499 Mohawk Road East
City of Hamilton

Storm Water Management Report

July 2022

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1.0 INTRODUCTION

Lamarre Consulting Group Inc. has been retained by LanHack Consultants Inc. to assess the storm water management requirements relating to the proposed re-development of the former Walmart Plaza located at 499 Mohawk Road East in the City of Hamilton. The property is approximately 3.896 ha in size and is located at the north-west corner of the intersection of Upper Sherman Avenue and Mohawk Road East.

Figure 1 – Site Location Map

The site was previously the Walmart plaza and consisted of a large single building with associated parking. The coverage of the site under existing conditions is approximately 100%.

It is proposed to develop the property with multi-storey buildings with underground parking. The site will be approximately 70.0% covered with impervious surfaces under the proposed scenario. This report will review the recommended storm water management strategy used to develop the proposed site in accordance with City of Hamilton storm water management criteria.

2.0 STORMWATER MANAGEMENT

The following section will describe the proposed stormwater management (SWM) plan for the existing and proposed development conditions.

2.1 Stormwater Management Criteria

There is a 900mm combined sewer to the east of the site on Upper Sherman Avenue. This sewer currently collects all storm and sanitary runoff from the subject lands. Based on the City of Hamilton standard conditions the following stormwater management (SWM) criteria will be applied to the site:

Stormwater Quantity Control

The 100yr post-development peak flow should be controlled to the 2-year pre-development flow taking into account the difference in sanitary flows to the receiving system.

Stormwater Quality Control

Water quality control requirement is to provide Level 1 (enhanced) treatment levels for the proposed site works as per the MOECC SWM Practices Planning and Design Manual (2003).

2.2 Existing/Proposed Conditions

The existing and proposed conditions were assessed using the SWMHYMO Hydrologic Modeling and the 2-year and 100-year IDF parameters for the City of Hamilton design storms.

Under existing conditions the 2yr peak flow to the City of Hamilton sewer system is estimated to be 897 l/s. The existing sanitary peak flow to the sewer system is estimated to be 11.2 l/s. Hence the total allowable 100yr peak flow to the sewer system is **908.2 l/s** based on City of Hamilton criteria.

It is estimated that the peak sanitary flows would increase to 80.3 l/s with the proposed development. Hence, the 100yr peak storm outlet rate from this site must be limited to **827.9 l/s** to meet the City of Hamilton criteria.

To control the storm runoff release rate to the Upper Sherman sewer system it is proposed to collect all site runoff internally. The storm runoff will be collected into a storm water tank to be located within the underground parking adjacent to Upper Sherman. The required tank footprint is estimated at **210m^2** with a total volume of **840m^3** It is proposed to control the outlet rate from the site using a **450mm orifice pipe** connecting the storage tank to the combined sewer on Upper Sherman Avenue. The depth of water in the SWM tank under a 100-year storm event will be approximately 3.08m (647m^3 at elevation 207.19). The 100yr peak flow to the Upper Sherman

combined sewer would be controlled to 737 l/s plus the post-development sanitary flows of 80.3 l/s for a total flow rate of **817.3 l/s**.

See SWMHYMO model analysis in **Appendix B** for more detail. Table 2.1 summarizes the stage-storage-discharge characteristics for the underground SWM tank.

Table 1: Stage-Storage-Discharge Relationship for Stormwater (SWM) Storage Tank

Stage Storage Discharge
Upper Sherman Outlet Tank

Input Data:		Orifice Diameter	450	mm				
		Orifice Elevation	204.11	Invert	204.335	Center		
		Pipe Diameter	300	mm	Overflow Pipe			
		Pipe Elevation		Invert		Center		
		C Co-efficient	0.62					

Stage Storage Discharge

Elev. (m)	Incr. Elev. (m)	Area Tank (m2)	Depth (m)	Total Volume (m3)		Orifice Outlet (m3/s)	Orifice Outlet (m3/s)	Total Outflow (m3/s)
204.11	0	210	0	0		0		0
204.41	0.30	210	0.30	63		0.120		0.120
204.71	0.30	210	0.60	126		0.267		0.267
205.01	0.30	210	0.90	189		0.359		0.359
205.31	0.30	210	1.20	252		0.431		0.431
205.61	0.30	210	1.50	315		0.493		0.493
205.91	0.30	210	1.80	378		0.548		0.548
206.21	0.30	210	2.10	441		0.598		0.598
206.51	0.30	210	2.40	504		0.644		0.644
206.81	0.30	210	2.70	567		0.687		0.687
207.11	0.30	210	3.00	630		0.728		0.728
207.41	0.30	210	3.30	693		0.766		0.766
207.71	0.30	210	3.60	756		0.802		0.802
208.11	0.40	210	4.00	840		0.849		0.849

***Table 2.2 Hydrologic modelling results**.*

	2yr (m^3/s)
Pre-Development	
2yr Storm Peak Flow l/s	897
Sanitary Peak Flow Rate l/s	11.2
Total Outlet Rate l/s	**908.2**
Post- Development	
100yr Storm Peak Inflow to Tank l/s	1607
Storage Volume m^3	647
Depth m	3.08
100yr Controlled Peak Outlet l/s	737
Sanitary Peak Flow Rate l/s	80.3
Total Outlet Rate l/s	**817.3**

Stormwater Quality Control

Level 1 enhanced quality control for the proposed site works is required. It is proposed to install a single Jellyfish JF10-13-4 stormwater treatment unit downstream of the storm tank. Based on the DJDEP/ETV distribution, this unit is sized to provide 90.0% TSS removal, "enhanced" treatment, for the new paved surfaces, excluding the buildings. The installation of an OGS unit on this site will significantly improve storm runoff quality from the property as the existing commercial use has no water quality treatment measures in place. See Servicing Plan for the JF1—13-4 location and refer to the detailed Jellyfish sizing report prepared by Imbrium in **Appendix C** for further detail.

2.3 Sediment and Erosion Control

During development of the site, it is important that sediment disturbed by the construction operations are controlled and maintained throughout the construction period. Sediment and erosion control measures will be implemented on site during construction and will conform to the Erosion & Sediment Control Guideline for Urban Construction and City of Hamilton Standards.

Sediment and erosion control measures will include:

- Installation of silt control fencing at strategic locations around the perimeter of the site where feasible;

- Preventing silt or sediment laden water from entering inlets (existing catch basins/catch basin manholes) by wrapping their tops with filter fabric or installing silt sacks, where feasible;
- Maintaining sediment and erosion control structures in good repair (including periodic cleaning as required) until such time that the Engineer or City of Hamilton approves their removal. Erosion control measures to be inspected daily and after any rainfall event.
- Should excess mud-tracking occur during construction, mud-mats shall be installed to assist with mud-tracking control; where feasible.

2.4 Conclusions and Recommendations

Based on the information provided herein, we conclude that:

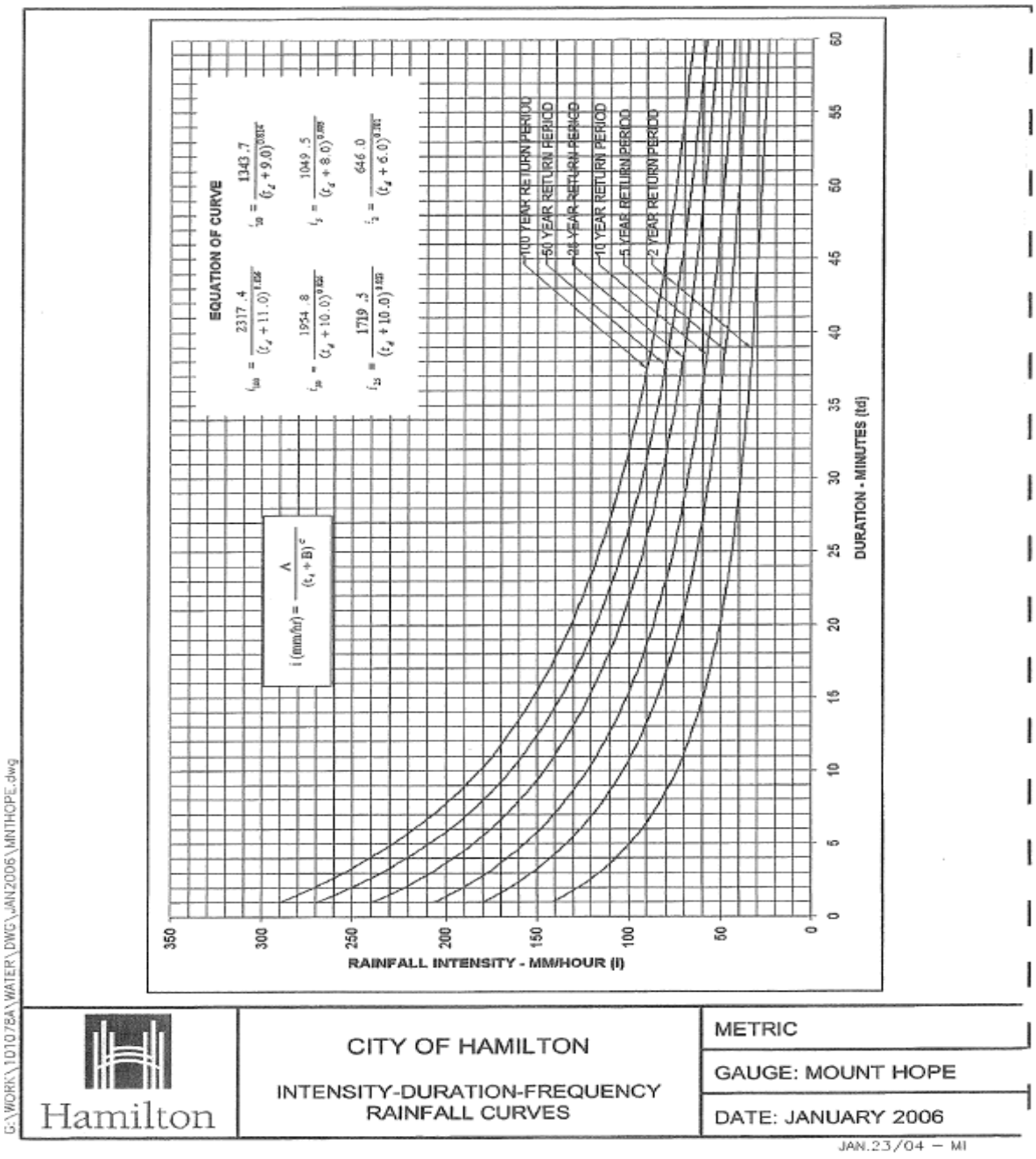
- The 100yr peak runoff rate from this site into the Upper Sherman sewer system will effectively be controlled to the existing 2yr peak rate, taking into account the estimated increase in sanitary sewer flow. This is achieved through the installation of a 647m^3 on-site storage with a 450mm orifice pipe to restrict the outlet rate.
- Quality of site storm water runoff from the paved areas will be to MOECC enhanced levels through the installation of a Jellyfish JF10-13-4 unit downstream of the stormwater management tank outlet.
- Erosion and sediment controls be installed as described in section 2.3 of this report.

Respectfully submitted,

John Lamarre, P.Eng.
Lamarre Consulting Group Inc.

APPENDIX A: Stormwater Management Information

The rainfall intensities used in the SWMHYMO Modeling Program were taken from the IDF Curve from the City of Hamilton design guidelines.



Design storm information used in the hydrologic modeling was based on Chicago Storm Distribution Intensity-Duration Frequency (IDF) equations for the City of Hamilton in the form:

$$i = \frac{A}{(t+B)^C}$$

- i = rainfall intensity (mm/hour)
- t = time of concentration in minutes (10 minutes)
- A, B and C = constant (see above)

APPENDIX B: SWMHYMO Input and Output

```
2
*#**********************************
*#                      *
*#  499 Mohawk Road East        *
*#                      *
*#                      *
*# DATE: July 2022             *
*# FILE:   499Mohawk.dat        *
*#                      *
*#**********************************
*#
START             TZERO=0.0hrs  METRIC=2 NSTORM=1 NRUN=1

*#---------------------------------------------------------------------
*# PRE-DEVELOPMENT 2yr
*#---------------------------------------------------------------------

CHICAGO STORM        IUNITS=2  TD=4hrs TPRAT=.40  DT=5 min
               ICASEcs=1    A=646  B=6  C=.781

CALIB STANDHYD       ID=1 NHYD=100 DT=5 min AREA=3.896ha XIMP=0.99
                TIMP=0.99  DWF=0 cms LOSS=2 CN=74
                IAper=5.0 mm SLPP=1.0% LGP=160m MNP=0.250 SCP=0.0
                IAimp=1.0 mm SLPI=1.0% LGI= 160m  MNI=0.014  SCI=0.0 -1


*#---------------------------------------------------------------------
*# POST DEVELOPMENT 100yr
*#---------------------------------------------------------------------

CHICAGO STORM      IUNITS=2  TD=4hrs TPRAT=.40  DT=5 min
               ICASEcs=1  A=2317.4  B=11  C=.836

CALIB STANDHYD     ID=2 NHYD=200 DT=5 min AREA=3.896ha XIMP=0.70
               TIMP=0.70  DWF=0 cms LOSS=2 CN=74
               IAper=5.0 mm SLPP=1.0% LGP=160m MNP=0.250 SCP=0.0
               IAimp=1.0 mm SLPI=1.0% LGI= 160m  MNI=0.014  SCI=0.0 -1
*#---------------------------------------------------------------------
*# STORAGE TANK WITH 525mm ORIFICE
ROUTE RESERVOIR    ID=3 NHYD=200  IDIN=2  DT=2min
                DISCH(cms)  STORAGE(ha m)
                  0.000        .0000
                  0.120        .0063
                  0.267        .0126
                  0.359        .0189
                  0.431        .0252
                  0.493        .0315
                  0.548        .0378
                  0.598        .0441
                  0.644        .0504
                  0.687        .0567
                  0.728        .0630
                  0.766        .0693
                  0.802        .0756
                  0.849        .0840    -1  -1

FINISH
```

```
********** S U M M A R Y  O U T P U T **********
*****************************************************************************************************
*            RUN DATE: 2022-08-02    TIME: 16:20:16    RUN COUNTER: 000001            *
*****************************************************************************************************
* Input   file: D:\WORK FILES\2022 Projects\2208 - 499 Mohawk Road East\499Mohawk.dat          *
* Output  file: D:\WORK FILES\2022 Projects\2208 - 499 Mohawk Road East\499Mohawk.out          *
* Summary file: D:\WORK FILES\2022 Projects\2208 - 499 Mohawk Road East\499Mohawk.sum          *
* User comments:                                                *
* 1:_____*
* 2:_____*
* 3:_____*
*****************************************************************************************************


#**********

#                    *
#  499 Mohawk Road East        *

#                    *
#                    *
# DATE: July 2022            *

# FILE:   499Mohawk.dat        *

#                    *
#**********

#
 RUN#:COMMAND#
R0001:C00001---------------------------------------------------------------------------------
   START
    [TZERO =    .00 hrs on       0]
    [METOUT=   2    (1=imperial, 2=metric output)]
    [NSTORM=   1 ]
    [NRUN  = 0001 ]
#---------------------------------------------------------------

# PRE-DEVELOPMENT 2yr

#---------------------------------------------------------------

R0001:C00002---------------------------------------------------------------------------------
   CHICAGO STORM
    [SDT= 5.00:SDUR=   4.00:PTOT=  35.07]
    [A/B/C= 646.000/   6.000/    .781]
R0001:C00003-----------DTmin-ID:NHYD---------AREAha-QPEAKcms-TpeakDate_hh:mm----RVmm-R.C.---DWFcms
*  CALIB STANDHYD       5.0 01:      100     3.90    .887 No_date    1:35   33.80 .964     .000
    [XIMP=.99:TIMP=.99]
    [LOSS= 2 :CN= 74.0]
    [Pervious     area: IAper= 5.00:SLPP=1.00:LGP= 160.:MNP=.250:SCP=   .0]
    [Impervious   area: IAimp= 1.00:SLPI=1.00:LGI= 160.:MNI=.014:SCI=   .0]
#---------------------------------------------------------------

# POST DEVELOPMENT 100yr

#---------------------------------------------------------------

R0001:C00004---------------------------------------------------------------------------------
   CHICAGO STORM
    [SDT= 5.00:SDUR=   4.00:PTOT=  91.39]
```

```
    [A/B/C=2317.400/  11.000/    .836]
R0001:C00005------------DTmin-ID:NHYD---------AREAha-QPEAKcms-TpeakDate_hh:mm----RVmm-R.C.---DWFcms
 *  CALIB STANDHYD       5.0 02:      200     3.90    1.607 No_date    1:35   76.02 .832     .000
    [XIMP=.70:TIMP=.70]
    [LOSS= 2 :CN= 74.0]
    [Pervious     area: IAper= 5.00:SLPP=1.00:LGP= 160.:MNP=.250:SCP=   .0]
    [Impervious   area: IAimp= 1.00:SLPI=1.00:LGI= 160.:MNI=.014:SCI=   .0]
#-------------------------------------------------------------------------

# STORAGE TANK WITH 525mm ORIFICE

R0001:C00006------------DTmin-ID:NHYD---------AREAha-QPEAKcms-TpeakDate_hh:mm----RVmm-R.C.---DWFcms
   ROUTE RESERVOIR ->    5.0 02:      200     3.90    1.607 No_date    1:35   76.02  n/a     .000
            out <=    1.7 03:      200     3.90     .737 No_date    1:43   76.02  n/a     .000
    {MxStoUsed=.6469E-01  m3}
R0001:C00007-----------------------------------------------------------------------------------------
   FINISH
```

APPENDIX C: Jellyfish Sizing

STANDARD OFFLINE
Jellyfish Filter Sizing Report

Project Information

Date	Wednesday, July 27, 2022
Project Name	499 Mohawk Rd. E
Project Number	
Location	Hamilton

Jellyfish Filter Design Overview

This report provides information for the sizing and specification of the Jellyfish Filter. When designed properly in accordance to the guidelines detailed in the Jellyfish Filter Technical Manual, the Jellyfish Filter will exceed the performance and longevity of conventional horizontal bed and granular media filters.
Please see ***www.ImbriumSystems.com*** *for more information.*

Jellyfish Filter System Recommendation

The Jellyfish Filter model JF10-13-4 is recommended to meet the water quality objective by treating a flow of 75.7 L/s, which meets or exceeds 90% of the average annual rainfall runoff volume based on 34 years of HAMILTON A rainfall data for this site. This model has a sediment capacity of 853 kg, which meets or exceeds the estimated average annual sediment load.

Jellyfish Model	Number of High-Flo Cartridges	Number of Draindown Cartridges	Manhole Diameter (m)	Treatment Flow Rate (L/s)	Sediment Capacity (kg)
JF10-13-4	13	4	3.0	75.7	853

The Jellyfish Filter System

The patented Jellyfish Filter is an engineered stormwater quality treatment technology featuring unique membrane filtration in a compact stand-alone treatment system that removes a high level and wide variety of stormwater pollutants. Exceptional pollutant removal is achieved at high treatment flow rates with minimal head loss and low maintenance costs. Each lightweight Jellyfish Filter cartridge contains an extraordinarily large amount of membrane surface area, resulting in superior flow capacity and pollutant removal capacity.

Maintenance

Regular scheduled inspections and maintenance is necessary to assure proper functioning of the Jellyfish Filter. The maintenance interval is designed to be a minimum of 12 months, but this will vary depending on site loading conditions and upstream pretreatment measures. Quarterly inspections and inspections after all storms beyond the 5-year event are recommended until enough historical performance data has been logged to comfortably initiate an alternative inspection interval.

Please see ***www.ImbriumSystems.com*** *for more information.*

Thank you for the opportunity to present this information to you and your client.

Performance

Jellyfish efficiently captures a high level of Stormwater pollutants, including:

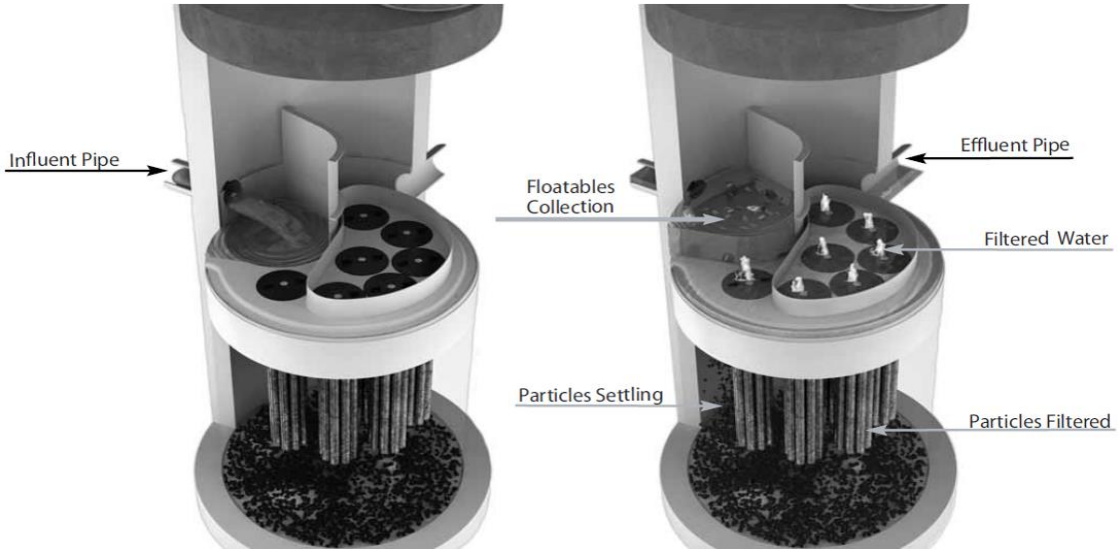
- ☑ 89% of the total suspended solids (TSS) load, including particles less than 5 microns
- ☑ 77% TP removal & 51% TN removal
- ☑ 90% Total Copper, 81% Total Lead, 70% Total Zinc
- ☑ Particulate-bound pollutants such as nutrients, toxic metals, hydrocarbons and bacteria
- ☑ Free oil, Floatable trash and debris

Field Proven Peformance

The Jellyfish filter has been field-tested on an urban site with 25 TARP qualifying rain events and field monitored according to the TARP field test protocol, demonstrating:

- A median TSS removal efficiency of 89%, and a median SSC removal of 99%;
- The ability to capture fine particles as indicated by an effluent d50 median of 3 microns for all monitotred storm events, and a median effluent turbidity of 5 NTUs;
- A median Total Phosphorus removal of 77%, and a median Total Nitrogen removal of 51%.

Jellyfish Filter Treatment Functions



Pre-treatment and Membrane Filtration

Jellyfish® Filter

Project Information

Date:	Wednesday, July 27, 2022
Project Name:	499 Mohawk Rd. E
Project Number:	
Location:	Hamilton

Designer Information

Company:	Lamarre Consulting Group Inc.
Contact:	John Lamarre
Phone #:	

Notes

Rainfall

Name:	HAMILTON A
State:	ON
ID:	3194
Record:	1970 to 2003
Co-ords:	43°10.N'N, 79°56.W'N

Drainage Area

Total Area:	3.96 ha
Imperviousness:	70%

Upstream Detention

Peak Release Rate:	n/a
Pretreatment Credit:	n/a

Design System Requirements

Flow Loading	90% of the Average Annual Runoff based on 34 years of HAMILTON A rainfall data:	**62.4 L/s**
Sediment Loading	Treating 90% of the average annual runoff volume, 13956 m³, with a suspended sediment concentration of 60 mg/L.	**837 kg***

** Indicates that sediment loading is the limiting parameter in the sizing of this Jellyfish system*

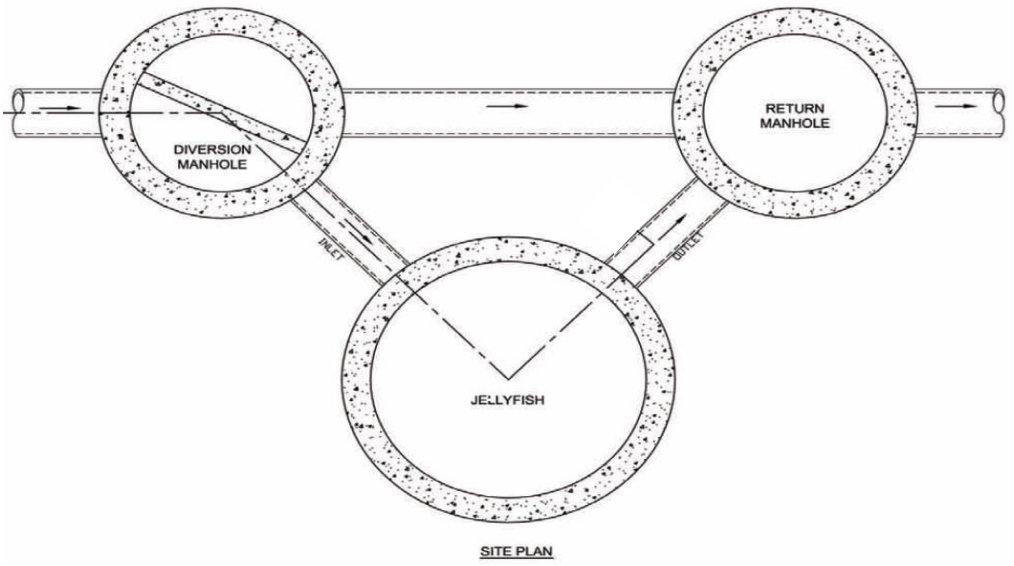
Recommendation

The Jellyfish Filter model JF10-13-4 is recommended to meet the water quality objective by treating a flow of 75.7 L/s, which meets or exceeds 90% of the average annual rainfall runoff volume based on 34 years of HAMILTON A rainfall data for this site. This model has a sediment capacity of 853 kg, which meets or exceeds the estimated average annual sediment load.

Jellyfish Model	Number of High-Flo Cartridges	Number of Draindown Cartridges	Manhole Diameter (m)	Wet Vol Below Deck (L)	Sump Storage (m³)	Oil Capacity (L)	Treatment Flow Rate (L/s)	Sediment Capacity (kg)
JF4-1-1	1	1	1.2	2313	0.34	379	7.6	85
JF4-2-1	2	1	1.2	2313	0.34	379	12.6	142
JF6-3-1	3	1	1.8	5205	0.79	848	17.7	199
JF6-4-1	4	1	1.8	5205	0.79	848	22.7	256
JF6-5-1	5	1	1.8	5205	0.79	848	27.8	313
JF6-6-1	6	1	1.8	5205	0.79	848	28.6	370
JF8-6-2	6	2	2.4	9252	1.42	1469	35.3	398
JF8-7-2	7	2	2.4	9252	1.42	1469	40.4	455
JF8-8-2	8	2	2.4	9252	1.42	1469	45.4	512
JF8-9-2	9	2	2.4	9252	1.42	1469	50.5	569
JF8-10-2	10	2	2.4	9252	1.42	1469	50.5	626
JF10-11-3	11	3	3.0	14456	2.21	2302	63.1	711
JF10-12-3	12	3	3.0	14456	2.21	2302	68.2	768
JF10-12-4	12	4	3.0	14456	2.21	2302	70.7	796
JF10-13-4	**13**	**4**	**3.0**	**14456**	**2.21**	**2302**	**75.7**	**853**
JF10-14-4	14	4	3.0	14456	2.21	2302	78.9	910
JF10-15-4	15	4	3.0	14456	2.21	2302	78.9	967
JF10-16-4	16	4	3.0	14456	2.21	2302	78.9	1024
JF10-17-4	17	4	3.0	14456	2.21	2302	78.9	1081
JF10-18-4	18	4	3.0	14456	2.21	2302	78.9	1138
JF10-19-4	19	4	3.0	14456	2.21	2302	78.9	1195
JF12-20-5	20	5	3.6	20820	3.2	2771	113.6	1280
JF12-21-5	21	5	3.6	20820	3.2	2771	113.7	1337
JF12-22-5	22	5	3.6	20820	3.2	2771	113.7	1394
JF12-23-5	23	5	3.6	20820	3.2	2771	113.7	1451
JF12-24-5	24	5	3.6	20820	3.2	2771	113.7	1508
JF12-25-5	25	5	3.6	20820	3.2	2771	113.7	1565
JF12-26-5	26	5	3.6	20820	3.2	2771	113.7	1622
JF12-27-5	27	5	3.6	20820	3.2	2771	113.7	1679

Jellyfish Filter Design Notes

- Typically the Jellyfish Filter is designed in an offline configuration, as all stormwater filter systems will perform for a longer duration between required maintenance services when designed and applied in off-line configurations. Depending on the design parameters, an optional internal bypass may be incorporated into the Jellyfish Filter, however note the inspection and maintenance frequency should be expected to increase above that of an off-line system. Speak to your local representative for more information.



Jellyfish Filter Typical Layout

- Typically, 18 inches (457 mm) of driving head is designed into the system, calculated as the difference in elevation between the top of the diversion structure weir and the invert of the Jellyfish Filter outlet pipe. Alternative driving head values can be designed as 12 to 24 inches (305 to 610mm) depending on specific site requirements, requiring additional sizing and design assistance.
- Typically, the Jellyfish Filter is designed with the inlet pipe configured 6 inches (150 mm) above the outlet invert elevation. However, depending on site parameters this can vary to an optional configuration of the inlet pipe entering the unit below the outlet invert elevation.
- The Jellyfish Filter can accommodate multiple inlet pipes within certain restrictions.
- While the optional inlet below deck configuration offers 0 to 360 degree flexibility between the inlet and outlet pipe, typical systems conform to the following:

Model Diameter (m)	Minimum Angle Inlet / Outlet Pipes	Minimum Inlet Pipe Diameter (mm)	Minimum Outlet Pipe Diameter (mm)
1.2	62º	150	200
1.8	59º	200	250
2.4	52º	250	300
3.0	**48º**	**300**	**450**
3.6	40º	300	450

- The Jellyfish Filter can be built at all depths of cover generally associated with conventional stormwater conveyance systems. For sites that require minimal depth of cover for the stormwater infrastructure, the Jellyfish Filter can be applied in a shallow application using a hatch cover. The general minimum depth of cover is 36 inches (915 mm) from top of the underslab to outlet invert.
- If driving head caclulations account for water elevation during submerged conditions the Jellyfish Filter will function effectively under submerged condtions.
- Jellyfish Filter systems may incorporate grated inlets depending on system configuration.
- For sites with water quality treatment flow rates or mass loadings that exceed the design flow rate of the largest standard Jellyfish Filter manhole models, systems can be designed that hydraulically connect multiple Jellyfish Filters in series or alternatively Jellyfish Vault units can be designed.

STANDARD SPECIFICATION
STORMWATER QUALITY – MEMBRANE FILTRATION TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

Specifies requirements for construction and performance of an underground stormwater quality membrane filtration treatment device that removes pollutants from stormwater runoff through the unit operations of sedimentation, floatation, and membrane filtration.

1.2 REFERENCE STANDARDS

ASTM C 891: Specification for Installation of Underground Precast Concrete Utility Structures
ASTM C 478: Specification for Precast Reinforced Concrete Manhole Sections
ASTM C 443: Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM D 4101: Specification for Copolymer steps construction

CAN/CSA-A257.4-M92
Joints for Circular Concrete Sewer and Culvert Pipe, Manhole Sections and Fittings Using Rubber Gaskets

CAN/CSA-A257.4-M92
Precast Reinforced Circular Concrete Manhole Sections, Catch Basins and Fittings

Canadian Highway Bridge Design Code

1.3 SHOP DRAWINGS

Shop drawings for the structure and performance are to be submitted with each order to the contractor. Contractor shall forward shop drawing submittal to the consulting engineer for approval. Shop drawings are to detail the structure's precast concrete and call out or note the fiberglass (FRP) internals/components.

1.4 PRODUCT SUBSTITUTIONS

No product substitutions shall be accepted unless submitted 10 days prior to project bid date, or as directed by the engineer of record. Submissions for substitutions require review and approval by the Engineer of Record, for hydraulic performance, impact to project designs, equivalent treatment performance, and any required project plan and report (hydrology/hydraulic, water quality, stormwater pollution) modifications that would be required by the approving jurisdictions/agencies. Contractor to coordinate with the Engineer of Record any applicable modifications to the project estimates of cost, bonding amount determinations, plan check fees for changes to approved documents, and/or any other regulatory requirements resulting from the product substitution.

1.5 HANDLING AND STORAGE

Prevent damage to materials during storage and handling.

PART 2 – PRODUCTS

2.1 GENERAL

2.1.1 The device shall be a cylindrical or rectangular, all concrete structure (including risers), constructed from precast concrete riser and slab components or monolithic precast structure(s), installed to conform to ASTM C 891 and to any required state highway, municipal or local specifications; whichever is more stringent. The device shall be watertight.

2.1.2 Cartridge Deck The cylindrical concrete device shall include a fiberglass deck. The rectangular concrete device shall include a coated aluminum deck. In either instance, the insert shall be bolted and sealed watertight inside the precast concrete chamber. The deck shall serve as: (a) a horizontal divider between the lower treatment zone and the upper treated effluent zone; (b) a deck for attachment of filter cartridges such that the membrane filter elements of each cartridge extend into the lower treatment zone; (c) a platform for maintenance workers to service the filter cartridges (maximum manned weight = 450 pounds (204 kg)); (d) a conduit for conveyance of treated water to the effluent pipe.

2.1.3 Membrane Filter Cartridges Filter cartridges shall be comprised of reusable cylindrical membrane filter elements connected to a perforated head plate. The number of membrane filter elements per cartridge shall be a minimum of eleven 2.75-inch (70-mm) diameter elements. The length of each filter element shall be a minimum 15 inches (381 mm). Each cartridge shall be fitted into the cartridge deck by insertion into a cartridge receptacle that is permanently mounted into the cartridge deck. Each cartridge shall be secured by a cartridge lid that is threaded onto the receptacle, or similar mechanism to secure the cartridge into the deck. The maximum treatment flow rate of a filter cartridge shall be controlled by an orifice in the cartridge lid, or on the individual cartridge itself, and based on a design flux rate (surface loading rate) determined by the maximum treatment flow rate per unit of filtration membrane surface area. The maximum design flux rate shall be 0.21 gpm/ft² (0.142 lps/m²).

Each membrane filter cartridge shall allow for manual installation and removal. Each filter cartridge shall have filtration membrane surface area and dry installation weight as follows (if length of filter cartridge is between those listed below, the surface area and weight shall be proportionate to the next length shorter and next length longer as shown below):

Filter Cartridge Length (in / mm)	Minimum Filtration Membrane Surface Area (ft2 / m2)	Maximum Filter Cartridge Dry Weight (lbs / kg)
15	106 / 9.8	10.5 / 4.8
27	190 / 17.7	15.0 / 6.8
40	282 / 26.2	20.5 / 9.3
54	381 / 35.4	25.5 / 11.6

2.1.4 Backwashing Cartridges The filter device shall have a weir extending above the cartridge deck, or other mechanism, that encloses the high flow rate filter cartridges when placed in their respective cartridge receptacles within the cartridge deck. The weir, or other mechanism, shall collect a pool of filtered water during inflow events that backwashes the high flow rate cartridges when the inflow

event subsides. All filter cartridges and membranes shall be reusable and allow for the use of filtration membrane rinsing procedures to restore flow capacity and sediment capacity; extending cartridge service life.

2.1.5 Maintenance Access to Captured Pollutants The filter device shall contain an opening(s) that provides maintenance access for removal of accumulated floatable pollutants and sediment, removal of and replacement of filter cartridges, cleaning of the sump, and rinsing of the deck. Access shall have a minimum clear vertical clear space over all of the filter cartridges. Filter cartridges shall be able to be lifted straight vertically out of the receptacles and deck for the entire length of the cartridge.

2.1.6 Bend Structure The device shall be able to be used as a bend structure with minimum angles between inlet and outlet pipes of 90-degrees or less in the stormwater conveyance system.

2.1.7 Double-Wall Containment of Hydrocarbons The cylindrical precast concrete device shall provide double-wall containment for hydrocarbon spill capture by a combined means of an inner wall of fiberglass, to a minimum depth of 12 inches (305 mm) below the cartridge deck, and the precast vessel wall.

2.1.8 Baffle The filter device shall provide a baffle that extends from the underside of the cartridge deck to a minimum length equal to the length of the membrane filter elements. The baffle shall serve to protect the membrane filter elements from contamination by floatables and coarse sediment. The baffle shall be flexible and continuous in cylindrical configurations, and shall be a straight concrete or aluminum wall in rectangular configurations.

2.1.9 Sump The device shall include a minimum 24 inches (610 mm) of sump below the bottom of the cartridges for sediment accumulation, unless otherwise specified by the design engineer. Depths less than 24 inches may have an impact on the total performance and/or longevity between cartridge maintenance/replacement of the device.

2.2 PRECAST CONCRETE SECTIONS

All precast concrete components shall be manufactured to a minimum live load of HS-20 truck loading or greater based on local regulatory specifications, unless otherwise modified or specified by the design engineer, and shall be watertight.

2.3 JOINTS All precast concrete manhole configuration joints shall use nitrile rubber gaskets and shall meet the requirements of ASTM C443, Specification C1619, Class D or engineer approved equal to ensure oil resistance. Mastic sealants or butyl tape are not an acceptable alternative.

2.4 GASKETS Only profile neoprene or nitrile rubber gaskets in accordance to CSA A257.3-M92 will be accepted. Mastic sealants, butyl tape or Conseal CS-101 are not acceptable gasket materials.

2.5 FRAME AND COVER Frame and covers must be manufactured from cast-iron or other composite material tested to withstand H-20 or greater design loads, and as approved by the

local regulatory body. Frames and covers must be embossed with the name of the device manufacturer or the device brand name.

2.6 DOORS AND HATCHES If provided shall meet designated loading requirements or at a minimum for incidental vehicular traffic.

2.7 CONCRETE All concrete components shall be manufactured according to local specifications and shall meet the requirements of ASTM C 478.

2.8 FIBERGLASS The fiberglass portion of the filter device shall be constructed in accordance with the following standard: ASTM D-4097: Contact Molded Glass Fiber Reinforced Chemical Resistant Tanks.

2.9 STEPS Steps shall be constructed according to ASTM D4101 of copolymer polypropylene, and be driven into preformed or pre-drilled holes after the concrete has cured, installed to conform to applicable sections of state, provincial and municipal building codes, highway, municipal or local specifications for the construction of such devices.

2.10 INSPECTION All precast concrete sections shall be inspected to ensure that dimensions, appearance and quality of the product meet local municipal specifications and ASTM C 478.

PART 3 – PERFORMANCE

3.1 GENERAL

3.1.1 Verification – The stormwater quality filter must be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV).

3.1.2 Function - The stormwater quality filter treatment device shall function to remove pollutants by the following unit treatment processes; sedimentation, floatation, and membrane filtration.

3.1.3 Pollutants - The stormwater quality filter treatment device shall remove oil, debris, trash, coarse and fine particulates, particulate-bound pollutants, metals and nutrients from stormwater during runoff events.

3.1.4 Bypass - The stormwater quality filter treatment device shall typically utilize an external bypass to divert excessive flows. Internal bypass systems shall be equipped with a floatables baffle, and must avoid passage through the sump and/or cartridge filtration zone.

3.1.5 Treatment Flux Rate (Surface Loading Rate) – The stormwater quality filter treatment device shall treat 100% of the required water quality treatment flow based on a maximum design treatment flux rate (surface loading rate) across the membrane filter cartridges of 0.21 gpm/ft² (0.142 lps/m²).

3.2 FIELD TEST PERFORMANCE

At a minimum, the stormwater quality filter device shall have been field tested and verified with a minimum 25 TARP qualifying storm events and field monitoring shall have been conducted according to the TARP 2009 NJDEP TARP field test protocol, and have received NJCAT verification.

3.2.1 Suspended Solids Removal - The stormwater quality filter treatment device shall have demonstrated a minimum median TSS removal efficiency of 85% and a minimum median SSC removal efficiency of 95%.

3.2.2 Runoff Volume – The stormwater quality filter treatment device shall be engineered, designed, and sized to treat a minimum of 90 percent of the annual runoff volume determined from use of a minimum 15-year rainfall data set.

3.2.3 Fine Particle Removal - The stormwater quality filter treatment device shall have demonstrated the ability to capture fine particles as indicated by a minimum median removal efficiency of 75% for the particle fraction less than 25 microns, an effluent d_{50} of 15 microns or lower for all monitored storm events.

3.2.4 Turbidity Reduction - The stormwater quality filter treatment device shall have demonstrated the ability to reduce the turbidity from influent from a range of 5 to 171 NTU to an effluent turbidity of 15 NTU or lower.

3.2.5 Nutrient (Total Phosphorus & Total Nitrogen) Removal - The stormwater quality filter treatment device shall have demonstrated a minimum median Total Phosphorus removal of 55%, and a minimum median Total Nitrogen removal of 50%.

3.2.6 Metals (Total Zinc & Total Copper) Removal - The stormwater quality filter treatment device shall have demonstrated a minimum median Total Zinc removal of 55%, and a minimum median Total Copper removal of 85%.

3.3 INSPECTION and MAINTENANCE

The stormwater quality filter device shall have the following features:

3.3.1 Durability of membranes are subject to good handling practices during inspection and maintenance (removal, rinsing, and reinsertion) events, and site specific conditions that may have heavier or lighter loading onto the cartridges, and pollutant variability that may impact the membrane structural integrity. Membrane maintenance and replacement shall be in accordance with manufacturer's recommendations.

3.3.2 Inspection which includes trash and floatables collection, sediment depth determination, and visible determination of backwash pool depth shall be easily conducted from grade (outside the structure).

3.3.3 Manual rinsing of the reusable filter cartridges shall promote restoration of the flow capacity and sediment capacity of the filter cartridges, extending cartridge service life.

3.3.4 The filter device shall have a minimum 12 inches (305 mm) of sediment storage depth, and a minimum of 12 inches between the top of the sediment storage and bottom of the filter cartridge tentacles, unless otherwise specified by the design engineer. Variances may have an impact on the total performance and/or longevity between cartridge maintenance/replacement of the device.

3.3.5 Sediment removal from the filter treatment device shall be able to be conducted using a standard maintenance truck and vacuum apparatus, and a minimum one point of entry to the sump that is unobstructed by filter cartridges.

3.3.6 Maintenance access shall have a minimum clear height that provides suitable vertical clear space over all of the filter cartridges. Filter cartridges shall be able to be lifted straight vertically out of the receptacles and deck for the entire length of the cartridge.

3.3.7 Filter cartridges shall be able to be maintained without the requirement of additional lifting equipment.

PART 4 – EXECUTION

4.1 INSTALLATION

4.1.1 PRECAST DEVICE CONSTRUCTION SEQUENCE

The installation of a watertight precast concrete device should conform to ASTM C 891 and to any state highway, municipal or local specifications for the construction of manholes, whichever is more stringent. Selected sections of a general specification that are applicable are summarized below.

4.1.1.1 The watertight precast concrete device is installed in sections in the following sequence:

- aggregate base
- base slab
- treatment chamber and cartridge deck riser section(s)
- bypass section
- connect inlet and outlet pipes
- concrete riser section(s) and/or transition slab (if required)
- maintenance riser section(s) (if required)
- frame and access cover

4.1.2 The precast base should be placed level at the specified grade. The entire base should be in contact with the underlying compacted granular material. Subsequent sections, complete with joint seals, should be installed in accordance with the precast concrete manufacturer's recommendations.

4.1.3 Adjustment of the stormwater quality treatment device can be performed by lifting the upper sections free of the excavated area, re-leveling the base, and re-installing the sections. Damaged sections and gaskets should be repaired or replaced as necessary to restore original condition and watertight seals. Once the stormwater quality treatment device has been constructed, any/all lift holes must be plugged watertight with mortar or non-shrink grout.

4.1.4 Inlet and Outlet Pipes Inlet and outlet pipes should be securely set into the device using approved pipe seals (flexible boot connections, where applicable) so that the structure is watertight, and such that any pipe intrusion into the device does not impact the device functionality.

4.1.5 Frame and Cover Installation Adjustment units (e.g. grade rings) should be installed to set the frame and cover at the required elevation. The adjustment units should be laid in a full bed of mortar with successive units being joined using sealant recommended by the manufacturer. Frames for the cover should be set in a full bed of mortar at the elevation specified.

4.2 MAINTENANCE ACCESS WALL
In some instances the Maintenance Access Wall, if provided, shall require an extension attachment and sealing to the precast wall and cartridge deck at the job site, rather than at the precast facility. In this instance, installation of these components shall be performed according to instructions provided by the manufacturer.

4.3 FILTER CARTRIDGE INSTALLATION Filter cartridges shall be installed in the cartridge deck only after the construction site is fully stabilized and in accordance with the manufacturer's guidelines and recommendations. Contractor to contact the manufacturer to schedule cartridge delivery and review procedures/requirements to be completed to the device prior to installation of the cartridges and activation of the system.

PART 5 – QUALITY ASSURANCE

5.1 FILTER CARTRIDGE INSTALLATION Manufacturer shall coordinate delivery of filter cartridges and other internal components with contractor. Filter cartridges shall be delivered and installed complete after site is stabilized and unit is ready to accept cartridges. Unit is ready to accept cartridges after is has been cleaned out and any standing water, debris, and other materials have been removed. Contractor shall take appropriate action to protect the filter cartridge receptacles and filter cartridges from damage during construction, and in accordance with the manufacturer's recommendations and guidance. For systems with cartridges installed prior to full site stabilization and prior to system activation, the contractor can plug inlet and outlet pipes to prevent stormwater and other influent from entering the device. Plugs must be removed during the activation process.

5.2 INSPECTION AND MAINTENANCE

5.2.1 The manufacturer shall provide an Owner's Manual upon request.

5.2.2 After construction and installation, and during operation, the device shall be inspected and cleaned as necessary based on the manufacturer's recommended inspection and maintenance guidelines and the local regulatory agency/body.

5.3 REPLACEMENT FILTER CARTRIDGES When replacement membrane filter elements and/or other parts are required, only membrane filter elements and parts approved by the manufacturer for use with the stormwater quality filter device shall be installed.

END OF SECTION

STANDARD PERFORMANCE SPECIFICATION
STORMWATER QUALITY – MEMBRANE FILTRATION TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground stormwater quality membrane filtration treatment device that removes pollutants from stormwater runoff through the unit operations of sedimentation, floatation, and membrane filtration.

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental Management – Environmental Technology Verification (ETV)

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: filtration surface area, treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, filtration treatment device product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 GENERAL

2.1.1 Maintenance Access to Captured Pollutants The filter device shall contain an opening(s) that provides maintenance access for removal of accumulated floatable pollutants and sediment, removal of and replacement of filter cartridges, cleaning of the sump, and rinsing of the internal components. Access shall have a minimum clear vertical clear space over all of the filter cartridges. Filter cartridges shall be able to be lifted straight vertically out of their installed placement for the entire length of the cartridge.

2.1.2 Pollutant Storage: The Filter device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants.

PART 3 – PERFORMANCE

3.1 GENERAL

3.1.1 Verification – The stormwater quality filter treatment device shall have been field tested in accordance with either TARP Tier II Protocol (TARP, 2003) and New Jersey Tier II Stormwater Test Requirements – Amendments to TARP Tier II Protocol (NJDEP, 2009) or Washington State Technology Assessment Protocol – Ecology (TAPE), 2011 or later version. The field test shall have been verified in accordance with ISO 14034:2016 Environmental Management – Environmental Technology Verification (ETV). See Section 3.2 of this specification for field test performance requirements.

3.2 FIELD TEST PERFORMANCE

The field test (as specified in section 3.1.1)shall have monitored a minimum of twenty (20) TARP or TAPE qualifying storm events, and report at **minimum** the following results:

3.2.1 Suspended Solids Removal - The stormwater quality filter treatment device shall have ISO 14034 ETV verified load based median TSS removal efficiency of at least 85% and load based median SSC removal efficiency of at least 98%.

3.2.2 Runoff Volume – The stormwater quality filter treatment device shall be engineered, designed, and sized to treat a minimum of 90 percent of the annual runoff volume determined from use of a minimum 15-year rainfall data set.

3.2.3 Fine Particle Removal - The stormwater quality filter treatment device shall have demonstrated the ability to capture fine particles as indicated by a minimum median removal efficiency of 75% for the particle fraction less than 25 microns, and an effluent d_{50} of 15 microns or lower for all monitored storm events.

3.2.4 Turbidity Reduction - The stormwater quality filter treatment device shall have demonstrated the ability to reduce turbidity such that effluent turbidity is 15 NTU or lower.

3.2.5 Nutrients & Metals – The stormwater quality filter treatment device shall have ISO 14034 ETV Verified minimum load based removal efficiencies for the following:

3.2.5.1 Total Phosphorus (TP) Removal - Median TP removal efficiency of at least 49%.

3.2.5.2 Total Nitrogen (TN) Removal - Median TN removal efficiency of at least 39%.

3.2.5.3 Total Zinc (Zn) Removal - Median Zn removal efficiency of at least 69%.

3.2.5.4 Total Copper (Cu) Removal - Median Cu removal efficiency of at least 91%.

END OF SECTION