Final

Functional Servicing and Stormwater Management Report
180 Groh Avenue, Cambridge
City of Cambridge

Prepared for 180 Groh Cambridge Limited
by IBI Group

November 2021

Document Control Page

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REVIEWER:	Kelly Cobbe
AUTHORIZATION:	IBI Group
CIRCULATION LIST:	
HISTORY:	

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1 Introduction

IBI Group was retained by 180 Groh Cambridge Limited to prepare a Functional Servicing and SWM Reports in support of a rezoning application for a proposed 4.51 ha residential development located in Cambridge, Ontario.

Please refer to Figure 1 below for the location of the proposed development.

Figure 1: Site Location *(source Region of Waterloo gis.region.waterloo.on.ca)*

The site will be comprised of residential development in the form of stacked townhouse blocks. Other supporting land uses will include stormwater management facilities, landscaped areas, and existing natural areas that are to be maintained. A copy of the proposed development plan showing the layout of the site is provided in **Appendix A**.

The purpose of this report is to describe the proposed grading, servicing and stormwater management controls for the site at a functional level to overview the design approach and demonstrate the feasibility of the proposed development from a municipal servicing perspective. Detailed engineering will be completed following Site Plan Approval

2 Existing Conditions

The existing subject property is currently occupied by a vacant industrial building, asphalt parking lot areas, and vegetated areas as shown on Figure 2, below. The existing building will be demolished and removed to facilitate developments.

The environs to the subject lands are industrial lands to the north, west and south of the property, and institutional lands to the east. There is a large wetland at the southwest corner of the site regulated by the GRCA.

Figure 1: Site Location *(source Region of Waterloo gis.region.waterloo.on.ca)*

2.1 Existing Roads and Pedestrian Access

The site is fronted by Groh Avenue to the north and Bechtel Street from the west. Vehicular and pedestrian access to the subject lands is from Groh Avenue.

2.2 Existing Topography and Drainage

In general, the existing overland flow direction of the subject lands is southwesterly toward an existing drainage easement on the adjacent property at the southeastern area of the development. There is moderate to steep topography at the southern portion of the site toward the GRCA wetlands.

2.3 Existing Municipal Servicing

On a review of existing information and visual field inspection, we have confirmed that there will be municipal services within Groh Avenue and Bechtel Street, adjacent to the property that could be used to provide services to the proposed development. Specifically:

- Storm Drainage: There are no storm infrastructure within the existing development. The storm runoff drains into road side ditches along Bechtel Street which outlets into the existing 525mm diameter concrete storm sewer on Bechtel Street towards the Utility Corridor. There is a 600mm diameter storm sewer to be constructed within the Bechtel Street Utility Corridor as part of the City's reconstruction of the Bechtel Street Corridor which will outlet into the 1200mm diameter existing sewer on Holiday Inn Drive.
- Sanitary Sewage: The existing 250mm diameter sanitary sewer on Groh Avenue is to be replaced with a new 250mm diameter sanitary sewer as part of the City's

reconstruction of Groh Avenue. The site will be serviced by two sanitary sewer networks separating the northern and southern portion of the site. The north internal sanitary network of 200mm diameter sanitary sewer within the site will connect to a manhole proposed by the Groh Avenue reconstruction. A manhole is proposed at the existing 450mm diameter sanitary sewer along Holiday Inn Drive to connect the south internal network of 200mm diameter sanitary sewer within the site.

- Potable Water: The existing 250mm diameter watermain on Groh Avenue is to be replaced with a new 250mm diameter watermain as part of the City's reconstruction of Groh Avenue. An internal network of 200mm diameter watermain connected to Groh Avenue will provide potable water. The existing water service to the Bechtel Street watermain will be removed.
- Fire protection: An existing hydrant on Groh Avenue north of the property provides existing fire protection to the site. This hydrant will be relocated 0.75m west as part of the City's reconstruction of Groh Avenue. A hydrant is proposed within the southern portion of the site and will connect to Groh Avenue to provide fire protection.

The City of Cambridge plans to reconstruct Groh Avenue, Bechtel Street and the Bechtel Street Utility Corridor in Spring 2022. For this report, the existing storm, sanitary and watermain have been utilized in the design. During Site Plan Approval stage, the details of the proposed underground services from the City of Cambridge reconstruction will be coordinated with the City prior to construction.

3 Proposed Conditions

The buildings will consist of twelve (12) stacked townhouse blocks consisting of 24 units each. The site will clear the existing vegetation and will include the addition of landscaped areas and surface parking lots.

The following sections describe on a functional level how the property will be grading and how municipal services will be provided. The purpose of the functional design is to demonstrate the feasibility of the development, outline the general strategy for the grading, and confirm the municipal servicing strategy. Final, detailed design (completed during the Site Plan Approval process) will establish the details of the development's design.

3.1 Proposed Roads and Pedestrian Access

Vehicular access will be provided by one driveway off Groh Avenue and one driveway off of Bechtel Street. Pedestrian access to the proposed development be provided along Groh Avenue and Bechtel Street.

3.2 Grading Design

As proposed, the development will be graded such that runoff is collected at low areas within the proposed driveway and parking areas. In these low areas, the runoff will be captured by catchbasins and conveyed via site sewers to the existing municipal storm sewer on Northumberland Street. Runoff from major storm events in excess of the 100-year storm will be routed overland at the west property line.

All hard surfaces will be sloped from 0.5% (minimum) to 5% (maximum) to provide adequate drainage while ensuring that vehicular and pedestrian access routes are accessible. A minimum of 2% and a maximum of 33% (3:1) slope will be used for landscaped areas.

Refer to **Appendix A** for the proposed Preliminary Grading Plan of the site.

3.3 Stormwater Servicing

Roof drains and on-site catch basins will capture stormwater from the rooftops, landscaped areas, surface parking and hardscape. The captured stormwater will outlet into a network of proposed storm sewers within the site. This storm system connects to the existing storm sewer on the southeastern easement which in turn outlets to Holiday Inn Drive's storm infrastructure.

The functional layout of the proposed storm system is shown in **Appendix A**.

3.3.1 Proposed Stormwater Management

The stormwater management criteria for the development are based on City of Cambridge requirements as follows:

- Stormwater management for quantity control is required to control proposed conditions peak flows to existing conditions levels for the 5 year and 100 year storm events; and
- Stormwater management for quality control is required to an Enhanced Protection Level as per MECP standards.

In order to provide quantity control, onsite stormwater storage areas will be provided in underground storage tanks and on surface parking lot areas.

In order to provide quality control, impervious surface areas will be treated to an Enhanced Level using an oil/grit separator (OGS) prior to discharging from the property.

Based on the Geotechnical Investigation completed by GeoPro Consulting Limited on February 21, 2017, the site soils include fill materials consisting of sandy silt, silty sand, sand and silt, sand, sand and gravel and gravelly sand, and native sandy/silty/gravelly deposits and/or glacial tills below the fill materials. Based on these soil conditions, a CN value of 65 was used for the stormwater modelling of pervious areas.

The following sections provide more detailed description of the stormwater management controls. Calculations and modelling are provided in **Appendix B**.

3.3.2 Stormwater Quantity Control

Three-hour duration Chicago-style storms derived from City of Cambridge IDF curves were used for the stormwater management modelling. The total depths of rainfall for the modelled storms are indicated in Table 1.

Table 1: Rainfall Depths

Return Event	Storm Duration (Hours)	Rainfall Depth (mm)
5 Year	3	48.6
100 Year	3	89.7

The existing conditions were modelled using MIDUSS, and the modelling parameters are summarized in Table 2. The total impervious area under existing conditions is approximately 16,280 m^2.

Table 2: Existing Conditions MIDUSS Modelling Variables

Catchment ID	Description	Area (Ha)	Length (m)	Gradient (%)	Imperv. (%)	Manning 'N'	Pervious Cn
Existing Conditions							
101	Grass/	0.087	10	2	11.4	0.250	65
102	Building	0.781	20	1	100.0	0.013	98
103	Parking Lot	0.481	20	2	73.9	0.250	65
104	Grass/ Parking	0.434	20	2	40.5	0.250	65
105	Grass/	0.103	10	20	0.0	0.250	65
106	Grass/	1.081	40	5	0.0	0.250	65
107	Grass/ Parking	0.139	10	2	73.0	0.250	65
108	Grass/ Parking	0.276	20	2	77.4	0.250	65
109	Grass/	0.146	10	20	0.0	0.250	65
110	Grass/Wooded	0.986	40	5	0.0	0.250	65
Total		**4.514**			**36.3**		

The proposed conditions were modelled using MIDUSS, and the modelling parameters are summarized in Table 3.

Table 3: Proposed Conditions MIDUSS Modelling Variables

Catchment ID	Description	Area (Ha)	Length (m)	Gradient (%)	Imperv. (%)	Manning 'N'	Pervious Cn
Proposed Conditions							
201	Grass Driveway	0.092	15	2	5	0.250	65
202	Building/Parking	1.646	20	1	85	0.013	98
203	Building/Parking	0.506	20	1	85	0.250	65
204	Building/Parking	1.000	20	1	85	0.250	65
205	Grass	1.126	40	5	10	0.250	65
206	Grass	0.139	10	5	5	0.250	65
Total		**4.514**			**62.1**		

In order to attenuate proposed conditions peak flows to existing conditions levels, on-site stormwater storage will be required. Table 4 summarizes the existing and proposed conditions peak flows, and Table 5 summarizes the available on-site stormwater storage locations under proposed conditions. The preliminary MIDUSS modelling is included in **Appendix B**.

Table 4: Exiting and Proposed Conditions Peak Flows

Return Event	Existing Peak Flow (m^3/s)	Proposed Peak Flow (m^3/s)
Draining North To Groh Avenue		
5 Year	0.003	0.002
100 Year	0.011	0.010
Draining South to Holiday Inn Drive		
5 Year	0.441	0.424
100 Year	0.722	0.686
Draining West to Adjacent Lot		
5 Year	0.030	-
100 Year	0.045	-

Table 5: Storage Volumes

Location	Available Storage Volume (m^3)	5-Year Storage Volume (m^3)	100-Year Storage Volume (m^3)
Parking Surface (Area 202)	250	80	205
Tank #1 (Area 204)	350	150	349
Tank #2 (Area 203)	100	28	69
Total	**700**	**258**	**623**

As indicated in Table 5, approximately 700 m^3 of combined parking surface and underground storage would be available which would allow proposed conditions peak flows to be attenuated to existing conditions levels for the 5 year and 100 year storm events. The locations and configuration of on-site storage areas and outlet flow controls will be confirmed at the detailed design stage. The preliminary storage locations are shown on the grading and servicing drawings. Note, if required, or if desired to reduce the frequency of surface ponding of stormwater, additional storage could be provided in underground tanks.

Note, the external storm drainage area from Bechtel Street will be routed through the property to the drainage easement to the south via a proposed storm sewer sized to convey the 100 year storm peak flow from this area.

3.3.3 Stormwater Quality Control

A Stormceptor OGS unit (model EF12 or approved equivalent) will be provided for catchment areas 202 and 204 at the outlet of the site's storm sewer to provide stormwater quality control for flows generated from the parking lot and driveway areas.

The total drainage area to the proposed OGS is 2.646 ha (85 percent impervious) from areas 202 to 204. Based on the output from the Stormceptor sizing software, included in **Appendix B**, an EF12 unit will provide a TSS removal efficiency of 80 percent for 90 percent of annual flows generated by areas tributary to the unit.

A Stormceptor OGS unit (model EF6 or approved equivalent) will be provided for catchment area 203 at the outlet of the site's storm sewer to provide stormwater quality control for flows generated from the parking lot and driveway areas.

The total drainage area to the proposed OGS is 0.506 ha (85 percent impervious) from areas 203. Based on the output from the Stormceptor sizing software, included in **Appendix B**, an EF6 unit will provide a TSS removal efficiency of 82 percent for 90 percent of annual flows generated by areas tributary to the unit.

The proposed OGS units meet the required Enhanced Protection Level for suspended solids removal. The unit should be inspected and cleaned regularly, once every 12 months as per the manufacturer's specifications. The sizing of the OGS will be confirmed at the detailed design stage once the on-site stormwater storage configuration has been confirmed.

The use of active infiltration measures, such as underground trenches for rooftop runoff will also be explored at the detailed design stage, subject to ground conditions.

3.4 Sanitary Servicing

The proposed development will have two gravity sanitary sewer systems due to the steep topography separating the northern and southern portion of the site.

The northern portion of the site will be serviced by a 200mm diameter sanitary sewer network towards the existing 250mm sanitary sewer on Groh Avenue. The peak design sanitary flow to the existing sanitary sewer on Bechtel Street Avenue is 8.26 L/s, which is 16% of the full capacity.

The southern portion of the site will be serviced by a 200mm diameter sanitary sewer network which will run through the easement between 215 and 221 Holiday Inn Drive and into the existing 450mm sanitary sewer on Holiday Inn Drive. This connection will require breaking into the existing sewer and installing a new sanitary manhole. The peak design sanitary flow to the existing sanitary sewer on Holiday Inn Drive is 4.91 L/s, which is 4% of the full capacity.

We anticipate that there is sufficient capacity in the municipal sewage system to allow the proposed intensification of the subject site and that the Region will confirm the overall existing capacity downstream of Holiday Inn Drive.

The functional layout of the proposed sanitary system is shown in **Appendix A**. Refer to **Appendix C** for calculations related to the sanitary servicing of the development.

3.5 Water Supply and Distribution

To provide domestic water and fire protection for the proposed site, a proposed internal network of 200mm diameter watermain will connect to the existing 250mm diameter watermain on Groh Avenue.

Two (2) private fire hydrants will be installed to provide adequate coverage to address fire flow requirements. A hydrant test has been completed on Groh Avenue to confirm system pressures. Provided a maximum fire separation area of 350 sq.m. is maintained, the proposed fire hydrant will be able to meet minimum fire flow and pressure requirements. Distribution system details will be finalized during the Site Plan process.

The preliminary layout of the proposed water servicing is shown in **Appendix A**. The water demand calculations, fire flow calculations and hydrant test results are shown in **Appendix D.**

4 Erosion and Sediment Control

During construction, erosion and sediment control measures will be required. Details of these controls will be provided during detailed engineering design. The measures will be in accordance

with the City of Cambridge and Grand River Conservation Authority requirements and will include, as a minimum:

- Silt fence erected around the site perimeter before any grading or topsoil stripping begins on the site to protect adjacent areas from migration of sediment in overland flow.
- A “mud mat” installed at the construction entrance(s) to the site to minimize the amount of sediment transported offsite by construction vehicles;
- Disturbed areas stabilized as quickly as possible to minimize the opportunity for erosion; and,
- Slopes greater than 5:1 stabilized using suitable methods (e.g. erosion control mats, tackifier, etc.) as soon as practical.

5 Utilities

The various utilities (i.e., Hydro, Gas, Cable and Telephone) all have existing facilities adjacent to the site on Groh Avenue and/or Bechtel Street. Extension of these existing facilities by the respective utility company will provide servicing for the proposed development.

It is anticipated that each of these utilities will, as required, identify their specific requirements through the standard application circulation, review and design process.

6 Summary

This Report demonstrates that the proposed development is feasible from a municipal grading and servicing perspective in accordance with municipal design and construction standards. The following summarizes the key aspects of the functional design presented in this report.

- The site will be graded per municipal guidelines, and ground elevations at the site limits will be matched into.
- The preliminary stormwater management will provide quantity and quality control for stormwater runoff generated by the proposed development for the 5 year and 100 year storm events, and the onsite storm network will convey the minor stormwater flows to the existing municipal network.
- The north portion of the proposed development will connect to the existing 300mm diameter sanitary sewer on Bechtel Street and the south portion of the proposed development will connect to the existing 450mm diameter sanitary sewer on Holiday Inn Drive.
- The existing 250mm diameter watermain on Groh Avenue will supply the site with potable water and fire protection.

At the final design stage, detailed grading, servicing and stormwater management control designs will be prepared and provided to the approval authorities. All design will conform to local and provincial municipal design standards.

We trust the foregoing demonstrates the proposed design methodology for the development and is satisfactory to support the rezoning application.

All of which is respectfully submitted.

Yours truly

IBI GROUP

Kelly Cobbe, P.Eng.
Director – Office Lead

Julianna Arcese, P.Eng.
Civil Engineer

APPENDIX A:
Drawings

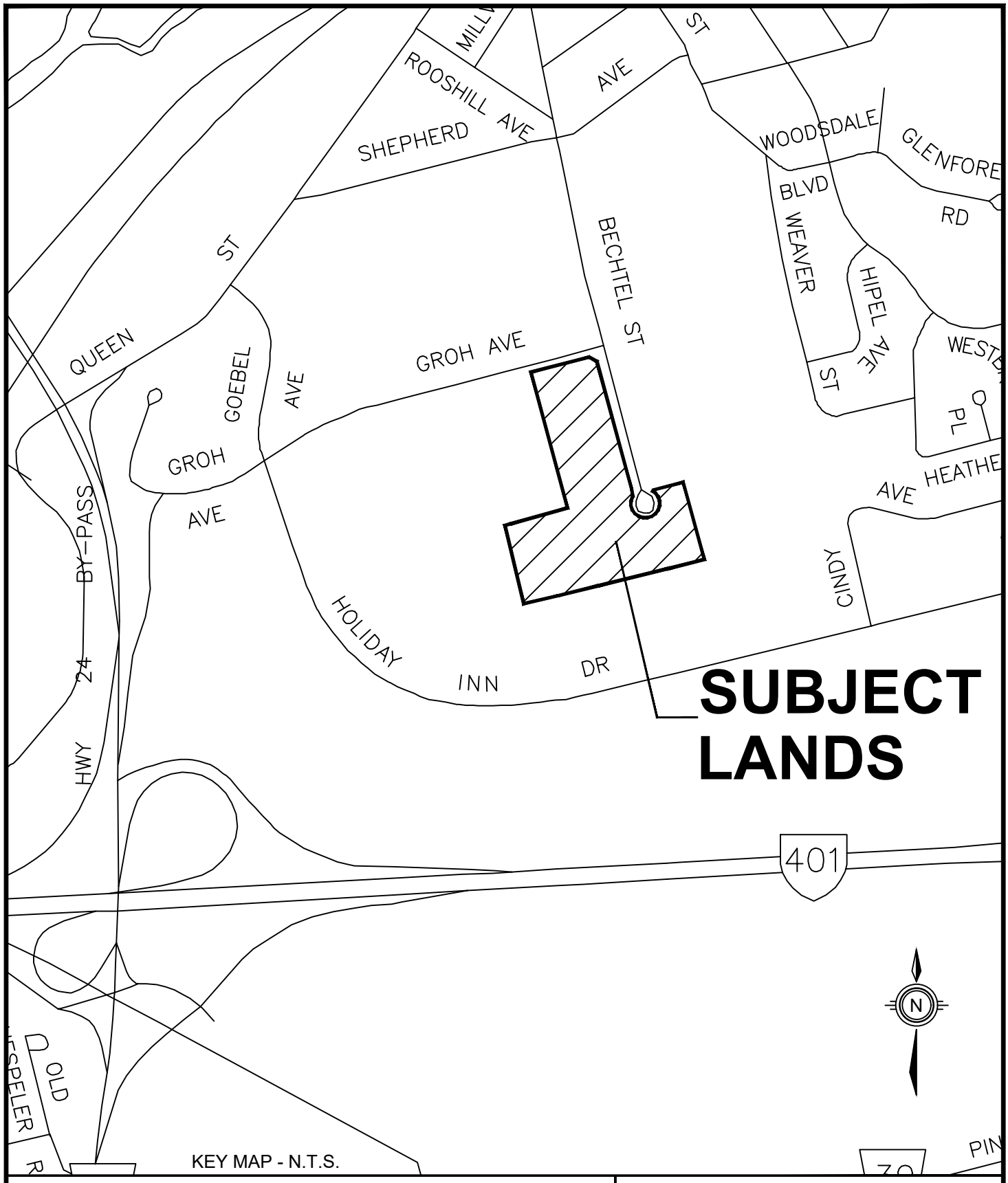

FIGURE 1
SITE LOCATION

180 GROH AVENUE
CITY OF CAMBRIDGE

SCALE	NTS
DATE	OCT 2021
PROJECT No.	121913

IBI GROUP
101 - 410 Albert Street
Waterloo ON N2L 3V3 Canada
tel 519 585 2255
ibigroup.com

CONSTRUCTION NORTH

15 0 10 20 40

1:1000 (m)

LEGEND

- EXISTING CATCHMENT BOUNDARIES
- DRANIAGE ARROWS
- EX. CATCHMENT SYMBOL
  CATCHMENT AREA NUMBER
  AREA (ha)

IBI GROUP
101 - 410 Albert Street
Waterloo ON N2L 3V3 Canada
tel 519 585 2255
ibigroup.com

SCALE	1:1000
DATE	NOVEMBER 2021
PROJECT No.	121913

CITY OF CAMBRIDGE
REGIONAL MUNICIPALITY
OF WATERLOO

180 GROH AVENUE RESIDENTIAL DEVELOPMENT

EXISTING STORM CATCHMENT AREAS

FIGURE 2

BECHTEL STREET

GROH AVENUE

206
0.1387

201
0.0915

202
1.6461

203
0.5057

204
1.0001

205
1.1324

Block 'A'
Stacked
Townhouse
24 Units

Block 'B'
Stacked
Townhouse
24 Units

Block 'C'
Stacked
Townhouse
24 Units

Block 'D'
Stacked
Townhouse
24 Units

Block 'E'
Stacked
Townhouse
24 Units

Block 'F'
Stacked
Townhouse
24 Units

Block 'G'
Stacked
Townhouse
24 Units

Block 'H'
Stacked
Townhouse
24 Units

192 Units/ ±280 Spaces

± 134 Spaces

Block 'I'
Stacked
Townhouse
24 Units

Block 'J'
Stacked
Townhouse
32 Units

96 Units/ ± 104 Spaces

Block 'K'
Stacked
Townhouse
16 Units

Block 'L'
Stacked
Townhouse
24 Units

Landscaped

3.0m Trail

CANADA TOOL

EXISTING INDUSTRIAL BUILDING
160 GROH AVENUE

SURVEYED WETLAND
NOVEMBER, 2021

215 HOLIDAY INN DR.

EX. INDUSTRIAL BLDG.
221 HOLIDAY INN DR.

CONSTRUCTION NORTH

15 0 10 20 40
1:1000 (m)

LEGEND

- PROPOSED CATCHMENT BOUNDARIES
- DRAINAGE ARROWS
- PROP. CATCHMENT SYMBOL (201 / 0.0563): CATCHMENT AREA NUMBER / AREA (ha)

IBI GROUP
101 - 410 Albert Street
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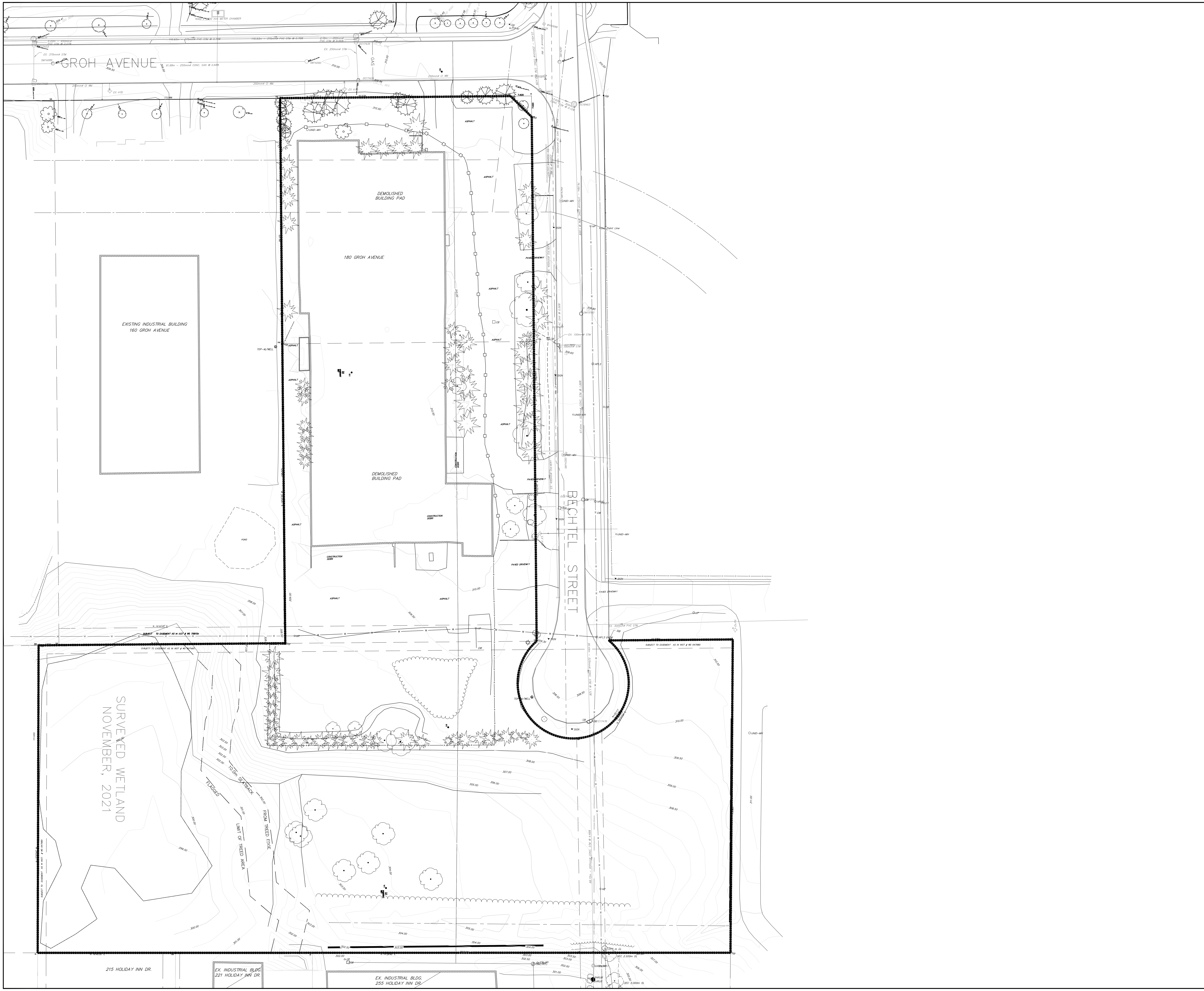
SCALE	1:1000
DATE	NOVEMBER 2021
PROJECT No.	105931

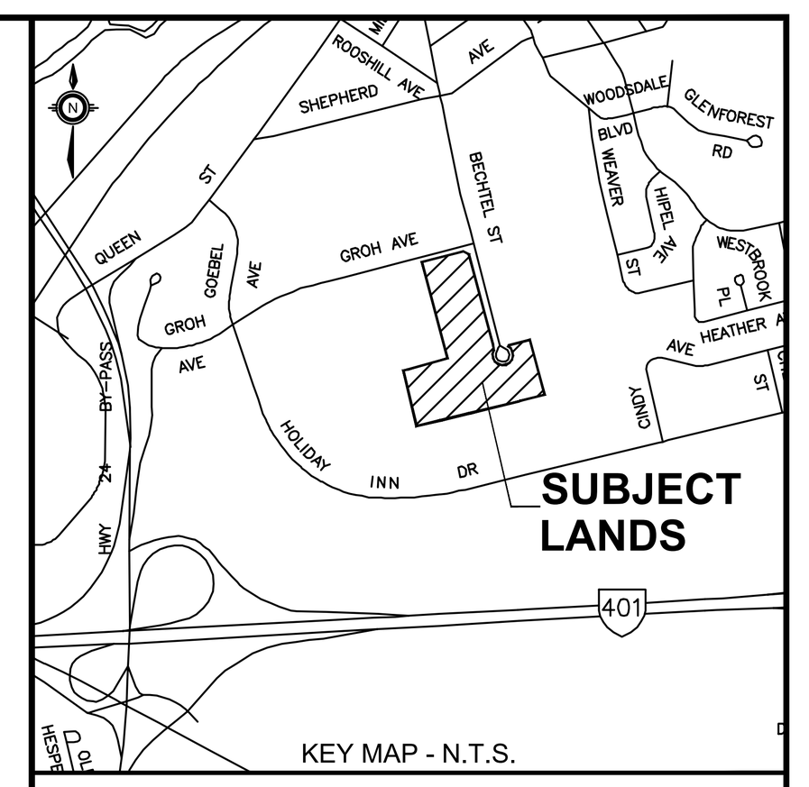
CITY OF CAMBRIDGE
REGIONAL MUNICIPALITY
OF WATERLOO

180 GROH AVENUE RESIDENTIAL DEVELOPMENT

PROPOSED STORM CATCHMENT AREAS

FIGURE 3





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BENCHMARK
SURVEY COORDINATES ARE IN UTM NAD-83 ZONE 17 AND ELEVATIONS ARE GEODETIC BOTH WERE DERIVED FROM THE LEICA SMARTNET COMMERCIAL GNSS RTK NETWORK
LEGAL SURVEY INFORMATION PROVIDED BY MacDONALD TAMBLYN LORD SURVEYING DATED JANUARY 31, 2017.
TOPOGRAPHIC SURVEY PROVIDED BY IBI GROUP DATED FEBRUARY 15, 2017.

LEGAL DESCRIPTION

PLAN OF SURVEY OF PART OF LOT 11, MUNICIPAL COMPILED PLAN 907 AND PART OF LOTS 15 AND 17 AND PART OF RESERVE LOTS 'B' AND 'D' MUNICIPAL COMPILED PLAN 908 (FORMERLY IN THE TOWN OF HESPELER)
CITY OF CAMBRIDGE
REGIONAL MUNICIPALITY OF WATERLOO

#	DATE	BY	DESCRIPTION
1	NOV 23, 2021	EC	ISSUED FOR ZBA - FIRST SUBMISSION

REVISIONS

APPROVALS

IBI GROUP
101 - 410 Albert Street
Waterloo ON N2L 3V3 Canada
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CITY OF CAMBRIDGE
REGION OF WATERLOO

RESIDENTIAL DEVELOPMENT
180 GROH AVENUE

EXISTING CONDITIONS PLAN

DESIGNED BY:	EMIR CERIC	SCALE HORIZ:	1:400
DRAWN BY:	EMIR CERIC	SCALE VERT:	N/A
CHECKED BY:	K. COBBE	FILE NUMBER:	121913
DATE:	NOV 23, 2021	SHEET NUMBER:	EX

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GROH AVENUE

EXISTING INDUSTRIAL BUILDING
160 GROH AVENUE

CANADA TOOL

SURVEYED WETLAND
NOVEMBER, 2021

SUBJECT TO EASEMENT AS IN INST # WS 758139

Landscaped

Block 'E'
Stacked Townhouse
24 Units

Block 'A'
Stacked Townhouse
24 Units

Block 'F'
Stacked Townhouse
24 Units

Block 'B'
Stacked Townhouse
24 Units

Block 'G'
Stacked Townhouse
24 Units

Block 'C'
Stacked Townhouse
24 Units

Block 'H'
Stacked Townhouse
24 Units

Block 'D'
Stacked Townhouse
24 Units

192 Units/ ± 280 Spaces

Block 'K'
Stacked Townhouse
16 Units

Block 'J'
Stacked Townhouse
32 Units

Block 'L'
Stacked Townhouse
24 Units

96 Units/ ± 104 Spaces

Block
Stacked Townhouse
24 Units

30 Units/ ± 134 Spaces

BECHTEL STREET

215 HOLIDAY INN DR.

EX. INDUSTRIAL BLDG.
221 HOLIDAY INN DR.

EX. INDUSTRIAL BLDG.
255 HOLIDAY INN DR.

SUBJECT LANDS

KEY MAP - N.T.S.

LEGEND

- 346.00 – PROPOSED GRADE ELEVATION
- 346.00 – EXISTING GRADE ELEVATION
- 2.0% – PROPOSED SLOPE
- – DRAINAGE DIVIDE
- – PROPOSED STORM MANHOLE
- CB – EXISTING CATCH BASIN
- ST-MH – EXISTING STORM MANHOLE
- CBMH – EXISTING CB MANHOLE
- – EXISTING STORM FLOW DIRECTION
- S-MH – EXISTING SANITARY MANHOLE
- – EXISTING SANITARY FLOW DIRECTION
- HYD – EXISTING HYDRANT
- WV – EXISTING WATER VALVE
- – EXISTING WATERMAIN
- 364.00 – ORIGINAL GROUND CONTOUR

1:400 (m)

BENCHMARK
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CITY OF CAMBRIDGE
REGIONAL MUNICIPALITY OF WATERLOO

#	DATE	BY	REVISIONS
1	NOV 23, 2021	EC	ISSUED FOR ZBA - FIRST SUBMISSION

APPROVALS

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tel 519 585 2255 fax 519 585 2269
ibigroup.com

CITY OF CAMBRIDGE
REGION OF WATERLOO

RESIDENTIAL DEVELOPMENT
180 GROH AVENUE

PRELIMINARY GRADING PLAN

DESIGNED BY:	E. CERIC	SCALE HORIZ:	1:400
DRAWN BY:	D.PHAM	SCALE VERT:	NA
CHECKED BY:	K. COBBE	FILE NUMBER:	121913
DATE:	NOV 23, 2021	SHEET NUMBER:	GR

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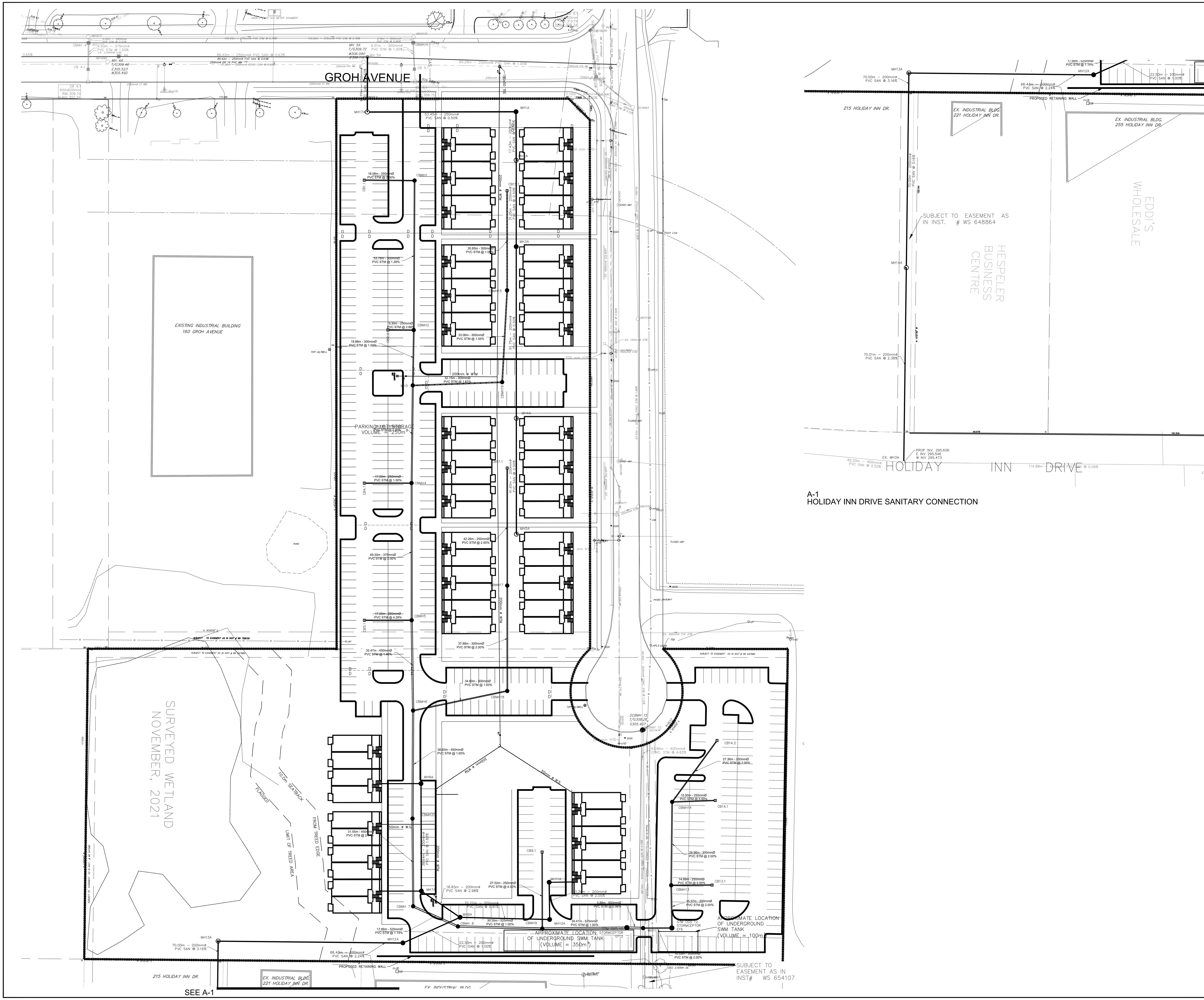

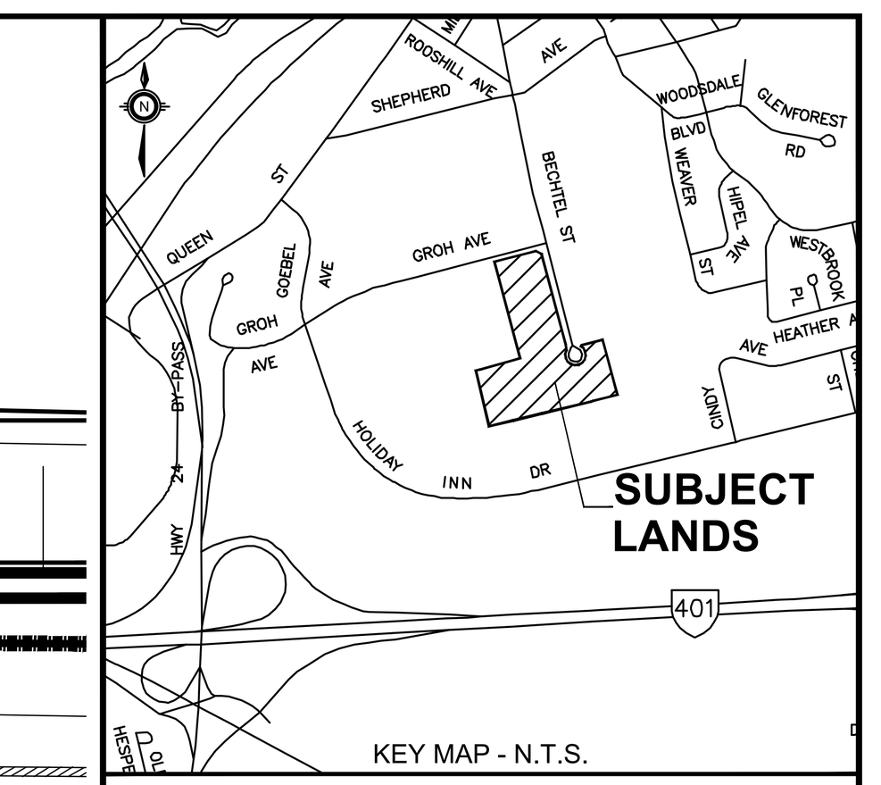

LEGEND

- PROPOSED MANHOLES
- PROPOSED WATERMAIN
- PROPOSED WATER SERVICE
- PROPOSED FIRE HYDRANT SET
- PROPOSED WATER VALVE
- PROPOSED TEE/BEND
- PROPOSED STORM SEWER
- PROPOSED STORM SERVICE
- PROPOSED CB, DCB/DI
- PROPOSED SANITARY SEWER
- PROPOSED SANITARY SERVICE
- EXISTING MANHOLES
- EXISTING WATERMAIN
- EXISTING FIRE HYDRANT
- EXISTING STORM SEWER
- EXISTING CB, DCB, DI
- EXISTING SANITARY SEWER

BENCHMARK
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APPROVALS

IBI GROUP
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CITY OF CAMBRIDGE
REGION OF WATERLOO

RESIDENTIAL DEVELOPMENT
180 GROH AVENUE

PRELIMINARY SERVICING PLAN

DESIGNED BY:	E. CERIC	SCALE HORIZ:	1:400
DRAWN BY:	D.PHAM	SCALE VERT:	N/A
CHECKED BY:	K.COBBE	FILE NUMBER:	121913
DATE:	NOV 23, 2021	SHEET NUMBER:	SERV

FILE:J:\121913_180GrohAve\7.0_Production\7.3_Design\04_Civil\121913E.dwg LAYOUT:121913-SERV
LAST SAVED BY:Dan.Pham, Tuesday, November 23, 2021 2:39:29 PM PLOTTED BY:Dan Pham Tuesday, November 23, 2021 2:42:40 PM

APPENDIX B:
Stormwater Calculations

City of Cambridge

STORM SEWER CALCULATIONS

FOR

180 Groh Avenue

City of Cambridge

DESIGN PARAMETERS: i = a/(t+b)^c

1:5-yr Storm Parameters a = 1219.8

as per City of Cambridge Standards b = 10.5

c= 0.8230

Min. velocity = 0.8000 m/s

Max. velocity = 6.0000 m/s

manning's n = 0.0130

Date: 20-Oct-21

File : 121193

Designed by : D.P

Checked by : T.C

IBI

LOCATION	FROM MH	TO MH	CATCHMENT AREA NUMBER	CATCHMENT CHARACTERISTICS				CONCENTRATION TIME (min)			CATCHMENT RUNOFF		PIPE CHARACTERISTICS						
				A (ha)	C	"AC"	ACCUM. "AC"	INLET	IN PIPE	TOTAL	"I" (mm/hr)	"Q" (m3/s)	LENGTH (m)	DIAMETER (mm)	SLOPE (%)	CAPACITY (m3/s)	FULL VEL. (m/s)	% FULL	ACT. VEL. (m/s)
Site	CBMH1	CBMH2	201	0.122	0.80	0.098	0.098	10.00	0.58	10.58	101.56	0.027	53.76	300	1.28	0.109	1.55	25%	1.17
Site	CBMH2	MH3	202	0.173	0.80	0.139	0.236	10.58	0.24	10.82	99.26	0.065	19.88	300	1.00	0.097	1.37	67%	1.46
Site	CBMH15	CBMH16	206+207	0.417	0.80	0.334	0.334	10.00	0.34	10.34	101.56	0.094	34.12	300	1.50	0.118	1.68	79%	1.85
Site	CBMH16	MH3	208	0.080	0.80	0.064	0.398	10.34	0.26	10.60	100.20	0.110	30.08	300	2.00	0.137	1.93	81%	2.15
Site	MH3	CBMH4		0.793	0.80	0.634	0.634	10.58	0.33	10.91	99.25	0.174	35.13	450	1.00	0.285	1.79	61%	1.88
Site	CBMH4	CBMH5	203	0.193	0.80	0.154	0.789	10.91	0.33	11.24	98.00	0.214	43.90	450	1.50	0.349	2.20	61%	2.30
Site	CBMH5	CBMH6	204	0.181	0.80	0.145	0.934	11.24	0.25	11.49	96.77	0.250	32.47	450	1.48	0.347	2.18	72%	2.36
Site	CBMH17	CBMH18	209+210	0.478	0.80	0.382	0.382	10.00	0.33	10.33	101.56	0.107	37.88	300	2.00	0.137	1.93	79%	2.14
Site	CBMH18	CBMH6	211	0.074	0.80	0.060	0.442	10.33	0.29	10.61	100.25	0.123	33.31	300	2.00	0.137	1.93	90%	2.18
Site	CBMH6	CBMH20					1.375	11.24	0.25	11.49	96.77	0.369	38.83	525	1.65	0.552	2.55	67%	2.72
Site	CBMH20	CBMH7	205	0.192	0.80	0.154	1.529	11.49	0.18	11.68	95.85	0.406	31.55	525	2.11	0.625	2.89	65%	3.04
Site	CBMH7	CBMH8					1.529	11.68	0.14	11.81	95.20	0.403	17.66	525	1.14	0.459	2.12	88%	2.39

PIPE DATA					
INVERTS		T/G		COVER	
U/S	D/S	U/S	D/S	U/S	D/S
308.42	307.73	310.12	309.15	2.00	1.72
307.71	307.51	309.15	309.40	1.74	2.19
307.48	306.97	310.19	309.42	3.01	2.75
306.91	306.31	309.42	309.40	2.81	3.39
306.25	305.90	309.40	308.70	3.60	3.25
305.88	304.89	308.70	308.25	3.27	3.81
304.87	304.39	308.25	307.91	3.83	3.97
305.92	305.16	308.95	308.53	3.33	3.67
305.10	304.43	308.53	307.91	3.73	3.78
304.37	303.73	307.91	305.86	4.07	2.66
303.71	303.05	305.86	304.49	2.68	1.97
302.99	302.79	304.49	304.34	2.03	2.07

DESIGN PARAMETERS: i = a/(t+b)^c

1:5-yr Storm Parameters — a = 1219.8

as per City of Cambridge Standards — b = 10.5

c= 0.8230

Min. velocity = 0.8000 m/s

Max. velocity = 6.0000 m/s

manning's n = 0.0130

STORM SEWER CALCULATIONS

FOR

180 Groh Avenue

City of Cambridge

Date: 20-Oct-21

File : 121193

Designed by : D.P

Checked by : T.C

IBI

LOCATION	FROM MH	TO MH	CATCHMENT AREA NUMBER	CATCHMENT CHARACTERISTICS A (ha)	C	"AC"	ACCUM. "AC"	CONCENTRATION TIME (min) INLET	IN PIPE	TOTAL	CATCHMENT RUNOFF "I" (mm/hr)	"Q" (m3/s)	PIPE CHARACTERISTICS LENGTH (m)	DIAMETER (mm)	SLOPE (%)	CAPACITY (m3/s)	FULL VEL. (m/s)	% FULL	ACT. VEL. (m/s)
Site	CBMH8	CBMH9					1.529	11.81	0.25	12.07	94.71	0.401	30.35	525	1.00	0.430	1.99	93%	2.26
Site	CBMH9	STM OGS 10					1.485	12.07	0.26	12.32	93.83	0.386	30.41	525	1.00	0.430	1.99	90%	2.24
Site	STM OGS 10	MH11	212	0.688	0.80	0.550	2.035	12.32	0.05	12.37	92.97	0.320	5.88	600	0.98	0.608	2.15	53%	2.18
Site	CBMH14	CBMH13	213	0.371	0.80	0.296	0.296	10.00	0.26	10.26	101.56	0.083	29.96	300	2.00	0.137	1.93	61%	2.02
Site	CBMH13	STM OGS 12	214	0.137	0.80	0.109	0.406	10.26	0.13	10.39	100.52	0.113	15.37	300	2.00	0.137	1.93	83%	2.16
Site	STM OGS 12	MH11					0.406	10.39	0.09	10.48	99.99	0.078	10.33	300	2.00	0.137	1.93	57%	1.98
Utility Corridor	MH11	EX MH	EXT (355 Holiday Inn Dr)	11.211	0.30	3.363	5.804	52.55	0.31	52.86	40.29	1.046	88.70	600	4.83	1.349	4.77	77%	5.24

PIPE DATA					
INVERTS		T/G		COVER	
U/S	D/S	U/S	D/S	U/S	D/S
302.73	302.42	304.34	304.95	2.13	3.05
302.40	302.10	304.95	305.12	3.08	3.54
302.08	302.02	305.12	305.11	3.64	3.69
303.27	302.68	307.55	306.11	4.58	3.73
302.66	302.35	306.11	305.51	3.75	3.46
302.29	302.08	305.51	305.11	3.52	3.33
		-			

*5-year flow from OGS 10 orifice = 0.320 m3/s, from OGS 12 orifice = 0.078 m3/s

Stormceptor®

FORTERRA

Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

10/21/2021

Province:	Ontario
City:	Cambridge
Nearest Rainfall Station:	WATERLOO WELLINGTON AP
Climate Station Id:	6149387
Years of Rainfall Data:	34

Site Name:	Area 202 and 204
Drainage Area (ha):	2.646
% Imperviousness:	85.00

Runoff Coefficient 'c': 0.81

Particle Size Distribution:	Fine
Target TSS Removal (%):	80.0

Project Name:	180 Groh Avenue
Project Number:	121913
Designer Name:	Andy Kroess
Designer Company:	IBI Group
Designer Email:	andy.kroess@ibigroup.com
Designer Phone:	519-585-2255
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	85.32
Oil / Fuel Spill Risk Site?	No
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EF4	48
EF6	61
EF8	69
EF10	75
EF12	80

Recommended Stormceptor EF Model: EF12

Estimated Net Annual Sediment (TSS) Load Reduction (%): 80

Water Quality Runoff Volume Capture (%): > 90

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THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterwavs.

PARTICLE SIZE DISTRIBUTION (PSD)

►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

Stormceptor® EF Sizing Report

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	20.0	20.0	5.96	357.0	34.0	93	18.6	18.6
2	15.8	35.8	11.92	715.0	68.0	91	14.4	33.0
3	11.2	47.0	17.87	1072.0	102.0	87	9.7	42.7
4	8.7	55.7	23.83	1430.0	136.0	84	7.3	50.0
5	7.6	63.3	29.79	1787.0	170.0	79	6.0	56.0
6	6.4	69.7	35.75	2145.0	204.0	76	4.9	60.9
7	4.1	73.8	41.71	2502.0	238.0	73	3.0	63.9
8	2.8	76.7	47.67	2860.0	272.0	70	2.0	65.9
9	2.7	79.4	53.62	3217.0	306.0	67	1.8	67.7
10	2.4	81.7	59.58	3575.0	340.0	63	1.5	69.2
11	2.7	84.5	65.54	3932.0	375.0	61	1.7	70.8
12	2.2	86.7	71.50	4290.0	409.0	58	1.3	72.1
13	1.8	88.4	77.46	4647.0	443.0	58	1.0	73.1
14	1.0	89.5	83.42	5005.0	477.0	57	0.6	73.7
15	1.7	91.2	89.37	5362.0	511.0	57	1.0	74.7
16	1.2	92.3	95.33	5720.0	545.0	57	0.7	75.4
17	1.1	93.5	101.29	6077.0	579.0	56	0.6	76.0
18	0.6	94.1	107.25	6435.0	613.0	56	0.3	76.3
19	0.3	94.3	113.21	6792.0	647.0	56	0.1	76.5
20	0.7	95.0	119.17	7150.0	681.0	56	0.4	76.9
21	0.7	95.7	125.12	7507.0	715.0	55	0.4	77.2
22	0.3	96.0	131.08	7865.0	749.0	55	0.2	77.4
23	0.9	96.9	137.04	8222.0	783.0	55	0.5	77.9
24	0.5	97.4	143.00	8580.0	817.0	55	0.3	78.2
25	0.2	97.6	148.96	8937.0	851.0	55	0.1	78.3
30	0.9	98.5	178.75	10725.0	1021.0	54	0.5	78.8
35	0.9	99.4	208.54	12512.0	1192.0	56	0.5	79.3
40	0.3	99.7	238.33	14300.0	1362.0	59	0.2	79.4
45	0.3	100.0	268.12	16087.0	1532.0	54	0.2	79.6
50	0.0	100.0	297.91	17875.0	1702.0	49	0.0	79.6
Estimated Net Annual Sediment (TSS) Load Reduction =								**80 %**

Climate Station ID: 6149387 *Years of Rainfall Data*: 34

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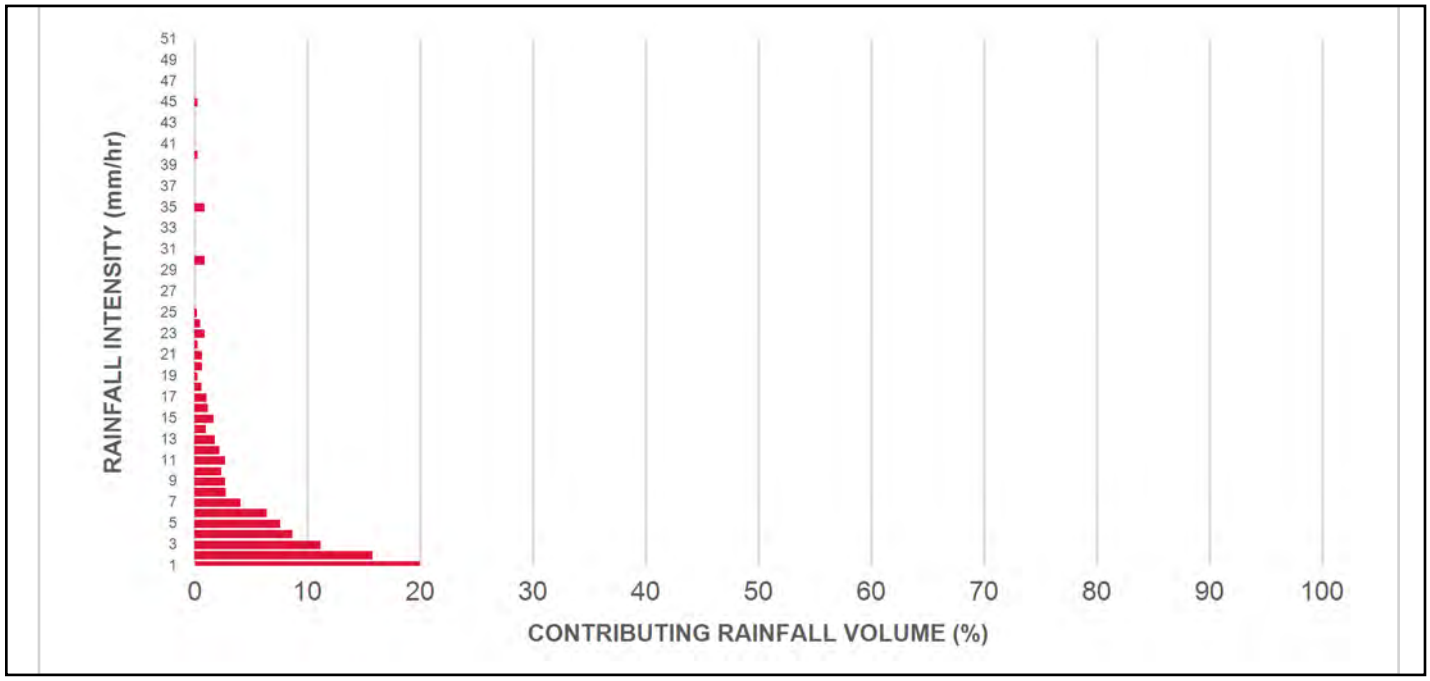
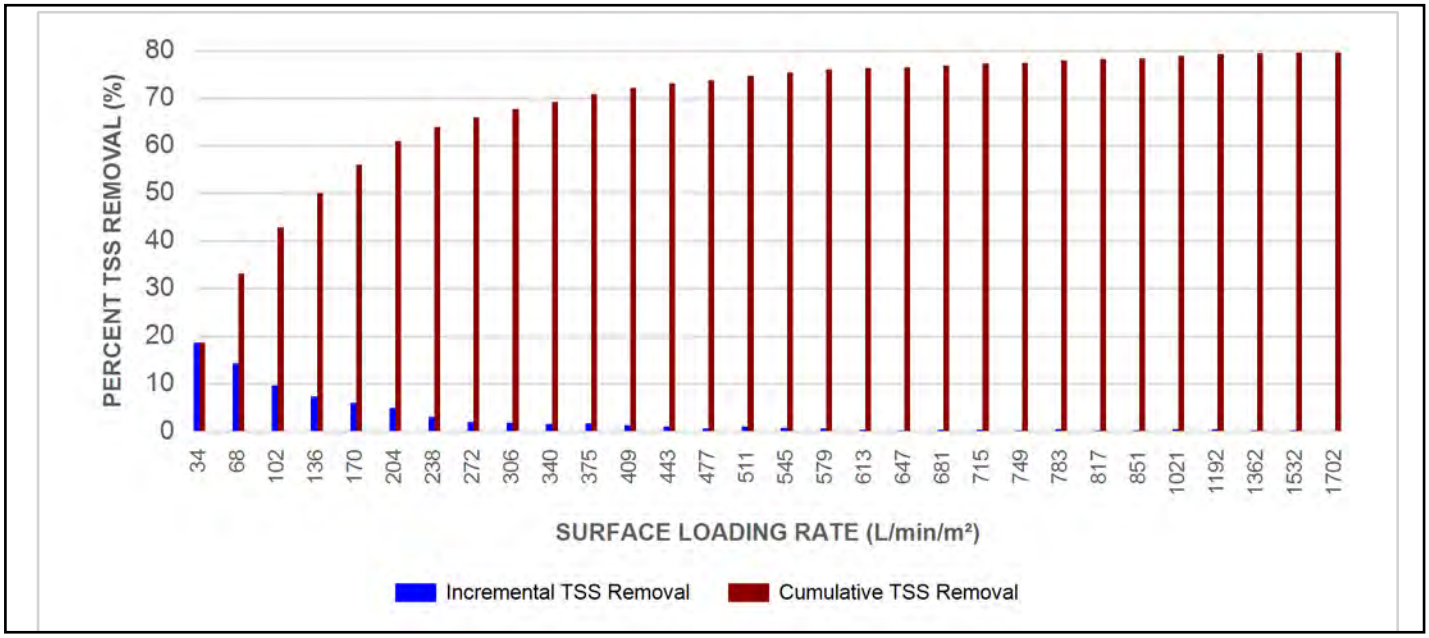
RAINFALL DATA FROM WATERLOO WELLINGTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter		Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter		Max Outlet Pipe Diameter		Peak Conveyance Flow Rate	
	(m)	(ft)		(mm)	(in)	(mm)	(in)	(L/s)	(cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

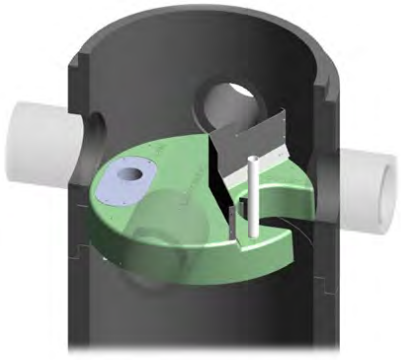
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

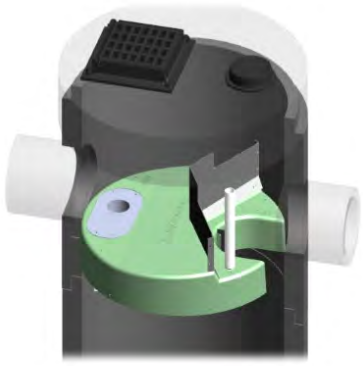
DESIGN FLEXIBILITY

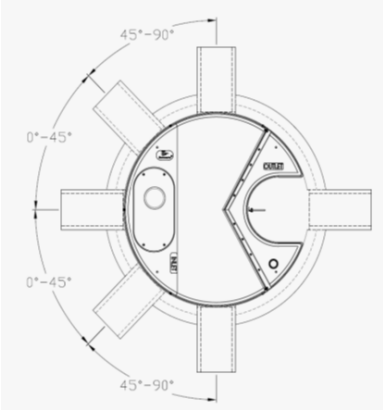
►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.







INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft^3)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft^3)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD PERFORMANCE SPECIFICATION FOR "OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

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: 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, OGS stormwater quality treatment 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 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The **minimum** sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1

4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

Stormceptor®

FORTERRA

Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

10/20/2021

Province:	Ontario
City:	Cambridge
Nearest Rainfall Station:	WATERLOO WELLINGTON AP
Climate Station Id:	6149387
Years of Rainfall Data:	34

Site Name:	Area 203
Drainage Area (ha):	0.51
% Imperviousness:	85.00

Runoff Coefficient 'c': 0.81

Particle Size Distribution:	Fine
Target TSS Removal (%):	80.0

Project Name:	180 Groh Avenue
Project Number:	121913
Designer Name:	Andy Kroess
Designer Company:	IBI Group
Designer Email:	andy.kroess@ibigroup.com
Designer Phone:	519-585-2255
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	16.45
Oil / Fuel Spill Risk Site?	No
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EF4	73
EF6	82
EF8	88
EF10	90
EF12	91

Recommended Stormceptor EF Model: EF6

Estimated Net Annual Sediment (TSS) Load Reduction (%): 82

Water Quality Runoff Volume Capture (%): > 90

imbrium

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterwavs.

PARTICLE SIZE DISTRIBUTION (PSD)

►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

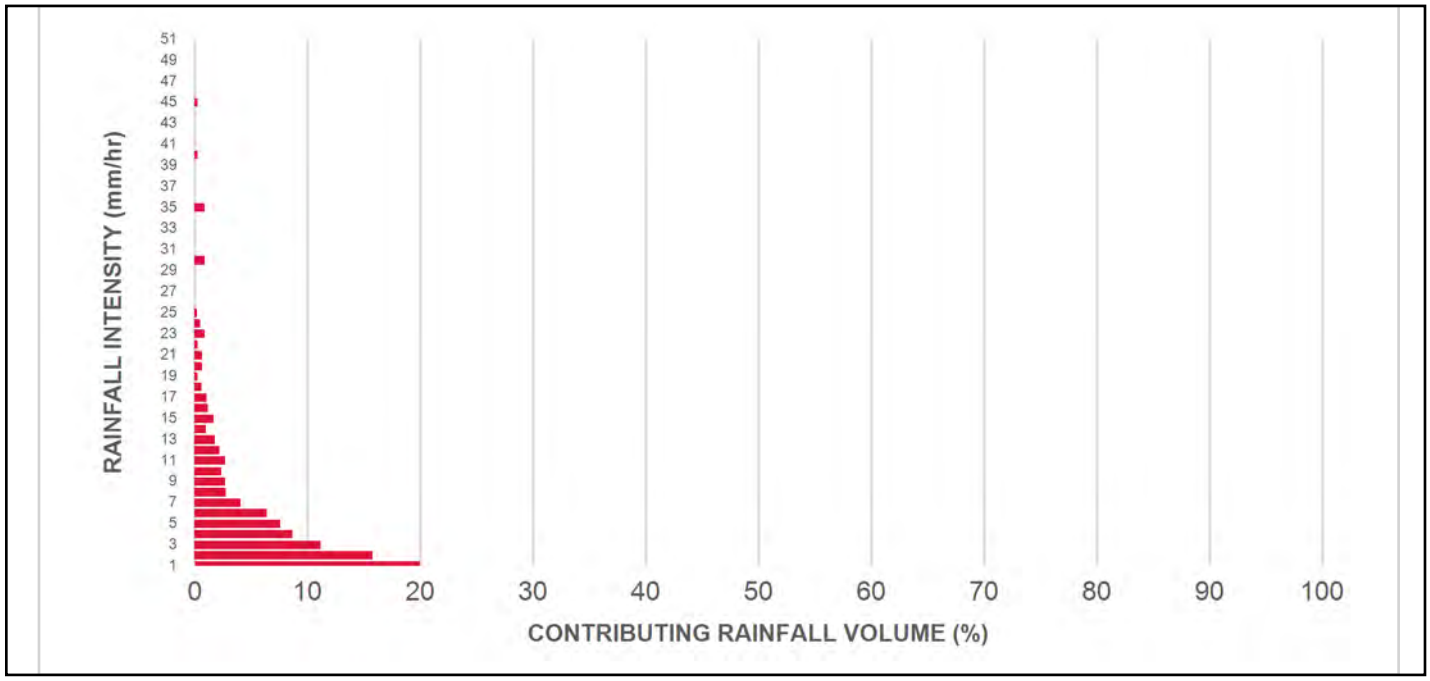
Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

Stormceptor® EF Sizing Report

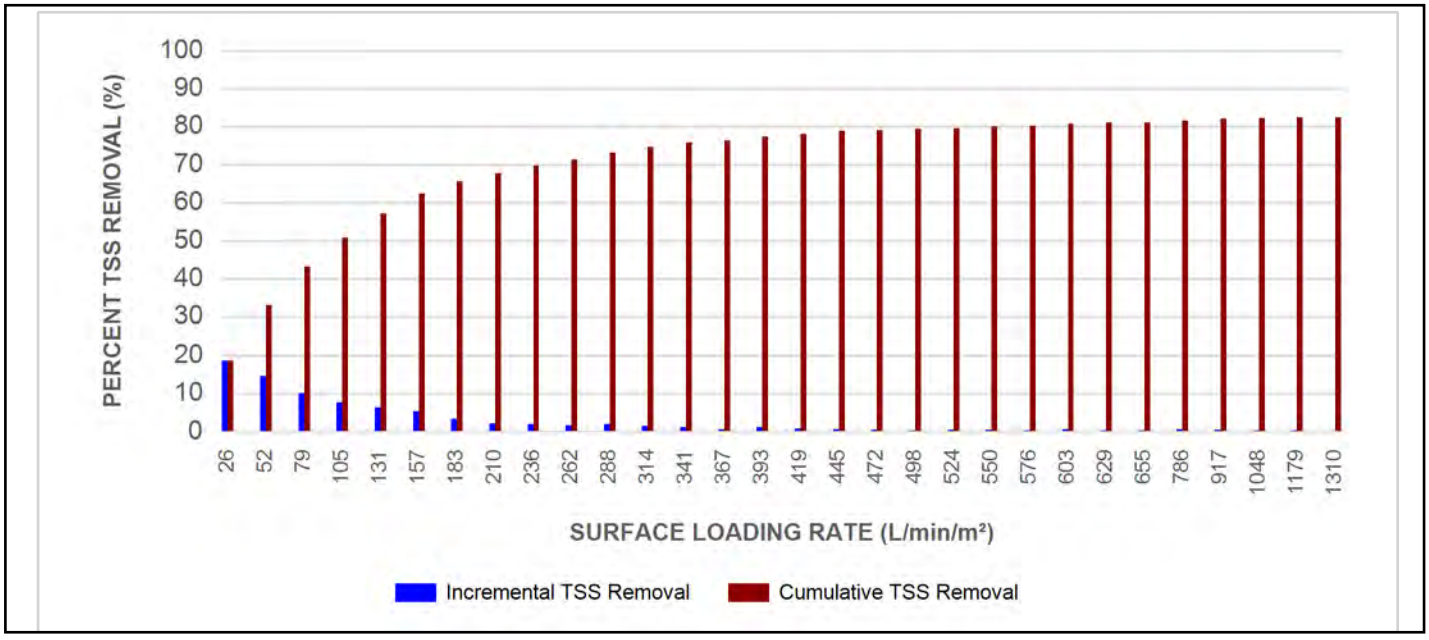
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	20.0	20.0	1.15	69.0	26.0	93	18.6	18.6
2	15.8	35.8	2.30	138.0	52.0	92	14.5	33.1
3	11.2	47.0	3.45	207.0	79.0	90	10.0	43.2
4	8.7	55.7	4.59	276.0	105.0	87	7.6	50.8
5	7.6	63.3	5.74	345.0	131.0	84	6.3	57.1
6	6.4	69.7	6.89	413.0	157.0	81	5.2	62.3
7	4.1	73.8	8.04	482.0	183.0	78	3.2	65.6
8	2.8	76.7	9.19	551.0	210.0	75	2.1	67.7
9	2.7	79.4	10.34	620.0	236.0	73	2.0	69.7
10	2.4	81.7	11.48	689.0	262.0	71	1.7	71.3
11	2.7	84.5	12.63	758.0	288.0	69	1.9	73.2
12	2.2	86.7	13.78	827.0	314.0	66	1.4	74.7
13	1.8	88.4	14.93	896.0	341.0	63	1.1	75.8
14	1.0	89.5	16.08	965.0	367.0	62	0.6	76.4
15	1.7	91.2	17.23	1034.0	393.0	59	1.0	77.4
16	1.2	92.3	18.37	1102.0	419.0	58	0.7	78.1
17	1.1	93.5	19.52	1171.0	445.0	58	0.7	78.8
18	0.6	94.1	20.67	1240.0	472.0	57	0.3	79.1
19	0.3	94.3	21.82	1309.0	498.0	57	0.1	79.3
20	0.7	95.0	22.97	1378.0	524.0	57	0.4	79.6
21	0.7	95.7	24.12	1447.0	550.0	57	0.4	80.0
22	0.3	96.0	25.27	1516.0	576.0	56	0.2	80.2
23	0.9	96.9	26.41	1585.0	603.0	56	0.5	80.7
24	0.5	97.4	27.56	1654.0	629.0	56	0.3	81.0
25	0.2	97.6	28.71	1723.0	655.0	56	0.1	81.1
30	0.9	98.5	34.45	2067.0	786.0	55	0.5	81.6
35	0.9	99.4	40.19	2412.0	917.0	54	0.5	82.1
40	0.3	99.7	45.94	2756.0	1048.0	55	0.1	82.2
45	0.3	100.0	51.68	3101.0	1179.0	56	0.2	82.4
50	0.0	100.0	57.42	3445.0	1310.0	58	0.0	82.4
Estimated Net Annual Sediment (TSS) Load Reduction =								**82 %**

Climate Station ID: 6149387 *Years of Rainfall Data*: 34

RAINFALL DATA FROM WATERLOO WELLINGTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter		Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter		Max Outlet Pipe Diameter		Peak Conveyance Flow Rate	
	(m)	(ft)		(mm)	(in)	(mm)	(in)	(L/s)	(cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

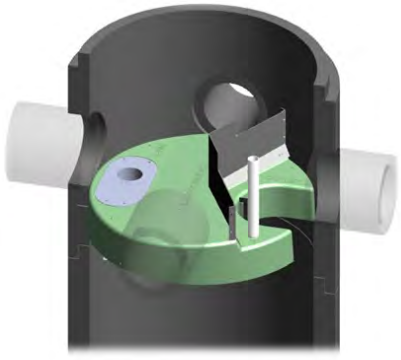
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

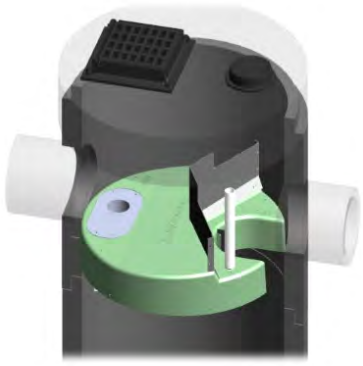
DESIGN FLEXIBILITY

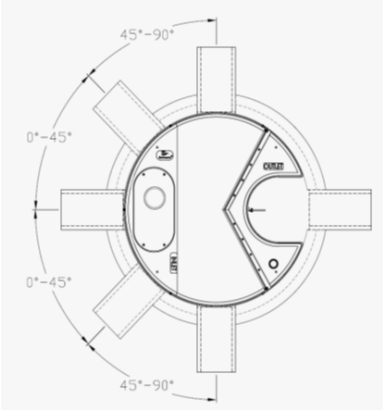
►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.







INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft^3)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft^3)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD PERFORMANCE SPECIFICATION FOR "OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

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: 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, OGS stormwater quality treatment 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 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The **minimum** sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1

4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

```
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      Units used are defined by G =    9.810
          36   960     5.000        are MAXDT MAXHYD & DTMIN values
      Licensee: PLANNING INITIATIVES LTD
35    COMMENT
     7     line(s) of comment
      ********************************
      * 121913 - 180 GROH AVENUE      *
      * CITY OF CAMBRIDGE             *
      * IBI GROUP                     *
      * PRELIMINARY SWM DESIGN        *
      * OCTOBER 2021                  *
      ********************************
35    COMMENT
     4     line(s) of comment
      ****************************************************
      * 5 YEAR CHICAGO STYLE RETURN STORM- 3 HOUR DURATION *
      * CITY OF CAMBRIDGE IDF PARAMETERS                   *
      ****************************************************
 2    STORM
          1     1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
   1219.800     Coefficient  a
     10.500     Constant  b    (min)
       .823     Exponent  c
       .400     Fraction to peak  r
    180.000     Duration ó  180 min
              48.647 mm     Total depth
 3    IMPERVIOUS
          1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
       .013     Manning "n"
     98.000     SCS Curve No or C
       .100     Ia/S Coefficient
       .518     Initial Abstraction
35    COMMENT
     3     line(s) of comment
      ***********************
      * EXISTING CONDITIONS *
      ***********************
35    COMMENT
     3     line(s) of comment
      *****************************
      * AREA 101 - GRASS/DRIVEWAY *
      *****************************
 4    CATCHMENT
    101.000     ID No.ó 99999
       .087     Area in hectares
     10.000     Length (PERV) metres
      2.000     Gradient (%)
     11.400     Per cent Impervious
     10.000     Length (IMPERV)
       .000     %Imp. with Zero Dpth
          1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
       .250     Manning "n"
     65.000     SCS Curve No or C
       .100     Ia/S Coefficient
     13.677     Initial Abstraction
          1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
             .003       .000       .000       .000 c.m/s
             .146       .863       .228     C perv/imperv/total
35    COMMENT
     3     line(s) of comment
      *********************************
      * DRAINING NORTH TO GROH AVENUE *
      *********************************
15    ADD RUNOFF
             .003       .003       .000       .000 c.m/s
```

```
14     START
       1     1=Zero; 2=Define
35     COMMENT
       3     line(s) of comment
        **********************
        * AREA 102 - BUILDING *
        **********************
 4     CATCHMENT
     102.000     ID No.ó 99999
        .781     Area in hectares
      20.000     Length (PERV) metres
       1.000     Gradient (%)
     100.000     Per cent Impervious
      20.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .013     Manning "n"
      98.000     SCS Curve No or C
        .100     Ia/S Coefficient
        .518     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .220       .000       .000       .000 c.m/s
              .880       .880       .880     C perv/imperv/total
15     ADD RUNOFF
              .220       .220       .000       .000 c.m/s
35     COMMENT
       3     line(s) of comment
        *************************
        * AREA 103 - PARKING LOT *
        *************************
 4     CATCHMENT
     103.000     ID No.ó 99999
        .481     Area in hectares
      20.000     Length (PERV) metres
       2.000     Gradient (%)
      73.900     Per cent Impervious
      20.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      65.000     SCS Curve No or C
        .100     Ia/S Coefficient
      13.677     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .103       .220       .000       .000 c.m/s
              .146       .880       .688     C perv/imperv/total
15     ADD RUNOFF
              .103       .324       .000       .000 c.m/s
35     COMMENT
       3     line(s) of comment
        ***************************
        * AREA 104 - GRASS/PARKING *
        ***************************
 4     CATCHMENT
     104.000     ID No.ó 99999
        .434     Area in hectares
      20.000     Length (PERV) metres
       2.000     Gradient (%)
      40.500     Per cent Impervious
      20.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      65.000     SCS Curve No or C
        .100     Ia/S Coefficient
      13.677     Initial Abstraction
```

```
          1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
             .051       .324       .000       .000 c.m/s
             .146       .880       .443     C perv/imperv/total
15     ADD RUNOFF
             .051       .375       .000       .000 c.m/s
35     COMMENT
       3     line(s) of comment
        ****************************
        * AREA 105 - GRASS/LANDSCAPED *
        ****************************
 4     CATCHMENT
     105.000     ID No.ó 99999
        .103     Area in hectares
      10.000     Length (PERV) metres
      20.000     Gradient (%)
        .000     Per cent Impervious
      10.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
          1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      65.000     SCS Curve No or C
        .100     Ia/S Coefficient
      13.677     Initial Abstraction
          1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
             .003       .375       .000       .000 c.m/s
             .145       .000       .145     C perv/imperv/total
15     ADD RUNOFF
             .003       .375       .000       .000 c.m/s
35     COMMENT
       3     line(s) of comment
        ***************************
        * AREA 106 - GRASS/WOODED *
        ***************************
 4     CATCHMENT
     106.000     ID No.ó 99999
        1.081     Area in hectares
      40.000     Length (PERV) metres
       5.000     Gradient (%)
        .000     Per cent Impervious
      40.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
          1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      65.000     SCS Curve No or C
        .100     Ia/S Coefficient
      13.677     Initial Abstraction
          1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
             .019       .375       .000       .000 c.m/s
             .146       .000       .146     C perv/imperv/total
15     ADD RUNOFF
             .019       .377       .000       .000 c.m/s
 9     ROUTE
         .000     Conduit Length
         .000     No Conduit defined
         .000     Zero lag
         .000     Beta weighting factor
         .000     Routing timestep
            0     No. of sub-reaches
             .019       .377       .377       .000 c.m/s
17     COMBINE
     500     Junction Node No.
             .019       .377       .377       .377 c.m/s
14     START
       1     1=Zero; 2=Define
35     COMMENT
       3     line(s) of comment
```

```
      **************************
      * AREA 108 - GRASS/PARKING *
      **************************
 4     CATCHMENT
     108.000     ID No.ó 99999
        .276     Area in hectares
      20.000     Length (PERV) metres
       2.000     Gradient (%)
      77.400     Per cent Impervious
      20.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      65.000     SCS Curve No or C
        .100     Ia/S Coefficient
      13.677     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .062       .000       .377       .377 c.m/s
              .146       .880       .714     C perv/imperv/total
 15    ADD RUNOFF
              .062       .062       .377       .377 c.m/s
 35    COMMENT
      3     line(s) of comment
      ****************************
      * AREA 109 - GRASS/LANDSCAPED *
      ****************************
 4     CATCHMENT
     109.000     ID No.ó 99999
        .146     Area in hectares
      10.000     Length (PERV) metres
      20.000     Gradient (%)
        .000     Per cent Impervious
      10.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      65.000     SCS Curve No or C
        .100     Ia/S Coefficient
      13.677     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .004       .062       .377       .377 c.m/s
              .145       .000       .145     C perv/imperv/total
 15    ADD RUNOFF
              .004       .063       .377       .377 c.m/s
 35    COMMENT
      3     line(s) of comment
      **************************
      * AREA 110 - GRASS/WOODED *
      **************************
 4     CATCHMENT
     110.000     ID No.ó 99999
        .986     Area in hectares
      40.000     Length (PERV) metres
       5.000     Gradient (%)
        .000     Per cent Impervious
      40.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      65.000     SCS Curve No or C
        .100     Ia/S Coefficient
      13.677     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .018       .063       .377       .377 c.m/s
              .146       .000       .146     C perv/imperv/total
 15    ADD RUNOFF
```

```
             .018       .064       .377       .377 c.m/s
 9     ROUTE
        .000     Conduit Length
        .000     No Conduit defined
        .000     Zero lag
        .000     Beta weighting factor
        .000     Routing timestep
           0     No. of sub-reaches
             .018       .064       .064       .377 c.m/s
17     COMBINE
    500     Junction Node No.
             .018       .064       .064       .441 c.m/s
35     COMMENT
       3     line(s) of comment
       ************************************
       * DRAINING SOUTH TO HOLIDAY INN DRIVE *
       ************************************
18     CONFLUENCE
    500     Junction Node No.
             .018       .441       .064       .000 c.m/s
14     START
       1     1=Zero; 2=Define
35     COMMENT
       3     line(s) of comment
       ****************************
       * AREA 107 - GRASS/PARKING *
       ****************************
 4     CATCHMENT
     107.000     ID No.ó 99999
        .139     Area in hectares
      10.000     Length (PERV) metres
       2.000     Gradient (%)
      73.000     Per cent Impervious
      10.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      65.000     SCS Curve No or C
        .100     Ia/S Coefficient
      13.677     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
             .030       .000       .064       .000 c.m/s
             .146       .863       .669     C perv/imperv/total
35     COMMENT
       3     line(s) of comment
       ********************************
       * DRAINING WEST TO ADJACENT LOT *
       ********************************
15     ADD RUNOFF
             .030       .030       .064       .000 c.m/s
14     START
       1     1=Zero; 2=Define
35     COMMENT
       3     line(s) of comment
       ***********************
       * PROPOSED CONDITIONS *
       ***********************
35     COMMENT
       3     line(s) of comment
       ****************************
       * AREA 201 - GRASS/DRIVEWAY *
       ****************************
 4     CATCHMENT
     201.000     ID No.ó 99999
        .092     Area in hectares
      15.000     Length (PERV) metres
```

```
       2.000     Gradient (%)
       5.000     Per cent Impervious
      15.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      65.000     SCS Curve No or C
        .100     Ia/S Coefficient
      13.677     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .002       .000       .064       .000 c.m/s
              .146       .875       .183     C perv/imperv/total
35     COMMENT
      3     line(s) of comment
       *******************************
       * DRAINING NORTH TO GROH AVENUE *
       *******************************
15     ADD RUNOFF
              .002       .002       .064       .000 c.m/s
14     START
      1     1=Zero; 2=Define
35     COMMENT
      3     line(s) of comment
       *******************************
       * AREA 202 - BUILDINGS/PARKING *
       *******************************
 4     CATCHMENT
     202.000     ID No.ó 99999
       1.646     Area in hectares
      20.000     Length (PERV) metres
       1.000     Gradient (%)
      85.000     Per cent Impervious
      20.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      65.000     SCS Curve No or C
        .100     Ia/S Coefficient
      13.677     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .395       .000       .064       .000 c.m/s
              .146       .880       .770     C perv/imperv/total
15     ADD RUNOFF
              .395       .395       .064       .000 c.m/s
35     COMMENT
      3     line(s) of comment
       ******************
       * SURFACE STORAGE *
       ******************
10     POND
      7 Depth - Discharge - Volume sets
          .000       .000         .0
          .050       .200        25.1
          .100       .210        50.1
          .150       .310       105.2
          .200       .320       175.0
          .250       .400       225.0
          .300       .450       250.0
       Peak Outflow    =      .265 c.m/s
       Maximum Depth   =      .127 metres
       Maximum Storage =       80. c.m
              .395       .395       .265       .000 c.m/s
16     NEXT LINK
              .395       .265       .265       .000 c.m/s
35     COMMENT
      3     line(s) of comment
```

```
      ******************************
      * AREA 204 - BUILDINGS/PARKING *
      ******************************
 4    CATCHMENT
    204.000     ID No.ó 99999
      1.000     Area in hectares
     20.000     Length (PERV) metres
      1.000     Gradient (%)
     85.000     Per cent Impervious
     20.000     Length (IMPERV)
       .000     %Imp. with Zero Dpth
         1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
       .250     Manning "n"
     65.000     SCS Curve No or C
       .100     Ia/S Coefficient
     13.677     Initial Abstraction
         1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
            .240       .265       .265       .000 c.m/s
            .146       .880       .770     C perv/imperv/total
15    ADD RUNOFF
            .240       .457       .265       .000 c.m/s
35    COMMENT
      3     line(s) of comment
      ***********************
      * UNDERGROUND STORAGE *
      ***********************
10    POND
      7 Depth - Discharge - Volume sets
          .000       .000          .0
          .200       .300         75.0
          .400       .320        150.0
          .600       .360        225.0
          .800       .410        300.0
         1.000       .430        325.0
         1.200       .460        350.0
      Peak Outflow    =      .320 c.m/s
      Maximum Depth   =      .400 metres
      Maximum Storage =      150. c.m
            .240       .457       .320       .000 c.m/s
17    COMBINE
    600     Junction Node No.
            .240       .457       .320       .320 c.m/s
14    START
      1     1=Zero; 2=Define
35    COMMENT
      3     line(s) of comment
      ******************************
      * AREA 203 - BUILDINGS/PARKING *
      ******************************
 4    CATCHMENT
    203.000     ID No.ó 99999
       .506     Area in hectares
     20.000     Length (PERV) metres
      1.000     Gradient (%)
     85.000     Per cent Impervious
     20.000     Length (IMPERV)
       .000     %Imp. with Zero Dpth
         1      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
       .250     Manning "n"
     65.000     SCS Curve No or C
       .100     Ia/S Coefficient
     13.677     Initial Abstraction
         1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
            .121       .000       .320       .320 c.m/s
            .146       .880       .770     C perv/imperv/total
15    ADD RUNOFF
```

```
             .121       .121       .320       .320 c.m/s
35     COMMENT
       3     line(s) of comment
        **********************
        * UNDERGROUND STORAGE *
        **********************
10     POND
       7 Depth - Discharge - Volume sets
           .000        .000          .0
           .200       .0600        10.0
           .400       .0800        30.0
           .600        .100        60.0
           .800        .130        80.0
          1.000        .150        90.0
          1.200        .170       100.0
        Peak Outflow    =      .078 c.m/s
        Maximum Depth   =      .377 metres
        Maximum Storage =       28. c.m
             .121       .121       .078       .320 c.m/s
17     COMBINE
     600     Junction Node No.
             .121       .121       .078       .397 c.m/s
14     START
       1     1=Zero; 2=Define
35     COMMENT
       3     line(s) of comment
        ***************************
        * AREA 205 - GRASS/WOODED *
        ***************************
 4     CATCHMENT
      205.000     ID No.ó 99999
        1.126     Area in hectares
       40.000     Length (PERV) metres
        5.000     Gradient (%)
       10.000     Per cent Impervious
       40.000     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       65.000     SCS Curve No or C
         .100     Ia/S Coefficient
       13.677     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
             .033       .000       .078       .397 c.m/s
             .146       .881       .220     C perv/imperv/total
15     ADD RUNOFF
             .033       .033       .078       .397 c.m/s
 9     ROUTE
        .000     Conduit Length
        .000     No Conduit defined
        .000     Zero lag
        .000     Beta weighting factor
        .000     Routing timestep
           0     No. of sub-reaches
             .033       .033       .033       .397 c.m/s
17     COMBINE
     600     Junction Node No.
             .033       .033       .033       .420 c.m/s
14     START
       1     1=Zero; 2=Define
35     COMMENT
       3     line(s) of comment
        ********************
        * AREA 206 - GRASS *
        ********************
 4     CATCHMENT
```

```
   206.000     ID No.ó 99999
      .139     Area in hectares
    10.000     Length (PERV) metres
     5.000     Gradient (%)
     5.000     Per cent Impervious
    10.000     Length (IMPERV)
      .000     %Imp. with Zero Dpth
         1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
      .250     Manning "n"
    65.000     SCS Curve No or C
      .100     Ia/S Coefficient
    13.677     Initial Abstraction
         1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
            .004       .000       .033       .420 c.m/s
            .146       .845       .181     C perv/imperv/total
15   ADD RUNOFF
            .004       .004       .033       .420 c.m/s
 9   ROUTE
      .000     Conduit Length
      .000     No Conduit defined
      .000     Zero lag
      .000     Beta weighting factor
      .000     Routing timestep
         0     No. of sub-reaches
            .004       .004       .004       .420 c.m/s
17   COMBINE
   600     Junction Node No.
            .004       .004       .004       .424 c.m/s
35   COMMENT
     3     line(s) of comment
      ************************************
      * DRAINING SOUTH TO HOLIDAY INN DRIVE *
      ************************************
18   CONFLUENCE
   600     Junction Node No.
            .004       .424       .004       .000 c.m/s
14   START
     1     1=Zero; 2=Define
35   COMMENT
     4     line(s) of comment
      ******************************************************
      * 100 YEAR CHICAGO STYLE RETURN STORM- 3 HOUR DURATION *
      * CITY OF CAMBRIDGE IDF PARAMETERS                     *
      ******************************************************
 2   STORM
         1     1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
  3015.100     Coefficient  a
    21.000     Constant  b    (min)
      .870     Exponent  c
      .400     Fraction to peak  r
   180.000     Duration ó  180 min
            89.669 mm     Total depth
 3   IMPERVIOUS
         1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
      .013     Manning "n"
    98.000     SCS Curve No or C
      .100     Ia/S Coefficient
      .518     Initial Abstraction
35   COMMENT
     3     line(s) of comment
      **********************
      * EXISTING CONDITIONS *
      **********************
35   COMMENT
     3     line(s) of comment
      ***************************
```

```
      * AREA 101 - GRASS/DRIVEWAY *
      ****************************
 4     CATCHMENT
     101.000     ID No.ó 99999
        .087     Area in hectares
      10.000     Length (PERV) metres
       2.000     Gradient (%)
      11.400     Per cent Impervious
      10.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      65.000     SCS Curve No or C
        .100     Ia/S Coefficient
      13.677     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .011       .000       .004       .000 c.m/s
              .301       .900       .370     C perv/imperv/total
35     COMMENT
      3     line(s) of comment
      *******************************
      * DRAINING NORTH TO GROH AVENUE *
      *******************************
15     ADD RUNOFF
              .011       .011       .004       .000 c.m/s
14     START
      1     1=Zero; 2=Define
35     COMMENT
      3     line(s) of comment
      ***********************
      * AREA 102 - BUILDING *
      ***********************
 4     CATCHMENT
     102.000     ID No.ó 99999
        .781     Area in hectares
      20.000     Length (PERV) metres
       1.000     Gradient (%)
     100.000     Per cent Impervious
      20.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .013     Manning "n"
      98.000     SCS Curve No or C
        .100     Ia/S Coefficient
        .518     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .337       .000       .004       .000 c.m/s
              .927       .927       .927     C perv/imperv/total
15     ADD RUNOFF
              .337       .337       .004       .000 c.m/s
35     COMMENT
      3     line(s) of comment
      *************************
      * AREA 103 - PARKING LOT *
      *************************
 4     CATCHMENT
     103.000     ID No.ó 99999
        .481     Area in hectares
      20.000     Length (PERV) metres
       2.000     Gradient (%)
      73.900     Per cent Impervious
      20.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      65.000     SCS Curve No or C
```

```
        .100     Ia/S Coefficient
      13.677     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .157       .337       .004       .000 c.m/s
              .301       .922       .760     C perv/imperv/total
15     ADD RUNOFF
              .157       .494       .004       .000 c.m/s
35     COMMENT
       3     line(s) of comment
        ***************************
        * AREA 104 - GRASS/PARKING *
        ***************************
 4     CATCHMENT
     104.000     ID No.ó 99999
        .434     Area in hectares
      20.000     Length (PERV) metres
       2.000     Gradient (%)
      40.500     Per cent Impervious
      20.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      65.000     SCS Curve No or C
        .100     Ia/S Coefficient
      13.677     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .082       .494       .004       .000 c.m/s
              .301       .922       .553     C perv/imperv/total
15     ADD RUNOFF
              .082       .576       .004       .000 c.m/s
35     COMMENT
       3     line(s) of comment
        *******************************
        * AREA 105 - GRASS/LANDSCAPED *
        *******************************
 4     CATCHMENT
     105.000     ID No.ó 99999
        .103     Area in hectares
      10.000     Length (PERV) metres
      20.000     Gradient (%)
        .000     Per cent Impervious
      10.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      65.000     SCS Curve No or C
        .100     Ia/S Coefficient
      13.677     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .013       .576       .004       .000 c.m/s
              .299       .000       .299     C perv/imperv/total
15     ADD RUNOFF
              .013       .584       .004       .000 c.m/s
35     COMMENT
       3     line(s) of comment
        *************************
        * AREA 106 - GRASS/WOODED *
        *************************
 4     CATCHMENT
     106.000     ID No.ó 99999
       1.081     Area in hectares
      40.000     Length (PERV) metres
       5.000     Gradient (%)
        .000     Per cent Impervious
      40.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
```

```
         1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
       .250     Manning "n"
     65.000     SCS Curve No or C
       .100     Ia/S Coefficient
     13.677     Initial Abstraction
         1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
            .104       .584       .004       .000 c.m/s
            .302       .000       .302     C perv/imperv/total
15     ADD RUNOFF
            .104       .601       .004       .000 c.m/s
 9     ROUTE
        .000     Conduit Length
        .000     No Conduit defined
        .000     Zero lag
        .000     Beta weighting factor
        .000     Routing timestep
           0     No. of sub-reaches
            .104       .601       .601       .000 c.m/s
17     COMBINE
    500     Junction Node No.
            .104       .601       .601       .601 c.m/s
14     START
      1     1=Zero; 2=Define
35     COMMENT
      3     line(s) of comment
       ***************************
       * AREA 108 - GRASS/PARKING *
       ***************************
 4     CATCHMENT
     108.000     ID No.ó 99999
        .276     Area in hectares
      20.000     Length (PERV) metres
       2.000     Gradient (%)
      77.400     Per cent Impervious
      20.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
         1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
       .250     Manning "n"
      65.000     SCS Curve No or C
        .100     Ia/S Coefficient
      13.677     Initial Abstraction
         1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
            .094       .000       .601       .601 c.m/s
            .301       .922       .782     C perv/imperv/total
15     ADD RUNOFF
            .094       .094       .601       .601 c.m/s
35     COMMENT
      3     line(s) of comment
       ******************************
       * AREA 109 - GRASS/LANDSCAPED *
       ******************************
 4     CATCHMENT
     109.000     ID No.ó 99999
        .146     Area in hectares
      10.000     Length (PERV) metres
      20.000     Gradient (%)
        .000     Per cent Impervious
      10.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
         1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
       .250     Manning "n"
      65.000     SCS Curve No or C
        .100     Ia/S Coefficient
      13.677     Initial Abstraction
         1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
            .019       .094       .601       .601 c.m/s
```

```
              .299       .000       .299     C perv/imperv/total
15     ADD RUNOFF
              .019       .105       .601       .601 c.m/s
35     COMMENT
       3     line(s) of comment
        *************************
        * AREA 110 - GRASS/WOODED *
        *************************
 4     CATCHMENT
     110.000     ID No.ó 99999
        .986     Area in hectares
      40.000     Length (PERV) metres
       5.000     Gradient (%)
        .000     Per cent Impervious
      40.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      65.000     SCS Curve No or C
        .100     Ia/S Coefficient
      13.677     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .094       .105       .601       .601 c.m/s
              .302       .000       .302     C perv/imperv/total
15     ADD RUNOFF
              .094       .152       .601       .601 c.m/s
 9     ROUTE
         .000     Conduit Length
         .000     No Conduit defined
         .000     Zero lag
         .000     Beta weighting factor
         .000     Routing timestep
           0     No. of sub-reaches
              .094       .152       .152       .601 c.m/s
17     COMBINE
     500     Junction Node No.
              .094       .152       .152       .722 c.m/s
35     COMMENT
       3     line(s) of comment
        *************************************
        * DRAINING SOUTH TO HOLIDAY INN DRIVE *
        *************************************
18     CONFLUENCE
     500     Junction Node No.
              .094       .722       .152       .000 c.m/s
14     START
       1     1=Zero; 2=Define
35     COMMENT
       3     line(s) of comment
        ***************************
        * AREA 107 - GRASS/PARKING *
        ***************************
 4     CATCHMENT
     107.000     ID No.ó 99999
        .139     Area in hectares
      10.000     Length (PERV) metres
       2.000     Gradient (%)
      73.000     Per cent Impervious
      10.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      65.000     SCS Curve No or C
        .100     Ia/S Coefficient
      13.677     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
```

```
            .045       .000       .152       .000 c.m/s
            .301       .900       .738     C perv/imperv/total
35     COMMENT
       3     line(s) of comment
        *********************************
        * DRAINING WEST TO ADJACENT LOT *
        *********************************
15     ADD RUNOFF
            .045       .045       .152       .000 c.m/s
14     START
       1     1=Zero; 2=Define
35     COMMENT
       3     line(s) of comment
        ***********************
        * PROPOSED CONDITIONS *
        ***********************
35     COMMENT
       3     line(s) of comment
        ****************************
        * AREA 201 - GRASS/DRIVEWAY *
        ****************************
 4     CATCHMENT
     201.000     ID No.ó 99999
        .092     Area in hectares
      15.000     Length (PERV) metres
       2.000     Gradient (%)
       5.000     Per cent Impervious
      15.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      65.000     SCS Curve No or C
        .100     Ia/S Coefficient
      13.677     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
            .010       .000       .152       .000 c.m/s
            .302       .915       .332     C perv/imperv/total
35     COMMENT
       3     line(s) of comment
        *********************************
        * DRAINING NORTH TO GROH AVENUE *
        *********************************
15     ADD RUNOFF
            .010       .010       .152       .000 c.m/s
14     START
       1     1=Zero; 2=Define
35     COMMENT
       3     line(s) of comment
        *******************************
        * AREA 202 - BUILDINGS/PARKING *
        *******************************
 4     CATCHMENT
     202.000     ID No.ó 99999
       1.646     Area in hectares
      20.000     Length (PERV) metres
       1.000     Gradient (%)
      85.000     Per cent Impervious
      20.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      65.000     SCS Curve No or C
        .100     Ia/S Coefficient
      13.677     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
            .608       .000       .152       .000 c.m/s
```

```
             .302       .927       .833     C perv/imperv/total
15     ADD RUNOFF
             .608       .608       .152       .000 c.m/s
35     COMMENT
       3     line(s) of comment
        ******************
        * SURFACE STORAGE *
        ******************
10     POND
       7 Depth - Discharge - Volume sets
           .000        .000          .0
           .050        .200        25.1
           .100        .210        50.1
           .150        .310       105.2
           .200        .320       175.0
           .250        .400       225.0
           .300        .450       250.0
        Peak Outflow    =      .368 c.m/s
        Maximum Depth   =      .230 metres
        Maximum Storage =      205. c.m
             .608       .608       .368       .000 c.m/s
16     NEXT LINK
             .608       .368       .368       .000 c.m/s
35     COMMENT
       3     line(s) of comment
        *******************************
        * AREA 204 - BUILDINGS/PARKING *
        *******************************
 4     CATCHMENT
     204.000     ID No.ó 99999
       1.000     Area in hectares
      20.000     Length (PERV) metres
       1.000     Gradient (%)
      85.000     Per cent Impervious
      20.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      65.000     SCS Curve No or C
        .100     Ia/S Coefficient
      13.677     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
             .369       .368       .368       .000 c.m/s
             .302       .927       .833     C perv/imperv/total
15     ADD RUNOFF
             .369       .680       .368       .000 c.m/s
35     COMMENT
       3     line(s) of comment
        ***********************
        * UNDERGROUND STORAGE *
        ***********************
10     POND
       7 Depth - Discharge - Volume sets
           .000        .000          .0
           .200        .300        75.0
           .400        .320       150.0
           .600        .360       225.0
           .800        .410       300.0
          1.000        .430       325.0
          1.200        .460       350.0
        Peak Outflow    =      .459 c.m/s
        Maximum Depth   =     1.191 metres
        Maximum Storage =      349. c.m
             .369       .680       .459       .000 c.m/s
17     COMBINE
    600     Junction Node No.
```

```
             .369       .680       .459       .459 c.m/s
14     START
       1     1=Zero; 2=Define
35     COMMENT
       3     line(s) of comment
        ******************************
        * AREA 203 - BUILDINGS/PARKING *
        ******************************
 4     CATCHMENT
     203.000     ID No.ó 99999
        .506     Area in hectares
      20.000     Length (PERV) metres
       1.000     Gradient (%)
      85.000     Per cent Impervious
      20.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      65.000     SCS Curve No or C
        .100     Ia/S Coefficient
      13.677     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
             .187       .000       .459       .459 c.m/s
             .302       .927       .833     C perv/imperv/total
15     ADD RUNOFF
             .187       .187       .459       .459 c.m/s
35     COMMENT
       3     line(s) of comment
        ***********************
        * UNDERGROUND STORAGE *
        ***********************
10     POND
       7 Depth - Discharge - Volume sets
           .000        .000          .0
           .200       .0600        10.0
           .400       .0800        30.0
           .600        .100        60.0
           .800        .130        80.0
          1.000        .150        90.0
          1.200        .170       100.0
        Peak Outflow    =      .113 c.m/s
        Maximum Depth   =      .685 metres
        Maximum Storage =       69. c.m
             .187       .187       .113       .459 c.m/s
17     COMBINE
    600     Junction Node No.
             .187       .187       .113       .558 c.m/s
14     START
       1     1=Zero; 2=Define
35     COMMENT
       3     line(s) of comment
        **************************
        * AREA 205 - GRASS/WOODED *
        **************************
 4     CATCHMENT
     205.000     ID No.ó 99999
       1.126     Area in hectares
      40.000     Length (PERV) metres
       5.000     Gradient (%)
      10.000     Per cent Impervious
      40.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      65.000     SCS Curve No or C
        .100     Ia/S Coefficient
```

```
      13.677     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .116       .000       .113       .558 c.m/s
              .302       .926       .365     C perv/imperv/total
15     ADD RUNOFF
              .116       .116       .113       .558 c.m/s
 9     ROUTE
        .000     Conduit Length
        .000     No Conduit defined
        .000     Zero lag
        .000     Beta weighting factor
        .000     Routing timestep
           0     No. of sub-reaches
              .116       .116       .116       .558 c.m/s
17     COMBINE
    600     Junction Node No.
              .116       .116       .116       .674 c.m/s
14     START
       1     1=Zero; 2=Define
35     COMMENT
       3     line(s) of comment
        ********************
        * AREA 206 - GRASS *
        ********************
 4     CATCHMENT
     206.000     ID No.ó 99999
        .139     Area in hectares
      10.000     Length (PERV) metres
       5.000     Gradient (%)
       5.000     Per cent Impervious
      10.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
           1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      65.000     SCS Curve No or C
        .100     Ia/S Coefficient
      13.677     Initial Abstraction
           1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .017       .000       .116       .674 c.m/s
              .299       .872       .328     C perv/imperv/total
15     ADD RUNOFF
              .017       .017       .116       .674 c.m/s
 9     ROUTE
        .000     Conduit Length
        .000     No Conduit defined
        .000     Zero lag
        .000     Beta weighting factor
        .000     Routing timestep
           0     No. of sub-reaches
              .017       .017       .017       .674 c.m/s
17     COMBINE
    600     Junction Node No.
              .017       .017       .017       .686 c.m/s
35     COMMENT
       3     line(s) of comment
        ************************************
        * DRAINING SOUTH TO HOLIDAY INN DRIVE *
        ************************************
18     CONFLUENCE
    600     Junction Node No.
              .017       .686       .017       .000 c.m/s
20     MANUAL
```

APPENDIX C:
Sanitary Calculations

SANITARY SEWER DESIGN SHEET

180 Groh Avenue
CITY OF CAMBRIDGE

date: October 20, 2021

FILE: 121913
DESIGN: TC
CHECK: KC

LOCATION			INCREMENTAL		CUMULATIVE						SEWER DATA						Capacity
Street	From MH	To MH	Zoning Category Townhouse (ppu) 2.44 No. of Units	Representative Population	Representative Population (Cumulative)	Area (ha)	Avg. Flow Residential (l/s)	Peaking Factor (Residential)	Infiltr. (l/s)	Peak Flow (l/s)	Pipe dia. (mm)	Length (m)	Slope (%)	Cap. (l/s)	Vel. (m/s)	Avail. Cap. (l/s)	
Groh Avenue Connection																	
Block C+D+G+H	MH5A	MH4A	96	234	234	4.514	0.95	4.12	0.68	4.59	200	41.6	0.50	24.3	0.75	19.7	19%
Block B+F	MH4A	MH3A	48	117	351	4.514	1.42	4.05	0.68	6.43	200	61.8	0.50	24.3	0.75	17.9	26%
Block A+E	MH3A	MH2A	48	117	468	4.514	1.90	3.99	0.68	8.26	200	31.1	0.50	24.3	0.75	16.0	34%
	MH2A	MH1A			468	4.514	1.90	3.99	0.68	8.26	250	35.5	0.50	44.1	0.87	35.8	19%
	MH1A	MH17A			468	4.514	1.90	3.99	0.68	8.26	250	65.4	0.50	44.1	0.87	35.8	19%
	MH17A	SM14290			468	4.514	1.90	3.99	0.68	8.26	250	19.8	0.50	44.1	0.87	35.8	19%
Groh Avenue	SM14290	SM14289			468	4.514	1.90	3.99	0.68	8.26	250	92.0	0.68	51.2	1.01	42.9	16%
Holiday Inn Drive Connection																	
Block K	MH8A	MH7A	16	39	39	4.514	0.16	4.34	0.68	1.37	200	38.6	1.83	46.4	1.43	45.0	3%
Block L	MH7A	MH9A	24	59	98	4.514	0.40	4.25	0.68	2.38	200	16.8	2.98	59	1.82	56.6	4%
Block I	MH11A	MH10A	24	59	156	4.514	0.63	4.19	0.68	3.32	200	27.5	4.50	72.6	2.24	69.3	5%
	MH10A	MH9A			156	4.514	0.63	4.19	0.68	3.32	200	32.2	1.00	34.4	1.06	31.1	10%
	MH9A	MH12A			254	4.514	1.03	4.11	0.68	4.91	200	22.5	1.00	34.4	1.06	29.5	14%
	MH12A	MH13A			254	4.514	1.03	4.11	0.68	4.91	200	66.4	2.24	51.2	1.58	46.3	10%
Easement	MH13A	MH14A			254	4.514	1.03	4.11	0.68	4.91	200	70.0	3.16	61	1.88	56.1	8%
Easement	MH14A	EX.MH 3A			254	4.514	1.03	4.11	0.68	4.91	200	70.0	2.38	52.9	1.63	48.0	9%
Holiday Inn Dr	EX.MH 3A	EXMH			254	4.514	1.03	4.11	0.68	4.91	450	82.0	0.52	215.1	1.31	210.2	2%

PIPE DATA						
INVERTS		T/G		COVER	
U/S	D/S	U/S	D/S	U/S	D/S
307.48	307.27	309.13	310.49	1.8	3.4
307.25	306.94	310.49	310.53	3.4	3.8
306.92	306.77	310.53	310.37	3.8	3.8
306.75	306.66	310.37	310.31	3.9	3.9
306.60	306.34	310.31	310.31	4.0	4.2
306.27	306.18	310.31	-	4.3	-
303.02	302.31	306.55	304.86	3.7	2.8
302.25	301.75	304.86	304.59	2.8	3.0
302.04	301.76	305.77	305.23	3.9	3.7
301.70	301.44	305.23	304.59	3.7	3.3
301.38	301.16	304.59	305.06	3.4	4.1
301.10	299.61	305.06	300.12	4.2	0.7
299.55	297.34	TBC	TBC	TBC	TBC
297.28	295.61	TBC	TBC	TBC	TBC

*Easement topography to be confirmed.

AVERAGE FLOWS

Commercial - Flow =	general	0.6	L/s/ha
	core	1.16	L/s/ha
	shopping mall	0.3	L/s/ha
Industrial- Flow =		0.5	L/s/ha
Institutional +		0.25	L/s/ha
Residential - Flow =		350	l/cap./day
=		0.00405	l/s/cap
Infiltration - Flow =		0.15	l/ha.sec.

PEAKING FACTORS

Residential
Harmon Peaking Factor, M = 1 + (14 / (4 + P^0.5))
where, P = population in thousands

Commercial/Institutional 2.5

PIPE CRITERIA

n=	*0.013*	PVC
Pipe Velocities:	*0.60*	m/s min.
	3.00	m/s max.

printed:2021-10-21

APPENDIX D:

Water Demand Calculations, FUS Calculations and Hydrant Test Results

IBI

180 Groh Avenue
City of Cambridge
DOMESTIC WATER DEMAND

File No: 121913
Date: 20-Oct-21
Sheet By: TC
Checked By: KC

Node	Proposed Residential Apartment	Ground Elevation (m)	Population Density[1]		Units	Equivalent Population (persons)	Water Demand[1] @ 225 L/p/day (L/day)	Average Day (L/s)	Min Hour (L/s)	Max Day (L/s)	Peak Hour (L/s)	Fire Flow (L/s)	Demand Required (L/s)
J-1	Block A+E	310.50	2.44	PPU	16	40	9,000	0.10	0.04	0.29	0.43	0	0.29
J-2	Block B+F	310.60	2.44	PPU	48	118	26,550	0.31	0.12	0.85	1.27	0	0.85
J-3	Block C+G	309.55	2.44	PPU	48	118	26,550	0.31	0.12	0.85	1.27	0	0.85
J-4	Block D+H	309.25	2.44	PPU	48	118	26,550	0.31	0.12	0.85	1.27	0	0.85
J-5	Block I	308.46	2.44	PPU	24	59	13,275	0.15	0.06	0.42	0.63	0	0.42
J-6	Block J+K+L	306.79	2.44	PPU	72	176	39,600	0.46	0.18	1.26	1.89	0	1.26
	Hyd	304.68										83	

*Assumed townhouse density = 2.44 PPU based on Region of Waterloo Planning Services

	Peaking Factor[1]
Min Hour (L/day)	0.4
Min Hour (L/s)	0.4
Maximum day (L/day)	2.75
Maximum day (L/s)	2.75
Peak hour (L/hr)	4.13
Peak hour (L/s)	4.13

1 - DGSSMS - Region of Waterloo
2 - Design Guidelines for Drinking Water Systems - Table 3.1 - MECP

FUS Fire Flow Estimation

Based on Part II of Water Supply for Public Fire Protection 1999 (Page 17 to 20 Guide for determination of required fire flow)

Project: 121913, 180 Groh Ave, Cambridge
Date: October 2021
Junction: J-1, Block A/E with Fire Wall in the middle

Floor area (each unit)	5780	ft^2 (or 537m^2)
Fire Wall Requirement	Yes	
Construction Type	Wood Frame	
Provision of Sprinkler	no	

Item A to D, P20) Fire flow rate based on type of construction

Item 1, P17 $F1=220C1A^{0.5}$ Fire Flow Formula (Rounded off to nearest 1000 L/min)

F1= Required fire Flow (L/min)

A= **269** m^2 Total Floor area Based on the site statistics prepared by architects

C1 = 1.5 Type of construction (Page 17)

C1=1.5 for wood frame construction (structure essentially all combustible)
C1=1.0 for ordinary construction (brick or other masonry walls, combustibles floor and interior)
C1=0.8 for non-combustible construction (unprotected metal structural components, masonry or metal walls)
C1=0.6 for fire-resistive construction (fully protected frame, floors, roof)
a) fire-resistive construction with vertical opening inadequately protected:
two largest floors plus 50% of each of any floors immediately above up to eight
b) fire-resistive construction with vertical opening and exterior communications adequately protected (one hour rating):
one largest floor plus 25% of each of the two immediately adjoining floors

F1= **5409** L/min

Item E, P20) Determine the increase or decrease for type of occupancies (Do not round off the answer)
Item 2, P18)

F2= F1 * C2 Adjusted Fire Flow rate (L/s)
C2= -25% C2=-25% Non-Combustible, P18
F2= **4056** L/min C2=-15% Limited Combustible, P18
C2=0 Non-residential

Item F, P20) Determine the decrease for automatic sprinkler system protection and standard design
Item 3, P18) (Do not round off the answer)

F3 = F2 *C3 C3=0 Non-Sprinkler
C3= 0% C3=-50% Complete automatic sprinkler System, if the water supply is standard for
F3= **0** L/min both the system and fire department hose lines required, P18
C3=-30% Adequately designed system conforming to NFPA 13 and other NFPA Sprinkler standards

Item G, P20) Determine the increase for structure exposure distance, P18 (Do not round off the answer)
Item 4, p18)

F4 = F2 *C4 Exposure to the other buildings,
C4= 35% C4 = 0% if >45 m
F4= **1420** L/min C4 = 25% (if 0 to 3 m)
C4 = 20% (if 3 to 10 m)
C4 = 15% (if 10 to 20 m)
C4 = 10% (if 20 to 30 m)
C4 = 5% (if 30 to 45 m)
C4=10% (if fire wall), P19

	Exposure	Percentage
Side	Distance (m)	Charge (%)
North	62	0
South	7	20
East	12	15
West	70	0
	Total	35

Item H, P20) Adjust the Fire Flow Value

F5= F2+F3+F4
F5= 5476 L/min
F5= 5000 L/min (Rounded off to nearest 1000 L/min)
F5= **83** L/s

FCFP
Making Life Safety Simple™

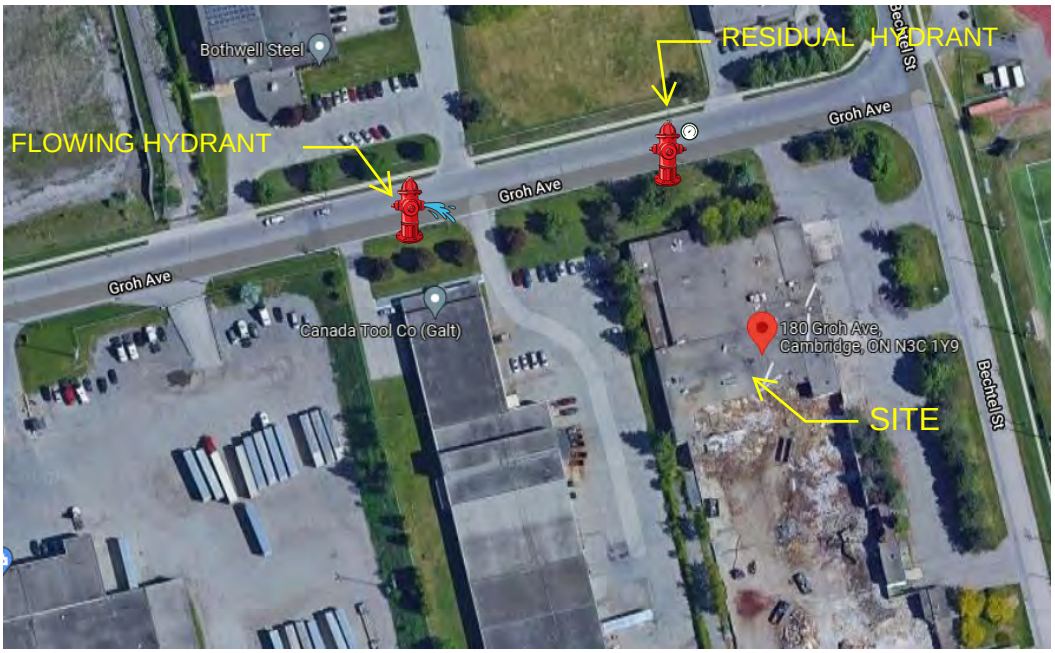
FLOW TEST REPORT

Form SD-003 RevDate: Sep 25, 2020

PROJECT INFORMATION			
Project Name:	180 Groh Ave-Cambridge Flow Test	Const. Project #:	SMC-0002183
Site Address:	180 Groh Ave-Cambridge ON	Design Project #:	2021-FCFP-370
City Contact:	City of Cambridge	Phone #:	519-621-0740
FCFP Contact:	Mike Ruck	Phone #:	519-668-0020
Technical Contact:	Andrew Peach	Phone #:	**226-448-3436**

SITE INFORMATION

SITE MAP



Note: If the main is a dead end, the flowing hydrant shall be closest to the dead end

ITEMS TO LABEL ON MAP	HYDRANTS USED	MAIN SIZE
☑ Static / Residual & Flow Hydrants	☑ City Hydrant(s)	City: 250 mm
☐ Flow Direction (if the main is dead end)	☐ Site Hydrant(s)	Site:

SITE NOTES

HEAD OFFICE
LONDON GTA CAMBRIDGE WINDSOR WINNIPEG
1.800.755.0962 fcfp.ca

FCFP
Making Life Safety Simple™

FLOW TEST REPORT

Form SD-003 RevDate: Sep 25, 2020

TEST INFORMATION			
Minimum Required Flow:	NA	Min Ports:	2
FCFP Personnel Present:	Mike Ruck / Dave Dibben	Test Date:	2021-10-07
City / External Company:	City of Cambridge	Test Time:	8:00pm

TEST EQUIPMENT	
☐ Hose Monsters with built in Pitot	Hose length used:
☐ Hand held pitot gauge	☑ Pollard diffuser elbow with built in Pitot
☐ Other:	

TEST RESULTS

Number of Ports	Outlet Size (IN)	Discharge Coefficient	Pitot Reading (PSI)	Total Flow (GPM)	Static / Residual Pressure (PSI)
0 Ports	STATIC				65
1 Port	2.5	0.9	42	1,088	58
2 Ports	2.5	0.9	26 / 26	1,712	52
3 Ports	2.5	0.9		0	
4 Ports	2.5	0.9		0	
0 Ports	STATIC RE-CHECK				68

TEST NOTES

HYDRAULIC ADJUSTMENTS (FOR OFFICE USE ONLY)			
ADJUSTMENTS FOR HYDRAULIC GRADE LINE (HGL)			
Reservoir HGL (m):		Site Elevation (m):	
Theoretical Static Head (PSI):	0	PSI to subtract from test pressures:	0
OTHER HYDRAULIC ADJUSTMENTS			
Other adjustment as required by the City / AHJ:			

HEAD OFFICE
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