2 (615)
HS-12	12 (3600)	1.5 (470)

*based on standard sump depths in Table 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.