70 Hope Avenue Apartment

Functional Servicing & Stormwater Management Report

Project Location:
70 Hope Avenue, Hamilton, ON

Prepared for:
City of Hamilton
71 Main Street West
Hamilton, Ontario, ON, L8P 4Y5

Prepared by:
MTE Consultants
1016 Sutton Drive, Unit A
Burlington, ON, L7L 6B8

August 01, 2025

MTE File No.: 60939_001
CoH File No.: PED23099(a)/
HSC23028(a)

Engineers, Scientists, Surveyors.

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1.0 INTRODUCTION

1.1 Overview

MTE Consultants Inc. was retained by the City of Hamilton to complete the preliminary site grading, servicing, and stormwater management design for the proposed development located at 70 Hope Avenue in the City of Hamilton (see **Figure 1**). This report will outline a functional servicing and stormwater management strategy for two proposed concepts on the Site in support of a Zoning By-Law Amendment (ZBA) application. These concepts are preliminary, subject to detailed design and refinement.

The site is located on a 0.284ha parcel of land bounded by Hope Avenue to the north, mixed residential with an alley to the west, Brittania Avenue to the south and residential dwellings to the east. The property has two entrances from each respective abutting right-of-ways that will remain, and the site is currently occupied by an asphalt municipal parking lot and has steel parking barriers to the east and wooden fencing to the east. Option 1 considers a 3-storey affordable housing building with 54 units. Option 2 considers two 3-storey townhouse blocks with 30 units combined. Parking will be provided on site for the proposed options via surface (above grade) parking. Existing municipal sanitary, storm sewers and watermain services are located on the abutting right-of-way on Hope Avenue will be utilized to service the proposed development. This report will review the feasibility of both Option 1 and Option 2 from a servicing and stormwater management perspective. For additional details, refer to the separately submitted conceptual engineering drawings.

1.2 Background Information

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

- Ref. 1: *MOE Stormwater Management Practices Planning and Design Manual (Ministry of Environment, March 2003).*
- Ref. 2: *Erosion & Sediment Control Guideline for Urban Construction (December 2006).*
- Ref. 3: *Design Guidelines for Drinking-Water Systems, Ministry of the Environment and Climate Change (2008).*
- Ref. 4: *Design Guidelines for Sewage Works, Ministry of the Environment and Climate Change (2008).*
- Ref. 5: *Ontario Building Code (2024).*
- Ref. 6: *City of Hamilton Development Charges Background Update Study (2024).*
- Ref. 7: *City of Hamilton Comprehensive Development Guidelines and Financial Polices Manual (2025).*

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MTE
Engineers, Scientists, Surveyors

PROJECT

70 HOPE AVENUE AFFORDABLE HOUSING

TITLE

SITE LOCATION PLAN

Drawn	Scale	Figure
MJR	N.T.S.	**1.0**
Checked HZN	Project No. 60939_001	
Date 2025-07-22	Rev No. 0	

Plot Date: July 23, 2025 - 10:48 AM

2.0 SANITARY SEWER SERVICING

2.1 Existing Conditions

There is an existing 300mm diameter sanitary sewer flowing west at approximately 0.60% within the Hope Avenue right-of-way. There is an existing 300mm diameter sanitary service lateral available to the site.

2.2 Proposed Sanitary Discharge

The anticipated sanitary discharge from the proposed development was estimated using City of Hamilton design criteria and the Ontario Building Code (2024) based on the proposed building use. **Table 2.1** provides an estimate of the residential population and the number of units in the building. The City of Hamilton Development Charges Update Study was used to calculate the expected population of the two options provided below.

Table 2.1 – Proposed Population Estimate for Options 1 & 2

Unit Types	Total Number of Units	People per Unit [A]	Population (people) [B]
3-Storey Apartment Building – Option 1			
1-bedroom unit	50	1.342	68
		Total Estimated Population	**68**
3-Storey Townhouse – Option 2			
3-bedroom unit	10	2.637	27
2-bedroom unit	20	2.637	53
		Total Estimated Population	**80**

[A] Population Density based City of Hamilton Development Charges Update Study (March 28, 2024).
[B] Population calculated as (Total # of Units) X (Persons per Unit).

Table 2.2 – Sanitary Sewer Discharge from Site for Options 1 & 2

Land Use	Population (people) [A]	Average Flow (L/s) [B]	Total Peak Flow (L/s) [C]
Residential Apartment Building – Option 1	68	0.28	1.42
Total Peak Sanitary Demand for Site (with infiltration allowance)			**1.48** [D]
Residential Townhouses – Option 2	80	0.33	1.67
Total Peak Sanitary Demand for Site (with infiltration allowance)			**1.73** [D]

[A] See **Table 2.1.**
[B] Average flow based on 360 L/ca/day for residential.
[C] Peak flow = Average Flow*PF, where Babbit Peaking Factor (PF) = $5/P^{0.2}$
$= 5/(58/1000)^{0.2} = 8.84$ (max 5.0)
[D] Total Peak flow with infiltration = Total Peak flow + infiltration allowance
Where infiltration is based on 0.40 l/s/ha. Area reflects site area (0.284 ha), I = 0.40*0.284 = 0.06 L/s

The sanitary sewer discharge rate from the development is summarized in **Table 2.2** and detailed calculations are found in **Appendix A**.

2.3 Proposed Sanitary Servicing Plan

The existing building is serviced by an existing sanitary service lateral that connects to the Hope Avenue sanitary sewer. It is proposed to reuse the existing sanitary service lateral.

Option 1: At the detailed design stage, the existing service lateral will be inspected using CCTV to assess its condition and suitability for re-use. If the lateral is found to be deficient, it will be replaced in accordance with City of Hamilton standards. A backwater valve will also be installed on the sanitary service to prevent potential backflow.

Option 2: The existing service lateral will be decommissioned in accordance with City of Hamilton standards. A new service lateral and sanitary manhole will be installed approximately 10 metres west of the current location on Hope Avenue, along with a control manhole at property line will be installed to accommodate the proposed townhouse development.

3.0 STORMWATER MANAGEMENT

3.1 Stormwater Management Criteria

Based on the City of Hamilton development guidelines and providing a conservative approach, the following stormwater management (SWM) criteria will be applied to the site:

3.1.1 Quantity Control

Attenuation of the post-development peak flows for the 100-year storm event to the 2-year City of Hamilton Mount Hope peak flow rate based on a runoff coefficient of 0.90.

The site has one existing outlet:

1) Hope Avenue 1200mm diameter storm sewer.

The storm sewer accounted for a drainage area of **0.284ha** with a runoff coefficient of 0.90 as majority of the site is impervious. The total allowable flow is calculated using the 2-year City of Hamilton Mount Hope design storm as summarized in the following table. The existing site has been defined as Catchment 101.

Table 3.1 – Allowable Discharge Rate for Site to Hope Avenue Storm Sewer (Catchment 101)

Area [A] A (ha)	Runoff Coefficient [B] C	Rainfall Intensity [C] i (mm/hr)	Total Flow [D] $Q_{allowable}$ (m^3/s)	Allowable Peak Storm Flow [F] (m^3/s)
0.284	0.90	74.10	0.053	**0.053**

[A] Referenced from Site Plan from INVIZIJ Architects Inc. (May 30, 2025).
[B] Runoff coefficient taken from the City of Hamilton Engineering Design Guidelines
[C] Calculated using 2-year Mount Hope IDF parameters, see **Appendix B**.
[D] Q = CiA/360
[E] Refer to **Table 2.2**.
[F] Allowable Peak Storm Flow = $Q_{allowable}$

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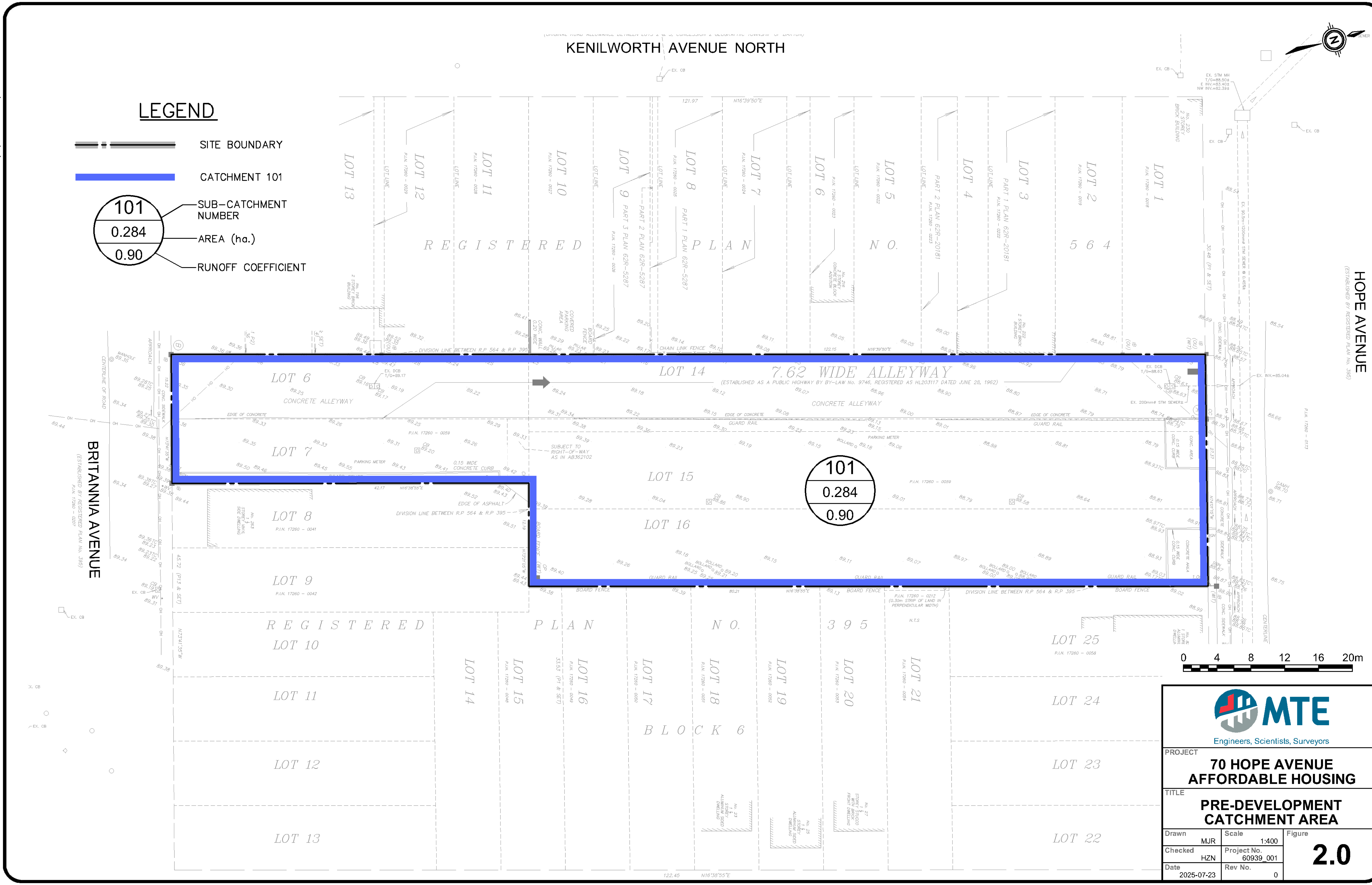

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3.1.2 Quality Control

An enhanced (Level 1) water quality treatment (80% TSS Removal) is required for all impacted surface runoff prior to discharging to the receiving system.

3.2 Existing Conditions

Under existing conditions, majority of the site is comprised of an asphalt parking lot, with a minority of landscape located to the east. The parking lot has catchbasins that collect and convey runoff towards the Hope Avenue right-of-way via an underground piped storm service lateral.

There is an existing 1200mm diameter storm pipe flowing west at approximately 0.45% on Hope Avenue and an existing 300mm diameter storm service into the site to remain. There is an existing 300mm diameter storm pipe flowing east at approximately 1.00% on Brittania Avenue.

3.3 Proposed Conditions

3.3.1 Quantity Control

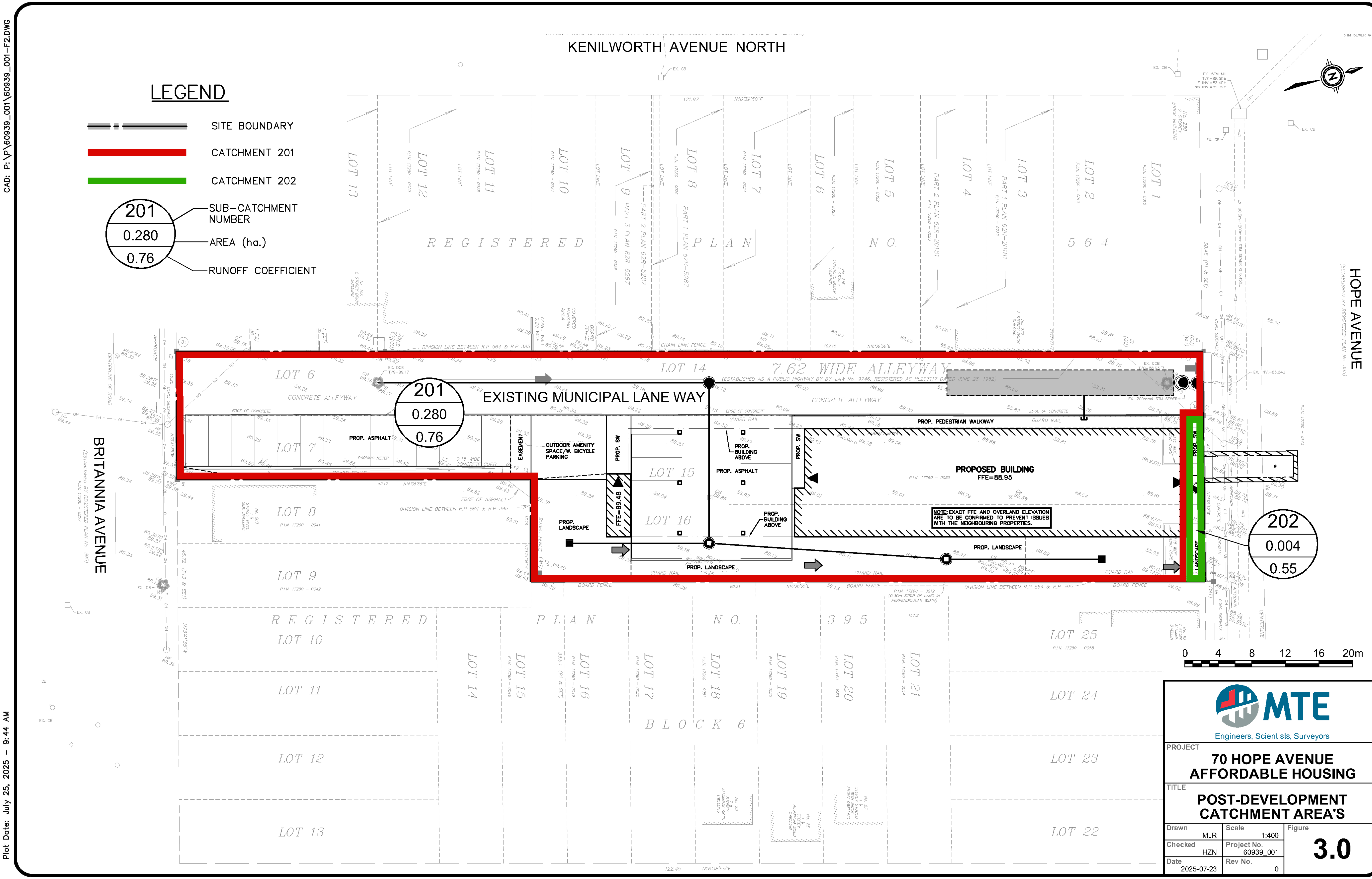
As part of the stormwater management strategy, a conservative approach has been adopted in the preparation of the quantity control calculations. Only Option 1 will be modeled as it results in a higher percent imperviousness under post development conditions than Option 2 and thus represent the worst case storage requirements. The existing municipal laneway will be retained and utilized to provide vehicular access to the building's ground-level parking area. The existing storm sewer connection to Hope Avenue is to remain in place, with a control manhole and oil-grit separator (OGS) proposed at the property line to manage stormwater quality and flow. An amenity area is planned south of the building, and an easement will be required to maintain access to adjacent Lot 8 driveway access.

The proposed conditions have been delineated using two (2) catchment areas. **Table 3.2** provides a brief description of each catchment area as well as the size and impervious cover (runoff coefficient) associated with each. **Figure 3** provides an illustration of the post-development catchment areas. **Appendix B** contains detailed information pertaining to the stormwater management model.

Table 3.2 – Proposed Conditions Catchment Area for Option 1

Catchment ID	Description	Area (ha)	Runoff Coefficient (C)
201	Building Roof, Parking & South Amenity Area (controlled to Hope Avenue)	0.280	0.76
202	Runoff Areas (uncontrolled to Hope Avenue)	0.004	0.55
	Total	**0.284**	**0.76**

Stormwater runoff from Catchment 201 will be collected by a series of roof drains and catch basins which will convey flows to an underground stormwater tank beneath the municipal lane way.



KENILWORTH AVENUE NORTH
HOPE AVENUE
BRITANNIA AVENUE
LEGEND
SITE BOUNDARY
CATCHMENT 201
CATCHMENT 202
SUB-CATCHMENT NUMBER
AREA (ha.)
RUNOFF COEFFICIENT
201
0.280
0.76
202
0.004
0.55
EXISTING MUNICIPAL LANE WAY
7.62 WIDE ALLEYWAY
PROPOSED BUILDING
FFE=88.95
PROP. PEDESTRIAN WALKWAY
PROP. ASPHALT
PROP. LANDSCAPE
PROP. BUILDING ABOVE
OUTDOOR AMENITY SPACE/W. BICYCLE PARKING
NOTE: EXACT FFE AND OVERLAND ELEVATION ARE TO BE CONFIRMED TO PREVENT ISSUES WITH THE NEIGHBOURING PROPERTIES.
REGISTERED PLAN NO. 564
REGISTERED PLAN NO. 395
BLOCK 6
0 4 8 12 16 20m
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Plot Date: July 25, 2025 - 9:44 AM
MTE
Engineers, Scientists, Surveyors
PROJECT
70 HOPE AVENUE AFFORDABLE HOUSING
TITLE
POST-DEVELOPMENT CATCHMENT AREA'S
Drawn MJR
Scale 1:400
Figure 3.0
Checked HZN
Project No. 60939_001
Date 2025-07-23
Rev No. 0

The runoff coefficient for Concept 1 (Building) was calculated as C = 0.76, while Concept 2 (Townhouse) yielded a slightly lower value of C = 0.71. To maintain a conservative design approach, the higher coefficient from Concept 1 was used in the calculation of the required underground storage volume. The underground tank will include an orifice-controlled outlet. The grading of the site will allow emergency overflow towards abutting Hope Avenue municipal right-of-way.

The required storage volume for the underground stormwater tank was determined using the Modified Rational Method. **Table 3.3** and **Table 3.4** summarize the stage-storage-discharge relationship of the proposed Storm Tank with the provided orifice control.

Table 3.3 – Stage-Storage-Discharge Calculations for Underground Storm Tank Option 1

Elevation (m)	Head, H (m)	Cumulative Storage Volume (m^3)[A]	Discharge Q (m^3/s)[B]	Comments
86.39	0.000	0.00	0.0000	Orifice Invert
86.47	0.000	0.00	0.0000	C/L of Orifice
86.50	0.030	0.00	0.0085	Tank Outlet Invert
87.06	0.590	37.89	0.0379	Top of Tank
87.36	0.895	47.76	0.0466	Top of Stone (Max Head)

[A] Storage volume based on Brentwood ST-24 tanks. See Appendix B and drawing C2.2 for more details.
[B] From orifice equation $Q = CA(2gH)^{0.5}$ for a 150 mm diameter orifice plate.
Where: C = 0.63, A=cross-sectional area, g=9.81, H=pressure head

Table 3.4 summarizes the proposed conditions site peak discharge rates for the site with the aforementioned stormwater management controls and compares them to allowable discharge rate.

Table 3.4 – Proposed Conditions Peak Discharge Rate (Total Site)

Storm Event	Post-Development Conditions			
	Catchment 201 [controlled] (m^3/s) [A]	Catchment 202 [uncontrolled] (m^3/s) [B]	Total Peak Storm Discharge Rate from the Site (m^3/s)	Allowable Site Peak Storm Flow (m^3/s) [C]
100-yr	0.047	<0.001	**0.047**	0.053

[A] See **Table 3.3**. Max flow through orifice.
[B] Calculated via Rational Method. See **Appendix B**.
[C] See **Table 3.1**.

Table 3.5 – Proposed Conditions Storage Volume Requirements

Storage Event	Underground Storm Tank	
	Active Storage Volume Req. [A] (m^3)	Active Storage Volume Provided (m^3) [B]
100-yr	47.44	47.76

[A] Storage volume calculated using Modified Rational method (see **Appendix B**).
[B] See **Table 3.3**.

3.3.2 Water Quality Control

A treatment train approach has been proposed to provide an enhanced (Level 1) water quality treatment (80% TSS Removal). This has been achieved through the tank debris isolator row and in series with an oil/grit separator (OGS).

Water quality control for the site will be provided by a debris isolator row within the underground storm tank and in the oil-grit separator as part of a treatment train approach. From testing reports for the debris, the following total suspended solids (TSS) removal efficiencies have been applied:

- Tank debris isolator row – 95% (see **Appendix B**).
- Oil-grit separator EFO4 – 92% (Maximum 60% Credit achieved as per City Guidelines (see **Appendix B**).

Catchment 201 will receive water quality treatment. Catchment 202 will not require water quality treatment as it is landscaped or walkway surfaces producing inherently clean runoff. The amount of asphalt surface area for the development is small and thus the total sediment loading will be minimal.

Table 3.6 – Quality Control (TSS Removal)

Catchment Number [A]	Treatment Area (ha) [A]	Treatment Method	Total TSS Removal [B]	TSS Removal Requirement [C]
201	0.280	Debris Row	95%	
201	0.280	Oil-Grit Separator	60%	
TOTAL	**0.280**		**97%**	**80%**

[A] Refer to **Figure 3**.
[B] Refer to **Appendix B**.
[C] Refer to **Appendix D**.

3.4 Sediment and Erosion Control

Sediment and erosion control measures will be implemented on site during construction and will conform to the Erosion & Sediment Control Guideline for Urban Construction and City of Hamilton Standards.

Sediment and erosion control measures will include:

- Installation of silt control fencing at strategic locations around the perimeter of the site where feasible.
- Preventing silt or sediment laden water from entering inlets (catch basins / catch basin manholes) by wrapping their tops with filter fabric or installing silt sacks.
- Construction of a mud mat at the exit from the site and the proposed drive aisle to Hope Avenue to mitigate the transportation of sediments to the surrounding roads.
- Maintaining sediment and erosion control structures in good repair (including periodic cleaning as required) until such time that the Engineer or City of Hamilton approves their removal. Erosion control measures to be inspected daily and after any rainfall event.

4.0 DOMESTIC AND FIRE WATER SUPPLY SERVICING

4.1 Existing Conditions

The existing municipal water distribution system around the site consists of a 150mm diameter watermain within the Hope Street right-of-way. There is an existing fire hydrant located across the site on 87 Hope Avenue and another located at 145 Hope Avenue. Hydrant flow testing was performed on April 14th 2025 and Hydrant Flow Test Report is attached in **Appendix C**.

4.2 Domestic Water Demands

The expected domestic water demands for the proposed development options were estimated using City of Hamilton design criteria. **Table 4.1** summarizes the domestic water demand requirements for the Average Day, Maximum Day and Peak Hour demand scenarios and detailed calculations are provided in **Appendix C**. It should be noted that average day peak factor is 1.0, the max day peak factor is 1.9 and the peak hour factor is 3.0 in accordance with City of Hamilton standards.

Table 4.1 – Domestic Water Demands for Options 1 & 2

Apartment Building Demands – Option 1		
Population:	68 people (see Table 3.1)	
Average Day Demand:	360 L/c/d x 68 people =	0.283 L/s
Maximum Day Demand:	1.9 x 0.283 L/s =	0.538 L/s
Peak Hour Demand:	3.0 x 0.283 L/s =	0.850 L/s
Townhouse Demands – Option 2		
Population:	80 people (see Table 3.1)	
Average Day Demand:	360 L/c/d x 80 people =	0.333 L/s
Maximum Day Demand:	1.9 x 0.333 L/s =	0.633 L/s
Peak Hour Demand:	3.0 x 0.333 L/s =	1.000 L/s

4.3 Fire Flow Demands

Fire flow demands for the proposed development were determined using the Ontario Building Code (OBC 2023) guidelines. The fire demands are summarized in **Table 4.2** and detailed calculations are provided in Appendix C.

Building Classification: Group D (To be confirmed at the Site Plan phase)

- Q = KVStot (Tables 1 & 2 of OBC 2012 Appendix A-3.2.5.7)

K = water supply coefficient (A-3.2.5.7 Table 1)

V = volume of building (m3)

Stot = 1 + total spatial coefficients

The fire demands for the proposed options are summarized in **Table 4.2**, **Figure 4** and detailed calculations are provided in **Appendix C**.

Table 4.2 – OBC Fire Flow Requirements

Building Type	Building Volume (m^3)	K	S_{tot}	Q (L)	Required Min. Water Supply Flow Rate (L/s)
3-Storey Apartment Building – Option 1	6,487	18	1.71	199,214	105 (6300 L/min)
Ultimate Maximum Day + Fire Flow [A]					150.54 L/s (9032 L/min)
3-Storey Townhouse – Option 2	5,828	18	1.39	145,816	75 (4500 L/min)
Ultimate Maximum Day + Fire Flow [A]					150.63 L/s (9038 L/min)
[A] Target AFF of 150 (L/s) for residential multi (greater than 3 units) taken from City of Hamilton Required Fire Flow form and OBC Fire Flow spreadsheet in Appendix C					

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PROJECT
70 HOPE AVENUE AFFORDABLE HOUSING

TITLE
BUILDING SEPARATION DISTANCES MAP

Drawn	Scale	Figure
MJR	N.T.S.	**4.0**
Checked HZN	Project No. 60939_001	
Date 2025-07-22	Rev No. 0	

Plot Date: July 23, 2025 - 4:38 PM

4.4 Proposed Water Servicing Plan

Water servicing for the site will include a proposed 150mm watermain teed off the existing 150mm diameter watermain on Hope Avenue to service for the proposed building in option 1 and 2.

For the building option 1, the proposed watermain will be split at property line into dual 100mm diameter domestic and 150mm diameter fire service into the building. A proposed water meter and backflow preventor is provided at the building for the domestic service, and a backflow preventor proposed for the fire service. Refer to **Drawing C2.2** for further details.

For the townhouse in option 2, the proposed 150mm watermain will be extended and teed off the 150mm watermain in Hope Avenue with a water chamber located on the private side of the property line. The watermain will then continue into the site with a fire hydrant at the end. The townhouse units will be serviced with the extended watermain and connected using tapping sleeve and valves.

Hydrant coverage for the site will be provided by the existing municipal hydrant located on Hope Avenue and inside the private site. All building's fire department connections will be within 45m of one of the aforementioned fire hydrants for sprinklered buildings and within 90m for non sprinklered buildings.

Hydrant flow testing on municipal hydrants along Hope Avenue was conducted by L&D Waterworks Inc. on April 14, 2025. The test results recorded a static pressure of 65 psi, with residual pressures of 60 psi and 55 psi. At 20 psi, the available flow was approximately 3476 US gallons per minute (GPM), which significantly exceeds the required fire flow for the area.

According to City standards, the minimum required fire flow is 75 L/s for existing single-family residential buildings and 150 L/s for the proposed development. The test results confirm that the existing watermain infrastructure is capable of maintaining sufficient pressure and flow to meet both the current and future fire protection requirements. Refer to Appendix C for hydrant flow results.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the information provided herein, it is concluded that the development can be constructed to meet the requirements of the City of Hamilton as detailed below.

i. Sanitary servicing can be provided via the existing service lateral to the Hope Avenue sanitary sewer. The service lateral will be CCTV inspected during the detailed design stage to confirm re-use potential. If the lateral is in poor condition, it will be replaced.

ii. Stormwater management will be provided via the underground storage tank and orifice to control the 100-year peak flow to the allowable release rate.

iii. Water servicing will be provided via a new connection to the existing Hope Avenue watermain. Hydrant coverage for the building will be provided via existing municipal hydrants and coverage for the townhouse will be provided by an on-site hydrant.

iv. Detailed design of the preferred concept be completed during SPA/Building Permit stage to refine the calculations and assumptions presented within this report.

We trust the information enclosed herein is satisfactory. Should you have any questions please do not hesitate to contact our office.

All of which is respectfully submitted,

MTE Consultants Inc.

Hasan Zubair, C.E.T.
Project Manager
905-639-2552
HZubair@mte85.com

Andrei Sawatsky, P.Eng.
Manager, Site Development Division(Interim)
519-743-6500
ASawatsky@mte85.com

HZN:axs

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Appendix A

Wastewater Calculations

MTE

70 Hope Avenue
City of Hamilton
Project No: 60939_001
Date: July 2025
By: HZN

Sanitary Demand Calculations for Options 1 & 2

Location	Residential			Total		
	Units [5]	Population Density [1]	Population (persons)	Total Demand (L/s)	Total Peaked Demand [4] (L/s)	Total Peaked Demand +Infiltration [6] (L/s)
Option 1						
Residential (3-Storey Apartment Building)						
1-Bedroom	50	1.342	68	0.28	1.42	
Totals	**50**		**68**	**0.28**	**1.42**	**1.48**
Option 2						
Residential (3-Storey Townhouses)						
3-Bedroom	10	2.637	27	0.11	0.56	
2-Bedroom	20	2.637	53	0.22	1.10	
Totals	**30**		**80**	**0.33**	**1.67**	**1.73**

Sanitary Demand [2]		
Residential Daily Demands	360	L/ca/day
	0.0042	L/ca/sec
Babbit Peaking Factor [3]	5.0	
Site Area	0.158	ha
Infiltration Allowance	0.4	L/s/ha
Site Infiltration	0.06	L/s

Note 1: Population Density based City of Hamilton Development Charges Update Study (December 21, 2023)
Note 2: Residential Demand based on City of Hamilton Design Guidelines Section E.1.4.
Note 3: Calculated as Total Demand x Peak Factor, (Babbit Peaking Factor PF = $5/P^{0.2}$)
Note 4: Infiltration allowance from City of Hamilton Design Criteria.
Note 5: Unit info provided by Invizij Architects Inc. dated May 30, 2025

Schedule 5
City of Hamilton
10-Year Growth Forecast
Late 2023 to Late 2033

			Population
Late 2023 Population			591,714
Occupants of New Housing Units, Late 2023 to Late 2033	*Units (2)*	35,226	
	multiplied by P.P.U. (3)	2.517	
	gross population increase	88,651	88,651
Occupants of New Equivalent Institutional Units, Late 2023 to Late 2033	*Units*	888	
	multiplied by P.P.U. (3)	1.100	
	gross population increase	976	976
Decline in Housing Unit Occupancy, Late 2023 to Late 2033	*Units (4)*	232,149	
	multiplied by P.P.U. decline rate (5)	-0.118	
	total decline in population	-27,491	-27,491
Population Estimate to Late 2033			653,850
Net Population Increase, Late 2023 to Late 2033			*62,136*

(1) Late 2023 Population based on:

2021 Population (569,353) + Mid 2016 to Late 2023 estimated housing units to beginning of forecast period (9,344 x 2.316 = 21,639) + (215 x 1.1 = 236) + (222,805 x 0.002 = 486) = 591,714

(2) Based upon forecast building permits/completions assuming a lag between construction and occupancy.

(3) Average number of persons per unit (P.P.U.) is assumed to be:

Structural Type		Persons Per Unit[1] (P.P.U.)	% Distribution of Estimated Units[2]	Weighted Persons Per Unit Average
Singles & Semi Detached		3.533	28%	0.986
Multiples (6)		2.637	32%	0.835
Apartments (7)		1.721	40%	0.696
one bedroom or less	1.342			
two bedrooms or more	2.166			
Total			100%	2.517

[1] Persons per unit based on adjusted Statistics Canada Custom 2021 Census database.

[2] Forecast unit mix based upon historical trends and housing units in the development process.

(4) Late 2023 households based upon 2016 Census (222,805 units) + Mid 2016 to Late 2023 unit estimate (9,344 units) = 232,149 units.

(5) Decline occurs due to aging of the population and family life cycle changes, lower fertility rates and changing economic conditions.

(6) Includes townhouses and apartments in duplexes.

(7) Includes bachelor, 1-bedroom and 2-bedroom+ apartments.

Note: Numbers may not add to totals due to rounding.

Appendix B

Stormwater Management Calculations

70 HOPE AVENUE
CITY OF HAMILTON
STORMWATER MANAGEMENT RATIONAL METHOD - EXISTING
ALLOWABLE RELEASE RATES

Design Storm Information

Intensity-Duration-Frequency (IDF) equations for the City of Hamilton [A] in the form:

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

Where: i = Rainfall intensity (mm/hr)
t_c = Time of concentration in minutes (5min)
A, B and C = Constant (see below)

The value of the parameters for the various storm events is provided below:

Constant	2-Yr.	5-Yr.	10-Yr.	25-Yr.	50-Yr.	100-Yr.
A	646.0	1049.5	1343.7	1719.5	1954.8	2317.4
B	6.0	8.0	9.0	10.0	10.0	11.0
C	0.781	0.803	0.814	0.823	0.826	0.836
Antecedant run-off factor						
Rainfall, i (mm/hr)	74.10	103.04	122.29	146.10	164.61	181.81
Runoff Rate Q (m3/s)						
Catchment 101 (uncontrolled)	0.053	0.073	0.087	0.104	0.117	0.129
Catchment 202 (uncontrolled)	0.000	0.001	0.001	0.001	0.001	0.001
Total	0.053	0.073	0.087	0.104	0.117	0.129

[A] IDF Parameters - Mount Hope Table 2.1 from City of Hamilton's Comprehensive Development Guidelines and Financial Policies Manual (2019)

Note: IDF equations used to generate rainfall files with Duration (TD) = 3 hours

70 HOPE AVENUE
CITY OF HAMILTON
MODIFIED RATIONAL STORM WATER STORAGE REQUIREMENTS
OPTION 1: TANK

Chicago Storm Rainfall Information		
City/Town:	**Hamilton**	
Return Period:	**100**	Years
A =	**2317**	
B =	**11**	
C =	**0.84**	
Tc =	**10**	minutes
	600	seconds

Area of site being investigated (ha) = **0.280** (Catchment 201)
Composite Runoff Coeff. (C) = **0.76**
Allowable Release Rate - Q_{ALLOW} (m^3/s) = **0.053** ($Q_{Allow} = Q_{101} - Q_{202}$)

Flows from site area calculated from

Roof flows (Q_{ROOF}) added in as a constant flow rate

Duration (T_D)		Rainfall Intensity		Post-Development Runoff Site	Roof	Total "Q_{POST}"	Runoff Volume	Release Volume	Storage Volume
(min)	(sec)	(mm/hr)	(m/s)	(m^3/s)	(m^3/s)	(m^3/ha)	(m^3)	(m^3)	(m^3)
5	300	228.222	0.0000634	0.135	0.00000	0.1349	40.47	23.69	16.78
10	600	181.813	0.0000505	0.107	0.00000	0.1075	64.48	31.59	32.89
15	900	152.084	0.0000422	0.090	0.00000	0.0899	80.91	39.49	41.42
20	1200	131.287	0.0000365	0.078	0.00000	0.0776	93.13	47.39	45.74
25	1500	115.860	0.0000322	0.068	0.00000	0.0685	102.73	55.29	47.44
30	1800	103.923	0.0000289	0.061	0.00000	0.0614	110.57	63.18	47.39
35	2100	94.392	0.0000262	0.056	0.00000	0.0558	117.17	71.08	46.09
40	2400	86.591	0.0000241	0.051	0.00000	0.0512	122.84	78.98	43.86
45	2700	80.078	0.0000222	0.047	0.00000	0.0473	127.81	86.88	40.93
50	3000	74.553	0.0000207	0.044	0.00000	0.0441	132.21	94.77	37.43
55	3300	69.801	0.0000194	0.041	0.00000	0.0413	136.16	102.67	33.49
60	3600	65.667	0.0000182	0.039	0.00000	0.0388	139.74	110.57	29.17
65	3900	62.036	0.0000172	0.037	0.00000	0.0367	143.01	118.47	24.54
70	4200	58.818	0.0000163	0.035	0.00000	0.0348	146.02	126.37	19.66
75	4500	55.945	0.0000155	0.033	0.00000	0.0331	148.81	134.26	14.55
80	4800	53.363	0.0000148	0.032	0.00000	0.0315	151.41	142.16	9.25
85	5100	51.030	0.0000142	0.030	0.00000	0.0302	153.84	150.06	3.78
90	5400	48.909	0.0000136	0.029	0.00000	0.0289	156.12	157.96	-1.84
95	5700	46.973	0.0000130	0.028	0.00000	0.0278	158.27	165.86	-7.59
100	6000	45.197	0.0000126	0.027	0.00000	0.0267	160.30	173.75	-13.45
105	6300	43.563	0.0000121	0.026	0.00000	0.0258	162.23	181.65	-19.42
110	6600	42.053	0.0000117	0.025	0.00000	0.0249	164.06	189.55	-25.49
115	6900	40.653	0.0000113	0.024	0.00000	0.0240	165.81	197.45	-31.64
120	7200	39.352	0.0000109	0.023	0.00000	0.0233	167.48	205.35	-37.87
125	7500	38.138	0.0000106	0.023	0.00000	0.0225	169.08	213.24	-44.16
130	7800	37.004	0.0000103	0.022	0.00000	0.0219	170.62	221.14	-50.53
135	8100	35.942	0.0000100	0.021	0.00000	0.0212	172.09	229.04	-56.95
140	8400	34.944	0.0000097	0.021	0.00000	0.0207	173.51	236.94	-63.43
145	8700	34.005	0.0000094	0.020	0.00000	0.0201	174.88	244.83	-69.96
150	9000	33.120	0.0000092	0.020	0.00000	0.0196	176.20	252.73	-76.53
155	9300	32.284	0.0000090	0.019	0.00000	0.0191	177.48	260.63	-83.15
160	9600	31.493	0.0000087	0.019	0.00000	0.0186	178.71	268.53	-89.82
165	9900	30.743	0.0000085	0.018	0.00000	0.0182	179.91	276.43	-96.52
170	10200	30.032	0.0000083	0.018	0.00000	0.0178	181.07	284.32	-103.25
175	10500	29.355	0.0000082	0.017	0.00000	0.0174	182.20	292.22	-110.02
180	10800	28.712	0.0000080	0.017	0.00000	0.0170	183.29	300.12	-116.83

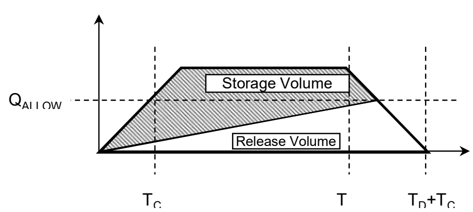
Max. required storage volume = **47.44 m^3**

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

Runoff Volume = Area under trapezoidal hydrograph
= $(T_D - T_C)Q_{POST} + (T_C\ Q_{POST})$

Release Volume = Area under triangular outflow hydrograph
= $½ (T_D + T_C)\ Q_{ALLOW}$

Storage Volume = Runoff Volume - Release Volume



70 HOPE AVENUE
CITY OF HAMILTON
STORMWATER MANAGEMENT
OPTION 1: TANK Stage Storage Discharge Curve

Outlet Device No. 1 (Quantity)	
Type:	Orifice Plate
Diameter (mm)	150
Area (m^2)	0.01767
Invert Elev. (m)	86.39
C/L Elev. (m)	86.47
Disch. Coeff. (C_d)	0.63
Discharge (Q) =	$C_d A (2 g H)^{0.5}$
Number of Orifices:	1

Description	Elevation	SWM Storage Volumes			Outlet No. 1		Total
	m	Area m^2	Increm. Volume m^3	Cumulative Volume m^3	Head m	Discharge m^3/s	Discharge m^3/s
Orifice Invert	86.39	-	0	0.00	0.000	0.0000	0.0000
CL of orifice	86.47	-	0	0.00	0.000	0.0000	0.0000
Tank Outlet Invert	86.50	-	0	0.00	0.030	0.0085	0.0085
Top of Tank	87.06	-	38	37.89	0.590	0.0379	0.0379
Top of Stone	87.36	-	10	47.76	0.895	0.0466	0.0466

70 HOPE AVENUE
CITY OF HAMILTON
STORMWATER MANAGEMENT
OPTION 1: TANK VOLUME CALCULATIONS

Tank-1 (Catchment 201)		
Single Stack of Brentwood ST-24		
Height	0.61	m
Void Space Volume	96.0%	
System Length	27.0	m
System Width	3.0	m
System Footprint	81.0	sq.m
Module Footprint	63.4	sq.m
Module Unit Footprint	0.42	sq.m
Volume per unit	0.244818	m^3
Total Number of Tanks	151	Units
Storage Volume (Net)	36.97	m^3
Volume of Top Stone	9.9	m^3
Volume of Side Stone	4.3	m^3
*Void Ratio = 0.4, exclude bottom stone		
Total Volume Provided	51.15	m^3
Bottom of Tank Elevation	86.45	m
Tank Outlet	86.50	m
Top of Tank Elevation	87.06	m
Top of Stone	87.36	m
Dead Storage Volume	**3.38**	m^3
Active Storage Volume	**47.76**	m^3

70 HOPE AVENUE
CITY OF HAMILTON
MODIFIED RATIONAL STORM WATER STORAGE REQUIREMENTS
OPTION 2: TANK

Chicago Storm Rainfall Information		
City/Town:	**Hamilton**	
Return Period:	**100**	Years
A =	**2317**	
B =	**11**	
C =	**0.84**	
Tc =	**10**	minutes
	600	seconds

Area of site being investigated (ha) = **0.278** (Catchment 201)
Composite Runoff Coeff. (C) = **0.71**
Allowable Release Rate - Q_{ALLOW} (m^3/s) = **0.053** ($Q_{Allow} = Q_{101} - Q_{202}$)

Flows from site area calculated from

Roof flows (Q_{ROOF}) added in as a constant flow rate

Duration (T_D)		Rainfall Intensity		Post-Development Runoff Site	Post-Development Runoff Roof	Post-Development Runoff Total "Q_{POST}"	Runoff Volume	Release Volume	Storage Volume
(min)	(sec)	(mm/hr)	(m/s)	(m^3/s)	(m^3/s)	(m^3/ha)	(m^3)	(m^3)	(m^3)
5	300	228.222	0.0000634	0.125	0.00000	0.1251	37.54	23.69	13.84
10	600	181.813	0.0000505	0.100	0.00000	0.0997	59.81	31.59	28.22
15	900	152.084	0.0000422	0.083	0.00000	0.0834	75.05	39.49	35.56
20	1200	131.287	0.0000365	0.072	0.00000	0.0720	86.38	47.39	38.99
25	1500	115.860	0.0000322	0.064	0.00000	0.0635	95.28	55.29	40.00
30	1800	103.923	0.0000289	0.057	0.00000	0.0570	102.56	63.18	39.38
35	2100	94.392	0.0000262	0.052	0.00000	0.0518	108.68	71.08	37.60
40	2400	86.591	0.0000241	0.047	0.00000	0.0475	113.94	78.98	34.96
45	2700	80.078	0.0000222	0.044	0.00000	0.0439	118.54	86.88	31.67
50	3000	74.553	0.0000207	0.041	0.00000	0.0409	122.63	94.77	27.85
55	3300	69.801	0.0000194	0.038	0.00000	0.0383	126.29	102.67	23.62
60	3600	65.667	0.0000182	0.036	0.00000	0.0360	129.61	110.57	19.04
65	3900	62.036	0.0000172	0.034	0.00000	0.0340	132.65	118.47	14.18
70	4200	58.818	0.0000163	0.032	0.00000	0.0322	135.44	126.37	9.08
75	4500	55.945	0.0000155	0.031	0.00000	0.0307	138.03	134.26	3.77
80	4800	53.363	0.0000148	0.029	0.00000	0.0293	140.44	142.16	-1.72
85	5100	51.030	0.0000142	0.028	0.00000	0.0280	142.69	150.06	-7.37
90	5400	48.909	0.0000136	0.027	0.00000	0.0268	144.80	157.96	-13.15
95	5700	46.973	0.0000130	0.026	0.00000	0.0258	146.80	165.86	-19.06
100	6000	45.197	0.0000126	0.025	0.00000	0.0248	148.68	173.75	-25.07
105	6300	43.563	0.0000121	0.024	0.00000	0.0239	150.47	181.65	-31.18
110	6600	42.053	0.0000117	0.023	0.00000	0.0231	152.17	189.55	-37.38
115	6900	40.653	0.0000113	0.022	0.00000	0.0223	153.79	197.45	-43.65
120	7200	39.352	0.0000109	0.022	0.00000	0.0216	155.34	205.35	-50.00
125	7500	38.138	0.0000106	0.021	0.00000	0.0209	156.83	213.24	-56.42
130	7800	37.004	0.0000103	0.020	0.00000	0.0203	158.25	221.14	-62.89
135	8100	35.942	0.0000100	0.020	0.00000	0.0197	159.62	229.04	-69.42
140	8400	34.944	0.0000097	0.019	0.00000	0.0192	160.94	236.94	-76.00
145	8700	34.005	0.0000094	0.019	0.00000	0.0186	162.21	244.83	-82.63
150	9000	33.120	0.0000092	0.018	0.00000	0.0182	163.43	252.73	-89.30
155	9300	32.284	0.0000090	0.018	0.00000	0.0177	164.62	260.63	-96.01
160	9600	31.493	0.0000087	0.017	0.00000	0.0173	165.76	268.53	-102.77
165	9900	30.743	0.0000085	0.017	0.00000	0.0169	166.87	276.43	-109.55
170	10200	30.032	0.0000083	0.016	0.00000	0.0165	167.95	284.32	-116.37
175	10500	29.355	0.0000082	0.016	0.00000	0.0161	169.00	292.22	-123.23
180	10800	28.712	0.0000080	0.016	0.00000	0.0157	170.01	300.12	-130.11

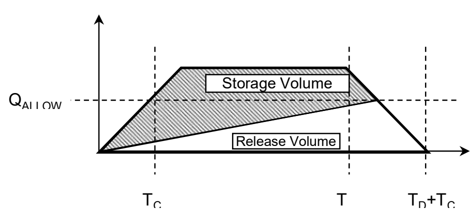
Max. required storage volume = **40.00 m^3**

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

Runoff Volume = Area under trapezoidal hydrograph
= $(T_D - T_C)Q_{POST} + (T_C\ Q_{POST})$

Release Volume = Area under triangular outflow hydrograph
= $½\ (T_D + T_C)\ Q_{ALLOW}$

Storage Volume = Runoff Volume - Release Volume



70 HOPE AVENUE
CITY OF HAMILTON
STORMWATER MANAGEMENT
OPTION 2: TANK Stage Storage Discharge Curve

Outlet Device No. 1 (Quantity)	
Type:	Orifice Plate
Diameter (mm)	150
Area (m^2)	0.01767
Invert Elev. (m)	86.39
C/L Elev. (m)	86.47
Disch. Coeff. (C_d)	0.63
Discharge (Q) =	$C_d A (2 g H)^{0.5}$
Number of Orifices:	1

Description	Elevation	SWM Storage Volumes			Outlet No. 1		Total
	m	Area m^2	Increm. Volume m^3	Cumulative Volume m^3	Head m	Discharge m^3/s	Discharge m^3/s
Orifice Invert	86.39	-	0	0.00	0.000	0.0000	0.0000
CL of orifice	86.47	-	0	0.00	0.000	0.0000	0.0000
Tank Outlet Invert	86.50	-	0	0.00	0.030	0.0085	0.0085
Top of Tank	87.06	-	32	32.18	0.590	0.0379	0.0379
Top of Stone	87.36	-	8	40.59	0.895	0.0466	0.0466

70 HOPE AVENUE
CITY OF HAMILTON
STORMWATER MANAGEMENT
OPTION 2: TANK VOLUME CALCULATIONS

Tank-1 (Catchment 201)		
Single Stack of Brentwood ST-24		
Height	0.61	m
Void Space Volume	96.0%	
System Length	23.0	m
System Width	3.0	m
System Footprint	69.0	sq.m
Module Footprint	53.8	sq.m
Module Unit Footprint	0.42	sq.m
Volume per unit	0.244818	m^3
Total Number of Tanks	128	Units
Storage Volume (Net)	31.34	m^3
Volume of Top Stone	8.4	m^3
Volume of Side Stone	3.7	m^3
*Void Ratio = 0.4, exclude bottom stone		
Total Volume Provided	43.47	m^3
Bottom of Tank Elevation	86.45	m
Tank Outlet	86.50	m
Top of Tank Elevation	87.06	m
Top of Stone	87.36	m
Dead Storage Volume	**2.87**	m^3
Active Storage Volume	**40.59**	m^3

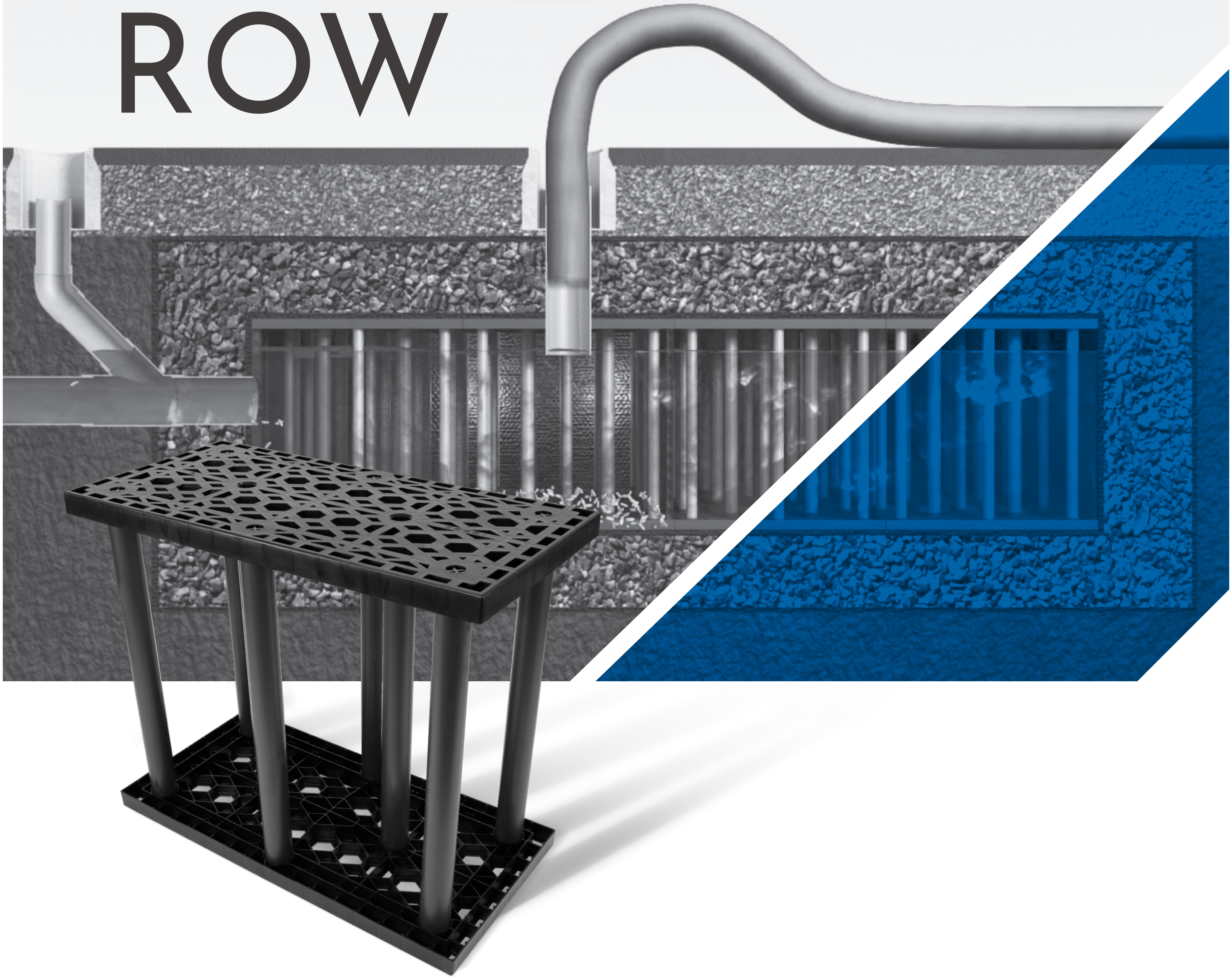
QUALITY CONTROL (TSS Removal Treatment Train)

70 Hope Ave - Option 1 (Building)

Treatment Area (201)	0.280
Tank debris row	0.95
Oil-Grit Separator	0.60
Total	**98%**
Uncontrolled Area (203)	0.004
Total	**0%**
Total catchment area	0.284
Total Site TSS removal	**97%**

STORMWATER TREATMENT

DEBRIS ROW



STORMTANK®
Expect Results™

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CONTENT

GENERAL NOTES

1. Brentwood recommends that the installing contractor contact either Brentwood or the local distributor prior to installation of the system to schedule a pre-construction meeting. This meeting will ensure that the installing contractor has a firm understanding of the installation instructions.
2. All systems must be designed and installed to meet or exceed Brentwood's minimum requirements. Although Brentwood offers support during the design, review, and construction phases of the Module system, it is the ultimate responsibility of the Engineer of Record to design the system in full compliance with all applicable engineering practices, laws, and regulations.
3. Brentwood requires a minimum cover of 24" (610 mm) and/or a maximum Module invert of 11' (3.35 m). Additionally, a minimum 6" (152 mm) leveling bed, 12" (305 mm) side backfill, and 12" (305 mm) top backfill are required on every system.
4. Brentwood recommends a minimum bearing capacity and subgrade compaction for all installations. If site conditions are found not to meet any design requirements during installation, the Engineer of Record must be contacted immediately.
5. All installations require a minimum two layers of geotextile fabric. One layer is to be installed around the Modules, and another layer is to be installed between the stone/soil interfaces.
6. Stone backfilling is to follow all requirements of the most current installation instructions.
7. The installing contractor must apply all protective measures to prevent sediment from entering the system during and after installation per local, state, and federal regulations.
8. The StormTank® Module carries a Limited Warranty, which can be accessed at www.stormtank.com.

1.0 DEBRIS ROW SIZING

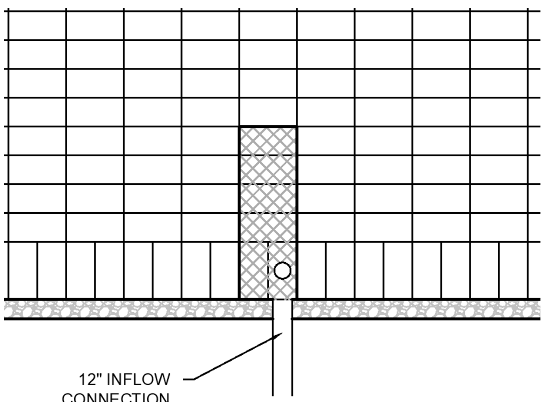
The Debris Row gathers debris and sediment in a section of modules. The Debris Row size is determined by the flow rate of the inflow connection to the system. Observation/cleanout ports are to be installed with a minimum of one port at the inflow pipe location. Based upon Debris Row size and shape, additonal ports may be required.

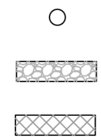
StormTank Module Count = Q / (F * 0.059933)

Q = Treatment Flow Rate
F = Module Footprint = 4.5 sf

EXAMPLE:
5.5618 Modules = 1.5 CFS / (4.5*0.059933)

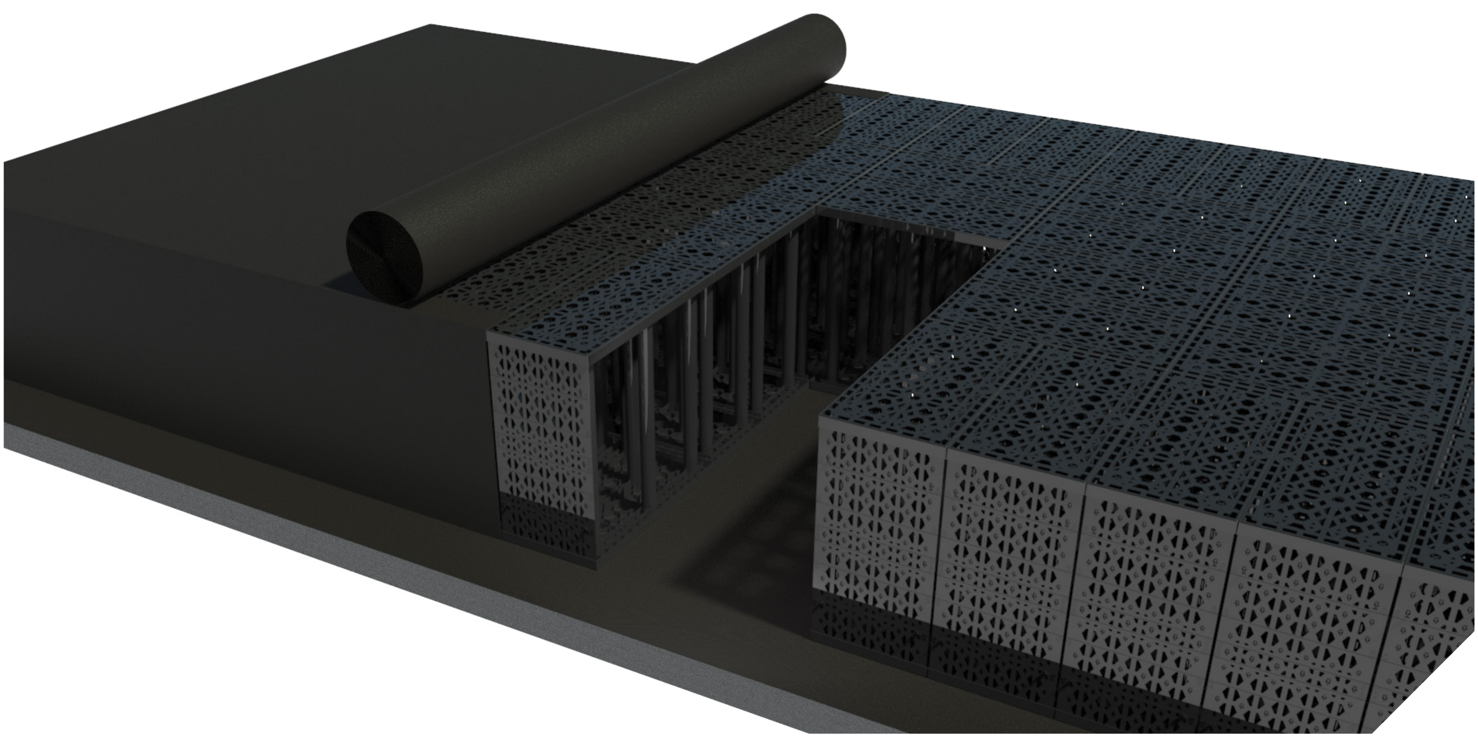
StormTank Module Count = 6 Modules





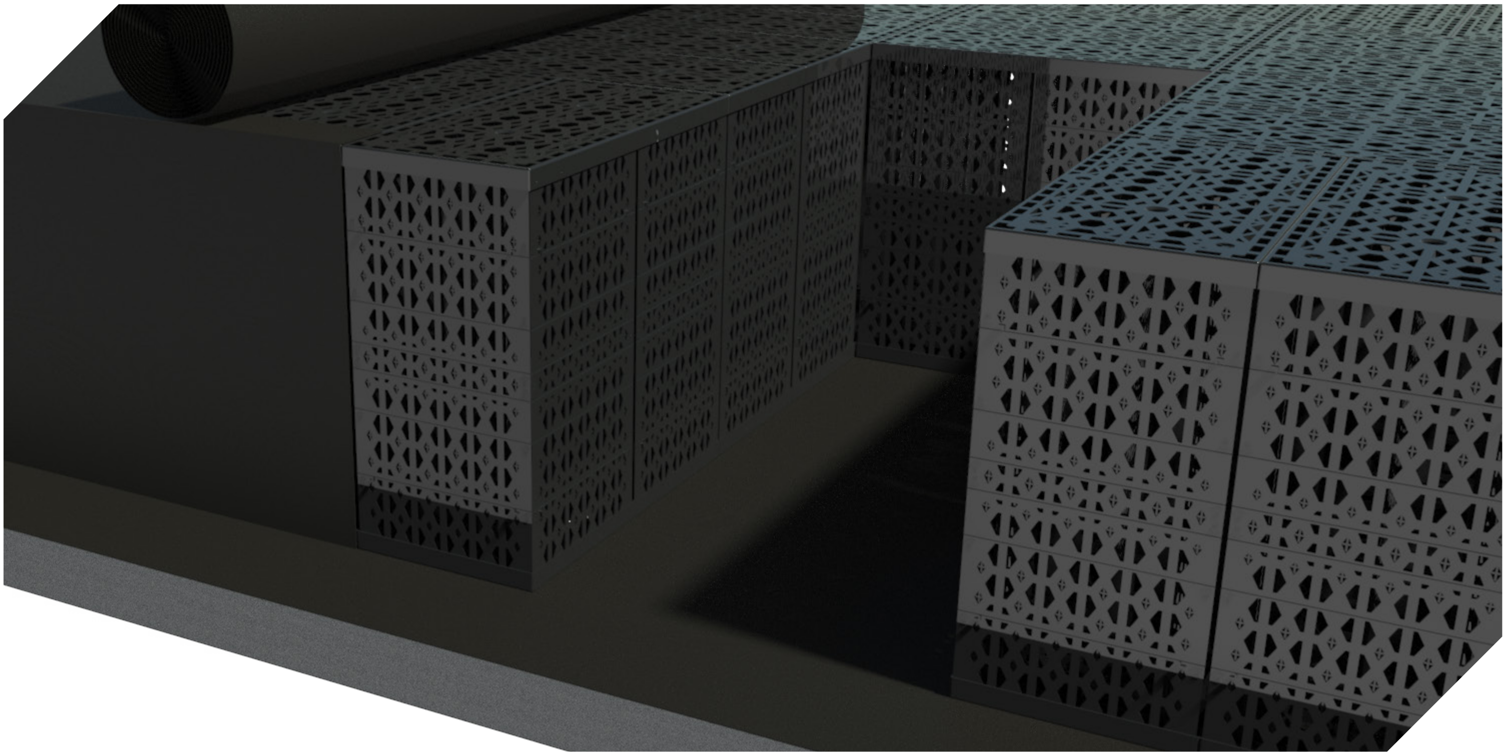
2.0 STORMTANK INSTALLATION

Install StormTank Modules per the approved StormTank submittal drawings. Do not include the Debris Row Modules.



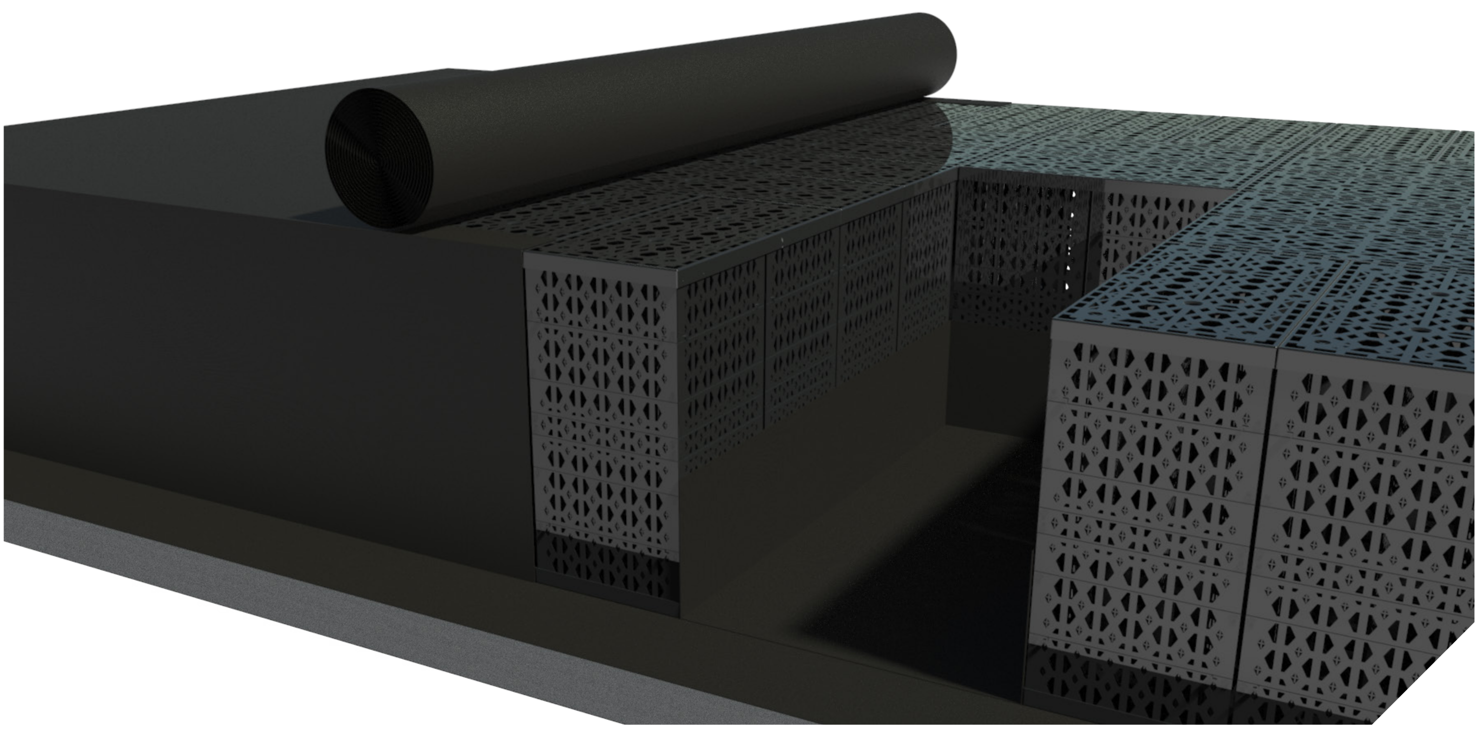
2.1 SIDE PANEL INSTALLATION

Install Debris Row side panels in the Modules adjacent to the Debris Row, per the approved plans.



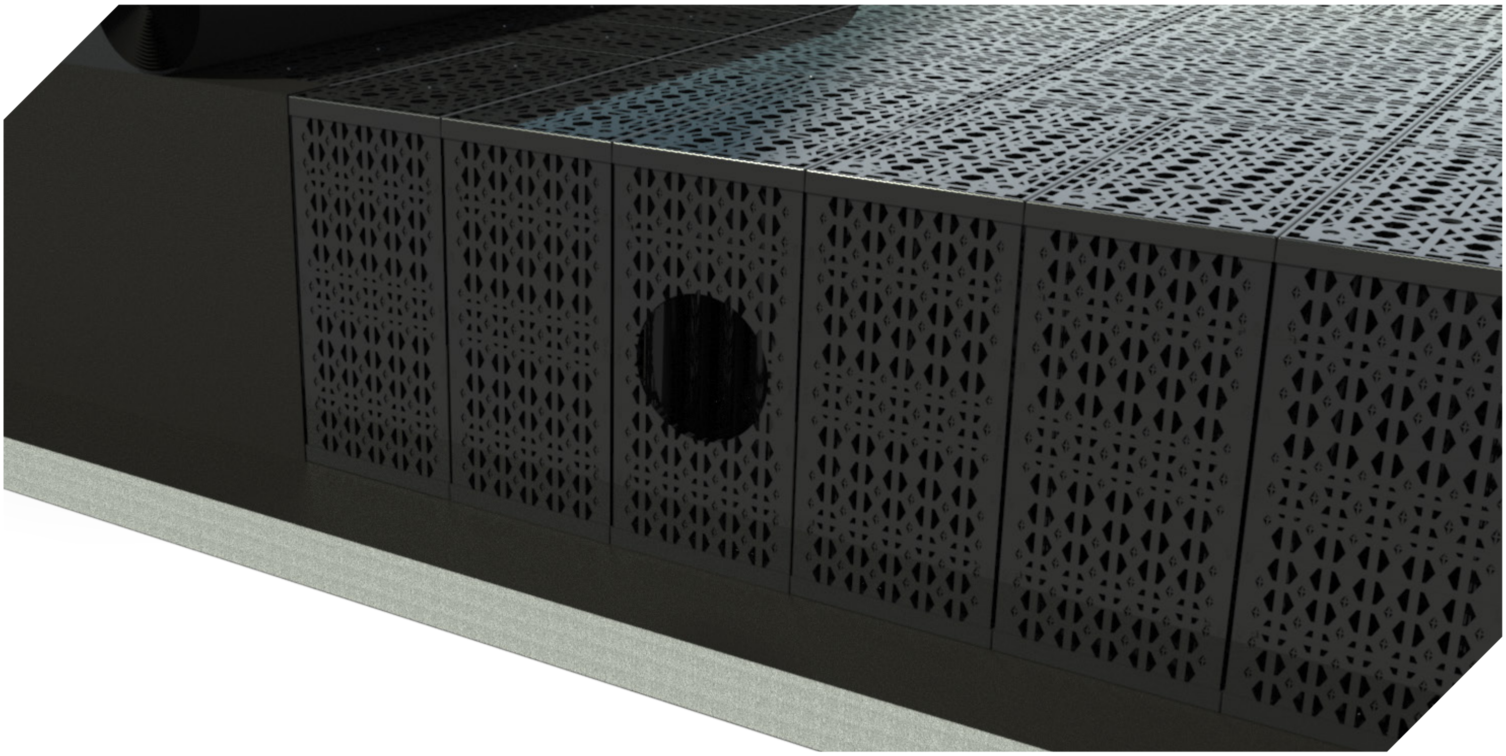
2.2 GEOTEXTILE INSTALLATION

Install a layer of geotextile across the bottom of the Debris Row, extending up the side panels of the adjacent Modules. Geotextile Fabric is to be installed to the height specified by the hydrograph elevation of the selected storm (per the engineer of record's plans), or a minimum of 12" (304.8mm), whichever is greater. Secure the geotextile fabric to the side panels with zip ties.



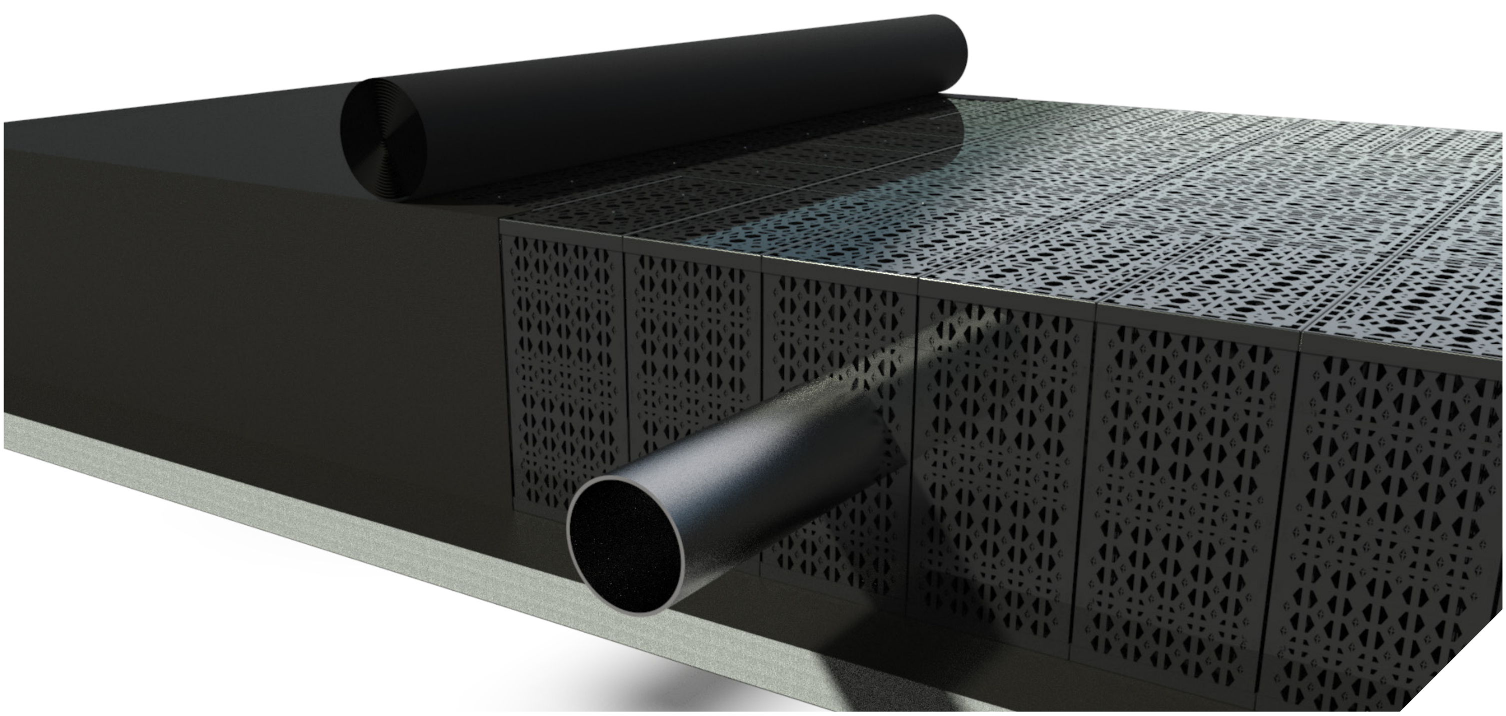
2.3 DEBRIS ROW MODULE PLACEMENT

Place and install the Debris Row Modules in the appropriate location per the approved StormTank submittal drawings.



2.4 COMPLETE SYSTEM INSTALLATION

Finally, make any necessary connections and complete the system installation per the StormTank installation instructions.

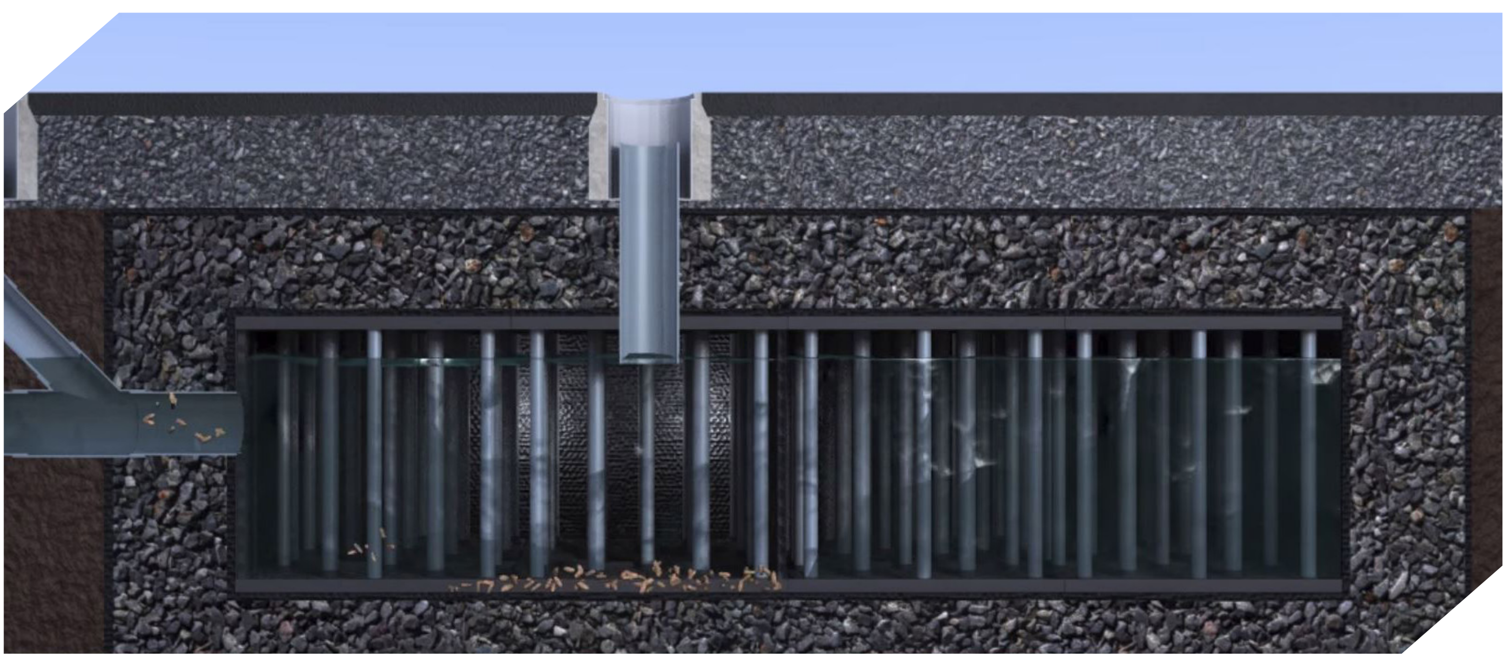


3.0 OPERATIONS & MAINTENANCE

The Debris Row design and operation make maintaining the system easier by containing debris and sediment. The StormTank Module Debris Row is an inexpensive way to provide stormwater treatment, removing suspended solids from stormwater as well as other checmicals and nutrients that have bonded to the solids. The Debris Row provides a means of containing debris to a smaller, more manageable section of an overall storage system.

3.1 OPERATION

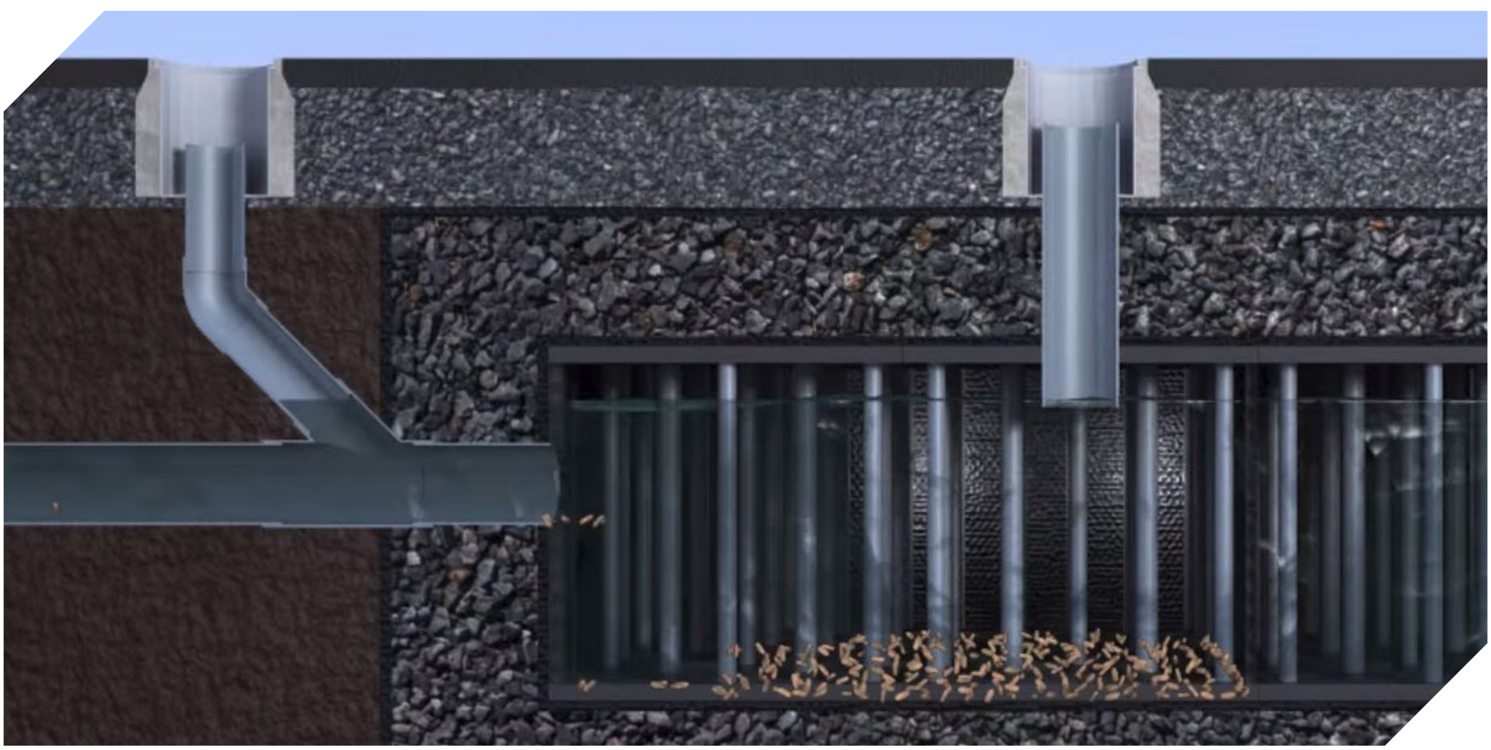
Designed to capture the first flush, the Debris Row provides full retention of large floatables. To do this, the Debris Row utilizes a layer of geotextile fabric around the lower perimeter of the cells. As stormwater enters the containment area, it passes through the geotextile, providing filtration of the stormwater. Internally located side panels are used to ensure retention of the debris by preventing large flow bypass and dispersion of captured material as the water elevation rises throughout the basin.



3.2 INSPECTION

Although frequency is site-specific and dependent upon criteria like land use, pollutant load, and climate, it is recommended that the Debris Row be inspected, at a minimum, every six months. The system is inspected through access ports located in every Debris Row. To inspect the system, remove/open the access port lid.

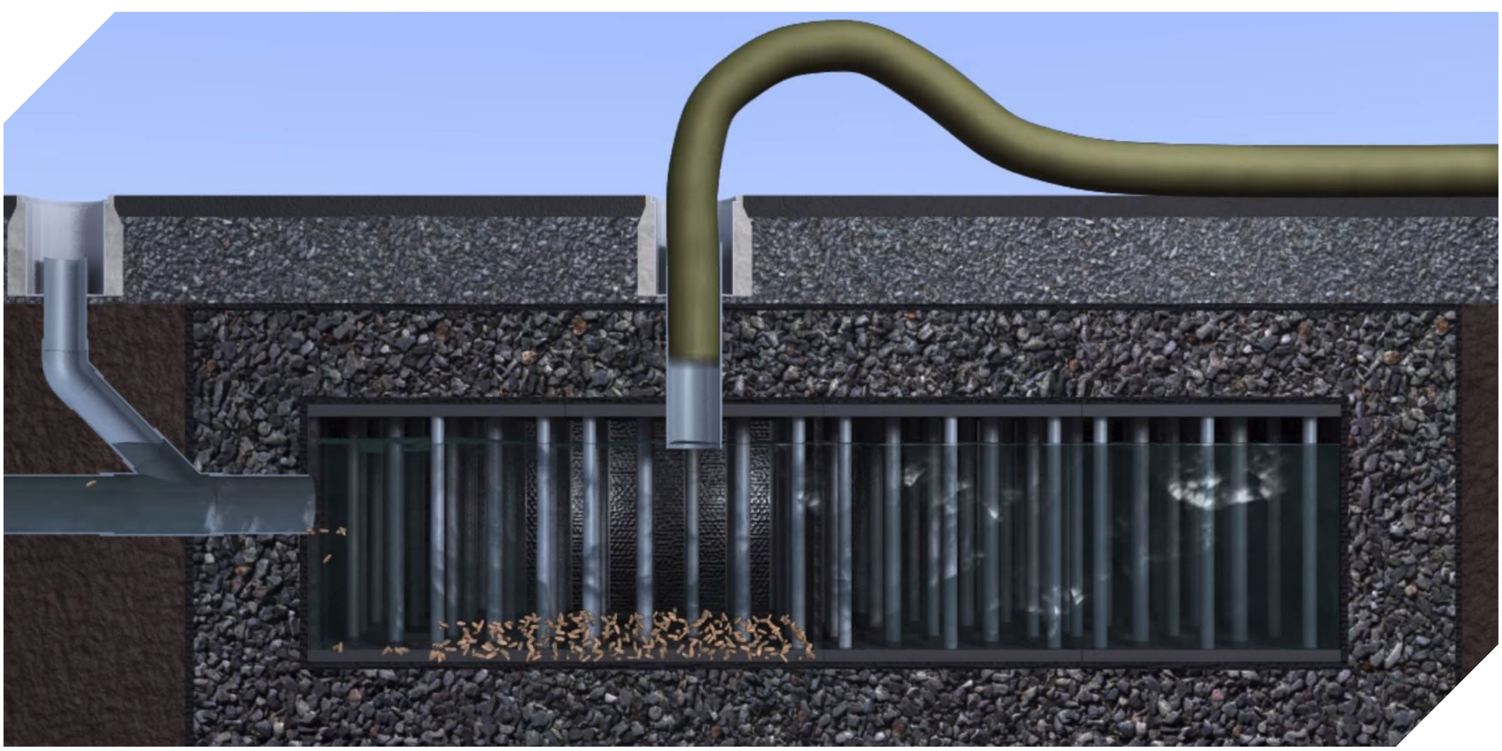
Using a flashlight, complete a visual inspection to evaluate debris accumulation. If the area cannot be fully observed, insert a closed-circuit camera into the system to perform inspection. If accumulation is noted, record the depth of debris. If the debris accumulation is greater than three inches, proceed to maintenance of the Debris Row. If not, record all data and inspection results and close all access lids.



3.3 CLEANOUT

Designed to reduce maintenance time and cost, the Debris Row provides a contained area for sediment and debris within the larger stormwater storage basin. If inspection has determined maintenance is necessary, access is provided through the inflow connection and any access ports within the Debris Row.

Maintenance is accomplished using a high-pressure nozzle to loosen and suspend debris that can then be removed with a vacuum hose. Once debris has been removed, remove any equipment and close any open ports. Be sure to inspect and vacuum any upslope catch basins and manholes as necessary. Most municipalities and private companies have vacuum equipment with the combined capability to both loosen and remove the accumulated debris.



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info@stormtank.com
+1.610.374.5109

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StormTank® Hydraulic Performance and Sediment Removal Efficiency

Karl Koch

Executive Summary

Testing for the hydraulic performance and sediment removal efficiency of the Brentwood Industries StormTank® Debris Row was conducted at the Brentwood Industries Research and Development Facilities following ASTM Standard C1746/C1746M-12, Standard Test Method for Measurement of Suspended Sediment Removal Efficiency of Hydrodynamic Stormwater Separators and Underground Settling Devices. Trapping efficiencies for AGSCO Silica Sand #110 was greater than 95% at all flow ranges tested. Hydraulic performance was limited only by the design of the test rig, namely the flow into the 8" slotted effluent pipe, with flow ranges tested up to nearly 27 GPM/ft^2. The hydraulic data was used to determine detention times and ultimately slurry feed and sampling rates.

The StormTank® Debris Row trapping efficiencies were determined using both a direct and indirect method. The direct method physically weighed the sediment injected into the system, the sediment trapped within the Debris Row, and the sediment trapped within the Effluent Sump. Mass Balances for each test accounted for over 97% of all solids mixed into the feed slurry. The indirect method followed Standard D3977-97, Standard Test Methods for Determining Sediment Concentration in Water Samples. Five evenly spaced samples were drawn from the both the Influent and Effluent flow streams, from which the average concentrations were used to determine the StormTank® Debris Row trapping efficiencies.

Introduction

The Brentwood StormTank system is a rugged yet lightweight subsurface stormwater storage unit. The simple to assemble and install modules, designed to exceed the AASHTO HS-25 load rating, are utilized under most surfaces for detention, infiltration, harvesting, and flood mitigation of rain water. Integral to the system is a Debris Row; a series of StormTank modules subsequential to the inlet pipe and isolated by a series of internally installed side panels with a geotextile fabric liner on the bottom and extending 12" up the side panels. The dual purpose of this Debris Row is: (1) the isolation of larger debris; (2) filtration of sediment.

Purpose

The purpose of this study is: (1) to quantify the hydraulic performance, in terms of stage and detention time for testing purposes; (2) to quantify the sediment removal efficiency of a StormTank® Debris Row system subjected to simulated stormwater runoff conditions.

Scope

Construct a 12’ x 6’ x 4’ Test Basin capable of holding 12’ x 6’ x 1’ #2 Angular stone, a three StormTank® module Debris Row, and a seven StormTank® module system surrounding the Debris Row. Set up a system capable of controlled water flow ranges of 90 – 400 GPM (7.0 – 30.6 GPM/ft^2), with a means of injecting a sediment slurry simulating stormwater runoff. Construct a 10’ x 6’ x 2’ sump to capture the simulated stormwater runoff and filter the effluent for recirculation. Have the means to directly weigh the sediment before and after addition to the test apparatus to determine the removal efficiency. Have the means to indirectly determine the influent and effluent sediment concentrations to determine the removal efficiency.

Apparatus (Appendix A – System Overview)

4000 gallon Reservoir Tank
(4) - 4” Ball Valve
Grundfos E-Pump, Model# CRE90-1-1AN-G-A-E-HQQE
DCT-7088 Portable Digital Correlation Transit Time Ultrasonic Flowmeter
Masterflex B/T variable-speed wash-down modular pump, 12-321rpm, Model# K-77110-40
30 gallon Slurry Tank
Dayton Tank Mixer, Model# 2M168D
8” Ball Valve
12” Inlet Connection, Brentwood Industries
12’ x 6’ x 4’ Test Basin with 12’ x 6’ x 1’ of #2 Angular stone
10’ x 6’ x 2’ Sump
8” Slotted High – Density Polyethylene Pipe, 12’
50 micron filter sock
(2) ISCO 4700 Refrigerated Samplers

Considerations

ASTM Standard C1746/C1746M-12 was followed with the following exceptions:

6.1, 6.4 – The influent system consists of an 8” pipe 78” long, with a slurry injection port 60” from the influent point, and a ball valve / mixing valve 40” from the influent point. This valve remains 100% open.

8.1.1 – Specific gravity and particle-size distribution is not necessary as the sediment is a specialty blend with included technical data sheets (Appendix B).

Conclusions

Using the flow/volume relationship to determine the Detention (residence) Time it can be concluded that the water load limiting factor is the test rig itself rather than any aspect of the StormTank® system through the flow levels tested. (See Test Results and Discussion)

At all flow levels tested sediment removal efficiency is greater than 95% by direct measurement and greater than 97% by indirect sampling. (See Test Results and Discussion)

Evaluation

Test Sample

(10) – 18” StormTank Modules, ST-18
(14) – 18” Side Panels
Geotextile Fabric (Appendix C)
AGSCO Silica Sand #110, Item# SSS000110—B5MBNK (Appendix B)

Test Method

Set-up and Test Run

1. Fill out the initial section of the StormTank Water Quality Test Data Sheet (Appendix D).
2. Record the tare weights of the Influent and Effluent sample containers in the StormTank Water Quality Test Data Sheet and place the crucibles and filter papers in the oven to dry. (See Sample Analysis Procedure, steps 40 – 43)
3. Ensure that the Reservoir Tank has ≥2000 gallons of water.
4. Cut approximately ½” behind the ring of a 50micron filter sock to remove the ring.
5. Weigh the filter sock and one Vacuum Filter as a unit and record in the StormTank Water Quality Test Data Sheet.
6. Cut and weigh the following three pieces of Geotextile 601 Fabric and record in the StormTank Water Quality Test Data Sheet:
    a. 2 pieces Geotextile @ 150” x 24”
    b. 1 piece Geotextile @ 150” x 80”

7. Place the 150” x 80” piece of geotextile fabric over the stone in the Test Basin, cutting around the well pipe.
8. Position the three StormTank Modules (STM’s) that make up the Debris Row down the center of the Test Basin. Module DB1 is placed on the influent pipe and placed against the Test Rig wall, with modules DB2 and DB3 lined up behind.
9. Place the two 150” x 24” geotextile fabric pieces on either side of the Debris Row with 12” lying against the Debris Row and 12” lying on the 150” x 80” piece of geotextile fabric. Each side will extend 12” past module DB1.
10. Cut the excess geotextile fabric near the inlet pipe in line with the wall.
    a. Tuck the vertical flaps between DB1 and the wall.
    b. Fold the vertical flaps up against the basin wall.
11. Position STM’s 1 – 3 and 4 – 6 on either side of the Debris Row, on top of the 150” x 24” geotextile fabric. Place one 25 lb weight on top of each STM.
12. Cut the geotextile fabric at approximately 45° from the corners of DB3 to allow wrapping of the fabric around the module. Position STM 7 against this fabric.
13. Cable tie the 12” of geotextile fabric between the debris and outer row to the side panels of the outer row.
14. Insert the Sump Effluent Filter sock frame into the sock and cable tie it around the 4” sump effluent line.
15. Position and attach the Influent Sampler to the Influent Sampler Port on the Influent Pipe. Program the sampler to the parameters listed in Table 1 – Hydraulic Performance for the testing conditions to be performed.
16. Position and attach the Effluent Sampler to the Effluent Sampler Line in the Test Basin Effluent Pipe. Program the sampler to the parameters listed in Table 1 – Hydraulic Performance for the testing conditions to be performed.
17. Attach the Slurry Pump to the Injection Port. Mix sediment slurry per the following:
    a. Add 20 gallons of water to the Slurry Tank.
    b. Plug in the Mixer Motor and Slurry Pump
    c. Slowly add 27.5 lbs of AGSCO #110 sediment.
    d. Fill with water until the mixture reaches the 25 gallon mark, cycling the mixer to achieve the correct volume.
    e. Power on the Slurry Pump but do not start.
18. Attach the flowmeter to the sensors and power on.
19. Open valves 1 and 4.
20. Open the bleeder valve on the Pump to extricate any air in the influent piping and pump.
21. Power on the Pump, and set the desired flow rate.
22. When the fill line is reached in the Sump open valve 2 and slowly close valve 1. To maintain the water level slowly open / close valve 1 as needed.
23. Record the time as the Equilibration Start Time. The test will need to equilibrate for 10 detention times. During this time:

   a. Take the Sump water temperature
   b. Program the Slurry Pump per Table 1
   c. Remove crucibles and filters from drying oven and place in desiccator.
   d. Record the actual flow rate on the StormTank Water Quality Test Data Sheet.
24. After 10 Detention Times record the time as the Equilibration End Time.
25. Start the Influent Sampler and record the time.
26. After 11 Detention Times start the Effluent Sampler and record the time.
27. Start the Slurry Pump.
28. Start the test timer.
29. Record the Sump water temperature and the time taken.
30. Halt the Influent and Effluent Sampler programs until the sampling interval has been met on the test timer.
   a. When the sampling interval has been met restart the Influent Sampler on bottle 2.
   b. After one detention time restart the Effluent Sampler on bottle 2.
31. Measure the maximum stage at the well and record in the StormTank Water Quality Test Data Sheet.
32. At this time the water in the reservoir Tank can begin to be replaced by a garden hose.
33. A few minutes before the end of the test, measure the water level in the StormTank chamber and record in the StormTank Water Quality Test Data Sheet.
34. When the Test Length has been met *and* the Influent Sampler has recovered the seventh sample, shut down the Influent Sampler and the Slurry Pump. Record the time.
35. When one more detention time has elapsed *and* the final Effluent grab sample has been recovered, shut down the Effluent Sampler. Record the time.
36. Record the Sump water temperature and the time taken.
37. Reduce the pump to the minimum flow rate and shut down the pump.
38. Close all the valves.
39. Check the water level in the Reservoir Tank and shut down the water if ≥2000 gallons.

Shutdown and Cleanout Procedure

40. Cut the cable ties holding the geotextile fabric to the STM side panels and carefully rinse each STM onto the Geotextile as it is removed from the Test Basin.
   a. Carefully fold the Geotextile lengthwise and remove from the Test Basin.
   b. Allow the geotextile to dry thoroughly before weighing and recording in the StormTank Water Quality Test Data Sheet.
41. Remove the slurry pump Influent Line and wash out the contents into the Slurry Tank.
42. Empty the contents of the Slurry Tank onto a tarp and allow to dry.
43. Carefully remove the filter sock from the Test Basin Sump effluent pipe and allow to dry thoroughly.

44. Using a sump pump placed in the Sump, begin a flow through the garden hose and then disconnect the garden hose from the sump pump, ensuring that it remains submerged at all times, and set on the floor of the Sump. Allow it to siphon to the sanitary sewer.
45. Disconnect the Flow Meter.
46. Disconnect the Influent Sampler from the influent pipe.
47. Disconnect the Effluent Sampler from the effluent pipe.
48. When the Sump has been drained, vacuum the remaining water and sediment with a vacuum containing the clean tared filter, disposing of the water in the sanitary sewer.
49. Place the Vacuum Filter with the Filter Sock and allow to dry thoroughly.
    a. Weight the Vacuum Filter and Filter Sock as a unit and record in the StormTank Water Quality Test Data Sheet.

Sample Analysis Procedure

50. Weigh and record tare weights for the 7 Influent and 7 Effluent Sample bottles making sure to include the lids. Weights are to be recorded on the data sheet in the Bottle Chart under the column Tare (g).
51. Wash the glass-fiber filter disc with water to remove soluble compounds. Record pore size and diameter on the data sheet.
52. Place the filter inside a crucible.
53. Dry the filter and its crucible in the drying oven for 1H at 105°C.
54. Weigh each of the 7 Influent and 7 Effluent Sample bottles with their samples inside and record on the data sheet in the Bottle chart under the column Gross (g).
55. Transfer the crucible and filter paper to the desiccator, then, after the parts have cooled to room temperature, weigh them to the nearest 0.0001 g and record the reading on the data sheet.
56. Place the crucible inside a crucible holder.
57. Place the crucible holder into the vacuum flask that is attached to the vacuum pump.
58. While a vacuum is being applied to the bottom of the crucible, filter sample into the crucible. Flush the inner surfaces of the sample bottle with water several times to complete the transfer.
59. As filtering proceeds, inspect the filtrate. If it is turbid, pour the filtrate back through the filter a second and possibly a third time. If the filtrate is still turbid, the filter may be leaking. In this case, substitute a new filter and repeat from step 51. If the filtrate is transparent but discolored, a natural dye is present; re-filtration is not necessary.
60. When filtration is complete, place the crucible and its contents in the drying oven for 1H at 105°C.
61. Remove crucible and filter from oven and place in desiccator. After the crucible has cooled, weigh to the nearest 0.0001 g and record on the data sheet.
62. Place crucible and filter back in oven for 1H at 105°C.
63. Remove crucible and filter from oven and place in desiccator. After the crucible has

cooled, weigh to the nearest 0.0001 g and record on the data sheet.

64. If values from steps 61 and 63 are less than 4% or 0.5 mg (whichever is smaller) different, then drying complete.
65. If values from steps 61 and 63 are more than 4% or 0.5 mg different, then repeat steps 52 – 53.
66. Enter all values in the Excel Spreadsheet "StormTank Water Quality Test Data Sheet".

Test Results and Discussion

Looking at the flow/volume relationship, determined by measuring the stage at each flow rate by means of a well installed midway through the test basin, several expected results occur: (1) the stage increases along with flow, (2) the volume increases along with flow, (3) the test length required to inject 21 pounds of sediment at an approximate concentration of 200 mg/L decreases as flow increases, (4) the indirect sampling interval decreases as the flow increases.

Table 1- Hydraulic Performance

Flow (cfs)	Flow (gpm)	Flow (gpm/ft^2)	Stage Relative to Outlet (in)	Total Volume (ft^3)	Total Volume (gal)	Detention Time, *X* (min)	Test Length (min)	Pump Speed to Deliver 20 gallons (GPM)	Sampling Interval (min)
0.21	95	7.0	5.03	30.08	225.00	2.37	139	0.14	23.1
0.30	133	10.0	6.09	36.44	272.52	2.05	99	0.20	16.5
0.42	192	14.0	8.34	49.89	373.14	1.94	69	0.29	11.4
0.50	217	16.6	9.97	59.60	445.81	2.05	61	0.33	10.1
0.61	276	20.3	13.03	77.92	582.77	2.11	48	0.42	8.0
0.69	305	22.9	15.22	91.00	680.59	2.23	43	0.46	7.2
0.80	357	26.6	19.41	116.03	867.86	2.43	37	0.54	6.2
0.92	413	30.6	25.00	149.48	1118.02	2.71	32	0.63	5.3
1.02	453	33.9	29.25	174.89	1308.08	2.89	29	0.69	4.8

However, the Detention Time, expected to decrease as flow increased, follows more of a second-order polynomial (See Chart 1 – Flow vs Detention Time). Considering the mechanism through which the water exits the test basin, an 8" slotted pipe, the increase in Detention Time can be explained by assuming a maximum flow through the total area of the slots dependent on head pressure. After passing through the StormTank® system, the geotextile, and the stone, the water must infiltrate the culvert pipe through the slots. For the first three data points, to 14.0 GPM/ft^2, the maximum flow through the pipe wall is not achieved, therefore, the results are as expected, a linear increase in the stage with decreasing Detention Times (See Chart 2 – Flow vs Stage). For the flows greater than 16.6 GPM/ft^2 the maximum flow through the pipe wall is achieved at equilibrium with head pressure, therefore, we see the stage increasing as a second-order polynomial with Detention Times increasing (See Chart 2 – Flow vs Stage).

Chart 1 - Flow vs Detention Time

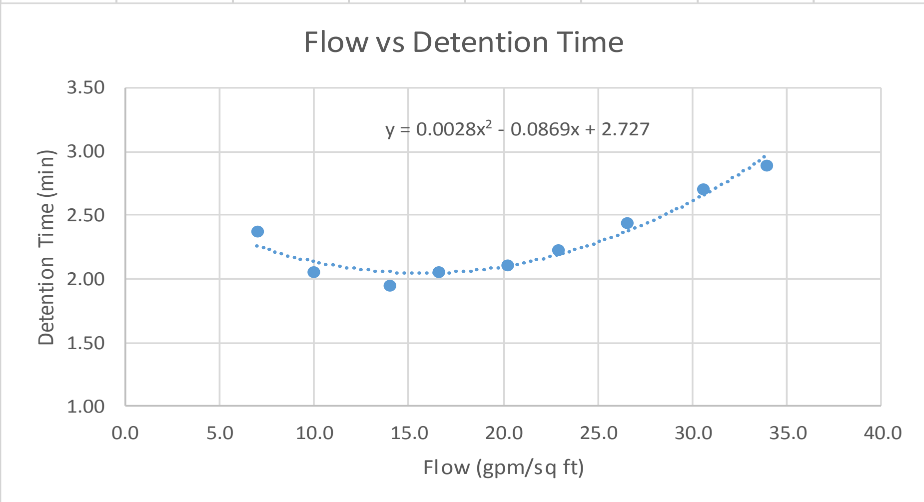
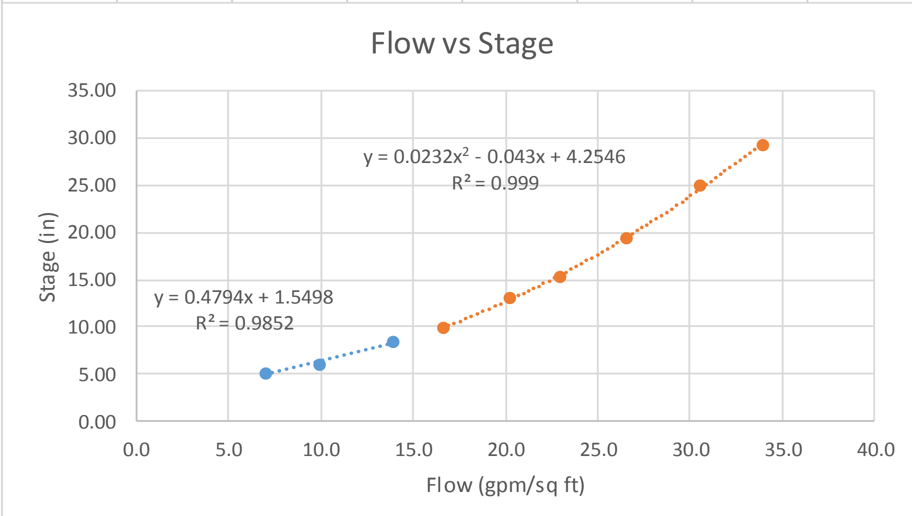


Chart 2 - Flow vs Stage



At all water flow rates tested, both the direct and indirect measurement methods indicated sediment trapping efficiencies greater than 95%. The direct method is the standard method and shows a 2% decline in sediment trapping efficiency, 97% to 95%, as the flow increases 400%, from 7.0 GPM/ft^2 to 26.9 GPM/ft^2 .The direct method also allows a mass balance to be performed between the sediment weighed from the packaging and the sediment collected at the completion of each test run. This mass balance shows that we can account for greater than 97% of the solids used.

Table 2- Sediment Removal Efficiency

Flow (gpm/ft^2)	Direct Sediment Measurements, Weight		Indirect Concentration Measurements		Removal Efficiency		Mass Balance (%)
	Injected in Influent Flow (lbs)	Retained in Debris Row (lbs)	Influent (mg/L)	Effluent (mg/L)	Direct Method (%)	Indirect Method (%)	
7.0	20.1	19.5	128.0	2.7	97.0	97.9	98.2
14.3	22.5	21.9	685.9	12.2	97.3	98.2	98.2
20.6	25.6	24.7	197.9	2.1	96.5	98.9	97.6
20.3*	18.1	17.2	346.4	0.0	95.0	100.0	97.1
26.9	20.5	19.7	410.4	1.5	96.1	99.6	97.8

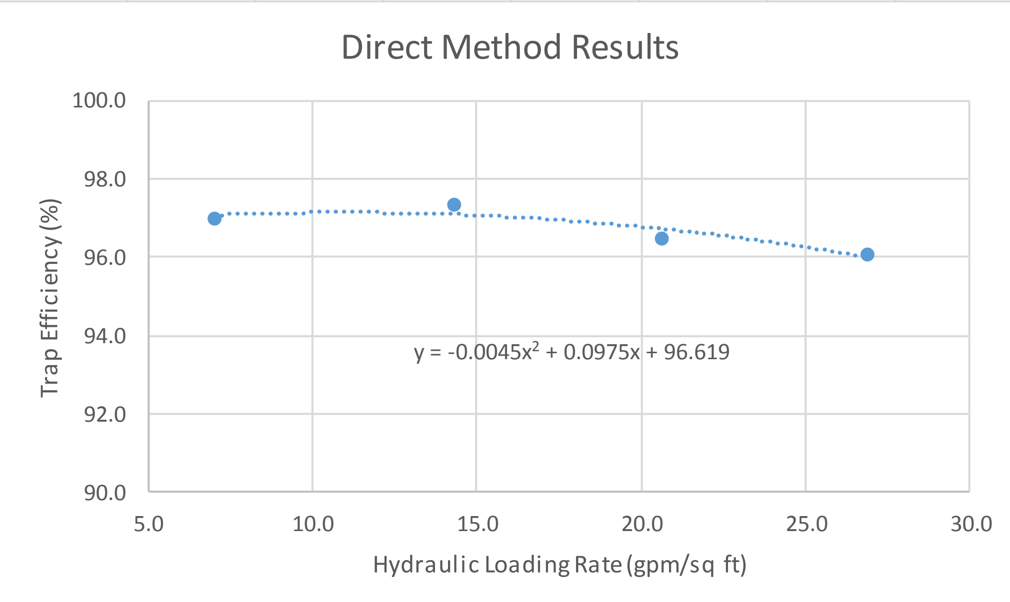
*Witnessed by Craig Momose, P.E.; Systems Design Engineering, Inc., October 15, 2015

The direct method for determining the sediment removal efficiency of the Brentwood StormTank® Debris Row utilizes a calibrated scale to weigh the sediment in the feed slurry, the sediment collected in the Debris Row, and the sediment deposited in the Effluent Sump. The sediment remaining in the slurry tank is also dried and weighed at the end of a test run to calculate the amount of sediment actually fed to the system. Through this measurement system the percentage of injected sediment trapped by the Debris Row is directly measured:

$$\text{Trap Efficiency} = (DB/IS) \times 100$$

Where, DB is the sediment captured by the Debris Row
And, IS is the Injected Sediment (Total added to the slurry tank – Total remaining at the end)

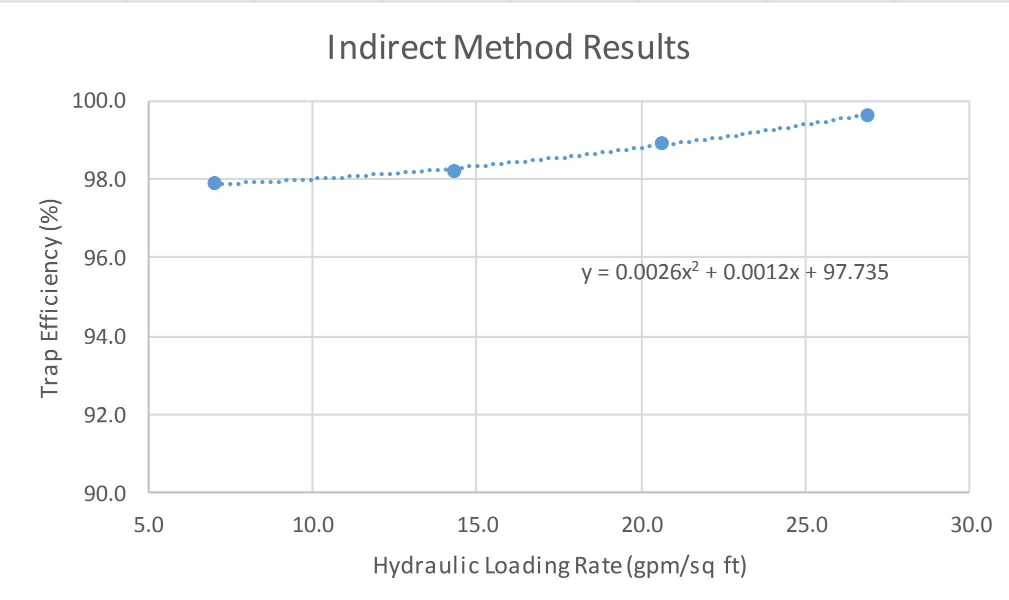
Chart 3 - Sediment Removal Efficiency, Direct Method



For the purposes of the evaluations in Chart 3 and Chart 4 the duplicate run (20.3 GPM/ft^2) for Systems Design Engineering, Inc. was omitted. Only 18.1 pounds of sediment were added, outside of the standard method. Additionally, there was no detectable sediment in the effluent samples, leading to a 100% trapping efficiency, which may lead one to question the validity of the results. However, the purpose of that test run was to allow the outside firm to verify our methods, not our results, and that was accomplished with the run.

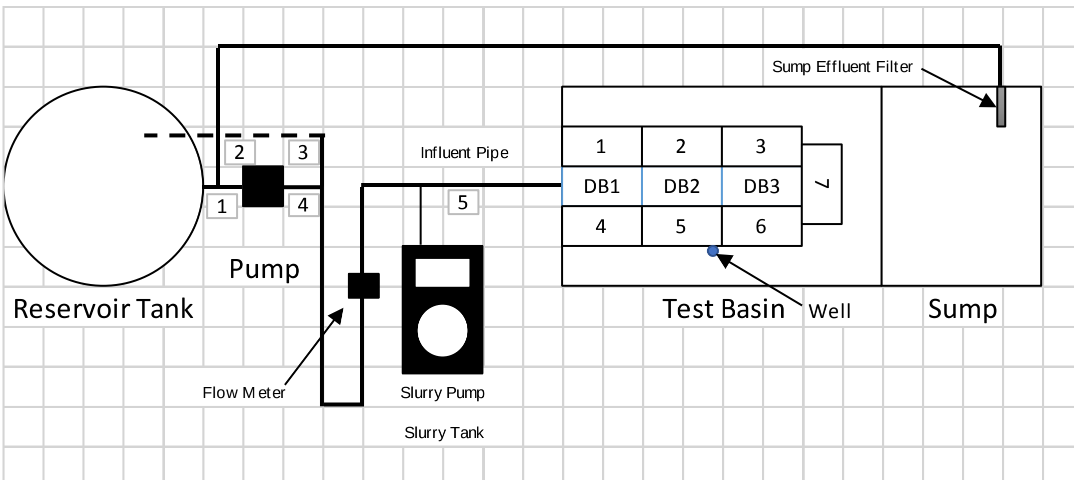
Brentwood utilized dormant resources to employ an indirect method to verify the results of the direct measurements. This was meant to be a broad verification, as the numerous steps involved and small concentrations of sediment, coupled with the difficulty of obtaining discrete well - mixed samples representative of the average concentrations, introduce compounding errors. Surprisingly, most of the results were within 3% of the direct method with the exception of the duplicate test, showing sediment trapping efficiencies greater than 97%. The results show a trend toward increasing sediment trapping efficiency as the flow increases. This could be due to numerous error factors: balance errors to the .00001g, humidity fluctuations, a decreasing sample cross-section as the water level in the effluent pipe increased (the sample line was set in the effluent pipe at the bottom counter to the flow).

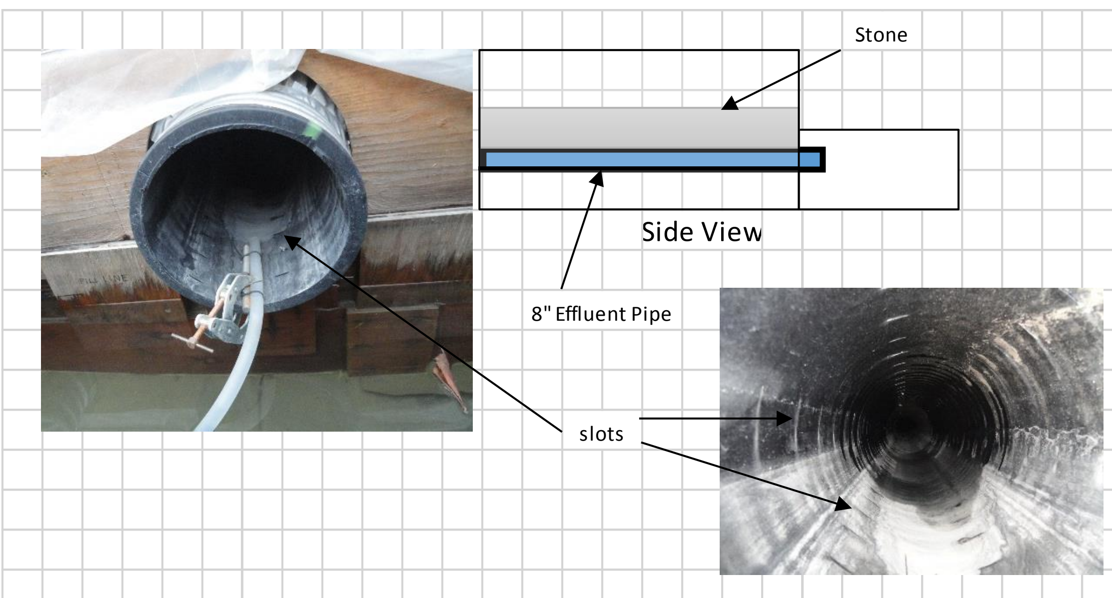
Chart 4 - Sediment Removal Efficiency, Indirect Method



Appendices

Appendix A – System Overview





Appendix B – AGSCO #110 Screen Analysis

AGSCO CORPORATION

TECHNICAL DATA

103,000# For wheeling

AGSCO SILICA SAND

TYPICAL SCREEN ANALYSIS

ROUND GRAIN SAND

(Percent Retained)

US SIEVE	20-40	(#1) 35-50	(#2) 40-70	50-80	(#7) 70-100	(#10) 100-140	(#110) 140-200	(#16) 140-270
12								
14								
16								
18								
20	0.2							
25	7.0	0.3						
30	20.6	2.0	0.3					
35	42.8	20.5	5.2					
40	23.3	35.3	16.5	2.7	2.9	1.2	0.3	
50	6.0	32.7	37.0	39.3	17.4	2.9	1.5	
60		4.7	14.2	23.8	---	---	---	
70		2.2	9.3	16.2	39.9	13.2	4.4	
80		2.3	5.5	9.1	---	---	---	
100			4.8	5.4	27.7	41.4	19.8	
120			7.2	3.5	---	---	---	---
140					11.2	36.3	42.8	27.8
170					---	---	---	---
200					0.9	4.8	20.5	50.9
230						---	---	---
270						0.1	8.3	19.3
325/PAN							2.3	2.0
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

AFS Grain Number	25	35	47	50	59.6	80.3	111.8	144
Effective Size (mm).	0.43	0.30	.15	.15	.11			

SILICA FLOUR

(Typical Percent Retained)

U.S. Sieve	#70 / 250	#140 / 106	#200 / 90	#325 / 45
70	3			
100	11	T		
140	8	1	T	
200	14	6	3	
270	9	10	7	T
325	5	8	7	2
Passing 325	50	75	83	98
Totals	100	100	100	100

160 West Hintz Road
Wheeling, Ilinois 60090
P: 847-520-4455 • F: 847-520-4970

60 Chapin Road, PO Box 669
Pine Brook, New Jersey 07058
P:973-244-0005 • F:973-244-0091

Appendix C: GEOTEX 601 Product Data

GEOTEX®
BY PROPEX

Product Data
GEOTEX® 601

GEOTEX® 601 is a polypropylene, staple fiber, needlepunched nonwoven geotextile produced by Propex, and will meet the following Minimum Average Roll Values (MARV) when tested in accordance with the methods listed below. The fibers are needled to form a stable network that retains dimensional stability relative to each other. The geotextile is resistant to ultraviolet degradation and to biological and chemical environments normally found in soils.

GEOTEX 601 conforms to the property values listed below[1]. Propex performs internal Manufacturing Quality Control (MQC) tests that have been accredited by the Geosynthetic Accreditation Institute – Laboratory Accreditation Program (GAI-LAP). This product is NTPEP approved for AASHTO standards.

		MARV[2]	
PROPERTY	TEST METHOD	ENGLISH	METRIC
ORIGIN OF MATERIALS			
% U.S. Manufactured Inputs		100%	100%
% U.S. Manufactured		100%	100%
MECHANICAL			
Tensile Strength (Grab)	ASTM D-4632	160 lbs	712 N
Elongation	ASTM D-4632	50%	50%
CBR Puncture	ASTM D-6241	410 lbs	1824 N
Trapezoidal Tear	ASTM D-4533	60 lbs	267 N
ENDURANCE			
UV Resistance % Retained at 500 hrs	ASTM D-4355	70%	70%
HYDRAULIC			
Apparent Opening Size (AOS)[3]	ASTM D-4751	70 US Std. Sieve	0.212 mm
Permittivity	ASTM D-4491	1.3 sec^{-1}	1.3 sec^{-1}
Water Flow Rate	ASTM D-4491	110 gpm/ft^2	4482 $l/min/m^2$

ROLL SIZES	12.5 ft x 360 ft 15 ft x 300 ft	3.81 m x 109.8 m 4.57 m x 91.5 m

NOTES:
1. The property values listed above are effective 04/2011 and are subject to change without notice.
2. Values shown are in weaker principal direction. Minimum average roll values (MARV) are calculated as the typical minus two standard deviations. Statistically, it yields a 97.7% degree of confidence that any samples taken from quality assurance testing will exceed the value reported.
3. Maximum average roll value.

Brentwood Industries, Inc.

610 Morgantown Road, Reading, PA 19611, USA

Phone: 610.374.5109

Fax: 610.376.6022

Appendix D – StormTank Water Quality Test Data Sheet

BRENTWOOD®

StormTank™ Water Quality Test Data Sheet

Date

Page 1 of 3

Test Name:		
Test Length:		min
Detention Time:		min
Target Influent Concentration:		mg/L
Slurry Concentration:		lbs/gal
Slurry Pump Speed:		gpm
Sampling Interval:		min
Glass-fiber Filter Diameter:		mm
Glass-fiber Filter Pore Size:		µm

Geotex Weight $_{Initial}$:		lbs
Geotex Weight $_{Final}$:		lbs
Filter Sock and Vacuum Filter Weight $_{Initial}$:		lbs
Filter Sock and Vacuum Filter Weight $_{Final}$:		lbs
Tarp Weight $_{Initial}$:		lbs
Tarp Weight $_{Final}$:		lbs
Flow $_{water}$:		cfs
Water Load:	0	gpm/ft^2
Maximum Stage $_{Rig}$:		in
Depth in Chamber:		in
Total Volume:	0.00	gal
Equilibration Start Time:		
Equilibration End Time:		
Sump Water Temperature / Time:		°F /
Sampler $_{Influent}$ Start Time:		
Sampler $_{Effluent}$ Start Time:		
Test / Slurry Pump Start Time:		
Sump Water Temperature / Time:		°F /
Sampler $_{Influent}$ End Time:		
Sampler $_{Effluent}$ End Time:		
Test / Slurry Pump End Time:		
Sump Water Temperature / Time:		°F /

StormTank™ Water Quality Test Data Sheet

Date

Page 2 of 3

Sample Bottle Weight Table

Sample	Tare (g)	Gross (g)	Net (g)	Solids (mg)	Water (mL)	Concentration (mg/L)
Influent 0			0.0000	0.0	0.0	#DIV/0!
Influent 1			0.0000	0.0	0.0	#DIV/0!
Influent 2			0.0000	0.0	0.0	#DIV/0!
Influent 3			0.0000	0.0	0.0	#DIV/0!
Influent 4			0.0000	0.0	0.0	#DIV/0!
Influent 5			0.0000	0.0	0.0	#DIV/0!
Influent 6			0.0000	0.0	0.0	#DIV/0!
Effluent 0			0.0000	0.0	0.0	#DIV/0!
Effluent 1			0.0000	0.0	0.0	#DIV/0!
Effluent 2			0.0000	0.0	0.0	#DIV/0!
Effluent 3			0.0000	0.0	0.0	#DIV/0!
Effluent 4			0.0000	0.0	0.0	#DIV/0!
Effluent 5			0.0000	0.0	0.0	#DIV/0!
Effluent 6			0.0000	0.0	0.0	#DIV/0!

Crucible Weight Table

Sample	Tare (g)	1H @ 105°C (g)	1H @ 105°C (g)	Solids (mg)
Influent 0				0.0
Influent 1				0.0
Influent 2				0.0
Influent 3				0.0
Influent 4				0.0
Influent 5				0.0
Influent 6				0.0
Effluent 0				0.0
Effluent 1				0.0
Effluent 2				0.0
Effluent 3				0.0
Effluent 4				0.0
Effluent 5				0.0
Effluent 6				0.0

StormTank™ Water Quality Test Data Sheet

Date

Page 3 of 3

Geotex Tare weight (lbs)	Dry Geotex Weight (lbs)	Solids (lbs)
0	0	0.0

Solids Remaining in Slurry Tank (lbs)	0

Vacuum Filter and Filter Sock Tare weight (lbs)	Dry Vacuum Filter and Filter Sock Weight (lbs)	Solids (lbs)
0	0	0.0

	Accounted	Unaccounted	Slurry
Mass Balance (lbs)	0.0	0.0	

Direct Removal Efficiency:	0	%
Indirect Removal Efficiency:	#DIV/0!	%

Appendix E – Sample Completed StormTank Water Quality Test Data Sheet

BRENTWOOD®

StormTank™ Water Quality Test Data Sheet

September 25, 2015

Page 1 of 3

Test Name:	WQ 0.4 cfs 2015 09 25		
Test Length:	69	min	
Detention Time:	1.94	min	
Target Influent Concentration:	200	mg/L	
Slurry Concentration:	1.1	lbs/gal	
Slurry Pump Speed:	0.29	gpm	
Sampling Interval:	11.0	min	
Glass-fiber Filter Diameter:	34	mm	
Glass-fiber Filter Pore Size:	1.5	µm	

Geotex Weight $_{Initial}$:	5.2	lbs	
Geotex Weight $_{Final}$:	27.1	lbs	
Filter Sock and Vacuum Filter Weight $_{Initial}$:	0.9	lbs	
Filter Sock and Vacuum Filter Weight $_{Final}$:	1.0	lbs	
Tarp Weight $_{Initial}$:	6.8	lbs	
Tarp Weight $_{Final}$:	11.8	lbs	
Flow $_{water}$:	0.43	cfs	
Water Load:	14.3	gpm/ft^2	
Maximum Stage $_{Rig}$:	9.88	in	
Depth in Chamber:	5.75	in	
Total Volume:	490.0	gal	
Equilibration Start Time:	9:55		
Equilibration End Time:	10:14		
Sump Water Temperature / Time:	71.8	°F /	9:56
Sampler $_{Influent}$ Start Time:	10:14		
Sampler $_{Effluent}$ Start Time:	10:16		
Test / Slurry Pump Start Time:	10:16		
Sump Water Temperature / Time:	72	°F /	10:17
Pause - Influent feed line not working; re-start at 10:31			
Sampler $_{Influent}$ End Time:	11:37		
Sampler $_{Effluent}$ End Time:	11:39		
Test / Slurry Pump End Time:	11:40		
Sump Water Temperature / Time:	72.3	°F /	11:39

StormTank™ Water Quality Test Data Sheet

September 25, 2015

Page 2 of 3

Sample Bottle Weight Table

Sample	Tare (g)	Gross (g)	Net (g)	Solids (mg)*	Water (mL)	Concentration (mg/L)
Influent 0	117.1047	211.1727	94.0680	1.0	94.1	10.6
Influent 1	113.7627	199.6820	85.9193	59.5	85.9	693.6
Influent 2	120.2428	205.2000	84.9572	77.9	84.9	917.2
Influent 3	119.0744	210.0568	90.9824	72.5	90.9	796.9
Influent 4	116.4428	212.7409	96.2981	69.1	96.2	718.1
Influent 5	116.5622	203.3854	86.8232	51.1	86.8	589.5
Influent 6	115.9707	206.8581	90.8874	36.3	90.9	400.1
Effluent 0	115.6987	203.4775	87.7788	1.2	87.8	13.1
Effluent 1	116.0757	205.6834	89.6077	1.1	89.6	12.3
Effluent 2	120.8946	215.6025	94.7079	1.5	94.7	15.8
Effluent 3	119.1743	214.1430	94.9687	1.6	95.0	16.8
Effluent 4	119.0589	231.6127	112.5538	0.7	112.6	5.8
Effluent 5	119.7286	214.6678	94.9392	1.0	94.9	10.5
Effluent 6	118.2419	211.6760	93.4341	1.1	93.4	11.8

*Negative values are recorded as zero

Crucible Weight Table

Sample	Tare (g)	1H @ 105°C (g)	1H @ 105°C (g)	Solids (mg)
Influent 0	44.5359	44.5362	44.5376	1.0
Influent 1	44.0679	44.1264	44.1285	59.5
Influent 2	44.9158	44.9929	44.9944	77.9
Influent 3	44.5755	44.6473	44.6486	72.5
Influent 4	43.5355	43.6040	43.6052	69.1
Influent 5	44.3170	44.3674	44.3689	51.1
Influent 6	44.4361	44.4718	44.4731	36.3
Effluent 0	44.3461	44.3469	44.3476	1.2
Effluent 1	44.4199	44.4204	44.4216	1.1
Effluent 2	44.5589	44.5595	44.5613	1.5
Effluent 3	44.4879	44.4889	44.4901	1.6
Effluent 4	44.2916	44.2916	44.2929	0.7
Effluent 5	44.3202	44.3207	44.3217	1.0
Effluent 6	44.2992	44.2998	44.3008	1.1

StormTank™ Water Quality Test Data Sheet

September 25, 2015

Page 3 of 3

Geotex Tare weight (lbs)	Dry Geotex Weight (lbs)	Solids (lbs)
5.2	27.1	21.9

Solids Remaining in Slurry Tank (lbs)	5

Vacuum Filter and Filter Sock Tare weight (lbs)	Dry Vacuum Filter and Filter Sock Weight (lbs)	Solids (lbs)
0.9	1	0.1

	Accounted	Unaccounted	Slurry	
Mass Balance (lbs)	27.0	0.5	27.5	98.2%

Direct Removal Efficiency:	97.3	%
Indirect Removal Efficiency:	98.2	%

SYSTEMS DESIGN
ENGINEERING, INC
"A Passion for Engineering Excellence"
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November 12, 2015

Karl Koch, Supervisor
Brentwood Industries, Inc.
Research & Development Laboratories
610 Morgantown Road
Reading, PA 19611

Re: StormTank Debris Row
Sediment Removal Efficiency
Certification of Testing

Dear Karl:

I have reviewed your technical report entitled, "StormTank® Hydraulic Performance and Sediment Removal Efficiency," dated November 11, 2015. Based on my personal observations of the test performed on October 15, 2015, I hereby certify that the testing procedure and results summarized in the technical report accurately describes the test that I observed.

If you require additional information, please do not hesitate to contact me.

Sincerely,

Craig Momose, P.E.
Director of Civil Engineering

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
CRAIG MOMOSE
ENGINEER
No. PE039211E

I:\Projects\Brentwood Industries\2015-11-12 Certification Letter.docx

1032 James Drive, Leesport, PA 19533 • P: 610.916.8500 • F: 610.916.8501
Schuylkill Haven, PA • P: 570.385.5549 Boyertown, PA • P: 610.369.1319

Stormceptor® Rinker MATERIALS

Stormceptor® EF Sizing Report

Imbrium® Systems
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

07/10/2025

Province:	Ontario
City:	Hamilton
Nearest Rainfall Station:	HAMILTON RBG CS
Climate Station Id:	6153301
Years of Rainfall Data:	20
Site Name:	70 Hope Avenue
Drainage Area (ha):	0.28
Runoff Coefficient 'c':	0.76

Project Name:	70 Hope Avenue
Project Number:	68281
Designer Name:	Hasan Zubair
Designer Company:	MTE Consultants
Designer Email:	HZubair@mte85.com
Designer Phone:	905-510-2898
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Particle Size Distribution:	Fine
Target TSS Removal (%):	80.0
Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	6.66
Oil / Fuel Spill Risk Site?	Yes
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Influent TSS Concentration (mg/L):	200
Estimated Average Annual Sediment Load (kg/yr):	282
Estimated Average Annual Sediment Volume (L/yr):	229

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	92
EFO5	95
EFO6	97
EFO8	99
EFO10	100
EFO12	100

Recommended Stormceptor EFO Model:	**EFO4**
Estimated Net Annual Sediment (TSS) Load Reduction (%):	**92**
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 waterways.

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.

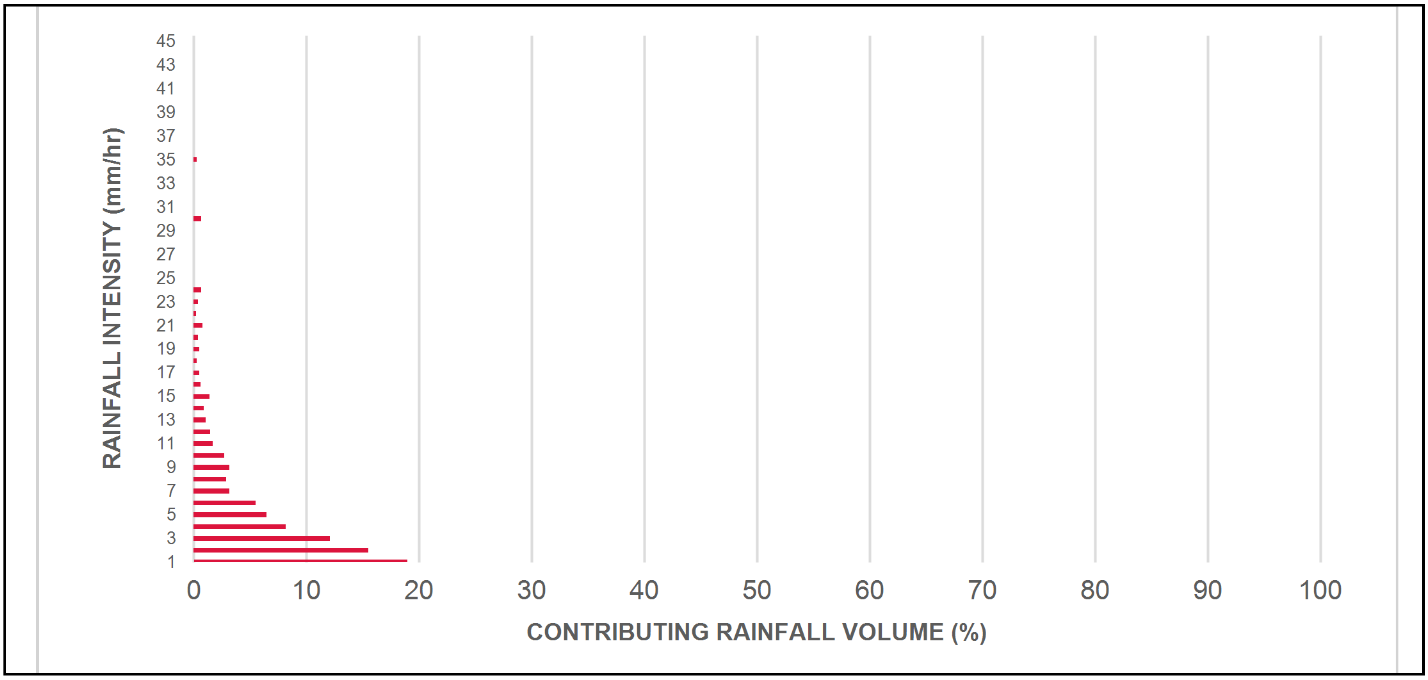
Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

Stormceptor® EF Sizing Report

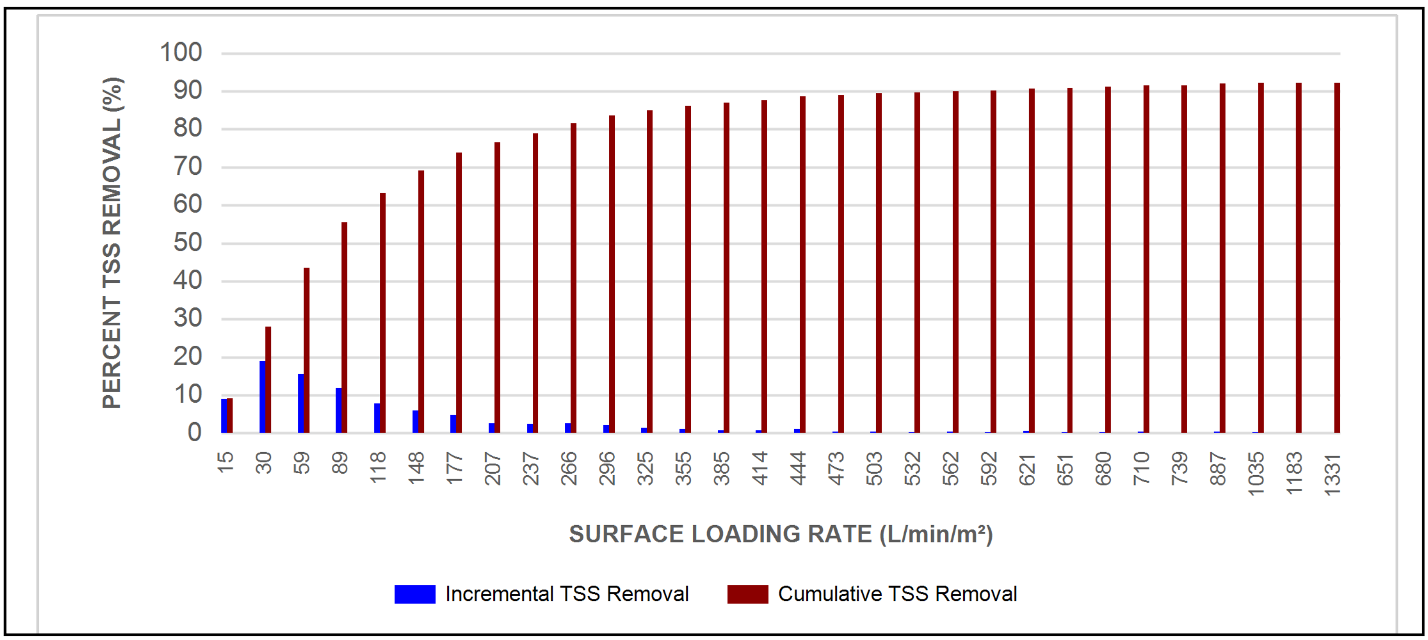
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
0.50	9.1	9.1	0.30	18.0	15.0	100	9.1	9.1
1.00	19.0	28.0	0.59	35.0	30.0	100	19.0	28.0
2.00	15.5	43.5	1.18	71.0	59.0	100	15.5	43.5
3.00	12.1	55.6	1.77	106.0	89.0	98	11.9	55.5
4.00	8.2	63.8	2.37	142.0	118.0	95	7.8	63.2
5.00	6.5	70.4	2.96	177.0	148.0	91	5.9	69.1
6.00	5.5	75.9	3.55	213.0	177.0	87	4.8	73.9
7.00	3.2	79.0	4.14	248.0	207.0	83	2.6	76.5
8.00	2.9	81.9	4.73	284.0	237.0	82	2.4	78.9
9.00	3.2	85.2	5.32	319.0	266.0	80	2.6	81.5
10.00	2.7	87.9	5.92	355.0	296.0	79	2.1	83.6
11.00	1.7	89.6	6.51	390.0	325.0	78	1.4	85.0
12.00	1.5	91.1	7.10	426.0	355.0	76	1.1	86.1
13.00	1.1	92.2	7.69	461.0	385.0	75	0.8	86.9
14.00	0.9	93.1	8.28	497.0	414.0	73	0.7	87.6
15.00	1.4	94.5	8.87	532.0	444.0	72	1.0	88.6
16.00	0.6	95.1	9.47	568.0	473.0	71	0.4	89.0
17.00	0.5	95.6	10.06	603.0	503.0	69	0.3	89.4
18.00	0.3	95.9	10.65	639.0	532.0	68	0.2	89.6
19.00	0.5	96.4	11.24	674.0	562.0	66	0.4	90.0
20.00	0.4	96.8	11.83	710.0	592.0	65	0.2	90.2
21.00	0.8	97.6	12.42	745.0	621.0	64	0.5	90.7
22.00	0.2	97.8	13.01	781.0	651.0	64	0.1	90.8
23.00	0.4	98.2	13.61	816.0	680.0	64	0.3	91.1
24.00	0.7	98.9	14.20	852.0	710.0	64	0.4	91.5
25.00	0.0	98.9	14.79	887.0	739.0	64	0.0	91.5
30.00	0.7	99.7	17.75	1065.0	887.0	62	0.5	92.0
35.00	0.3	100.0	20.71	1242.0	1035.0	61	0.2	92.2
40.00	0.0	100.0	23.66	1420.0	1183.0	57	0.0	92.2
45.00	0.0	100.0	26.62	1597.0	1331.0	54	0.0	92.2
Estimated Net Annual Sediment (TSS) Load Reduction =								**92 %**

Climate Station ID: 6153301 *Years of Rainfall Data*: 20

RAINFALL DATA FROM HAMILTON RBG CS 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
EF5 / EFO5	1.5	5	90	762	30	762	30	710	25
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

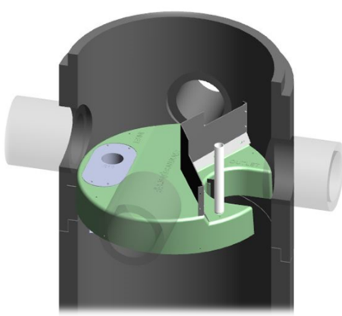
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test 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.

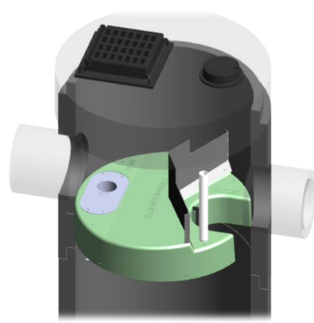
DESIGN FLEXIBILITY

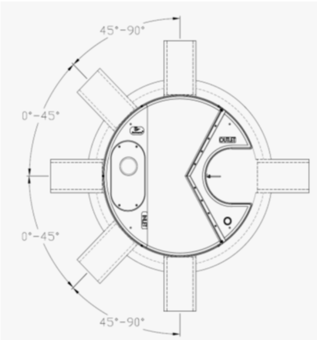
►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend 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
EF5 / EFO5	1.5	5	1.62	5.3	420	111	305	10	2124	75	2612	5758
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 TREAMENT 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** S**eparators**

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
	5 ft (1524 mm) Diameter OGS Units:	1.95 m^3 sediment / 420 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 of the OGS shall be determined by use of a minimum ten (10) years of local historical rainfall data provided by Environment Canada. Sizing shall also be determined by use of the sediment removal performance data derived from the ISO 14034 ETV third-party verified laboratory testing data from testing conducted in accordance with the Canadian ETV protocol Procedure for Laboratory Testing of Oil-Grit Separators, as follows:

3.2.1 Sediment removal efficiency for a given surface loading rate and its associated flow rate shall be based on sediment removal efficiency demonstrated at the seven (7) tested surface loading rates specified in the protocol, ranging 40 L/min/m^2 to 1400 L/min/m^2, and as stated in the ISO 14034 ETV Verification Statement for the OGS device.

3.2.2 Sediment removal efficiency for surface loading rates between 40 L/min/m^2 and 1400 L/min/m^2 shall be based on linear interpolation of data between consecutive tested surface loading rates.

3.2.3 Sediment removal efficiency for surface loading rates less than the lowest tested surface loading rate of 40 L/min/m^2 shall be assumed to be identical to the sediment removal efficiency at 40 L/min/m^2. No extrapolation shall be allowed that results in a sediment removal efficiency that is greater than that demonstrated at 40 L/min/m^2.

3.2.4 Sediment removal efficiency for surface loading rates greater than the highest tested surface loading rate of 1400 L/min/m^2 shall assume zero sediment removal for the portion of flow that exceeds 1400 L/min/m^2, and shall be calculated using a simple proportioning formula, with 1400 L/min/m^2 in the numerator and the higher surface loading rate in the denominator, and multiplying the resulting fraction times the sediment removal efficiency at 1400 L/min/m^2.

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.

3.4 LIGHT LIQUID RE-ENTRAINMENT SIMULATION TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of completed third-party Light Liquid

Re-entrainment Simulation Testing in accordance with the Canadian ETV **Program's Procedure for Laboratory Testing of Oil-Grit Separators,** with results reported within the Canadian ETV or ISO 14034 ETV verification. This re-entrainment testing is conducted with the device pre-loaded with low density polyethylene (LDPE) plastic beads as a surrogate for light liquids such as oil and fuel. Testing is conducted on the same OGS unit tested for sediment removal to assess whether light liquids captured after a spill are effectively retained at high flow rates.

3.4.1 For an OGS device to be an acceptable stormwater treatment device on a site where vehicular traffic occurs and the potential for an oil or fuel spill exists, the OGS device must have reported verified performance results of greater than 99% cumulative retention of LDPE plastic beads for the five specified surface loading rates (ranging 200 L/min/m^2 to 2600 L/min/m^2) in accordance with the Light Liquid Re-entrainment Simulation Testing within the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.** However, an OGS device shall not be allowed if the Light Liquid Re-entrainment Simulation Testing was performed with screening components within the OGS device that are effective at retaining the LDPE plastic beads, but would not be expected to retain light liquids such as oil and fuel.

Appendix C

Water Calculations

70 Hope Avenue
City of Hamilton
Project No: 60939_001
Date: July 2025
By: HZN

Water Demand Calculations for Options 1 & 2

Location	Residential: Number of Units (ea) [1]	Population Density [2] (people/unit)	Population (persons)	Demand (L/s)	Floor Area (m^2)	Population Density [5] (m^2/person)	Equiv. Population (persons)	Demand (L/s)	Final Demand: Avg Day Demand Qavg (L/s)	Max Day Demand [3] Qmax.day (L/s)	Peak Hour Demand [3] Qpeak (L/s)
Option 1											
Residential (3-Storey Apartment Building)											
1-Bedroom	50	1.342	68	0.28					0.28	0.54	0.85
Totals	**50**		**68**	**0.283**					**0.283**	**0.538**	**0.850**
Option 2											
Residential (3-Storey Townhouses)											
3-Bedroom	10	2.637	27	0.11					0.11	0.21	0.34
2-Bedroom	20	2.637	53	0.22					0.22	0.42	0.66
Totals	**30**		**80**	**0.333**					**0.333**	**0.633**	**1.000**

Water Demand [3]		
Average Daily Demand	360	L/d/person
Maximum Day Demand (1.9 Max Day Factor)	684	L/d/person
Peak Hour Demand (3.0 Peak Hour Factor)	1080	L/d/person

Max Day + Fire Flow Demand		
Qmax.day+fire for option 1 - Building	**150.54**	L/s
Qmax.day+fire for option 2 - Townhouse	**150.63**	L/s

Target Available Fire Flow [4 6]		
Fire Flow	150.00	L/s

Note 1: Unit information for both options provided by Invizij Architects Inc.
Note 2: Population Density based City of Hamilton Development Charges Update Study (December 21, 2023)
Note 3: Water Demands per MOE Design Guidelines for Drinking Water Systems & City of Hamilton Guidelines
Note 4: Fire flows from OBC (2024) - See attached worksheet
Note 5: Daily flow density based on OBC Table 8.2.1.3.B.
Note 6: Target AFF of 150 (L/s) for residential multi (greater than 3 units) taken from City of Hamilton Required Fire Flow form.

70 Hope Avenue
FIRE FLOW ANALYSIS
Hamilton, Ontario

Project Number: 60939_001
Date: July 2025
Design By: HZN

File: Q:\60939_001\WTM\60939_001 Water Calculations_Combined.xlsx

Step 1: Determining Water Supply Coefficient

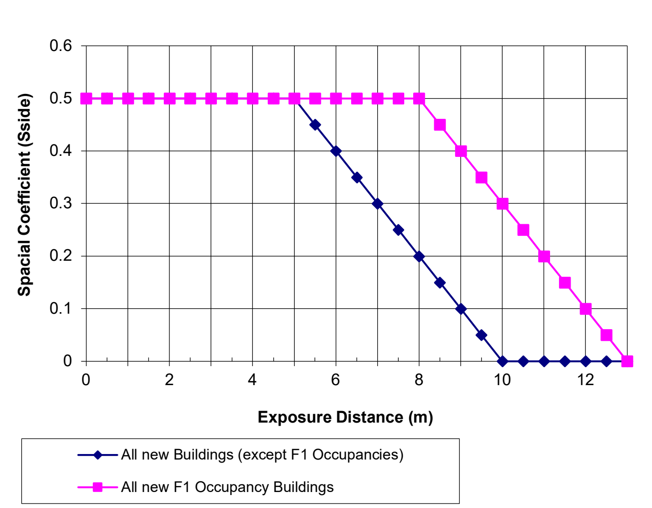
	Table 1 from OBC 2012 A3.2.5.7													
	Type of Construction	Classification by group or division in Accordance with Table 3.1.2.1 of the Ontario Building Code												
		A2	B1	B2	B3	C	D	A4	F3	A1	A3	E	F2	F1
1	Building is of Noncombustible construction with fire separation and fire-resistance ratings provided in accordance with Subsection 3.2.2 of the OBC, including loadbearing walls, columns and arches						10		12		14		17	23
2	Building is of Noncombustible construction or of heavy timber construction conforming to Article 3.1.4.6 of the OBC. Floor assemblies are fire separations but no fire-resistance rating. Roof assemblies, mezzanines, loadbearing walls, columns and arches do not have a fire-resistance rating.						16		19		22		27	37
3	Building is of Combustible Construction with fire separations and fire-resistance ratings provided in accordance with Subsection 3.2.2 of the OBC, including loadbearing walls, columns and arches. Noncombustible construction may be used in lieu of fire resistance rating where permitted in subsection 3.2.2 of the OBC						18		22		25		31	41
4	Building is of combustible construction. Floor assemblies are fire separations but with no fire-resistance rating. Roof assemblies, mezzanines, loadbearing walls, columns and arches do not have a fire-resistance rating.						23		28		32		39	53

Type of Construction	Building Classification	Water Supply Coefficient (K)
3	C	**18**

Step 2: Determine the Spacial Coefficient

EXISTING BUILDING	Distance	S_{side}
East Exposure (m)	8.74	0.13
South Exposure (m)	24.70	0.00
West Exposure (m)	9.20	0.08
North Exposure (m)	2.10	0.50
	S_{tot}	**1.71**

Figure 1 - Spatial Coefficient vs Exposure Distance



Step 3: Determine Volume of Building

PROPOSED BUILDING

Floor	GFA	Height	Volume (m^3)
1	709	3.05	2162.45
2	709	3.05	2162.45
3	709	3.05	2162.45
			6,487

Step 4: Calculate Minimum Water Supply

$$Q = KVS_{tot}$$

Water Supply (L)	**199,214**

Step 5: Calculate Minimum Supply Flow Rate

Table 2 from OBC 2012 A3.2.5.7			
Minimum Water Supply Flow Rates			
Building Code, Part 3 Buildings	**Required Minimum Water Supply Flow**		
One Storey Building with building area		1800	
All Other Buildings	if Q> and	Q<=	
		108000	2700
	108000	135000	3600
	135000	162000	4500
	162000	190000	5400
	190000	270000	6300
	270000		9000

Minimum Water Supply Flow Rate (L/min)	**6300**

70 Hope Avenue
FIRE FLOW ANALYSIS
Hamilton, Ontario

Project Number: 60939_001
Date: July 2025
Design By: HZN

File: Q:\60939_001\WTM\60939_001 Water Calculations_Combined.xlsx

Step 1: Determining Water Supply Coefficient

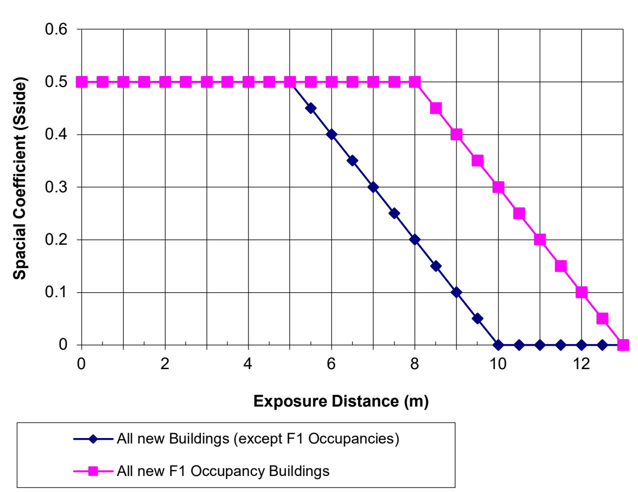
	Table 1 from OBC 2012 A3.2.5.7													
	Type of Construction	**Classification by group or division in Accordance with Table 3.1.2.1 of the Ontario Building Code**												
		A2	**B1**	**B2**	**B3**	**C**	**D**	**A4**	**F3**	**A1**	**A3**	**E**	**F2**	**F1**
1	Building is of Noncombustible construction with fire separation and fire-resistance ratings provided in accordance with Subsection 3.2.2 of the OBC, including loadbearing walls, columns and arches						10		12		14		17	23
2	Building is of Noncombustible construction or of heavy timber construction conforming to Article 3.1.4.6 of the OBC. Floor assemblies are fire separations but no fire-resistance rating. Roof assemblies, mezzanines, loadbearing walls, columns and arches do not have a fire-resistance rating.						16		19		22		27	37
3	Building is of Combustible Construction with fire separations and fire-resistance ratings provided in accordance with Subsection 3.2.2 of the OBC, including loadbearing walls, columns and arches. Noncombustible construction may be used in lieu of fire resistance rating where permitted in subsection 3.2.2 of the OBC						18		22		25		31	41
4	Building is of combustible construction. Floor assemblies are fire separations but with no fire-resistance rating. Roof assemblies, mezzanines, loadbearing walls, columns and arches do not have a fire-resistance rating.						23		28		32		39	53

Type of Construction	Building Classification	Water Supply Coefficient (K)
3	D	**18**

Step 2: Determine the Spacial Coefficient

EXISTING BUILDING	**Distance**	**S_{side}**
East Exposure (m)	8.74	0.13
South Exposure (m)	24.70	0.00
West Exposure (m)	9.20	0.08
North Exposure (m)	2.10	0.50
	S_{tot}	**1.71**

Figure 1 - Spatial Coefficient vs Exposure Distance



Step 3: Determine Volume of Building

PROPOSED TOWNHOUSES

Floor	GFA	Height	Volume (m^3)
1	709	2.74	1942.66
2	709	2.74	1942.66
3	709	2.74	1942.66
			5,828

Step 4: Calculate Minimum Water Supply

$$Q = KVS_{tot}$$

Water Supply (L)	178,966

Step 5: Calculate Minimum Supply Flow Rate

Table 2 from OBC 2012 A3.2.5.7			
Minimum Water Supply Flow Rates			
Building Code, Part 3 Buildings	**Required Minimum Water Supply Flow**		
One Storey Building with building area	1800		
All Other Buildings	if Q> and	Q<=	
		108000	2700
	108000	135000	3600
	135000	162000	4500
	162000	190000	5400
	190000	270000	6300
	270000		9000

Minimum Water Supply Flow Rate (L/min)	4500

Adequate Water Services - Required Fire Flow-RFF and Available Fire Flow-AFF – (PILOT VERSION-01)

Application Number :	PED23099(a)/ HSC23028(a)
Municipal Address :	70 Hope Avenue, Hamilton

Through staff report PW19096 - City of Hamilton Watermain Fire Flow Requirement Design Guidelines Policy on November 27th, 2019 Council adopted the new fire flow policy. This form is intended to guide applicants through the documentation requirements of this change. FUS calculations are no longer required for new submissions. This form is supplemental to related and supporting documentation/calculations.

1 - REQUIRED FIRE FLOW – RFF

1 a) Required Fire Flow-RFF a)

$Q = KVS_{Tot}$

Please provide required fire flow-RFF using the water supply flow rate method (OBC section A-3.2.5.7 ; OFM-TG-03-1999 FIRE PROTECTION WATER SUPPLY GUIDELINE FOR PART 3 IN THE ONTARIO BUILDING CODE - 6.3 Buildings Requiring On-Site Fire Protection Water Supply ; $Q = KVS_{Tot}$). This methodology shall be applied to all buildings falling under Part 3 and Part 9 of the Building Code (OBC sections 1.1.2.2 and 1.1.2.4). Detailed calculations shall be submitted as an appended memo.

Enter calculated value here (highest if multiple buildings)

105 Litres / second

Comments :

Proposed building Q=199214 Litres, therefore RFF=6300 L/min=105 L/s. Refer to report for other fire flow calculation

1 b) Required Fire Flow-RFF b)

Target Table

Please select from **Table 1 : Target Available Fire Flow**

Table 1: Target Available Fire Flow

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

[1] 1800m^3 represents a maximum building volume that qualifies as "Small ICI"

Enter applicable value for Target Available Fire Flow (highest value if multiple Land Uses) here:

150 Litres / second

Comments :

For Residential Multi, target available fire flow is 150 L/s. Refer to report for other fire flow calculation

1 c) Required Fire Flow-RFF c)

Enter higher of a) or b) from above

Enter value here :

150 Litres / second

Comments :

Refer to report for other fire flow calculation

Application Number :	PED23099(a)/ HSC23028(a)
Municipal Address :	70 Hope Avenue, Hamilton

2 - AVAILABLE FIRE FLOW - AFF

2 a) Available Fire Flow-AFF a)

Field Hydrant Test calculated at 20 psi

Please provide available fire flow-AFF as determined through developer hydrant fire flow test or City Hydrant test database.

Enter value here :

90 Litres / second

Please check :

- [x] Developer hydrant fire flow test, or *(as directed in FC or thereafter)*
- [ ] City Hydrant test database

Comments :

Fire Hydrant Municipal ID: HB22H001

OR (as directed in FC or thereafter)

2 b) Available Fire Flow-AFF b)

Computer Modelling

Please provide available fire flow-AFF as determined through computer modelling.

- [ ] Modelling criteria and boundary conditions were approved by Hamilton Water

Enter value here :

______ Litres / second

Comments :

DECLARATION OF ADEQUATE SERVICES

- [ ] RFF c) is less than or equal to AFF, or
- [x] RFF c) is greater than AFF.

Prepared by : Hasan Zubair

Date : July 31, 2025

ArcGIS Web Map

4/13/2025, 2:17:43 PM

Hydrant Branch

Main

100 to 399mm

Hydrant

Hydrant

1:1,128

0 0.01 0.01 0.03 mi

0 0.01 0.03 0.06 km

City of Hamilton

Hydrant Flow Test Report

SITE NAME:

SITE ADDRESS / MUNICIPALITY: **70 Hope Avenue Hamilton , ON**

TEST HYDRANT LOCATION : **Front of # 145 Hope Ave**
(Municipal ID: HB33H028)

BASE HYDRANT LOCATION: **Front od # 87 Hope Ave**
(Municipal ID: HB22H001)

TEST BY: Luzia Wood

TEST DATE:
April 14 2025

TEST TIME:
12:56PM

TEST DATA

FLOW HYDRANT — Pipe Diam. (in / mm): 150mm

	PITOT 1	PITOT 2
SIZE OPENING (inches):	2.5	2.5
COEFFICIENT (**note 1**):	0.90	0.90
PITOT READING (psi):	40	18 / 18
FLOW (usgpm):	**1061**	**1424**

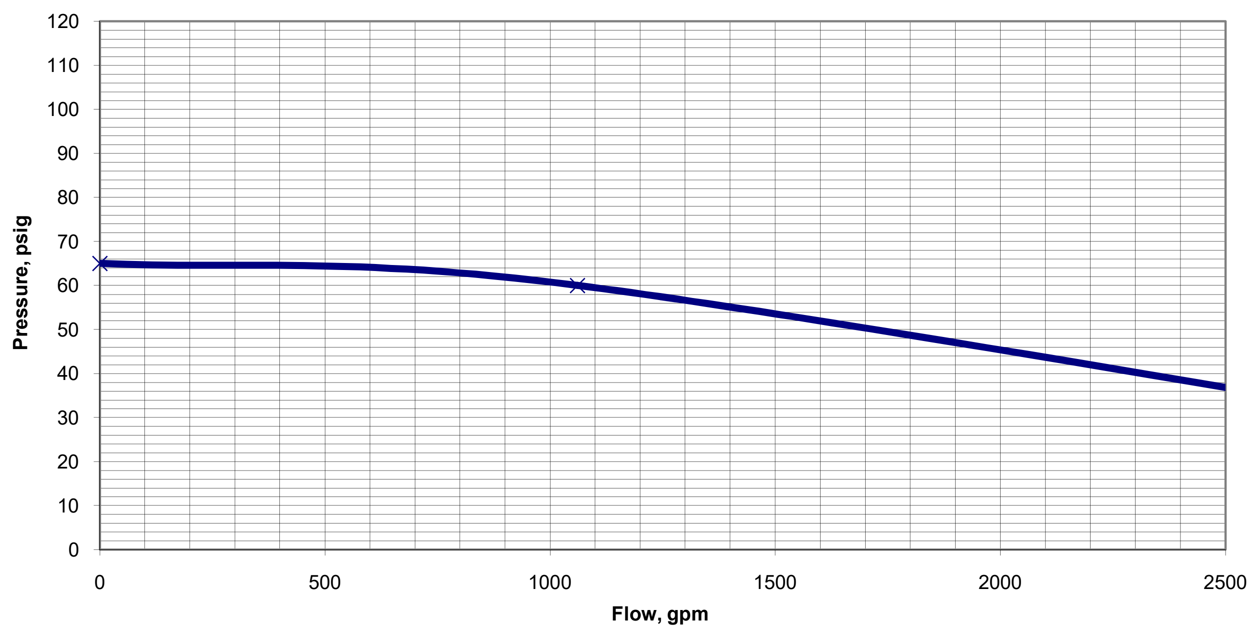
THEORETICAL FLOW @ 20 PSI 3476

BASE HYDRANT — Pipe Diam. (in / mm): 150mm

STATIC READING (psi): 65 RESIDUAL 1 (psi): 60 RESIDUAL 2 (psi): 55

REMARKS:

NOTE 1 : Conversion factor of .90 used for flow calculation based on rounded and flush internal nozzle configuration. No appreciable difference in pipe invert between flow and base hydrants.



L & D Waterworks Inc.
491 Port Maitland Rd
Dunnville, ON N1A 2W6
Ph: 289.684.6747
Email: ldwaterworks2005@gmail.com

Appendix D

Correspondence

Planning and Development Department
Development Division - Engineering Section
71 Main Street West 6th floor
Hamilton, Ontario, Canada
L8P 4Y5
www.city.hamilton.on.ca

Memorandum

To: Justin Waud
Planning Technician
Planning and Economic Development

From: Sandra Al-Dabbagh
Development Coordinator
Development Engineering

Phone: (905) 546 - 2424 Ext. 5197

Date: December 10, 2024 **File:** PED23099(a)/HSC 23028(a)

Subject: **Request for Review and Comments for Proposed City-Initiated Zoning By-law Amendment for Lands Located at 70 Hope Avenue, Hamilton (Ward 4)**

The zoning of the subject property is proposed to be changed from the Parking (U3) Zone to the Mixed-Use Medium Density (C5) Zone in Zoning By-law No. 05-200 to facilitate the development of a three-storey multiple dwelling with approximately 54 units, and a fourplex dwelling.

The Development Engineering section has reviewed the above noted application attached to your memo dated November 6, 2024, and provide the following comments:

Development Engineering Comments:

1. A Functional Servicing Report (FSR) shall be submitted with any future planning applications to demonstrate that the existing municipal watermains and sewer systems can support the proposed development and intensification, as per the current City of Hamilton Development Guidelines,

2. The applicant will be required to submit a Grading Plan and Erosion & Sediment Control Plan along with the grading inspection fee and drawing review fee (at current time of fee schedule).

3. The applicant will be required to submit a Site Servicing Plan, signed, and stamped by a licensed professional (P.Eng). Excavation permits for new service installations will be required.

Subject: Request for Review and Comments for Proposed City-Initiated Zoning By-law Amendment for Lands Located at 70 Hope Avenue, Hamilton (Ward 4)

Stormwater Management

1. The current submission did not provide a SWM Brief. A SWM brief/ FSR shall be submitted in support of the proposed development demonstrating how the following stormwater quantity and quality control criteria will be achieved for the subject development in accordance with the City standards:

<u>Storm water quantity control criteria:</u>

2. The SWM brief/FSR shall demonstrate existing drainage conditions including existing storm outlets and provide suitable storm outlet (s) for the proposed development.

3. The subject site is located in the City's combined sewer area.

4. The 100-year post-development flow at the subject site should be controlled to the lesser of the 2-year pre-development level (based on the contributing drainage areas under existing conditions at each proposed storm outlet) or free flow capacity of existing lateral (if any). Additionally, the design should also confirm that proposed release/discharge (up to 100-year) from the subject site is consistent with City's GIS storm/combined polygons (i.e. proposed release up to 100-year storm event should not exceed 2-year allowable flow based on City's GIS storm/combined Polygon layer area and ultimate runoff coefficient for each storm outlet).

5. Any newly proposed storm lateral should connect to the storm relief sewer where applicable. There is a 1200mm combined sewer available on Hope Avenue fronting the subject site.

<u>Storm water quality control criteria:</u>

6. 'Level 1' ('Enhanced Protection') stormwater quality control should be provided considering treatment train design principles in accordance with City of Hamilton and MECP's standards. The SWM design shall consider landscape based green infrastructure LIDs to achieve treatment train water quality control objectives in accordance with the City's Green Development Standards. The subject development shall implement Low Impact Development (LID) measures in accordance with City's Green Development Standards.

Subject: Request for Review and Comments for Proposed City-Initiated Zoning By-law Amendment for Lands Located at 70 Hope Avenue, Hamilton (Ward 4)

Source Water Protection

The proposal is for the development of a 3-storey multiple dwelling and a fourplex unit. It is unclear if there will be any underground parking/basement levels. Our comments are as follows:

1. If the proposed building will have any underground parking/basement levels, then the following would be required:
   - As a condition of approval to the satisfaction of Director, Hamilton Water, Source Protection Planning would require a Hydrogeological Brief conducted by a qualified professional (P.Eng., P.Geo.) that discusses soil/groundwater conditions to properly characterize potential dewatering needs. This brief should discuss seasonal high groundwater levels, excavation depths, dewatering calculations (on a L/s and L/day basis), and if dewatering is required, groundwater quality sampling to compare against Sewer Use Bylaw criteria.
   - Due to limited capacity in the sewer system among other factors, the applicant shall demonstrate that no long-term dewatering (due to groundwater) will be conveyed to the municipal sewer infrastructure. Foundation / subsurface structures shall be designed / waterproofed accordingly.

2. If dewatering is required, the applicant shall provide the following during the site plan approval stage:

- If an EASR Registration with the MECP is required to permit temporary dewatering during the construction period, the applicant shall provide a copy of the EASR Permit issued by the MECP
- A dewatering and discharge plan showing the location of: (i) premise location; (ii) source of water taking; (iii) flow meter; (iv) sampling port; (v) settlement / holding tank and/or treatment system; (vi) discharge location (incl. maintenance access hole ID); (vii) hoses / piping for conveying water; and (viii) other useful information (i.e., cardinal arrows, landmarks, road names etc.).

3. If dewatering is not anticipated, as a condition of approval to the satisfaction of Director, Hamilton Water, the applicant shall provide a technical memorandum from a qualified professional (P.Eng, P.Geo) that regarding a Groundwater Monitoring and Contingency plan that outlines their protocol for action in case impacts arise from private well owners nearby. This contingency plan would include identification and monitoring of potential impacts, triggers, timelines for investigation, City notification protocol, and mitigation plans in case impacts arise.

4. **Information Only:** If dewatering is required to support construction activities, the applicant is reminded that dewatering discharge must comply with City of Hamilton Sewer Use Bylaw standards. It is recommended to consult with the Superintendent of Environmental Monitoring and Enforcement Group within Hamilton Water as early as possible in the approval process, given that additional review may be required by Hamilton Water to verify the wastewater system could accept the quantity and/or quality of the discharge. Email sewerusebylaw@hamilton.ca to better understand water discharges to City infrastructure. If dewatering is expected to exceed 50,000 L/day, registration with the Environmental Activity Sector Registry or a Permit to Take Water from the Ministry of Environment, Conservation, and Parks may be required.

Water Servicing

Regarding the memo of November 6, 2024, requesting comments on the proposal to facilitate the development of a three-storey multiple dwelling with approximately 54 residential units, on the subject lands at 70 Hope Avenue in Hamilton:

1. Water service for the proposed development can be connected to the existing 150 mm diameter municipal watermain on Hope Avenue.

2. To determine the approximate static pressure of the watermain, and collect calibration data for hydraulic modelling if needed, two-hydrant flow tests should be conducted at the closest municipal hydrants by the proponent through a licensed private contractor.

3. With the application for site plan control, the proponent is required to provide a servicing report, prepared by a licensed Professional Engineer, addressing:

   - How the proponent intends to provide water servicing for the new development.
   - Intended occupancy, intended land use from the table below, and the anticipated water demands.
   - The required fire flow (RFF) for the building calculated per the Ontario Building Code (OBC) Water Supply Flow Rate Method (OBC Section A-3.2.5.7) falling under Part 3 and Part 9 of the Building Code (OBC sections 1.1.2.2 and 1.1.2.4). Details to support the RFF calculation (e.g., building volume, type of construction, major occupancy classifications and property line exposures) shall be clearly identified and properly documented.
   - Summary of the available fire flow in the area, based on two-hydrant flow tests, and a conclusion as to the adequacy of available flow from the municipal system for the proposal. The municipal system as is, or with enhancement, must be able to provide the greater of the RFF calculated

using the OBC methodology, or the target available fire flow (AFF) for the proposed land use, as per the table below.

Land Use	Target AFF (L/s)
Commercial	150
Small ICI (<1800 m^3)	100
Industrial	250
Institutional	150
Residential Multi (greater than three units)	150
Residential Medium (three or less units)	125
Residential Single	75
Residential Single (dead end)	50

- The Adequate Water Services – Required Fire Flow-RFF and Available Fire Flow-AFF Form found at pedpolicies-developmentguidelines-financialpolices-manual-waterservices.pdf (hamilton.ca) should be completed and submitted for the proposed development.

4. A watermain hydraulic analysis (WHA), identifying the modelled system pressures at pressure district (PD1) level under various boundary conditions and demand scenarios, will be required to support the site plan control application. Please note that the requirement for a WHA may be waived following review of the water demand and fire flow requirements if it can be demonstrated that there is adequate service for the proposed development within the existing municipal system based on hydrant tests.

5. If the proponent intends to install sprinkler systems to ensure fire protection of the proposed building, the hydraulic parameters (flow and pressure) required by this system will need to be provided during the building permit application stage.

6. It will be the responsibility of the proponent to ensure that any unique hydraulic requirements to support private site appurtenances such as process equipment, domestic or fire booster pumps, minimum suction side pressure, large volumes, compliance with the OBC, etc., have been accounted for.

Recommendations:

The proposed development may be subject but not limited to the following requirements. Under the following future applications:

Subject: Request for Review and Comments for Proposed City-Initiated Zoning By-law Amendment for Lands Located at 70 Hope Avenue, Hamilton (Ward 4)

Required for ZBA application:

- Functional Servicing Report, including:
  - Wastewater Assessment based on OBC Part 8 (for informational purposes of Hamilton Water)
  - Watermain Hydraulic Analysis (may be waived following review of the water demand and fire flow requirements)
  - Two-hydrant flow test data
  - Stormwater Management Brief
  - Hydrogeological Brief
  - Preliminary Servicing Plan
  - Preliminary Grading Plan

Should you have any questions please contact me at 905-546-2424 x 5197 or by email at Sandra.Al-Dabbagh@hamilton.ca.

Sandra Al-Dabbagh
Development Coordinator
Development Engineering

cc. Helen McArthur, P.Eng., Senior Project Manager, Development Engineering
Monir Moniruzzaman, P. Eng., Manager – East Team, Development Engineering

T-3645

PLAN OF SURVEY OF
LOTS 6 & 7 BLOCK 6 REGISTERED PLAN No. 395
AND
LOTS 14, 15 & 16 REGISTERED PLAN No. 564
IN THE
CITY OF HAMILTON

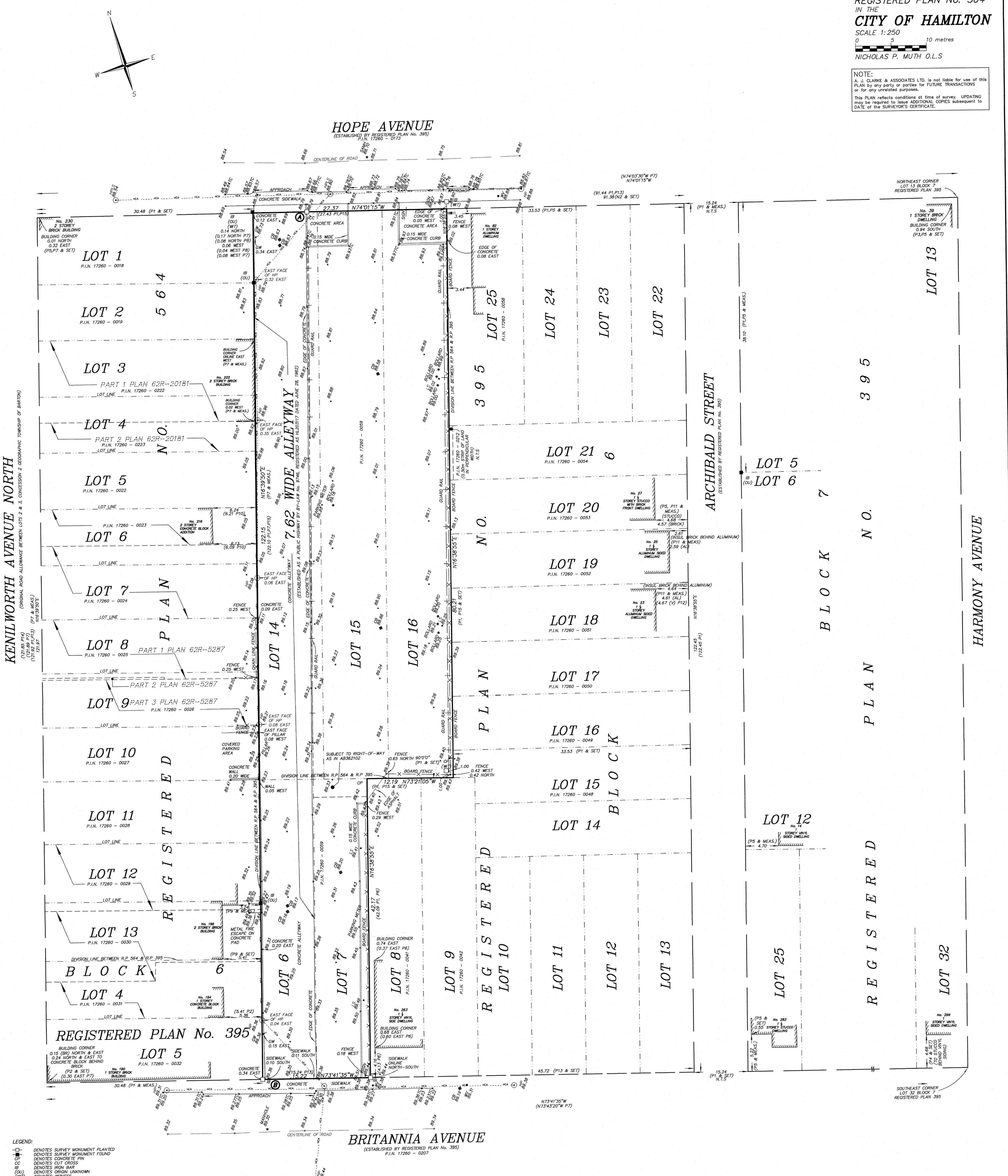
SCALE 1:250

0 5 10 metres

NICHOLAS P. MUTH O.L.S

NOTE:
A. J. CLARKE & ASSOCIATES LTD. is not liable for use of this PLAN by any party or parties for FUTURE TRANSACTIONS or for any unrelated purposes.

This PLAN reflects conditions at time of survey. UPDATING may be required to issue ADDITIONAL COPIES subsequent to DATE of the SURVEYOR'S CERTIFICATE.



LEGEND:

─□─	DENOTES SURVEY MONUMENT PLANTED
─■─	DENOTES SURVEY MONUMENT FOUND
CP	DENOTES CONCRETE PIN
CC	DENOTES CUT CROSS
IB	DENOTES IRON BAR
(OU)	DENOTES ORIGIN UNKNOWN
(WIT)	DENOTES WITNESS
(MEAS.)	DENOTES MEASURED
(P1)	DENOTES REGISTERED PLAN No. 564
(P2)	DENOTES BUILDING LOCATION SURVEY BY EDWARD BARICH O.L.S DATED MAY 18, 1988 (INDEX 2L–1633)
(P3)	DENOTES PLAN BY A.J. CLARKE & ASSOCIATES LTD DATED JANUARY 2, 1968 (INDEX H–4767)
(P4)	DENOTES BUILDING LOCATION SURVEY BY A.J. CLARKE & ASSOCIATES LTD DATED SEPTEMBER 12, 1985 (INDEX E–6689)
(P5)	DENOTES BUILDING LOCATION SURVEY BY A.J. CLARKE & ASSOCIATES LTD. DATED MARCH 1, 1988 (INDEX E–8344)
(P6)	DENOTES PLAN BY CITY OF HAMILTON DATED OCTOBER 21, 1974 (INDEX SS–1261)
(P7)	DENOTES PLAN 62R–20181
(P8)	DENOTES BUILDING LOCATION SURVEY BY GUIDO CONSOLI SURVEYING LTD. DATED APRIL 2, 1990 (INDEX 90–111)
(P9)	DENOTES PLAN BY JOSEPH FLAHERTY O.L.S DATED DECEMBER 5, 1966 (INDEX JF0225)
(P10)	DENOTES PLAN BY A.J. CLARKE & ASSOCIATES LTD. DATED MAY 1963 (INDEX H–1201)
(P11)	DENOTES PLAN BY A.J. CLARKE & ASSOCIATES LTD. DATED OCTOBER 12, 1973 (INDEX E–3028)
(P12)	DENOTES SURVEYOR'S REAL PROPERTY REPORT BY ASHENHURST NOUWENS & ASSOCIATES INC. DATED MARCH 10, 2017 (INDEX 17014)
(P13)	DENOTES REGISTERED PLAN No. 395
(P14)	DENOTES PLAN 62R–5287
(P15)	DENOTES PLAN BY CITY OF HAMILTON DATED JUNE 11 1962 (INDEX N.S.931) ATTACHED TO INST. HL203117
(N2)	DENOTES FIELD NOTES BY A.J. CLARKE & ASSOCIATES LTD. DATED SEPTEMBER 11, 1985
(BR)	DENOTES BRICK
(AL)	DENOTES ALUMINUM SIDING
(V)	DENOTES VINYL SIDING
HPLS	DENOTES HYDRO POLE & LIGHT STANDARD
CB	DENOTES CATCH BASIN
HP	DENOTES HYDRO POLE
GW	DENOTES GUY WIRE
WV	DENOTES WATER VALVE
LS	DENOTES LIGHT STANDARD
TC	DENOTES OF CURB
TW	DENOTES TOP OF WALL
N.T.S	DENOTES NOT TO SCALE
----- HCA -	DENOTES OVERHEAD WIRES

NOTE:

BUILDING MEASUREMENT TIES TAKEN TO FOUNDATION UNLESS NOTED OTHERWISE

BENCH MARK

CITY OF HAMILTON
MONUMENT No: 07720100036

RIB WITH BRASS CAP
MONUMENT IS LOCATED AT THE EAST SIDE OF MAHONY PARK, 90m NORTH OF THE CENTERLINE OF BARTON STREET EAST, 15m NORTH OF THE CENTERLINE OF GOGGIN AVENUE AND 16m WEST OF THE CENTERLINE OF ADELINE AVENUE.

ELEVATION= 86.893m CGVD 28:78

METRIC:

DISTANCES, COORDINATES & ELEVATIONS SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048

BEARINGS ARE UTM GRID, DERIVED FROM OBSERVED REFERENCE POINTS Ⓐ AND Ⓑ BY REAL TIME NETWORK (RTN) OBSERVATIONS, UTM ZONE 17, NAD83 (CSRS) (2010)

DISTANCES ARE GROUND AND CAN BE CONVERTED TO GRID BY MULTIPLYING BY THE COMBINED SCALE FACTOR OF 0.999707

OBSERVED REFERENCE POINTS: UTM ZONE 17, NAD83 (CSRS)(2010) COORDINATES TO URBAN ACCURACY PER SEC. 14 (2) OF O.REG. 216/10		
POINT ID	NORTHING	EASTING
Ⓐ	4788933.790	596890.596
Ⓑ	4788818.906	596848.246
COORDINATES CANNOT, IN THEMSELVES, BE USED TO RE-ESTABLISH CORNERS OR BOUNDARIES SHOWN ON THIS PLAN.		

FOR BEARING COMPARISON A ROTATION OF 02°27'35" COUNTERCLOCKWISE WAS APPLIED TO PLANS P1, P2, P4, P5, P6 P8, P11, P12, P13, P14 TO CONVERT TO GRID BEARINGS.

ASSOCIATION OF ONTARIO LAND SURVEYORS
PLAN SUBMISSION FORM
V–88409

THIS PLAN IS NOT VALID UNLESS IT IS AN EMBOSSED ORIGINAL COPY ISSUED BY THE SURVEYOR In accordance with Regulation 1026, Section 29(3)

SURVEYOR'S CERTIFICATE:

I CERTIFY THAT:

1. THIS SURVEY AND PLAN ARE CORRECT AND IN ACCORDANCE WITH THE SURVEYS ACT, THE SURVEYORS ACT, LAND TITLES ACT AND THE REGULATIONS MADE UNDER THEM.
2. THE SURVEY WAS COMPLETED ON THE 31st DAY OF OCTOBER, 2024

NOVEMBER 5, 2024
DATE

NICHOLAS P. MUTH
ONTARIO LAND SURVEYOR

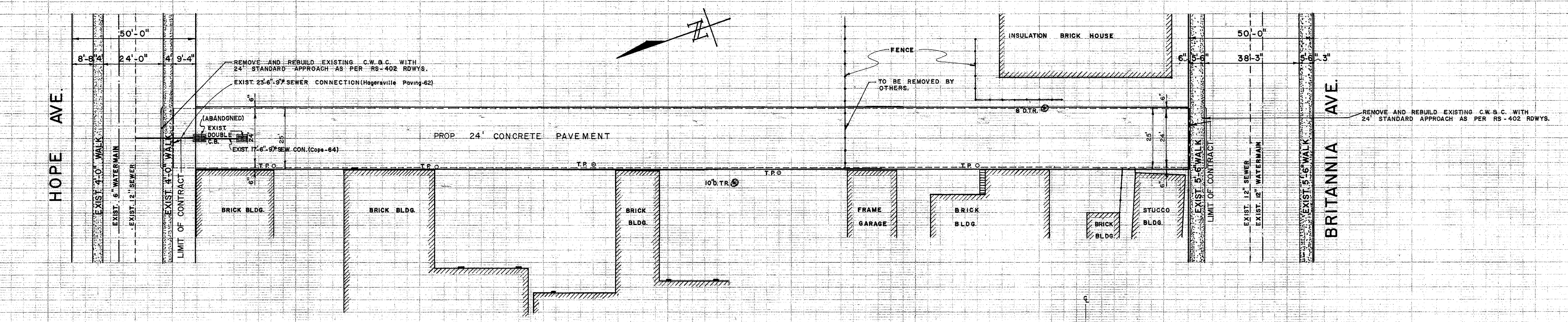
A. J. Clarke and Associates Ltd.
SURVEYORS • PLANNERS • ENGINEERS
25 MAIN STREET WEST, SUITE 300
HAMILTON, ONTARIO, L8P 1H1
TEL. 905–528–8761 FAX 905–528–2289
email: ajc@ajclarke.com

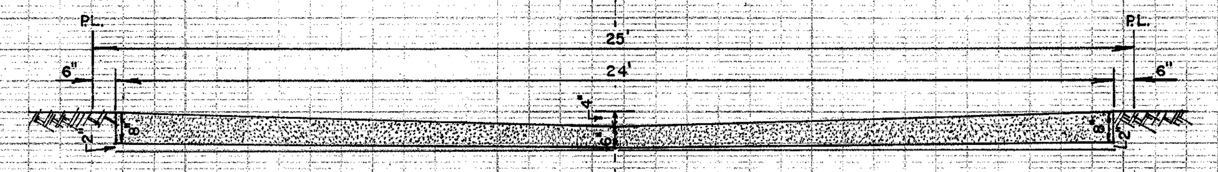
DRAWN BY:	CHECKED BY:	PROJECT No.	INDEX No.
MW	TK/NPM	248096D	T–3645

H:\Jobs\N-to-S\RP\395\BLK6\LOT6\70 Hope Street (248096D)\Current Work\T–3645.dwg

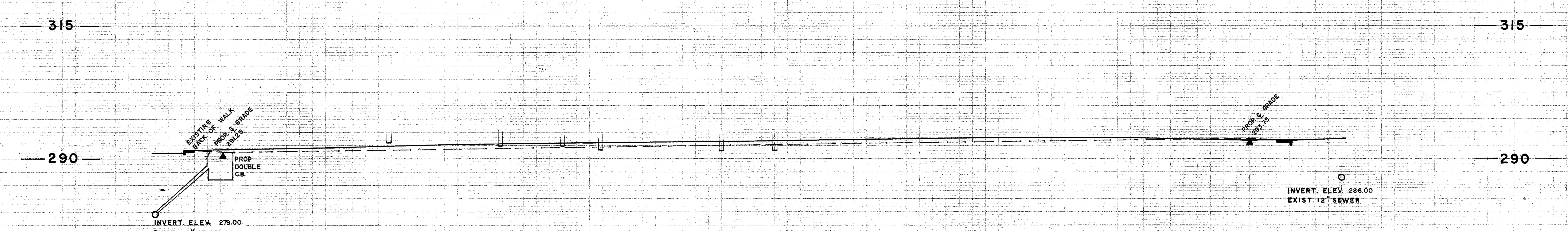
T–3645

ALLEYWAY
1ST. EAST OF KENILWORTH AV.
FROM HOPE AV. TO BRITANNIA AV.

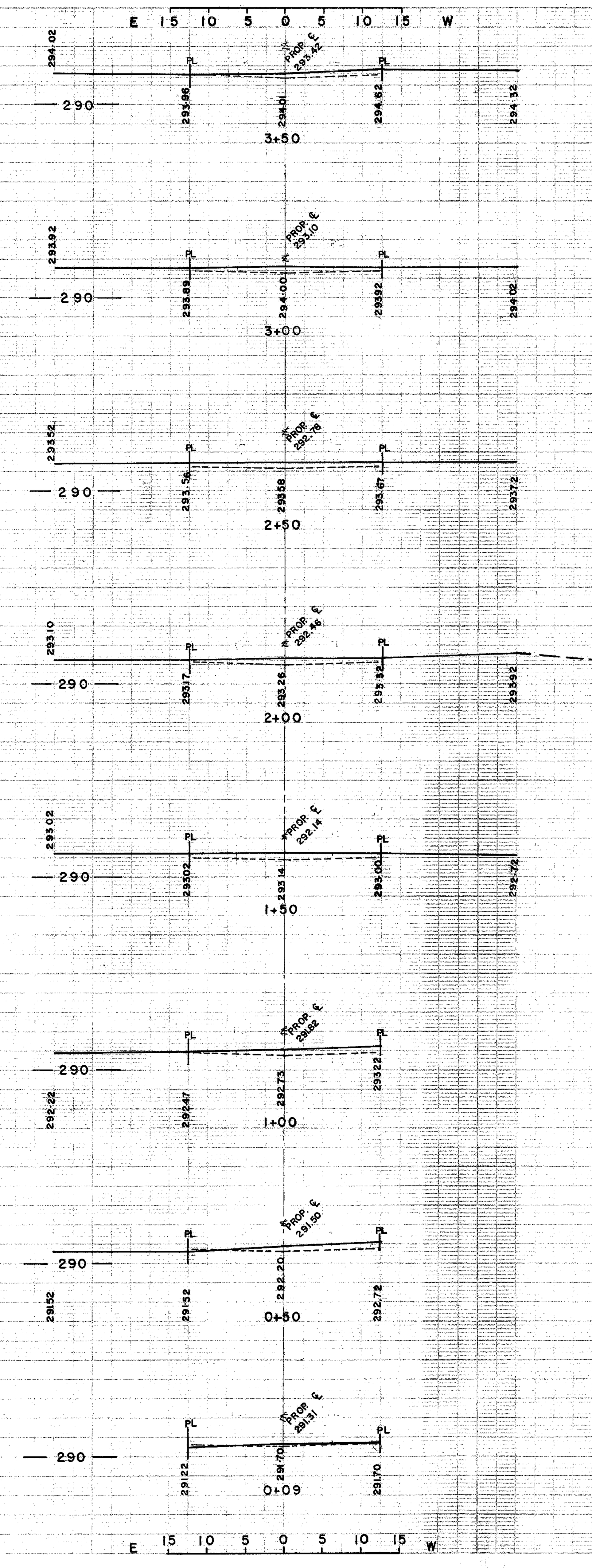


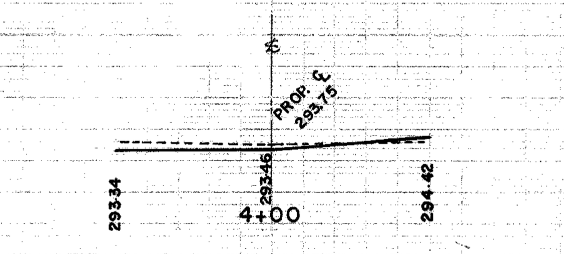


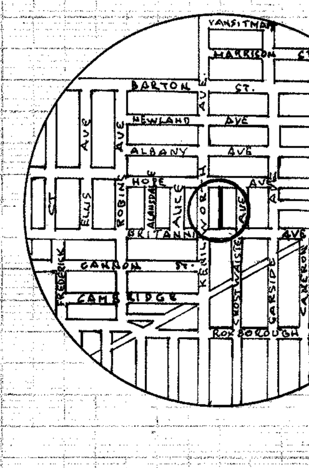
PROPOSED CONCRETE ALLEYWAY LAYOUT
SCALE 1" = 3'-0"



					door step		door step	door step		door step		door step	door step										
ELEVATIONS	291.12	291.11	291.57	291.70	292.20	293.02	292.73	292.42	292.45	293.14	291.62	293.26	291.57	291.62	293.58	294.00	294.01	293.46	293.67	293.10	293.98	ELEVATIONS
CHAINAGES	0-16	0-04	0+00	0+09	0+50	0+74(ws)	1+00	1+16(ws)	1+40(ws)	1+50	1+54(ws)	2+00	2+00(ws)	2+20(ws)	2+50	3+00	3+50	4+00	4+10.8	4+16.3	4+31	CHAINAGES







KEY PLAN
1" = 1000'

PROJECT NO. ER-61-168

BENCH MARK:
295.02 S.W. CORN. BRITANNIA AVE. AND TRAGINA AVE.
295.37 L.A.H. BRITANNIA AVE. IN FRONT OF #308

No.	REVISIONS	DATE	BY

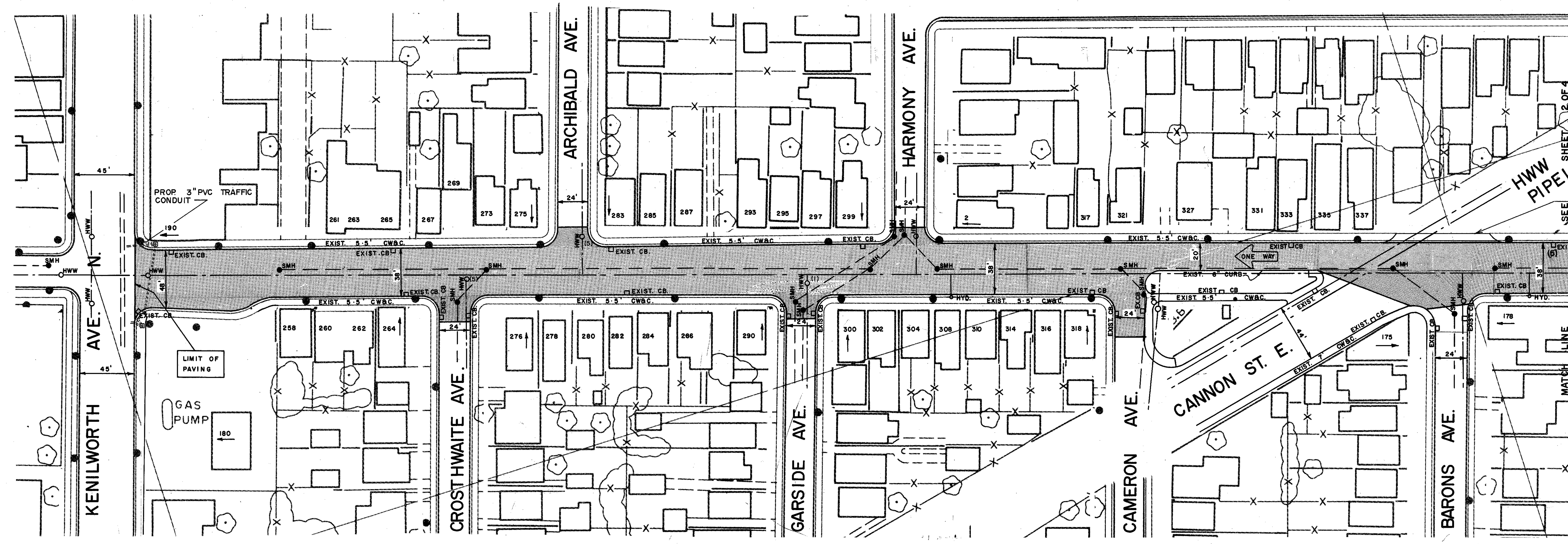
CITY OF HAMILTON
DEPARTMENT OF ENGINEERING
ROADWAY SECTION

ALLEYWAY
IST EAST OF KENILWORTH FROM HOPE TO BRITANNIA

SCALE: HOR. 1" = 20' VER. 1" = 10'
DATE: DEC. 21 - 1961
REF. DWGS. H-11, B-95 SEWER
DES. ENG: George Stone
ROADWAY ENG: [signature]
DEP. CITY ENG: [signature]
SURVEY BY: K. MESKAUSKAS
FIELD BOOKS: 583
DRAWN BY: S. PATRIZIO
CHECKED BY: [signature]
APPROVED:
CITY ENGINEER
PLAN No. A275 RDWYS SHEET OF

19296 19297

BRITANNIA AVENUE



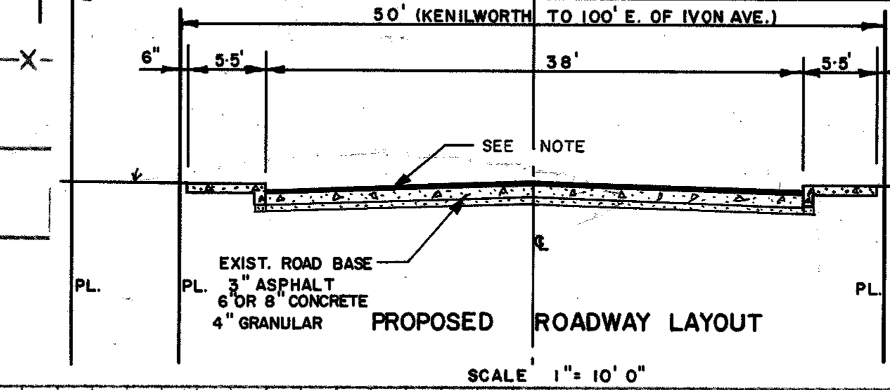
NOTE: INSTRUMENT MAN TO CHECK WITH SURVEY OFFICE FOR PROPERTY LINES PRIOR TO CONSTRUCTION.

PROPOSED 5'-0" SIDEWALK APPROX. 80' LONG.

NOTE: PARKDALE AVENUE TO IVON AVENUE
1 1/2" HOT MIX TYPE "C"
IVON AVENUE TO KENILWORTH AVENUE
COMPLETE STRIPPING
2" HM 5 1 1/2" HM 3

REPAIR LEGEND

(1) REPLACE FRAME & COVER
(2) REBUILD
(3) REBUILD & REPLACE FRAME & COVER
(4) CATCH BASIN
(5) REBUILD NECK



PROPOSED ROADWAY LAYOUT

SCALE 1" = 10' 0"

CHAINAGE	EXIST. ℄ ELEVATIONS
0+00	293.76
0+50	293.85
1+00	293.97
1+50	294.02
2+00	293.98
2+50	294.11
3+00	294.25
3+50	294.21
4+00	294.25
4+50	294.34
5+00	294.34
5+50	294.25
6+00	294.16
6+50	293.85
7+00	293.63
7+50	293.57
8+00	293.26
8+50	293.27
9+00	293.44
9+50	293.87
10+00	294.03
10+50	293.93
11+00	294.08
11+50	294.23
12+00	294.38

NOTES • TENDERERS SHALL SATISFY THEMSELVES AS TO THE NATURE OF THE GROUND AND BID ACCORDINGLY.
• ALL ROCK LINE INDICATIONS SHOWN ON THE PROFILE MUST BE VERIFIED BY THE CONTRACTOR.
• CITY INSPECTOR TO CHECK OFFICE COPY PRIOR TO CONSTRUCTION FOR DATA.

SCALE: 5 0 10 VERTICAL; 20 0 40 HORIZONTAL

REVISIONS: REPAIR LEGEND ADDED – APR. 7, 1976

UTILITIES:

REF. DWG'S: W-31 SURVEYS. Z-57 HIGHWAYS B-270 " B-344 SEWERS

SURVEY BY	D. MORROW
FIELD BOOKS	BLK. 6A, P. 65-68.
DATE	FEB. 2, 1976
BENCH MARK	CITY OF HAMILTON, VERTICAL CONTROL B.M. NO. – 238, ELEV. – 295.68.
DRAWN BY	J.D.
CHECKED BY	

ASST. DIRECTOR, ENGRG. DESIGN.:
DIRECTOR, ENGRG. DESIGN.:

APPROVED
CITY ENGINEER

CITY OF HAMILTON
DEPARTMENT OF ENGINEERING
DESIGN SECTION

PROJECT No. ER-76-1 | ACCOUNT No.

BRITANNIA AVENUE
KENILWORTH AVE. N. TO PARKDALE AVE. N.
RESURFACING

DRAWING No. 71-H-315 | SHEET 1 OF 4

71-H-315
184

HOPE AVE.

1. "AS BUILT" INFORMATION 82-05-27 I.H.

REVISIONS:	SCALES: VERTICAL 0' 5' 10' / HORIZONTAL 0' 20' 40'	DIRECTOR	APPROVED COMMISSIONER OF ENGINEERING	THE REGIONAL MUNICIPALITY OF HAMILTON-WENTWORTH DEPARTMENT OF ENGINEERING	STORM SEWERS
BENCH MARK: INDEX No. 278				DATE: MARCH 25 1979 · PROJECT No. 803-14	DRAWING No. 79-S-6 · SHEET 2 OF

STORM SEWERS
- DUNSMURE RD. FROM BARONS AVE. TO CROSTHWAITE AVE.
- CROSTHWAITE AVE. FROM DUNSMURE RD. TO BRITANNIA AVE.
- ARCHIBALD ST. FROM BRITANNIA AVE. TO HOPE AVE.
- HOPE AVE. FROM ARCHIBALD ST. TO KENILWORTH AVE.
- KENILWORTH AVE. FROM HOPE AVE. TO BARTON ST.

SEQ# - 07627