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### PROPOSED RETIREMENT RESIDENCE DEVELOPMENT 2380 LAKESHORE ROAD WEST OAKVILLE, ONTARIO

PROJECT No. : 18219

# FUNCTIONAL SERVICING & STORMWATER MANAGEMENT REPORT

Prepared For:

### SUCCESSION DEVELOPMENT CORPORATION

Prepared By:

The Odan/Detech Group Inc.

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### TABLE OF CONTENTS

DESCRIPTION

page

1.0	INTRODUCTION	1
2.0	SCOPE OF WORK	1
3.0	WATER DISTRIBUTION	2
4.0	SANITARY SEWERS	7
i)	Available & Existing Infrastructure	7
ii)	Proposed Sanitary Servicing	7
iii)	Downstream Sanitary Sewer Capacity	9
5.0	STORM WATER MANAGEMENT	13
i)	Terms of Reference & Available Infrastructure	13
ii)	Allowable & Pre-Development Discharge Rate	13
iii)	Proposed Conditions & Post-Development Flow Analysis	16
iv)	Erosion Control	19
v)	Stormwater Quality Control	20
6.0	CONCLUSIONS	21
7.0	REFERENCES	22

### LIST OF FIGURES

Figure 1 - Pre-Development Visual OTTHYMO Model	(100-Year Storm)15
Figure 2 – Post-Development Visual OTTHYMO Mo	del (100Y Storm Flows)18

### LIST OF TABLES

TABLE 1 – Total Water Demand	2
TABLE 2 – Proposed Sanitary Flows	7
TABLE 3 - Catchment Characteristics for Site, Pre-Development	15
TABLE 4 – Pre-Development (allowable) Discharge	
TABLE 5 - Catchment Characteristics for Post-Developed Site	
TABLE 6 - Stormwater Storage	19
TABLE 7 - Summary of Discharge from Site	19
TABLE 8 - Summary	21

### **APPENDIX A**

Existing Site	Aerial view of Site and surrounding areas

Site Plan by Michael Spaziani Architect Inc.

Development statistics by Michael Spaziani Architect Inc.

### **APPENDIX B**

Pre-Development Visual OTTHYMO Model Output 5-year storm & 100-year storm

Post-Development Visual OTTHYMO Model Output 5-year storm & 100-year storm

HydroWorks HD-5

**CETV** Verification Statement

### 1.0 INTRODUCTION

The property under study is a 0.385 Ha (0.95 acre) site located at 2380 Lakeshore Road West in Oakville, Ontario. The site is presently occupied by the following:

- A three-storey commercial building with associated paved parking areas surrounding, located at the east side of the site
- A one-storey detached house building with associated driveway located at the west side of the site

The site is bound by the following:

- To the north: Lakeshore Road West
- To the east: Existing commercial/residential townhouse development
- To the south: Existing residential apartment development
- To the west: Existing commercial development and associated parking lot

For detailed topography of the existing site conditions, as of May 30, 2018, refer to the topographic survey prepared by Cunningham McConnell Limited.

It is proposed to construct a mixed-use six-storey commercial and retirement home development on the property. There is a below-grade parking structure proposed beneath the entire site. A driveway access is proposed from Lakeshore Road West from the site's north property line.

A 2.94m road widening of Lakeshore Road West is proposed in the subject development – refer to the architectural Site Plan and Servicing/Grading Plans. The site's area post-development will be 0.366 Ha (0.90 acres).

Refer to the Site Plan by Michael Spaziani Architect Inc. in Appendix A for the site's layout.

This report will evaluate the serviceability of the site with respect to sanitary waste water, water and storm water management (SWM) and will implement the Servicing criteria identified by Region engineering staff in prior correspondence.

### 2.0 SCOPE OF WORK

THE ODAN/DETECH GROUP INC. was retained by **Succession Development Corporation.** to review the Site, collect data, evaluate the Site for the proposed use and present the findings in a Functional Servicing and Storm Water Management Report in support of a Site Plan Application. The scope of work in brief involves the following:

- a) Collecting existing servicing drawings from the CITY in order to establish availability and feasibility of Site servicing;
- b) Meetings/conversations with CITY Engineers and Design Team.
- c) Evaluation of the data and presentation of the findings in a FSR and Storm Water Management Report in support of the Site Plan Application.

### 3.0 WATER DISTRIBUTION

### **Design Considerations**

There is an existing 300mm PVC watermain beneath the north side of Lakeshore Road West, opposite the subject site.

One 150mm fire service with branch 100mm branch domestic water service connection are proposed to the above main. Refer to the Site Servicing Plan.

The unit rate and peaking factors of water consumption, minimum pipe size and allowable pressure in line were established from the City Design Manual Standards. The pressures and volumes must be sufficient for peak hour conditions and under fire conditions as established by the Ontario Building Code 2006. The minimal residual pressure under fire conditions is 140 kpa. (or 20.3 psi).

Fire flow demand is calculated using the Fire Underwriters' Survey Fire Flow calculation, on the following page.

The allowable pressures are as follows:

	Condition		Allowable Pr	essures (kpa)	
			min.	max.	
	1) Min. Hour		275	700	
	2) Peak Hour		275	700	
	3) Peak Day + Fire Flow		140	700	
The w	ater demand for redeveloped Building	g is calculated a	as follows:		
a)	Average Day domestic demand -				0.86 L/s
b)	Peak day demand -	2.25 x averag	e daily demand	ł	1.94 L/s
c)	Fire flow as per FUS 1999 manual				200 L/s

### TABLE 1 – Total Water Demand

	L/sec	USGM
Peak Domestic Flow Demand	1.9	30
Fire Flow Demand (FUS)	200	3170
Total Water Demand	202	3200
Available Flow at 20 PSI Residual Pressure	383	6068

The following assumptions were made in the Fire Underwriters' Survey fire flow calculation:

- The building will be of fire-resistive (reinforced concrete) construction
- The contents will be non-combustible (residences)
- The building will be sprinklered as per NFPA 13 and the sprinklers fully monitored
- Horizontal separation from adjacent buildings as shown on the following *Fire Separation Distance Plan*

A hydrant flow test was prepared by Jackson Water Works to the NFPA 291 standard. The flow test reports are included on the following pages. The hydrant flow test shows that there is a flow rate of rate of 6068 USGM available at residual pressure 20 psi, which is greater than the development's water demand (3200 USGM) therefore it follows that **the existing main is sufficient to provide fire protection to the subject development and no infrastructure improvements are necessary to service the subject development.** 



#### 2380 LAKESHORE ROAD WEST – PROPOSED RETIREMENT RESIDENCE DEVELOPMENT FUNCTIONAL SERVICING & STORMWATER MANAGEMENT REPORT

WATER SUPPLY FOR PUBLIC FIRE PROTEC GUIDE FOR DETERMINATION OF REQUIR	TION , FIRE UN ED FIRE FLOWS	DERWRITERS	SURVEY					
F = 220 x C x √ A Where:							Coefficient related to construction	o type of
E - required fire flow in liters per minute							15	Wood Frame
C= Coefficient related to the type of const	ruction						1.5	Ordinary
A = the total floor area in square meters								Non
(excluding basements) in the building							0.0	combustible
							0.8	Fire
	Oakville			PROJECT	2380 Lakesh	ore Road W	0.6 est Retirement Home	Resistive
OPC OCCUPANCY:	Residential &	Commercial		DROJECT No	.19310			
BUILDING FOOT PRINT (m2)	2642			PROJECT NO	10219		Contents	Charge
	6						Non-Combustible	-25%
# OF STOREYS	0						limited	2570
							Combustible	-15%
							Compustible	0%
CONSTRUCTION CLASS:		FIFE RESISTIVE					Free Burning	15%
AUTOMATED SPRINKLER PROTECTION	Cre	edit Total					Napiù bulling	2370
NFPA 13 sprinkler standard	yes	30%						
Standard Water Supply	yes 2	LO% 50%						
Fully Supervised System	yes	LO%						
		078						
CONTENTS FACTOR:		Limited Comb	ustible	CHARGE:	-15%		Separation	Chargo
EXPOSURE 1 (south) Ex Apartments	Distar	ice to Exposur	e Building (m)	19.3	159/		0-3 m	25%
		L	ength - Height		15%		3.1 -10 m	20%
EXPOSURE 2 (east) Existing Townhouses	Distar	ice to Exposur	e Building (m)	1.8	25%		10.1 - 20 m	15% 10%
EXPOSURE 3 (west) Existing Comm	Distar	ice to Exposur	e Building (m)	21.5	1.09/		30.1 - 45	5%
		L	ength - Height		10%		> 45 m	0%
EXPOSURE 4 (north) Existing House	Distar	ice to Exposur	e Building (m) ength - Height	32.4	5%			
		_		Total:	55%	no more		
						than 75%		
ARE BUILDINGS CONTIGUOUS:	Yes							
FIRE RESISTANT BUILDING	Are vertical open	ings and exterior	vertical communication	ns protected wit	h a minimum c	one (1) hr rat	No	
CALCULATIONS	<i>C</i> = 0.6	i	Fire Resistive					i
	A = 89	32 m2	(2 Largest floors	s + 50% of flo	ors above)	S	TOREY AREAS m2	1
	F = 12	475 L/min					2305	2
Round to Nearest 1000 L/min	F = 13	000 L/min	must be > 2000	L/min			2353	3
CORRECTION FACTORS:							2353	4 5
OCCUPANC	Y -19	950 L/min					2353	6
FIRE FLOW ADJUSTED FOR OCCUPANC	Y 11	050 L/min						
REDUCTION FOR SPRINKLE	R -55	525 L/min						
EXPOSURE CHARG	e 60	77.5 L/min						
<b>REQUIRED FIRE FLOW</b>	<b>F</b> = 11	603 L/min						
Round to Nearest 1000 L/min	<b>F =</b> 12	000 L/min	3170 usg	m				
	<b>F =</b> 20	0 L/sec						

ACKSON WATERWORKS



(905) 547-6770 (800)-734-5732 jww@bellnet.ca www.jacksonwaterworks.ca

### FIRE HYDRANT FLOW TEST RESULTS



No. of Ports Open	No. of Ports Open Port Dia. (in) Pitot Reading (psig)		Pitot Conversion (usgpm) Conversion Factor = 0	Residual Pressure (psig)	Γ	Test Date	25 May 2018
1	2.50	58	1278	71		Test Time	11:30am
2	2 2.50 44/44		2226	68		Pipe Diameter (in)	12
THEORET	ICAL FLOW @ 20psi		6086			Static Pressure (psig)	74

	Site Information												
Site Name or Developer Name	Southbound Developments Inc.	Engineer: Odan Detech Group Inc.											
Site Address/Municipality	2380 Lakeshore Road West, Oakville												
Location of Test Hydrant	In Front of 2381 Lakeshore Road West												
Location of Base Hydrant	Lakeshore Road West, 1st West of Jones Street												
Comments	Testing has been completed in accordance with NFPA-291 guidelines wherever and whenever possible and practical. Conversion factors for pitot tube readings have been used depending on hose nozzle internal design and installation profile. Refer to attached cover letter for additional information.												
Verified By	clif Mark Schmidt												

221 Sherman Avenue North, Hamilton, Ontario L8L 6N2

### 4.0 SANITARY SEWERS

### *i)* Available & Existing Infrastructure

The following sewers presently exist beneath the streets bordering the subject site. Refer to the Servicing Plan for the layout of the sewers bordering the subject site.

• Lakeshore Road West – there is a 300mm sanitary sewer flowing easterly adjacent to the site's north frontage. There is a high point in the sewer at the site's frontage from which the sewer flows east and west.

### *ii)* Proposed Sanitary Servicing

It is proposed to drain the subject development to the 300mm Lakeshore Road sanitary sewer with a 200mm @ 2.00% sanitary service connection.

The sanitary sewer design criteria and unit flow is provided in the Regional Municipality of Halton's *Water and Wastewater Linear Design Manual* (October 2019), as follows. The following information is provided in Tables 3-1 and 3-2 of the foregoing manual.

- Unit flow: q = average daily residential per capita dry weather unit flow = 0.275 m<sup>3</sup>/cap/day
- I/I = Unit of peak inflow/infiltration = 0. 286 L/s/ha
- Light Commercial 90 p/Ha or 24.75 m<sup>3</sup>/ha/day
- Apartment (over 6-storey): 285 p/Ha and 0.275 m<sup>3</sup>/p/day or 0.003183 x 10<sup>-3</sup> m<sup>3</sup>/p/s
- Apartment (less than 6-storey): 135 p/Ha and 0.275 m<sup>3</sup>/p/day or 0.003183 x 10<sup>-3</sup> m<sup>3</sup>/p/s
  - Notwithstanding the above unit population, however, a unit population of 2.7 P/unit is assumed for the proposed retirement home development because the Region standard 135 P/Ha unit population would result in a unit population of approximately 0.5 P/unit for the proposed statistics, which is unrealistic

Peaking Factor (Residential)

$$M = 1 + \frac{4}{4 + \sqrt{P}}$$

The peak sanitary flow from the proposed development is thus calculated as follows, in Table 2.

TABLE 2 – Proposed Sanitary Flows														
	Population (P)	Average Flow (I/s)	Peak Factor	Peak Sanitary (I/s)	Infiltration Allowance (l/s)	Total Flow (l/s)								
Retirement Home Units	421	1.17	4.01	4.69	0.11	4.85								
Retail	5	0.01	3.55	0.05										

A 150mm @ 2.0% sanitary sewer connection is proposed to the 300mm sanitary sewer beneath Lakeshore Road. The pipe has a capacity of 22 L/s, which is adequate to convey the above post-development sanitary flow.

# 2380 LAKESHORE ROAD WEST – PROPOSED RETIREMENT RESIDENCE DEVELOPMENT FUNCTIONAL SERVICING & STORMWATER MANAGEMENT REPORT

SANITARY & WATER FLOW	CALCULAT	TIONS		SCENAR	ю:	PROPOSED DEVELOPMENT								
This program coloulates the conitery	diaabarga fram		duco											
	uscharge from	i various iai	iu use											
					FILL IN COLC	JURED CELLS	AS REQU	RED						
COMMERCIAL SITE AREA (ha) =			NOTE:											
RESIDENTIAL SITE AREA (ha) =	0.37													
TOTAL SITE AREA (ha) =	0.385													
LAND USE	NUMBER OF UNITS	SITE AREA, (ha)	GROSS FLOOR AREA, m2	TOTAL POPULATION	TOTAL DAILY FLOW (LITERS)	AVERAGE DAILY FLOW I/sec	PEAKING FACTOR, M	TOTAL FLOW FROM LAND USE, I/sec						
RESIDENTIAL Detached, using 55 person/site area				0	0	0.00	4.50	0.00						
RESIDENTIAL Semi Houses, using 100 persons/site area				0	0	0.00	4.50	0.00						
RESIDENTIAL Apartments (<6 st), using 135 persons/site area				0	0	0.00	4.50	0.00						
RESIDENTIAL Apartments (>6 st), using 285 persons/site area				0	0	0.00	4.50	0.00						
RESIDENTIAL Density 3, using 2.7 persons/unit	156			421	101088	1.17	4.01	4.69						
COMMERCIAL, Using 90 persons/ha (Floor Ha)	_	0.05		5	1238	0.01	3.55	0.05						
COMMERCIAL, Using 0.60 L/sec per	•													
ha				0	0	0.00	2.50	0.00						
TOTAL				V1=	102326	Q1=	4.69							
$\Omega = (MaP/86400) \pm \Lambda \pm I_{1}(1/862)$						Q2=	0.05							
$\mathbf{x} = (\text{widr} 100400) + \mathbf{X} + \mathbf{I} (\mathbf{D} 360)$						Otot	4.85	<u> </u>						
Q1= total flow from Residential Land	Use (L/sec)		where :	P is popu	lation	Q.01	00							
Q2= total flow from Commercial Land	Use (L/sec)			q = 0.275 m3/d/p = 0.004 L/sec/person for residential and										
Qinfil = total flow from infiltration (L/se	ec)			q = 0.60 l										
Qtot = total flow (Land use + infiltration	on)			A = gross	site area									
)/4 Total )/aluma from Land Line in li	toro		Deal-ing 5	i = 0.286	L/sec/ha (infiltr	ration rate)								
VI = TOTAL VOIUTHE FROM LANG USE IN II	lers		Peaking F	actor M	= 1 + [14/(4) - 0.8*(1 + 14)]	+ (P/1000, 1/2) 4 / (A + (P/100)	) (IUF FESIDE	ential) or Commorci	)					
			r caning r		- 0.0 (1+[]/	+ / (+ + (F / 100	0, 1/2 <i>))</i> ]} (10							

### *iii)* Downstream Sanitary Sewer Capacity

Region engineering staff have stated that an independent downstream sanitary sewer analysis is required to confirm the capacity of the receiving sanitary sewers to receiving flows from the subject development.

The following downstream sanitary sewer analysis shows that the receiving sanitary sewers have capacity for the proposed development and no offsite infrastructure improvements are necessary to accommodate the flows from the proposed development.

Region staff stated that an independent analysis of the immediate downstream segments is acceptable. That is, it is not necessary to analyze all segments to the trunk discharge point.

The Odan/Detech Group subsequently prepared an original analysis. The methodology for the analysis is as follows.

- 1) The downstream sewer catchment plan on the following page was prepared to show the tributary catchment areas for sanitary flow, path of the sewer pipe, etc.
- 2) Catchment areas as shown on the downstream sewer catchment plan were delineated by original research by the Odan/Detech Group.
- Population density and unit flow was established as given in Tables 3-1 and 3-2 in the Regional Municipality of Halton's Water and Wastewater Linear Design Manual (October 2019).
- 4) Downstream sewer design sheets were prepared in pre-development and post-development scenarios as shown on the following pages.
- 5) The slopes, pipe diameters, as-built information was taken from as-built plan & profile drawings provided by the Region of Halton as well as inverts surveyed in the survey prepared for this development by Cunningham McConnell (May 2018).

We provide the following discussion on the downstream sanitary sewer analysis.

- 1) Pre-development, no pipes are flowing at more than 13.9% of their respective capacity.
- 2) Post-development, with the additional flow from the subject development, no pipes are flowing at more than 21.4% of their capacity. This is acceptable, therefore no improvements are necessary to the downstream sanitary sewer network on account of the proposed development.
- 3) There is a high point in the receiving local sanitary sewers adjacent to the site's north frontage to Lakeshore Road West. That is, the site is tributary to two different tributary branches of the downstream sanitary network. Note that the two legs ultimately converge at a bifurcation located at Marine Drive and Nelson Street. The site is proposed to drain to the easterly leg because that is a more direct path to the downstream outlet. Refer to the downstream sanitary sewer catchment plan on the following page for the layout of the receiving sewer network. The westerly leg also serves a much larger catchment area originating on Jones Street, therefore it stands to reason that the easterly leg is a sounder outlet for the proposed development.
- 4) There is a discrepancy in the Region's sanitary sewer public works information operating maps. The maps show that EX SAN MH1 adjacent to the site's north frontage slopes up to the east. That is, in this case, the sanitary sewers adjacent to the site's north frontage flow westerly across the site's entire north frontage. The as-built plan & profile as well as the inverts surveyed by Cunningham McConnel in this sewer, on the other hand, show that the pipe slopes down to the east away from EX SAN MH1. This is reflected in this analysis.



### 2380 LAKESHORE ROAD WEST – PROPOSED RETIREMENT RESIDENCE DEVELOPMENT FUNCTIONAL SERVICING & STORMWATER MANAGEMENT REPORT

																								÷								
	DOWNSTRE	EAM SANIT.	ARYSE	WERS (F	Pre-Dev	/elopm	ent)																								1	
	Site location:	Subject Proposed D	evelopment - 2380	) Lakeshore Road \	West																									ODAN.D	ЕТЕСИ	
	D - (# DN 40040																													CONSULTING	ENGINEERS	
Image: Note of the state o	Ref# PN 18219																												-			
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Low         Low <thlow< th=""> <thlow< th=""> <thlow< th=""></thlow<></thlow<></thlow<>						Existing	Industrial/Co	ommercial			Exis	sting Reside	ential Popu	lation		Inflow/	Re	∋sidential P/F	Peak Residential Sanitary Flow	Commercial P/F	Peak Commercia Sanitary Flow	I Unit Inflow/	Segment Inflow/	Accumulative	Accumulative Sanitary Flow					Full Flow	Full Flow	
Open No.       No.      <	Compart CAN	Location	116	De	Commercial	Cohool	Acchin Area	Deputation		h Anortmor		Tourshouse	Deteched	Deputet		n Aroc			0(n)		0 (n)	1/1	Infiltration	0(i)	O(d)	Length	Size	Slope	Shape	Capacity	Velocity	% Full
1       1	Trib ID	Street Name	Node	Node	(ha)	(ha)	(ha)	(Person)	(Person)	(>6 St)(H	Ha) (<6 St)(Ha)	(Ha)	(Ha)	(Perso	n) (Person)	(ha)	, <del>````</del>	М	(275 L/c/d) (L/s)	М	(24.75 m3/ha/d) (L/s	(0.28 L/Sec/ha	a) (L/s)	(L/s)	(L/s)	(m)	(mm)	(%)	· · · · · ·	(L/s)	(m/s)	Q(d)/Qcap
11         Ling with Mith         Ling with Mith <thling mith<="" th="" with=""> <thling mith<="" th="" with=""></thling></thling>																																
1       1	1 (Trib of MH 1)	Lakeshore Rd W	EX SAN MH1	EX SAN MH2	0.420	)	0.420	37.8	0 37.80	<u>- (</u>	-	-	-	-	-	0.	1.98	4.50	-	3.47	7 0.4	12 0.280	0.27	0.27	0.69	67.49	300	0.50	circle	68.38	0.97	1.01%
STM: M49:0       XMA0.0       XMA0.04	2 (Trib of MH 2)	Lakeshore Rd W	EX SAN MH2	EX SAN MH3			0.420	-	37.80	0 -	-	0.150	-	20.	25 20.25	0 ز	).26	4.38	0.28	3.47	7 0.4	12 0.280	0.07	0.35	5 1.05	69.11	300	0.51	circle	69.06	0.98	1.52%
Affini       Name       Cont	3 (Trib of MH 3)	Nelson St	EX SAN MH3	EX SAN MH4	2 300	) -	2 720	207.0	244.80	0 -		1 020	3.030	304	35 324.60	2 8	8 27	4.06	4 20	3.20	9 2	6 0.28	1 2.32	2.66	9.43	75 20	300	0.49	circle	67.69	0.96	13 93%
4       Incode 1       EXAMUM*			E/(G/ III III)	Enternanti	2.000		220	20110					0.000		00 02 1100							0.20		2.00	0.10	10.20		0.10			0.00	
How Calculation Citized         Charles - 1 and 32, Regional Municipality of Halton, Water and Wasterwater Linear Design Manual, April 2015)         Image Charles - 1 and 32, Regional Municipality of Halton, Water and Wasterwater Linear Design Manual, April 2015)         Image Charles - 1 and 32, Regional Municipality of Halton, Water and Wasterwater Linear Design Manual, April 2015)         Image Charles - 1 and 32, Regional Municipality of Halton, Water and Wasterwater Linear Design Manual, April 2015)         Image Charles - 1 and 32, Regional Municipality of Halton, Water and Wasterwater Linear Design Manual, April 2015)         Image Charles - 1 and 32, Regional Municipality of Halton, Water and Wasterwater Linear Design Manual, April 2015)         Image Charles - 1 and 32, Regional Municipality of Halton, Water and Wasterwater Linear Design Manual, April 2015)         Image Charles - 1 and 32, Regional Municipality of Halton, Water and Wasterwater Linear Design Manual, April 2015)         Image Charles - 1 and 32, Regional Municipality of Halton, Water and Wasterwater Linear Design Manual, April 2015)         Image Charles - 1 and 32, Regional Municipality of Halton, Water and Wasterwater Linear Design Manual, April 2015)         Image Charles - 1 and 32, Regional Municipality of Halton, Water and Wasterwater Linear Design Manual, April 2015)         Image Charles - 1 and 32, Regional Municipality of Halton, Water and Wasterwater Linear Design Manual, April 2015)         Image Charles - 1 and 32, Regional Municipality of Halton, Water and Wasterwater Linear Design Manual, April 2015)         Image Charles - 1 and 32, Regional Municipality of Halton, Water and Wasterwater Linear Design Manual, April 2015)         Image Charles - 1 and 32, Regional Municipality of Halton, Water and Wasterwater Linear Design Manual, April 2015)         Image Ch	4 (Trib of MH 4)	Nelson St	EX SAN MH4	EX SAN MH5			2.720	-	244.80	<u> </u>	0.180	) -	0.100	29.	80 354.40	<u>/ 0</u> .	1.41	4.05	4.56	3.29	9 2.5	56 0.280	0.11	2.78	9.91	69.57	300	1.08	circle	100.49	1.42	9.86%
Flow Calculation Circle/a       Circle/A Diversion Additional April 2015)       Circle/A Diversion Addition Addit			1																								î					
a) a setup daily resident and tory = 0.275 rolls and if if on y = 0.275 rolls and if on y = 0.285 (Laba)       Image: Control on y = 0.286 (Laba)       <	Flow Calculation Cr	iteria	al Municipalit	of Halton Wa	tor and Mas	tountor Line	par Dosign M	Ionual An	ril 2015)																					<u> </u>		
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Semi-detachediduptex/-plex       100 Pha       135 Pha       135 Pha       135 Pha       135 Pha       135 Pha       136 Pha       136 Pha       136 Pha       137 Pha	Single Family Populat	tion Density		55 P/ha						1																			( )	( )		
135 Pha	Semi-detached/duple:	x/4-plex		100 P/ha																							-			( )		
Apartment (Over 6 Stories High)       285 P/ha       90 P/ha	Townhouse, Maisonet	tte		135 P/ha																							1					
Commercial       90 P/ha       90 P/ha <td>Apartment (Over 6 Sto</td> <td>ories High)</td> <td></td> <td>285 P/ha</td> <td></td> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td></td>	Apartment (Over 6 Sto	ories High)		285 P/ha																							1					
Community Services (S-bo)       40 Pha       6       <	Commercial			90 P/ha																							1					
Peaking Factor from 3.2.3, Rejort Halton, Water and Wasewater Linear Design Manual, April 2015)       Manuul, April 2015)       Manual, April	Community Services (	(School)		40 P/ha																										!		
PEAKING FACTOR (Residential)       M =1 + 14/(4+(P/1000^0.5)))       M =0.8[1 + 14/(4+(P/1000^0.5))]       M	(Peaking Factor from	Section 3.2.3., Reai	ional Municipal	lity of Halton. W	Vater and Wa	astewater Li	inear Desian	Manual. A	April 2015)				-	_																l		
PEAKING FACTOR (Commercial)       M =0.8[1 + 14/(4+(P/10000.5))]       M = 0.8[1 + 14/(4+(P/10000.5))] <td< td=""><td>PEAKING FACTOR (I</td><td>Residential)</td><td></td><td>M =1 + 14/(4+</td><td>+(P/1000^0.5</td><td>5))</td><td></td><td></td><td>· · · · ·</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>1</td><td></td><td></td><td></td><td></td><td></td></td<>	PEAKING FACTOR (I	Residential)		M =1 + 14/(4+	+(P/1000^0.5	5))			· · · · ·																		1					
PEAK DESIGN FLOW,       Q(d) = Q(p) + Q(i) L / Sec.       A	PEAKING FACTOR (	Commercial)		M =0.8[1 + 14	I/(4+(P/1000	0^0.5))]																					1					
PIPE ROUGHORESS,       n = 0.013 For Manning's Equation       M       <	PEAK DESIGN FLOV	, V,		Q(d) = Q(p) +	Q(i) L / Sec.																						1					
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### 2380 LAKESHORE ROAD WEST – PROPOSED RETIREMENT RESIDENCE DEVELOPMENT FUNCTIONAL SERVICING & STORMWATER MANAGEMENT REPORT

																														1	
DOWNSTRE	AM SANITA	RY SEWI	ERS (Pos	t-Develop	oment)																										
Site location:	Subject Proposed D	evelopment - 2380	Lakeshore Road W	est																									<b>004N</b> •D	FTECH	
D. (" DN 40040																												U	CONSULTING	ENGINEERS	
Ref# PN 18219																												-			
																												Pipe			
				Exist	ing + Propos	sed Industria	al/Commerc	cial		Existi	ng + Propos	ed Residentia	al Popula	tion		Inflow/	Residential	Peak Residential Sanitary Flow	Commercial P/F	Peak Commercial	Unit Inflow/	Segment Inflow/	Accumulative	Accumulative Sanitary Flow					Full Flow	Full Flow	
	Location	110			<u></u>												.,,	Ourmary Flow	.,,	Ourmary 1 low	14	Infiltration		Carnary 1 low	Length	Size	Slope	Shape	Capacity	Velocity % Ful	<u>il</u>
Trib ID	Street Name	Node	Node	(ha)	(ha)	(ha)	(Person)	(Person)	(2.7PPU) (U)	(>6 St)(Ha)	(<6 St)(Ha)	(Ha)	(Ha)	(Person)	(Person)	(ha)	М	(275 L/c/d) (L/s)	М	(24.75 m3/ha/d) (L/s)	(0.28 L/Sec/ha)	(L/s)	(L/s)	(L/s)	(m)	(mm)	(%)		(L/s)	v (m/s) Q(d)/Qca	ар
1 (Trib of MH 1)	Lakeshore Rd W	EX SAN MH1	EX SAN MH2	0.467		0.467	42.03	42.03	156.000	-	-	-		421.20	421.20	0.98	4.01	5.38	3.46	0.46	0.280	0.27	0.27	6.12	67.49	300	0.50	circle	68.38	0.97 8.9%	_
2 (Trib of MH 2)	Lakesbore Rd W	EX SAN MH2	EX SAN MH3			0.467		42.03	-			0.150		20.25	441.45	0.26	4.00	5.62	3.46	0.46	0.280	0.07	0.35	6.43	69.11	300	0.51	circle	69.06	0.98 9.3%	
2 (110 01 W112)	Lateshore reality	EX OAN WITE	EX OARTINES			0.407	_	42.00	-	_	_	0.100	-	20.20		0.20	4.00	5.02	0.40	0.40	0.200	0.07	0.00	0.45	05.11		0.01		05.00	0.30 3.37	_
3 (Trib of MH 3)	Nelson St	EX SAN MH3	EX SAN MH4	2.300	-	2.767	207.00	249.03	-	-	-	1.020	3.030	304.35	745.80	8.27	3.88	9.21	3.29	2.61	0.280	2.32	2.66	14.48	75.20	300	0.49	circle	67.69	0.96 21.4%	<u>د</u>
4 (Trib of MH 4)	Nelson St	EX SAN MH4	EX SAN MH5			2.767	-	249.03	-	-	0.180	-	0.100	29.80	775.60	0.41	3.87	9.55	3.29	2.61	0.280	0.11	2.78	14.93	69.57	300	1.08	circle	100.49	1.42 14.9%	6
(Unit Flow from Table 3 q = average daily reside q = average daily comm l/l = Unit of peak inflow	-1 and 3-2, Regiona ential per capita dry nercial dry weather infiltration allowanc	I Municipality o weather unit flo unit flow = 24.7 e = 0.286 (L/s/h	f Halton, Water ow = 0.275 m3/c 50m3/ha/d or 0.2	and Wastewate ap/d 28646 L/ha/s	er Linear De	esign Manual	I, April 2015	5)																		Mannings Qcap=(D/1	Equation: 000)^2.667*(\$	S/100)^0.5/	(3.211*n)*1	000(L/s)	
Q(p) = peak population	flow (L/s)																									D: pipe size	e (mm)		<u>, , , , , , , , , , , , , , , , , , , </u>		
Q(I) = peak extraneous	flow (L/s)																									S: slope (g	rade) of pipe	(%)			
Q(d) = peak design flow	v (L/s)																									n = Mannin	ng roughness	coefficient	= 0.013		
(Unit Population from T	able 3-1 and 3-2, R	egional Municip	ality of Halton, V	Vater and Was	tewater Line	ear Design N	/anual, Apri	il 2015)																							
Single Family Population	n Density		55 P/ha																												
Semi-detached/duplex/	4-plex		100 P/ha																												
Townhouse, Maisonette	1		135 P/ha													·'															
Apartment (Over 6 Stor	ies High)		285 P/ha													'															
Commercial			90 P/ha																												
Community Services (S	chool)		40 P/ha																												
(Peaking Factor from S	ection 3.2.3., Regio	nal Municipality	of Halton, Wate	er and Wastewa	ater Linear D	Design Manu	ıal, April 20	15)																							
PEAKING FACTOR (Re	sidential)		$M = 1 + \frac{14}{4+1}$	(P/1000^0.5))																											
PEAKING FACTOR (Co	mmercial)		M =0.8[1 + 14/	(4+(P/1000^0.5	5))]																										
PEAK DESIGN FLOW,			Q(d) = Q(p) +	Q(i) L / Sec.																											
PIPE ROUGHGNESS,			n = 0.013 For	Manning's Equ	ation																										
vmin. = 0.6m/s and Vm	ax. = 3m/s																														

### 5.0 STORM WATER MANAGEMENT

### *i)* Terms of Reference & Available Infrastructure

There is an existing 375mm storm sewer beneath the north side of Lakeshore Road West. The following criteria is assumed based on the Town of Oakville's *Development Engineering Procedures and Guidelines Manual* (May 2005).

- 1) Quantity Control: Control 100-year post-development storm events to 5-year predevelopment storm events
- 2) Quality Control: 50% TSS Removal by an Oil/Grit Separator or other such measure

Design storm data for the Town of Oakville 5-year and 100-year storms are shown below.

$$I_5 = 1170 / (5.8 + t)^{0.843}$$
  
$$I_{100} = 2150 / (5.7 + t)^{0.861}$$

When time of concentration, *t*, is 10 minutes, the 5-year and 100-year rainfall intensities are as follows.

$$I_5 = 114.2 \text{ mm/hr}$$
  
 $I_{100} = 200.8 \text{ mm/hr}$ 

### ii) Allowable & Pre-Development Discharge Rate

The subject site drained in pre-development conditions as shown on the *Pre-Development Drainage Plan* on the following page. Pre-development catchment areas are delineated on that plan.

The site drained predominantly northerly to Lakeshore Road West in pre-development conditions. There is no evidence that any of the adjacent properties drained onto the subject site. All adjacent properties are graded to drain internally and appear to have internal catchbasins etc.



The site was modelled in the pre-development scenario using Visual OTTHYMO 2.3.2 to determine the pre-development 2-year storm runoff flow rates. Note that the pre-development catchment areas used to establish the allowable release rate conservatively considers the post-development 2.94m Lakeshore Road West road widening.

For drainage areas with significant imperviousness the calculation of effective rainfall in Visual OTTHYMO is accomplished using the "Standhyd" method. This method is used in urban watersheds to simulate runoff by combining two parallel standard unit hydrographs resulting from the effective rainfall intensity over the pervious and impervious surfaces. For pervious surfaces, losses are calculated using the SCS modified CN method.

TABLE 3 - Catchi	ment Cł	naracteristics	for Site	, Pre-Devel	opment			
Area I.D.	Area (ha)	Hydrology Method	% impervious	imperviousness directly connected %	Loss Method for Pervious Area	CN for Pervious Area	Initial Abstraction for Pervious	Time to peak (T <sub>p</sub> )
EX-A Paved Surfaces	0.25	StandHyd	90	90	SCS	80	1	-
EX-B Roofs	0.04	StandHyd	99	99	SCS	80	1	-
EX-C Landscape/ Pervious	0.08	NashHyd	-	-	SCS	80	5	0.11

The catchment area statistics in the pre-development scenario are as follows.

The pre-development Visual OTTHYMO Model is as follows. Refer to the output in Appendix B.

### Figure 1 - Pre-Development Visual OTTHYMO Model (100-Year Storm)



The peak pre-development 2-year storm discharge rate on the 375mm storm sewer beneath Lakeshore Road West is as follows. Refer to the pre-development visual OTTHYMO output in Appendix B. These flow rates form the basis for the allowable release rate.

TABLE 4 – Pre-Development (allowable) Dis	charge	
Outlet Location	5-Year Storm	100-Year Storm
Flow to Lakeshore Road West	90 L/s	165 L/s

### *iii)* Proposed Conditions & Post-Development Flow Analysis

City staff have not provided preconsultation comments regarding stormwater management quantity control criteria, therefore it is proposed to control storm flows 100-Year-Post-Development to 5-year-Pre-Development based on the pre-development flows established in Table 4, above.

The following table summarizes the parameters used in Visual OTTHYMO to characterize the post development catchment areas. Refer to the Post-Development Drainage Plan on the following page and the Post-Development Visual OTTHYMO Model thereafter.

TABLE 5 - Catchment	Character	ristics for Post	t-Deve	loped Site				
Area I.D.	Area (ha)	Hydrology Method	% impervious	imperviousness directly connected %	Loss Method for Pervious Area	CN for Pervious Area	Initial Abstraction for Pervious	Time to peak (T <sub>p</sub> )
A – Tower Rooftop	0.20	StandHyd	99	99	SCS	80	1	-
B – Ground Level Paved	0.07	StandHyd	99	99	SCS	80	1	-
C – Landscape Areas	0.03	NashHyd	-	-	SCS	80	5	0.11
D – Uncontrolled Ground Level Paved	0.004	StandHyd	99	99	SCS	80	1	-
E – Tower Green Roof	0.07	StandHyd	60	60	SCS	80	1	-



Visual OTTHYMO 2.3.2. will be used to model and determine the detention volume required. For drainage areas with significant imperviousness the calculation of effective rainfall in Visual OTTHYMO is accomplished using the "Standhyd" method. This method is used in urban watersheds to simulate runoff by combining two parallel standard unit hydrographs resulting from the effective rainfall intensity over the pervious and impervious surfaces. For pervious surfaces, losses are calculated using the SCS modified CN method.

The foregoing catchment areas appear in the post-development Visual OTTHYMO Model, as follows. The model shows flows in a 100-year storm. Refer to the detailed Visual OTTHYMO Output in Appendix B for detailed results for both 5-year and 100-year storms.

Stormwater quantity controls will be provided in the basement (via storm tank) of the proposed building to provide controlled release

Figure 2 – Post-Development Visual OTTHYMO Model (100Y Storm Flows)



As evident above, the discharge to the Lakeshore Road West 375mm storm sewer is 85 L/s, which is less than the 5-year pre-development flow rate (90 L/s – Table 4), therefore the development is in compliance with the stormwater quantity control criteria identified above.

The following is a description of the SWM quantity control system via storm tank:

- storm tank will be a cast in place concrete structure located in the basement underneath the underground parking entrance ramp and detailed by Structural.
- Using a combination of impervious roof and pervious green roof, runoff form the building's roof will be directed (uncontrolled) via mechanical storm drains to the storm tank
- A mechanical sump pump will be installed in the storm tank, pumping at a release rate of 40 L/s to the Control MH
- The mechanical sump pump requires submersion in water to remain operational. A float valve will be used to activate the pump once incoming storm flows raise the water level above the pumps baseline.
- 100 year flows will result in an depth of approximately 1.50m within the storm water tank. The total height of the tank is 3.20m. Approximately 68 cu.m. is required for the tank volume. Total available volume in the tank is 136 cu.m.

Adequate stormwater storage is provided to the 100-year storm in the basement of the building based on the foregoing storm tank as follows in Table 6.

Catchment Areas B and C (Ground-level areas) are to drain directly to the Jellyfish Filter, uncontrolled - as shown in Figure 2, those catchment areas do not contribute to the 100-Year storm tank.

TABLE 6 – Stormwater Storage		
	<b>5 Yr. Storm</b> (m <sup>3</sup> )	<b>100 Yr. Storm</b> (m <sup>3</sup> )
Required Storage Volume	28	68
Provided Storage Volume via Storm Tank	1	136

The controlled and uncontrolled discharge from the site is as follows based on the Visual OTTHYMO Model. The site's peak storm flow in the 100-year storm (85 L/s) is less than the 5-year predevelopment storm flow (90 L/s - Table 4) therefore the development meets the stormwater quantity control criteria.

TABLE 7 - Summary of Discharge from Site		
	5 Yr. Storm (L/s)	<b>100 Yr. Storm</b> (L/s)
Controlled flow from Storm Tank (Catchment A&E)	40	40
Flow from ground-level paved areas (Catchment B)	22	39
Flow from ground-level landscape areas (Catchment C)	2	4
Flow from ground level paved (overland to Lakeshore Rd) (Catchment D)	1	2
Entire Development Peak Flow (Controlled + Uncontrolled)*	65	85

\*Note: The entire development's Peak Discharge Rate to Lakeshore Rd. W. is not the sum of the peak flows from all tributary areas within the site. Rather, the peak discharge considers the different peaking time between the attenuated/controlled discharge and the uncontrolled drainage areas based on "overlaying" the hydrographs in the Visual OTTHYMO Model.

#### iv) **Erosion Control**

Erosion and sediment control will be implemented on-site prior to construction and be maintained through the entire duration of construction. Erosion control measures to be implemented are:

- silt fence around the entire site
- sediment socks within existing and proposed catchbasins
- an entrance mud mat for trucks
- daily cleaning and weekly washing of roads

### v) Stormwater Quality Control

The City of Oakville's *Development Engineering Procedures & Guidelines Manual* states in Section 6.2.4, *Storm Drainage Criteria*, that:

Quality treatment of stormwater is required. The level of treatment is to be determined per the receiving system (see Halton Conservation). Wet Ponds, Oil/Grit Separators and Landscape Filter Strips are acceptable methods.

It is accordingly proposed to provide a Hydrowork HD-5 Oil/Grit Separator which is certified by the Canadian Environmental Technology Verification (CETV) program and sized to provide 80% TSS Removal with a percent imperviousness of 85%. The Oil/Grit design report and CETV verification statement is provided here in Appendix B. Refer to the Site Servicing Plan for the location of the OGS.

Alternatively any OGS that provides the same level of treatment and is able to be located in the available space allocated for this unit will be considered for use on the site during tender and construction. If any change is made the Town will be notified accordingly.

Town engineering review staff stated in the SPA review memorandum of October 3, 2018 that stormwater quality control criteria is to provide 80% TSS Removal for the whole development. 88% TSS Removal is provided for the whole development using the strategy below and based on an area-weighted approach as follows, therefore the quality control criteria is satisfied.

Catchment ID	Area (Ha)	Area (% of total)	TSS Removal	Weighted TSS Removal (%) (=%A x %TSSR)
Catchment 'A'&'E' – Reg. Roofs	0.27	73%	90%	66%
Catchment 'B' – Paved areas subject to winter maintenance – drains to Stormceptor OGS	0.06	15%	80%	12%
Catchment 'C' – Landscape Surfaces	0.04	11%	90%	10%
Catchment 'D' – Paved areas – drain uncontrolled to Lakeshore Road	0.004	1%	0%	0%
Total	0.37			88%

### 6.0 CONCLUSIONS

From the foregoing investigation, the site is serviceable utilizing existing sanitary, storm and watermain infrastructure within and adjacent to the site. Storm water management can be accommodated with on-site storage as described in this report.

The following table summarizes the SWM and Servicing components of the proposed development.

TABLE 8 - Summary	
Peak Sanitary Discharge (L/s)	3.6 L/s (City criteria)
Proposed Sanitary Service	150mm at 2.00%
Receiving Sanitary Sewer	Lakeshore Rd. W. 300mm Sanitary
Development Water Demand (Fire + Domestic)	3200 USGM
Proposed Fire Service	150mm Fire Service
Proposed Domestic Service	Branch 100mm Domestic
Allowable release rate from site	90 L/s (5-Y Pre-Development)
Proposed release rate from site to (100 year storm)	85 L/s (100-Y Post-Development)
Quantity Control	Stormwater Management Tank

### 7.0 REFERENCES

- 1. Town of Oakville Development Engineering Procedures and Guidelines Manual (May 2005).
- 2. Storm water Management Planning and Design Manual, Ontario Ministry of the Environment, March 2003.
- 3. Visual OTTHYMO v2.0 Reference Manual, July 2002

Respectfully Submitted; The Odan Detech Group Inc.



Paul Hecimovic, P.Eng.

Mark Harris, Dipl. Tech.

### **APPENDIX A**

Existing Site	Aerial view of Site and surrounding areas
Site Plan	by Michael Spaziani Architect Inc.
Development statistics	by Michael Spaziani Architect Inc.





	MSAi Ministration of the second secon
	NORTH
	7         Numero for (PAXIDA Sus.         APPC 34.2           7         Numero for (PAXIDA Sus.         APPC 34.2           6         RESSUED FOR CODERX.         APPC 34.2           7         B RESSUED FOR PERMIT         NOV 19.21           3         RESSUED FOR PERMIT         NOV 19.21           2         SSUED FOR PERMIT         MAY 1321.           2         SSUED FOR PERMIT         MAY 1321.           2         SSUED FOR PERMIT         MAY 1321.           10         RESSUED FOR PERMIT         MAY 1321.           2         SSUED FOR PERMIT         MAY 1321.           2         SSUED FOR PERMIT         MAY 1321.           10         RESSUED FOR PERMIT         MAY 1321.           12         SSUED FOR PERMIT         MAY 1321.           13         RESSUED FOR PERMIT         MAY 1321.           14         RESSUED FOR PERMIT         MAY 1321.           15         RESSUED FOR PERMIT         MAY 1321.           16         RESSUED FOR PERMIT         MAY 1321.           17         RESSUED FOR PERMIT         MAY 1321.           16         RESSUED FOR PERMIT         MAY 1321.           17         RESSUED FOR PERMIT         MAY 1321.
	A M I C A SENIOR LIFESTYLES PROJECTIMME BRONTE VILLAGE RETIREMENT RESIDENCE 2996-2300 LAKESHORE PD. W. DAVAILE ONT LS, IHS
SITE PLAN (1) ROLL + 10 (A078)	SITE PLAN AND STATS PROJECT NO. CTODE SCALE A indicate April 1918, 2023 DRM/N: April 1918, 2023 DRM/N: CHECKED Checked FLE NO. CTODE CHECKED C

### **APPENDIX B**

Pre-Development Visual OTTHYMO Model Output 5-year storm & 100-year storm

Post-Development Visual OTTHYMO Model Output 5-year storm & 100-year storm

HydroWorks - HD 5 Sizing Report

**CETV** Verification Statement

#### Pre-Development Visual OTTHYMO Output (5-year & 100-year Storm)

SSSSS U U V Ι А L SS U U A A L SS U U AAAAA L SS U U AAAAA L SS U U A A L SSSSS UUUUU A A LLLLL V V I v v I SS v v I vv Ι 000 TTTTT TTTTT H H Y 0 0 0 0 000 Developed and Distributed by Clarifica Inc. Copyright 1996, 2007 Clarifica Inc. All rights reserved. \*\*\*\*\* DETAILED OUTPUT \*\*\*\*\* Input filename: C:\Program Files (x86)\Visual OTTHYMO 2.3.3\voin.dat Output filename: P:\2018\18219\Visual OTTHYMO\Rev1\18219 V02\Pre-Dev.out Summary filename: P:\2018\18219\Visual OTTHYMO\Rev1\18219 V02\Pre-Dev.sum DATE: 7/2/2019 TIME: 10:14:03 AM USER: COMMENTS: \*\*\*\*\* \*\* SIMULATION NUMBER: 1 \*\* \*\*\*\*\* | CHICAGO STORM 1 IDF curve parameters: A=1170.000 | Ptotal= 45.17 mm | B= 5.800 C= .843 used in: INTENSITY =  $A / (t + B)^{C}$ Duration of storm = 4.00 hrs Storm time step = 10.00 min Time to peak ratio = .33 TIME RAIN | TIME RAIN | TIME RAIN | TIME RAIN mm/hr | hrs 2.32 | 1.17 mm/hr | hrs 2.17 hrs 3.17 hrs mm/hr | mm/hr | mm/hr .17 24.01 | 6.09 | 2.81 
 114.21
 2.33

 32.30
 2.50

 15.74
 2.67

 10.30
 2.83
 2.70 | 1.33 114.21 | 3.24 | 1.50 32.30 | 5.07 | 4.35 | .33 3.33 2.59 3.50 2.40 .50 .67 4.08 | 1.67 3.82 | 3.67 2.24 5.57 | 1.83 8.96 | 2.00 .83 3.41 | 3.83 2.10 1.00 7.65 | 3.00 3.08 4.00 1.98 -----| CALIB 1 (0003) Area (ha) = Ia (mm) = .08 Curve Number (CN) = 80.0 5.00 # of Linear Res.(N) = 3.00 I NASHYD |ID= 1 DT=10.0 min | 5.00 ----- U.H. Tp(hrs)= .20 Unit Hyd Qpeak (cms)= .015 PEAK FLOW (cms)= .004 (i) TIME TO PEAK (hrs) = 1.500 RUNOFF VOLUME (mm) = 15.155 TOTAL RAINFALL (mm) = 45.171 RUNOFF COEFFICIENT = .335 (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY. \_\_\_\_\_ L CALTB 1 STANDHYD (0002) | (ha)= .04 Area Total Imp(%) = 99.00 Dir. Conn.(%) = 99.00 |ID= 1 DT= 5.0 min | \_\_\_\_\_

		IMPERVIOUS	PERVIOUS (i)	
Surface Area	(ha) =	.04	.00	
Dep. Storage	(mm) =	1.00	1.00	
Average Slope	(%) =	1.00	2.00	
Length	(m) =	16.30	40.00	
Mannings n	=	.013	.250	

NOTE: RAINFALL WAS TRANSFORMED TO 5.0 MIN. TIME STEP.

	?	FRANSFORM	ED HYETOGRA	APH	
TIME RA	hr br	s RAIN	TIME	mm/hr   hr	s RAIN
.083 2.	32   1.083	3 24.01	2.083	6.09   3.08	3 2.81
.167 2.	32   1.167	24.01	2.167	6.09   3.17	2.81
.250 2.	70   1.250	114.21	2.250	5.07   3.25	5 2.59
.333 2.	70   1.333	3 114.21	2.333	5.07   3.33	3 2.59
.417 3.	24   1.417	7 32.30	2.417	4.35   3.42	2 2.40
.500 3.	24   1.500	32.30	2.500	4.35   3.50	2.40
.583 4.	08   1.583	3 15./4	2.583	3.82   3.58	3 2.24
.00/ 4. 750 5	57   1 750	) 10.30	2.007	3 41   3 75	5 2.24
.833 5.	57   1.833	3 10.30	2.833	3.41   3.83	3 2.10
.917 8.	96   1.917	7.65	2.917	3.08   3.92	2 1.98
1.000 8.	96   2.000	7.65	3.000	3.08   4.00	1.98
May Eff Inton (mm/hr)-	11/	0.1	12 13		
over (min)	5.0	00	5.00		
Storage Coeff. (min)=		32 (ii)	1.88 (ii)		
Unit Hyd. Tpeak (min)=	5.0	00	5.00		
Unit Hyd. peak (cms)=	.:	34	.32		
				*TOTALS*	
PEAK FLOW (cms)=	.(	)1	.00	.013 (:	LII)
TIME TO PEAK (HIS) = BUNOPE VOLUME (mm) =	1.1	17	18 12	13 01	
TOTAL RAINFALL (mm) =	45 1	7	45 17	45.17	
RUNOFF COEFFICIENT =		98	.40	.97	
***** WARNING: STORAGE COEF	F. IS SMAI	LER THAN	TIME STEP		
(i) CN PROCEDURE SEL	ECTED FOR	PERVIOUS	LOSSES:		
CN* = 80.0	Ia = Dep.	. Storage	(Above)		
(ii) TIME STEP (DT) S	HOULD BE S	SMALLER O	R EQUAL		
(iii) PEAK FLOW DOES N	OT INCLUDE	E BASEFLO	W TF ANY.		
(					
CALIB	(ba) =	25			
CALIB     STANDHYD (0001)   Area  ID= 1 DT= 5.0 min   Tota	(ha) =	.25	Dir. Conn	. (%) = 90.00	
CALIB     STANDHYD (0001)   Area  ID= 1 DT= 5.0 min   Tota	(ha) = l Imp(%) =	.25 90.00	Dir. Conn	.(%)= 90.00	
CALIB     STANDHYD (0001)   Area  ID= 1 DT= 5.0 min   Tota	(ha) = 1 Imp(%) = IMPERVI	.25 90.00 IOUS P	Dir. Conn. ERVIOUS (i)	.(%)= 90.00	
CALIB     STANDHYD (0001)   Area  ID= 1 DT= 5.0 min   Tota 	(ha) = 1 Imp(%) = IMPERV1	.25 90.00 10US P	Dir. Conn ERVIOUS (i) .03	.(%)= 90.00	
CALIB     STANDHYD (0001)   Area  ID= 1 DT= 5.0 min   Tota 	(ha) = l Imp(%) = IMPERVI .2 1.0	.25 90.00 COUS P 22	Dir. Conn ERVIOUS (i) .03 1.00	.(%)= 90.00	
CALIB     STANDHYD (0001)   Area  ID= 1 DT= 5.0 min   Tota 	(ha) = 1 Imp(%) = .2 1.0 1.0	.25 90.00 10US P 22 00	Dir. Conn. ERVIOUS (i) .03 1.00 2.00	.(%)= 90.00	
CALIB     STANDHYD (0001)   Area  ID= 1 DT= 5.0 min   Tota Surface Area (ha)= Dep. Storage (mm)= Average Slope (%)= Length (m)= Mannings n =	(ha) = 1 Imp(%) = IMPERVI .2 1.0 1.0 40.6	.25 90.00 COUS P 22 00 00 30 13	Dir. Conn. ERVIOUS (i) .03 1.00 2.00 40.00 .250	.(%)= 90.00	
CALIB       STANDHYD (0001)   Area  ID= 1 DT= 5.0 min   Tota 	(ha) = 1 Imp(%) = IMPERVI .2 1.( 1.( 40.6 .01	.25 90.00 22 20 20 30 13	Dir. Conn. .03 1.00 2.00 40.00 .250	.(%)= 90.00	
CALIB       STANDHYD (0001)   Area  ID= 1 DT= 5.0 min   Tota Dep. Storage (mm)= Average Slope (%)= Length (m)= Mannings n = Max.Eff.Inten.(mm/hr)=	(ha) = 1 Imp(%) = IMPERVI 1.( 1.( 40.6 .01 114.2	.25 90.00 10US P 22 00 00 13 21	Dir. Conn ERVIOUS (i) 1.00 2.00 40.00 .250 42.13	.(%)= 90.00	
CALIB     STANDHYD (0001)   Area  ID=1 DT= 5.0 min   Tota Dep. Storage (mm)= Average Slope (%)= Length (m)= Mannings n = Max.Eff.Inten.(mm/hr)= over (min)	(ha) = 1 Imp(%) = IMPERVI .2 1.0 40.8 .01 114.2 5.0	.25 90.00 22 00 30 30 13 21	Dir. Conn. ERVIOUS (i) .03 1.00 2.00 40.00 .250 42.13 5.00	.(%)= 90.00	
CALIB     STANDHYD (0001)   Area  ID= 1 DT= 5.0 min   Tota Dep. Storage (mm)= Average Slope (%)= Length (m)= Mannings n = Max.Eff.Inten.(mm/hr)= over (min) Storage Coeff. (min=	(ha) = 1 Imp(%) = IMPERVI 1.0 40.8 .01 114.2 5.0 1.4	.25 90.00 10US P 22 00 30 30 13 21 00 11 (ii)	Dir. Conn. ERVIOUS (i) .03 1.00 2.00 40.00 .250 42.13 5.00 4.19 (ii)	. (%) = 90.00	
CALIB       STANDHYD (0001)   Area  ID= 1 DT= 5.0 min   Tota Dep. Storage (mm) = Average Slope (%) = Length (m) = Mannings n = Max.Eff.Inten.(mm/hr) = Over (min) Storage Coeff. (min) = Unit Hyd. Tpeak (min) =	(ha) = 1 Imp(%) = IMPERVI 1.0 1.0 40.8 .01 114.2 5.0 1.4 5.0	.25 90.00 EOUS P 22 00 80 13 21 00 41 (ii) 00	Dir. Conn. ERVIOUS (i) .03 1.00 2.00 40.00 .250 42.13 5.00 4.19 (ii) 5.00	.(%)= 90.00	
CALIB       STANDHYD (0001)   Area  ID= 1 DT= 5.0 min   Tota Dep. Storage (mm)= Average Slope (%)= Length (m)= Mannings n = Max.Eff.Inten.(mm/hr)= over (min) Storage Coeff. (min)= Unit Hyd. Tpeak (mn)= Unit Hyd. peak (cms)=	<pre>(ha) = 1 Imp(%) = IMPERVI 2 1.( 1.( 40.8 .01 114.2 5.( 1.( 5.0 .1) 114.2 5.0 1.( 1.( 1.( 1.( 1.( 1.( 1.( 1.( 1.( 1.(</pre>	.25 90.00 COUS P 22 00 00 30 30 31 31 41 (ii) 00 33	Dir. Conn. ERVIOUS (i) .03 1.00 2.00 40.00 .250 42.13 5.00 4.19 (ii) 5.00 .24	.(%)= 90.00	
<pre>  CALIB       STANDHYD (0001)   Area  ID= 1 DT= 5.0 min   Tota Dep. Storage (mm)= Average Slope (%)= Length (m)= Mannings n = Max.Eff.Inten.(mm/hr)= over (min) Storage Coeff. (min)= Unit Hyd. Tpeak (mn)= Unit Hyd. peak (cms)= PEAK FLOW (cms)=</pre>	<pre>(ha) = 1 Imp(%) = IMPERV: 2 1.0 40.6 .00 114.2 5.0 1.4 5.0 .00 114.2 .0</pre>	.25 90.00 cous P 22 00 00 30 33 21 00 11 (ii) 00 33 33	Dir. Conn. ERVIOUS (i) .03 1.00 2.00 40.00 .250 42.13 5.00 4.19 (ii) 5.00 .24 .00	*TOTALS*	iii)
<pre>  CALIB       STANDHYD (0001)   Area   ID= 1 DT= 5.0 min   Tota Dep. Storage (nm)= Average Slope (%)= Length (m)= Mannings n = Max.Eff.Inten.(mm/hr)= Over (min) Storage Coeff. (min)= Unit Hyd. Tpeak (min)= Unit Hyd. Tpeak (min)= Dinit Hyd. Tpeak (ms)= PEAK FLOW (cms)= TIME TO PEAK (hrs)=</pre>	<pre>(ha) = 1 Imp(%) = IMPERVI 2 1.0 1.0 40.8 .01 114.2 5.0 1.4 5.0 .0 1.4 5.0 5.0 1.4 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0</pre>	.25 90.00 rous P 22 00 00 13 11 (ii) 00 11 (ii) 00 33 33	Dir. Conn. ERVIOUS (i) .03 1.00 2.00 40.00 .250 42.13 5.00 4.19 (ii) 5.00 .24 .00 1.33	*TOTALS* .074 ( <u>i</u> 1.33	iii)
<pre>  CALIB       STANDHYD (0001)   Area   ID= 1 DT= 5.0 min   Tota Dep. Storage (mm)= Average Slope (%)= Length (m)= Mannings n = Max.Eff.Inten.(mm/hr)= Over (min) Storage Coeff. (min)= Unit Hyd. Tpeak (min)= Unit Hyd. peak (cms)= PEAK FLOW (cms)= TIME TO PEAK (hrs)= RUNOFF VOLUME (mm)</pre>	<pre>(ha) = 1 Imp(%) = IMPERVI</pre>	.25 90.00 rous P 22 00 00 13 21 14 (ii) 00 33 33 77 33 77	Dir. Conn. ERVIOUS (i) .03 1.00 2.00 40.00 .250 42.13 5.00 4.19 (ii) 5.00 .24 .00 1.33 18.12	*TOTALS* .074 (1 1.33 41.56	iii)
CALIB       STANDHYD (0001)   Area  ID= 1 DT= 5.0 min   Tota Dep. Storage (mm)= Average Slope (%)= Length (m)= Mannings n = Max.Eff.Inten.(mm/hr)= over (min) Storage Coeff. (min)= Unit Hyd. Tpeak (min)= Unit Hyd. peak (cms)= PEAK FLOW (cms)= TIME TO PEAK (hrs)= RUNOFF VOLUME (mm)= TOTAL RAINFALL (mm)=	<pre>(ha) = 1 Imp(%) = IMPERVI 2 1.( 1.( 40.8 .01 114.2 5.( 1.( 5.( 1.( 5.( 1.( 44.1 45.2 </pre>	.25 90.00 rous P 22 00 00 33 21 11 (ii) 00 13 33 77 13 33 77	Dir. Conn. ERVIOUS (i) .03 1.00 2.00 40.00 .250 42.13 5.00 4.19 (ii) 5.00 .24 .00 1.33 18.12 45.17	*TOTALS* .074 (± 1.33 41.56 45.17	iii)
<pre>  CALIB       STANDHYD (0001)   Area  ID= 1 DT= 5.0 min   Tota Dep. Storage (mm)= Average Slope (%)= Length (m)= Mannings n = Max.Eff.Inten.(mm/hr)= over (min) Storage Coeff. (min)= Unit Hyd. Tpeak (min)= Unit Hyd. Tpeak (cms)= TIME TO PEAK (hrs)= RUNOFF VOLUME (mm)= TOTAL RAINFALL (mm)= RUNOFF COEFFICIENT =</pre>	<pre>(ha) = 1 Imp(%) = IMPERV: 2 1.( 40.6 .00 114.2 5.( 1.4 5.( 1.4 5.( 1.4 5.( 1.4 40.7 1.4 40.7 1.4 40.7 1.4 40.7 1.4 5.( 1.4 40.7 1.4 1.4 1.4 1.4 1.4 1.4 1.4 1.4 1.4 1.4</pre>	.25 90.00 cous P 22 00 00 30 33 33 11 (ii) 00 13 33 33 17 73 33 27 28	Dir. Conn. ERVIOUS (i) .03 1.00 2.00 40.00 .250 42.13 5.00 4.19 (ii) 5.00 .24 .00 1.33 18.12 45.17 .40	*TOTALS* .074 (5 1.33 41.56 45.17 .92	iii)
<pre>  CALIB       STANDHYD (0001)   Area   ID= 1 DT= 5.0 min   Tota Dep. Storage (mm)= Average Slope (%)= Length (m)= Mannings n = Max.Eff.Inten.(mm/hr)= over (min) Storage Coeff. (min)= Unit Hyd. Tpeak (min)= Unit Hyd. Tpeak (cms)= PEAK FLOW (cms)= TIME TO PEAK (hrs)= RUNOFF VOLUME (mm)= RUNOFF VOLUME (mm)= RUNOFF COEFFICIENT = ***** WARNING: STORAGE COEF</pre>	<pre>(ha) = 1 Imp(%) = IMPERV: 2 1.( 40.8 .00 114.2 5.( 1.4 5.( .0 1.4 5.( .0 1.4 4.1 4.5.( .0 5.( 1.4 4.5.( .0 5.( 1.4 5.( 1.</pre>	.25 90.00 cous P 22 00 30 33 33 41 (ii) 00 41 (ii) 00 33 33 77 33 33 77 79 88 24 77 79 88 25 77 77 88 26 77 77 78 78 77 77 77 77 77 77 77 77 77	Dir. Conn. ERVIOUS (i) .03 1.00 2.00 40.00 .250 42.13 5.00 42.19 (ii) 5.00 .24 .00 1.33 18.12 45.17 .40 TIME STEP	*TOTALS* .074 (: 1.33 41.56 45.17 .92	iii)
<pre>  CALIB     STANDHYD (0001)   Area  ID= 1 DT= 5.0 min   Tota Dep. Storage (nm)= Average Slope (%)= Length (m)= Mannings n = Max.Eff.Inten.(mm/hr)= Over (min) Storage Coeff. (min)= Unit Hyd. Tpeak (min)= Unit Hyd. Tpeak (min)= PEAK FLOW (cms)= TIME TO PEAK (hrs)= RUNOFF VOLUME (mm)= TOTAL RAINFALL (mm)= RUNOFF COEFFICIENT = ****** WARNING: STORAGE COEF</pre>	<pre>(ha) = 1 Imp(%) = IMPERVI</pre>	.25 90.00 rous P 22 00 00 03 13 14 (ii) 00 13 14 (ii) 00 13 15 17 17 17 17 17 17 17 17 17 17 17 17 17	Dir. Conn. ERVIOUS (i) .03 1.00 2.00 40.00 .250 42.13 5.00 4.19 (ii) 5.00 .24 .00 1.33 18.12 45.17 .40 TIME STEP	*TOTALS* .074 (i 1.33 41.56 45.17 .92	iii)
<pre>  CALIB       STANDHYD (0001)   Area  ID= 1 DT= 5.0 min   Tota Dep. Storage (mm)= Average Slope (%)= Length (m)= Mannings n = Max.Eff.Inten.(mm/hr)= Unit Hyd. Tpeak (min)= Unit Hyd. Tpeak (min)= Unit Hyd. Tpeak (min)= EAK FLOW (cms)= TIME TO PEAK (hrs)= RUNOFF VOLUME (mm)= TOTAL RAINFALL (mm)= RUNOFF COEFFICIENT = ****** WARNING: STORAGE COEF (i) CN PROCEDURE SEL</pre>	<pre>(ha) = 1 Imp(%) = IMPERVI .2 1.0 (</pre>	.25 90.00 10US P 22 00 00 13 11 (ii) 00 11 (ii) 00 13 11 (ii) 00 13 11 (ii) 00 13 13 17 17 17 18 8 21 20 20 20 20 20 20 20 20 20 20 20 20 20	Dir. Conn. ERVIOUS (i) .03 1.00 2.00 40.00 .250 42.13 5.00 4.19 (ii) 5.00 .24 .00 1.33 18.12 45.17 .40 TIME STEP LOSSES:	*TOTALS* .074 (: 1.33 41.56 45.17 .92	iii)
<pre>  CALIB       STANDHYD (0001)   Area   ID= 1 DT= 5.0 min   Tota Dep. Storage (mm)= Average Slope (%)= Length (m)= Mannings n = Max.Eff.Inten.(mm/hr)= Over (min) Storage Coeff. (min)= Unit Hyd. Tpeak (min)= Unit Hyd. Tpeak (min)= Unit Hyd. peak (cms)= PEAK FLOW (cms)= TIME TO PEAK (hrs)= RUNOFF VOLUME (mm)= RUNOFF COEFFICIENT = ****** WARNING: STORAGE COEF (i) CN PROCEDURE SEL CN* = 80.0 (ii) TIME STEP (DT) S</pre>	<pre>(ha) = 1 Imp(%) = IMPERVI</pre>	.25 90.00 COUS P 22 00 00 13 21 00 14 (ii) 00 33 33 77 77 78 8 LLR THAN PERVIOUS Storage	Dir. Conn. ERVIOUS (i) .03 1.00 2.00 40.00 .250 42.13 5.00 4.19 (ii) 5.00 .24 .00 1.33 18.12 45.17 .40 TIME STEP LOSSES: (Above) E EQUIAL	*TOTALS* .074 (5) 41.33 41.56 45.17 .92	iii)
<pre>  CALIB       STANDHYD (0001)   Area  ID= 1 DT= 5.0 min   Tota Dep. Storage (mm)= Average Slope (%)= Length (m)= Mannings n = Max.Eff.Inten.(mm/hr)= over (min) Unit Hyd. Tpeak (min)= Unit Hyd. Tpeak (min)= Unit Hyd. peak (cms)= TIME TO PEAK (hrs)= TIME TO PEAK (hrs)= RUNOFF VOLUME (mm)= TOTAL RAINFALL (mm)= RUNOFF COEFFICIENT = ****** WARNING: STORAGE COEF (i) CN PROCEDURE SEL CN* = 80.0 (ii) TIME STORAGE (DT) S THAN THE STORAGE</pre>	<pre>(ha) = 1 Imp(%) = IMPERVI</pre>	.25 90.00 COUS P 22 00 00 13 21 11 (ii) 00 11 (ii) 00 33 77 78 83 77 78 84 LLER THAN PERVIOUS Storage SMALLER O SNT.	Dir. Conn. ERVIOUS (i) .03 1.00 2.00 40.00 .250 42.13 5.00 .24 .00 1.33 18.12 45.17 .40 TIME STEP LOSSES: (Above) R EQUAL	*TOTALS* .074 (1 1.33 41.56 45.17 .92	iii)
<pre>  CALIB       STANDHYD (0001)   Area  ID= 1 DT= 5.0 min   Tota Dep. Storage (mm)= Average Slope (%)= Length (m)= Mannings n = Max.Eff.Inten.(mm/hr)= over (min) Unit Hyd. Tpeak (min)= Unit Hyd. Tpeak (min)= Unit Hyd. peak (cms)= TIME TO PEAK (hrs)= RUNOFF VOLUME (mm)= TOTAL RAINFALL (mm)= RUNOFF COEFFICIENT = ****** WARNING: STORAGE COEF (i) CN PROCEDURE SEL CN* = 80.0 (ii) TIME STEP (DT) S THAN THE STORAGE (iii) PEAK FLOW DOES N</pre>	<pre>(ha) = 1 Imp(%) = IMPERV:</pre>	.25 90.00 10US P 22 00 00 33 33 21 11 (ii) 00 33 33 77 17 88 5. LLER THAN PERVIOUS S. Storage MALLER O NT. 5 BASEFLO	Dir. Conn. ERVIOUS (i) .03 1.00 2.00 40.00 .250 42.13 5.00 .24 .00 1.33 18.12 45.17 .40 TIME STEP LOSSES: (Above) R EQUAL W IF ANY.	*TOTALS* .074 (f 1.33 41.56 45.17 .92	iii)
<pre>  CALIB       STANDHYD (0001)   Area  ID= 1 DT= 5.0 min   Tota Dep. Storage (mm)= Average Slope (%)= Length (m)= Mannings n = Max.Eff.Inten.(mm/hr)= over (min) Storage Coeff. (min)= Unit Hyd. Tpeak (mn)= Unit Hyd. Tpeak (mn)= Unit Hyd. peak (cms)= TIME TO PEAK (hrs)= RUNOFF VOLUME (mm)= RUNOFF VOLUME (mm)= RUNOFF COEFFICIENT = ****** WARNING: STORAGE COEF (i) CN PROCEDURE SEL CN* = 80.0 (ii) TIME STEP (DT) S THAN THE STORAGE (iii) PEAK FLOW DOES N</pre>	<pre>(ha) = 1 Imp(%) = IMPERV:</pre>	.25 90.00 22 00 33 33 33 33 33 77 47 88 5111 (ii) 00 33 33 77 47 88 512 512 512 512 512 512 512 512 512 512	Dir. Conn. ERVIOUS (i) .03 1.00 2.00 40.00 .250 42.13 5.00 .24 .00 1.33 18.12 45.17 .40 TIME STEP LOSSES: (Above) R EQUAL W IF ANY.	*TOTALS* .074 (1 1.33 41.56 45.17 .92	iii)
<pre>  CALIB       STANDHYD (0001)   Area  ID= 1 DT= 5.0 min   Tota Dep. Storage (nm)= Average Slope (%)= Length (m)= Mannings n = Max.Eff.Inten.(mm/hr)= Over (min) Storage Coeff. (min)= Unit Hyd. Tpeak (min)= Unit Hyd. Tpeak (min)= Unit Hyd. Tpeak (cms)= TIME TO PEAK (hrs)= RUNOFF VOLUME (mm)= TOTAL RAINFALL (mm)= RUNOFF VOLUME (mm)= TOTAL RAINFALL (mm)= RUNOFF COEFFICIENT = ****** WARNING: STORAGE COEF (i) CN PROCEDURE SEL CN* = 80.0 (ii) TIME STEP (DT) S THAN THE STORAGE (iii) PEAK FLOW DOES N</pre>	<pre>(ha) = 1 Imp(%) = IMPERVI</pre>	.25 90.00 10US P 22 00 10 13 11 (ii) 00 11 (ii) 00 13 33 11 (ii) 00 13 33 17 7 8 8 LLER THAN PERVIOUS Storage SMALLER O Storage SMALLER O Storage	Dir. Conn. ERVIOUS (i) .03 1.00 2.00 40.00 .250 42.13 5.00 .24 .00 1.33 18.12 45.17 .40 TIME STEP LOSSES: (Above) R EQUAL W IF ANY.	*TOTALS* .074 (i 1.33 41.56 45.17 .92	iii)
<pre>  CALIB       STANDHYD (0001)   Area  ID= 1 DT= 5.0 min   Tota Dep. Storage (nm)= Average Slope (%)= Length (m)= Mannings n = Max.Eff.Inten.(mm/hr)= Unit Hyd. Tpeak (min)= Unit Hyd. Tpeak (min)= Unit Hyd. Tpeak (min)= EAK FLOW (cms)= TIME TO PEAK (hrs)= RUNOFF VOLUME (mm)= TOTAL RAINFALL (mm)= RUNOFF COEFFICIENT = ****** WARNING: STORAGE COEF (i) CN PROCEDURE SEL CN* = 80.0 (ii) TIME STEP (DT) S THAN THE STORAGE (iii) PEAK FLOW DOES N</pre>	<pre>(ha) = 1 Imp(%) = IMPERVI .2 1.(</pre>	.25 90.00 IOUS P 22 00 00 13 21 00 13 21 00 13 33 17 77 27 28 21 00 20 21 00 21 00 21 00 21 00 21 00 21 00 21 00 21 21 00 21 21 00 21 21 00 21 21 21 21 21 21 21 21 21 21 21 21 21	Dir. Conn. ERVIOUS (i) .03 1.00 2.00 40.00 .250 42.13 5.00 .24 .00 1.33 18.12 45.17 .40 TIME STEP LOSSES: (Above) R EQUAL W IF ANY.	*TOTALS* .074 (: 1.33 41.56 45.17 .92	iii)
<pre>  CALIB       STANDHYD (0001)   Area  ID= 1 DT= 5.0 min   Tota Dep. Storage (mm)= Average Slope (%)= Length (m)= Mannings n = Max.Eff.Inten.(mm/hr)= Over (min) Storage Coeff. (min)= Unit Hyd. Tpeak (min)= Unit Hyd. Tpeak (min)= Unit Hyd. peak (cms)= PEAK FLOW (cms)= TIME TO PEAK (hrs)= TOTAL RAINFALL (mm)= RUNOFF COEFFICIENT = ****** WARNING: STORAGE COEF (i) CN PROCEDURE SEL CN* = 80.0 (ii) TIME STEP (DT) S THAN THE STORAGE (iii) PEAK FLOW DOES N (iii) PEAK FLOW DOES N</pre>	<pre>(ha) = 1 Imp(%) = IMPERVI .2 .1.(</pre>	.25 90.00 COUS P 22 00 00 13 21 00 11 (ii) 00 11 (ii) 00 33 27 77 78 8 50 50 77 77 79 8 8 50 50 77 77 79 8 8 50 77 77 70 8 8 50 77 70 70 70 70 70 70 70 70 70 70 70 70	Dir. Conn. ERVIOUS (i) .03 1.00 2.00 40.00 .250 42.13 5.00 .24 .00 1.33 18.12 45.17 .40 TIME STEP LOSSES: (Above) R EQUAL W IF ANY.	*TOTALS* .074 (: 1.33 41.56 45.17 .92	iii)
<pre>  CALIB       STANDHYD (0001)   Area  ID= 1 DT= 5.0 min   Tota Dep. Storage (mm)= Average Slope (%)= Length (m)= Mannings n = Max.Eff.Inten.(mm/hr)= over (min) Unit Hyd. Tpeak (min)= Unit Hyd. Tpeak (min)= Unit Hyd. peak (cms)= TIME TO PEAK (hrs)= RUNOFF VOLUME (mm)= TOTAL RAINFALL (mm)= RUNOFF COEFFICIENT = ****** WARNING: STORAGE COEF (i) CN PROCEDURE SEL CN* = 80.0 (ii) TIME STEP (DT) S THAN THE STORAGE (iii) PEAK FLOW DOES N </pre>	<pre>(ha) = 1 Imp(%) = IMPERVI</pre>	.25 90.00 rous P 22 00 00 13 21 11 (ii) 00 11 (ii) 00 33 77 33 77 78 8 LLER THAN PERVIOUS Storage SMALLER O SMALLER O SMALLON SMALLON SM	Dir. Conn. ERVIOUS (i) .03 1.00 2.00 40.00 .250 42.13 5.00 .24 .00 1.33 18.12 45.17 .40 TIME STEP LOSSES: (Above) R EQUAL W IF ANY. 	*TOTALS* .074 (1 1.33 41.56 45.17 .92	iii)
<pre>  CALIB     STANDHYD (0001)   Area   ID= 1 DT= 5.0 min   Tota Dep. Storage (mm)= Average Slope (%)= Length (m)= Mannings n = Max.Eff.Inten.(mm/hr)=</pre>	<pre>(ha) = 1 Imp(%) = IMPERVI</pre>	.25 90.00 rous P 22 00 00 30 33 21 11 (ii) 00 11 (ii) 00 33 77 73 33 77 78 8 LLER THAN PERVIOUS Storage MALLER O Storage MALLER O Storage BASEFIO COMPACTION Storage MALLER O Storage MALLER O St	Dir. Conn. ERVIOUS (i) .03 1.00 2.00 40.00 .250 42.13 5.00 4.19 (ii) 5.00 .24 .00 1.33 18.12 45.17 .40 TIME STEP LOSSES: (Above) R EQUAL W IF ANY.  TPEAK (hrs) 1.33 4.3	<pre>*TOTALS*     .074 (1     .33     41.56     45.17     .92 </pre>	iii)

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NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY. \_\_\_\_\_ | ADD HYD (0005) | | 1 + 2 = 3 | R.V. AREA QPEAK TPEAK (hrs) (mm, 1.50 15.15 33 41.88 (cms) (ha) (mm) .004 .08 ID1= 1 (0003): + ID2= 2 (0004): .29 .087 35.97 ID = 3 (0005): .37 .090 1.33 NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY. \*\*\*\*\* \*\* SIMULATION NUMBER: 2 \*\* | CHICAGO STORM | | Ptotal= 75.20 mm | IDF curve parameters: A=2150.000 B= 5.700 C= .861 \_\_\_\_\_ used in: INTENSITY =  $A / (t + B)^{C}$ Duration of storm = 4.00 hrs Storm time step = 10.00 min Time to peak ratio = .33 TIME RAIN | TIME RAIN | TIME RAIN | TIME RATN hrs mm/hr | hrs mm/hr | hrs mm/hr | hrs mm/hr 39.75 | 200.80 | 2.17 3.17 3.33 .17 3.49 | 1.17 9.50 | 4.26 4.08 | 1.33 7.85 I 3.91 .33 .50 4.93 1.50 54.01 2.50 6.70 3.50 3.62 .67 6.26 | 1.67 25.55 I 2.67 5.85 I 3.67 3.37 8.66 | 1.83 16.41 | 2.83 5.19 3.83 .83 3.15 1.00 14.21 | 2.00 12.04 | 3.00 4.68 | 4.00 2.96 \_\_\_\_\_ L CALTB 1 NASHYD (0003) | Area (ha)= .08 Curve Number (CN) = 80.0 |ID= 1 DT=10.0 min | Ia (mm) = 5.00 # of Linear Res.(N) = 3.00 \_\_\_\_\_ U.H. Tp(hrs)= .20 Unit Hyd Qpeak (cms)= .015 PEAK FLOW (cms) = .011 (i) TIME TO PEAK 1.500 (hrs)= RUNOFF VOLUME (mm) = 35.894(mm) = 75.204 TOTAL RAINFALL RUNOFF COEFFICIENT = .477 (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY. \_\_\_\_\_ CALIB 1 STANDHYD (0002) | (ha)= Area .04 Total Imp(%) = 99.00 Dir. Conn.(%) = 99.00 |ID= 1 DT= 5.0 min | IMPERVIOUS PERVIOUS (i) Surface Area (ha)= .04 1.00 .00 (mm) = (%) = Dep. Storage Average Slope 1.00 16.30 .013 2.00 40.00 Length (m) = Mannings n = NOTE: RAINFALL WAS TRANSFORMED TO 5.0 MIN. TIME STEP. ---- TRANSFORMED HYETOGRAPH ---TIME RAIN | TIME RAIN | TIME RAIN | TIME RAIN hrs mm/hr | hrs mm/hr | hrs mm/hr | hrs mm/hr .083 3.49 | 1.083 39.75 | 2.083 9.50 | 3.08 4.26 .167 3.49 | 1.167 4.08 | 1.250 39.75 | 2.167 200.80 | 2.250 9.50 | 3.17 3.25 4.26 .250 7.85 | 3.91 .333 4.08 | 1.333 200.80 | 2.333 7.85 | 3.33 3.91 .417 4.93 | 1.417 54.01 | 2.417 6.70 I 3.42 3.62 .500 4.93 | 1.500 54.01 | 2.500 6.70 3.50 3.62 25.55 | 2.583 .583 6.26 | 1.583 5.85 I 3.58 3.37 .667 6.26 | 1.667 25.55 | 2.667 5.85 | 3.67 3.37

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ID = 3 (0004): .29 .087 1.33 41.88

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onic nya. pean (omo)	.01	.00	*TOTALS*
PEAK FLOW (cms) =	.02	.00	.022 (iii)
TIME TO PEAK (hrs) =	1.33	1.33	1.33
RUNOFF VOLUME (mm) =	74.20	39.99	73.86
TOTAL RAINFALL (mm) =	/5.20	/5.20	/5.20
KUNUFF CUEFFICIENT =	. 99		. 20
***** WARNING: STORAGE COEFF	. IS SMALLER T	HAN TIME STEP!	
<pre>(i) CN PROCEDURE SELE     CN* = 80.0</pre>	CTED FOR PERVI Ia = Dep. Stor	OUS LOSSES: age (Above)	
(ii) TIME STEP (DT) SH	OULD BE SMALLE	R OR EQUAL	
THAN THE STORAGE	COEFFICIENT.		
(iii) PEAK FLOW DOES NO	T INCLUDE BASE	FLOW IF ANY.	
CALIB	(ba) - 0	5	
STANDHYD (UUUI)   Area	(ha) = .2 Tmp(%) = 90 0	Dir Conn (%)	= 90 00
10tal	Tub(0)= 20.0	5 DIL. COUNT. (8)	50.00
	IMPERVIOUS	PERVIOUS (i)	
Surface Area (ha) =	.22	.03	
Dep. Storage (mm) =	1.00	1.00	
Average Slope (%)=	1.00	2.00	
Mannings n =	40.80	40.00	
	.013	.200	
Max.Eff.Inten.(mm/hr)=	200.80	103.62	
over (min)	5.00	5.00	
Storage Coeff. (min)=	1.13 (ii	) 3.35 (ii)	
Unit Hyd. Tpeak (min)=	5.00	5.00	
unit Hya. peak (cms)=	.34	.20	*TOTALS*
PEAK FLOW (cms) =	.13	.01	.133 (iii)
TIME TO PEAK (hrs) =	1.33	1.33	1.33
RUNOFF VOLUME (mm) =	74.20	39.99	70.77
TOTAL RAINFALL (mm) =	75.20	75.20	75.20
RUNOFF COEFFICIENT =	.99	.53	.94
***** WARNING: STORAGE COFF	. IS SMALLER T	HAN TIME STEP!	
(i) CN PROCEDURE SELE	CTED FOR PERVI	OUS LOSSES:	
UN* = 80.0	IA = Dep. Stor	age (Above) R OR FOUNT	
(II) IIME STEP (DT) SH THAN THE STORAGE	COEFFICIENT	N OK EQUAL	
(iii) PEAK FLOW DOES NO	T INCLUDE BASE	FLOW IF ANY.	
ADD HYD (0004)			
1 + 2 = 3	AREA QPEAK	TPEAK R.V	•
	(ha) (cms)	(hrs) (mm	.)
ID1 = 1 (0002):	.04 .022	1.33 73.86	
+ 1D2= 2 (0001):	.25 .133	1.33 /0.77	=
ID = 3 (0004):	.29 .155	1.33 71.20	
NOTE: PEAK FLOWS DO NO	T INCLUDE BASE	FLOWS IF ANY.	
ADD HYD (0005)			
1 + 2 = 3	AREA QPEAK	TPEAK R.V	•
TD1= 1 (0002)	(ha) (cms)	(hrs) (mm	1)
IDI = 1 (0003): + $ID2 = 2 (0004).$	.U8 .U11 29 155	1.50 35.89 1.33 71.20	
+ 1D2= 2 (UUU4):	.25 .23	1.33 /1.20	=
ID = 3 (0005):	.37 .165	1.33 63.37	
NOTE: PEAK FLOWS DO NO	T INCLUDE BASE	FLOWS IF ANY.	
FINISH			

Max.Eff.Inten.(mm/hr) = over (min) Storage Coeff. (min) = Unit Hyd. Tpeak (min) = Unit Hyd. peak (cms) = 200.80 210.66 5.00 5.00 .65 (ii) 1.50 (ii) 5.00 5.00 .34 .33

 .750
 8.66 | 1.750
 16.41 | 2.750

 .833
 8.66 | 1.833
 16.41 | 2.833

 .917
 14.21 | 1.917
 12.04 | 2.917

 1.000
 14.21 | 2.000
 12.04 | 3.000

5.19 | 3.75 5.19 | 3.83 4.68 | 3.92 4.68 | 4.00

3.15 3.15 2.96 2.96

#### Post-Development Visual OTTHYMO Output (5-year & 100-year Storms)

V SSSSS U U I А L V I SS U U A A L V I SS U U AAAAA L v v v v v I SS U U A A L SSSSS UUUUU A A LLLLL vv I 000 TTTTT TTTTT н ү у м м 000 TITIT TITIT H H T T M M 000 T T H H Y M MM 0 O T T H H Y M M 0 O T T H H Y M M 000 0 0 0 0 000 Developed and Distributed by Clarifica Inc. Copyright 1996, 2007 Clarifica Inc. All rights reserved. \*\*\*\*\* DETAILED OUTPUT \*\*\*\*\* Input filename: C:\VO Dongle Driver\Visual OTTHYMO 2.3.3\voin.dat Output filename: P:\2018\18219\Visual OTTHYMO\Rev4\18219 VO2\Post-Dev.out Summary filename: P:\2018\18219\Visual OTTHYMO\Rev4\18219 VO2\Post-Dev.sum DATE: 6/30/2023 TIME: 9:44:55 AM USER: COMMENTS: \*\*\*\*\*\* \*\* SIMULATION NUMBER: 1 \*\* | CHICAGO STORM | | Ptotal= 45.17 mm | IDF curve parameters: A=1170.000 B= 5.800 C= .843 used in: INTENSITY = A / (t + B)^C Duration of storm = 4.00 hrs Storm time step = 10.00 min Time to peak ratio = .33 TIME RAIN | TIME RAIN | TIME RAIN | TIME RAIN hrs mm/hr | hrs mm/hr | hrs mm/hr | hrs mm/hr 2.32 | 1.17 24.01 | 2.17 6.09 j 3.17 2.81 .17 2.70 | 1.33 114.21 | | 2.33 | 2.50 .33 5.07 I 3.33 2.59 32.30 .50 3.24 | 1.50 4.35 | 3.50 2.40 4.08 | 1.67 5.57 | 1.83 15.74 | 2.67 10.30 | 2.83 3.82 | 3.41 | 3.67 3.83 .67 2.24 .83 2.10 1.00 8.96 | 2.00 7.65 | 3.00 3.08 | 4.00 1.98 L CALTB (0003) Area (ha)= .03 Curve Number (CN)= 80.0 Ia (mm)= 5.00 # of Linear Res.(N)= 3.00 NASHYD Ia (mm) = U.H. Tp(hrs) = |ID= 1 DT=10.0 min | -----.20 Unit Hyd Qpeak (cms)= .006 PEAK FLOW (cms) = .002 (i) 1.500 TIME TO PEAK (hrs) = (mm) = 15.137 RUNOFF VOLUME TOTAL RAINFALL (mm) = 45.171 RUNOFF COEFFICIENT = .335 (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY. | CALIB 1 STANDHYD (0012) | Area (ha)= .07 |ID= 1 DT= 5.0 min | Total Imp(%)= 99.00 Dir. Conn.(%)= 99.00 IMPERVIOUS PERVIOUS (i)

rea (ha	) =	.07	.00
age (mm	) = 1	.00	1.00
lope (%	) = 1	.00	2.00
(m	) = 21	60 4	10.00
n		013	.250
	rea (ha age (mm lope (% (m n	rea (ha) = age (mm) = 1 lope (%) = 1 (m) = 21 n =	rea (ha)= .07 age (mm)= 1.00 lope (%)= 1.00 (m)= 21.60 4 n = .013

		TRA	ANSFORMED H	YETOGRA	РН		
TIME	RAIN	TIME	RAIN	TIME	RAIN	TIME	RAIN
hrs	mm/hr	hrs	mm/hr	hrs i	mm/hr	hrs	mm/hr
.083	2.32	1.083	24.01   2	.083	6.09	3.08	2.81
.167	2.32	1.167	24.01   2	.167	6.09	3.17	2.81
.250	2.70	1.250	114.21   2	.250	5.07	3.25	2.59
.333	2.70	1.333	114.21   2	.333	5.07	3.33	2.59
.417	3.24	1.417	32.30   2	.417	4.35	3.42	2.40
.500	3.24	1.500	32.30   2	.500	4.35	3.50	2.40
.583	4.08	1.583	15.74   2	.583	3.82	3.58	2.24
.667	4.08	1.667	15.74   2	.667	3.82	3.67	2.24
.750	5.57	1.750	10.30   2	.750	3.41	3.75	2.10
.833	5.57	1.833	10.30   2	.833	3.41	3.83	2.10
.917	8.96	1.917	7.65   2	.917	3.08	3.92	1.98
1.000	8.96	2.000	7.65   3	.000	3.08	4.00	1.98
Max.Eff.Inten.(m	m/hr)=	114.21	259.	04			
over	(min)	5.00	5.	00			
Storage Coeff.	(min) =	.97	(ii) 2.	03 (ii)			
Unit Hyd. Tpeak	(min) =	5.00	5.	00			
Unit Hyd. peak	(cms) =	.34		31			
					*TOTA	LS*	
PEAK FLOW	(cms) =	.02		00	.0	22 (ii:	)
TIME TO PEAK	(hrs)=	1.33	1.	33	1.	33	
RUNOFF VOLUME	(mm) =	44.17	18.	12	43.	91	
TOTAL RAINFALL	(mm) =	45.17	45.	17	45.	17	
RUNOFF COEFFICIE	NT =	.98		40		97	
* MADNING. CHODAC	F COFFF	TO OMATTE		E CEEDI			

NOTE: RAINFALL WAS TRANSFORMED TO 5.0 MIN. TIME STEP.

\*\*\*\*\* WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

(i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:

CN\* = 80.0 Ia = Dep. Storage (Above)
 (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL THAN THE STORAGE COEFFICIENT.
 (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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CA.	LIB							
ST	ANDHYD (0001)	Area	(ha) =	.20				
ID=	1 DT= 5.0 min	Total	Imp(%)=	99.00	Dir. (	Conn.(%)	= 99.00	)
			IMPERVIC	JUS	PERVIOUS	5 (1)		
	Surface Area	(ha)=	.20	)	.00			
	Dep. Storage	(mm) =	1.00	)	1.00			
	Average Slope	(%) =	1.00	)	2.00			
	Length	(m) =	36.50	)	40.00			
	Mannings n	=	.013	3	.250			
	Max.Eff.Inten.(r	nm/hr)=	114.23	L	129.52			
	over	(min)	5.00	)	5.00			
	Storage Coeff.	(min) =	1.32	2 (ii)	2.39	(ii)		
	Unit Hyd. Tpeak	(min) =	5.00	)	5.00			
	Unit Hyd. peak	(cms) =	.33	3	.30			
							*TOTALS*	r
	PEAK FLOW	(cms) =	.00	5	.00		.063	(iii)
	TIME TO PEAK	(hrs) =	1.33	3	1.33		1.33	
	RUNOFF VOLUME	(mm) =	44.17	7	18.12		43.91	
	TOTAL RAINFALL	(mm) =	45.17	7	45.17		45.17	
	RUNOFF COEFFICIE	ENT =	.98	3	.40		.97	

\*\*\*\*\* WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

(i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES: CN\* = 80.0 Ia = Dep. Storage (Above)
 (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL THAN THE STORAGE COEFFICIENT.
 (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

CALIB     STANDHYD (0002)    ID= 1 DT= 5.0 min	Area Total	(ha) = Imp(%) =	.07 99.00	Dir. Conn.(%)=	99.00
Surface Area Dep. Storage	(ha)= (mm)=	IMPERVI .0 1.0	OUS 7 0	PERVIOUS (i) .00 1.00	

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RUNOFF COEFFICIENT =	.98	.4	0	.80
***** WARNING: STORAGE COEFF. IS	SMALLER TH	IAN TIME	STEP!	
<ul> <li>(i) CN PROCEDURE SELECTED CN* = 80.0 Ia =</li> <li>(ii) TIME STEP (DT) SHOULD THAN THE STORAGE COEFF (iii) PEAK FLOW DOES NOT INC</li> </ul>	FOR PERVIC Dep. Stora BE SMALLEF ICIENT. LUDE BASEF	DUS LOSS Age (Ab OR EQU FLOW IF	ES: ove) AL ANY.	
ADD HYD (0013)     1 + 2 = 3   AREA ID1= 1 (0012): .07 + ID2= 2 (0001): .20	QPEAK (cms) .022 .063	TPEA (hrs 1.33 1.33	K R.V. ) (mm) 43.91 43.91	
ID = 3 (0013): .27	.085	1.33	43.91	
NOTE: PEAK FLOWS DO NOT INC	LUDE BASEP	LOWS IF	ANY.	
RESERVOIR (0007)     IN= 2> OUT= 1     DT= 5.0 min   OUTFLOW (cms) .0000 .0400	STORAGE (ha.m.) .0001 .0002		UTFLOW S (cms) ( .0401 .0000	STORAGE (ha.m.) .0136 .0000
INFLOW : ID= 2 (0013) OUTFLOW: ID= 1 (0007) PEAK FLOW	AREA (ha) .270 .270 REDUCTION	QPEAK (cms) .085 .040 [Qout/Q	TPEAK (hrs) 1.33 1.42 in](%)= 47.	R.V. (mm) 43.91 43.55
TIME SHIFT OF MAXIMUM STORA	PEAK FLOW GE USED	(	(min)= 5. ha.m.)= .	00 0028

L CALTB							
STANDHYD (0004)	Area	(ha) =	.00				
TD=1 DT=5.0 min	Total	Tmp (%) =	99.00	Dir. (	lonn.	(%) = 99.00	
						(-)	
		IMPERVIC	US	PERVIOUS	5 (i)		
Surface Area	(ha) =	.00		.00	- (-)		
Dep. Storage	(mm) =	1.00		1.00			
Average Slope	(%) =	1.00		2.00			
Length	(m) =	5.20		40.00			
Mannings n	=	.013		.250			
Max.Eff.Inten.(r	nm/hr)=	114.21		42.13			
over	(min)	5.00		5.00			
Storage Coeff.	(min) =	.41	(ii)	1.48	(ii)		
Unit Hvd. Tpeak	(min) =	5.00	. ,	5.00	. ,		
Unit Hvd. peak	(cms) =	. 34		.33			
	( ==== )					*TOTALS*	
PEAK FLOW	(cms) =	.00		.00		.001	(iii)
TIME TO PEAK	(hrs) =	1.33		1.33		1.33	()
RUNOFF VOLUME	(mm) =	44.17		18.12		36.01	
TOTAL RAINFALL	(mm) =	45.17		45.17		45.17	
BUNOFF COEFFICIE	ENT =	. 98		. 40		.80	

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\*\*\*\*\* WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP! (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES: CN\* = 80.0 Ia = Dep. Storage (Above)
 (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL THAN THE STORAGE COEFFICIENT.
 (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

Average Slope	(%) =	1.00	2.00		
Length	(m) =	21.60	40.00		
Mannings n	=	.013	.250		
Max.Eff.Inten.(m	nm/hr)=	114.21	64.76		
over	(min)	5.00	5.00		
Storage Coeff.	(min) =	.97	(ii) 2.03	(ii)	
Unit Hyd. Tpeak	(min) =	5.00	5.00		
Unit Hyd. peak	(cms) =	.34	.31		
				*TOTALS	*
PEAK FLOW	(cms) =	.02	.00	.022	(iii)
TIME TO PEAK	(hrs) =	1.33	1.33	1.33	
RUNOFF VOLUME	(mm) =	44.17	18.12	43.91	
TOTAL RAINFALL	(mm) =	45.17	45.17	45.17	
RUNOFF COEFFICIE	ENT =	.98	.40	.97	

| ADD HYD (0005) | | 1 + 2 = 3 | R.V. TPEAK AREA QPEAK Treak (hrs) (mm) 1.42 43.55 22 43.91 ..... (ha) (cms) (mm) ID1= 1 (0007): .27 .040 + ID2= 2 (0002): .07 .022 ID = 3 (0005): .34 .062 1.33 43.62 NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY. \_\_\_\_\_ | ADD HYD (0006) | | 1 + 2 = 3 | R.V. AREA QPEAK TPEAK (ha) .03 .34 (hrs) (mm) 1.50 15.14 1.33 43.62 ------(cms) ID1= 1 (0003): .002 + ID2= 2 (0005): .062 \_\_\_\_\_ \_\_\_\_\_ ------ID = 3 (0006):.37 .063 1.33 41.31 NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY. | ADD HYD (0008) | | 1 + 2 = 3 | AREA QPEAK TPEAK R.V. TPErn. (hrs) (ium., 1.33 41.31 1.33 36.01 (ha) (cms) ID1= 1 (0006): .37 + ID2= 2 (0004): .00 .063 + ID2= 2 (0004): .001 \_\_\_\_\_ \_\_\_\_\_ ID = 3 (0008):.37 .065 1.33 41.25 NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY. \*\*\*\*\* \*\* SIMULATION NUMBER: 2 \*\* | CHICAGO STORM | IDF curve parameters: A=2150.000 | Ptotal= 75.20 mm | B= 5.700 C= .861 \_\_\_\_\_ used in: INTENSITY =  $A / (t + B)^{C}$ Duration of storm = 4.00 hrs Storm time step = 10.00 min Storm time step = 10.00 Time to peak ratio = .33 TIME RAIN | TIME RAIN | TIME RAIN | TIME RAIN mm/hr | 39.75 | 200.80 | hrs 3.17 3.33 mm/hr | mm/hr | mm/hr hrs hrs hrs 2.17 .17 .33 1.17 1.33 9.50 | 7.85 | 3.49 | 4.26 4.08 | 3.91 54.01 | 2.50 25.55 | 2.67 16.41 | 2.83 .50 4.93 | 1.50 6.26 | 1.67 6.70 3.50 3.67 3.62 3.37 .67 5.85 | . 83 8.66 1.83 16.41 5.19 3.83 3.15 14.21 | 2.00 1.00 12.04 | 3.00 4.68 | 2.96 4.00 ------CALIB (0003) | (7) | Area (ha) = Ia (mm) = .03 Curve Number (CN) = 80.0 5.00 # of Linear Res.(N) = 3.00 |ID= 1 DT=10.0 min | U.H. Tp(hrs)= -----.20 Unit Hyd Qpeak (cms)= .006 PEAK FLOW (cms)= .004 (i) (cms) = .004 (hrs) = 1.500 (mm) = 35.892 TIME TO PEAK RUNOFF VOLUME (mm) = 75.204 TOTAL RAINFALL RUNOFF COEFFICIENT = .477 (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY. | CALIB | STANDHYD (0012) | Area (ha) = .07 |ID= 1 DT= 5.0 min | Total Imp(%)= 99.00 Dir. Conn.(%)= 99.00

------IMPERVIOUS PERVIOUS (i) .07 .00 Surface Area (ha)= Dep. Storage Average Slope (mm) =(%)= 1.00 2.00 Length (m) = 21.60 40.00 Mannings n .013 .250 NOTE: RAINFALL WAS TRANSFORMED TO 5.0 MIN. TIME STEP. -- TRANSFORMED HYETOGRAPH ---TIME RAIN | TIME RAIN | TIME RATN | TIME RATN mm/hr mm/hr mm/hr | mm/hr hrs hrs hrs hrs 1.083 2.083 .083 3.49 | 3.49 | 39.75 | 2.083 39.75 | 2.167 9.50 | 9.50 | 3.08 4.26 3.17 4.26 .167 1.167 .250 4.08 1.250 200.80 2.250 7.85 3.25 3.91 .333 4.08 | 1.333 200.80 | 2.333 7.85 | 3.33 3.91 .417 4.93 1.417 54.01 | 2.417 6.70 3.42 3.62 500 4 93 1.500 54.01 | 2.500 6.70 3.50 3.62 .583 6.26 | 1.583 25.55 | 2.583 5.85 3.58 3.37 .667 6.26 1.667 25.55 | 2.667 16.41 | 2.750 5.85 3.67 3.75 3.37 .750 8.66 | 5.19 | 3.15 .833 8.66 | 1.833 16.41 | 2.833 5.19 | 3.83 3.15 12.04 | 2.917 12.04 | 3.000 .917 14.21 | 1.917 4.68 | 3.92 2.96 14.21 | 2.000 1.000 4.68 | 4.00 2.96 Max.Eff.Inten.(mm/hr)= 200.80 103.62 5.00 1.62 (ii) over (min) Storage Coeff. (min)= 5.00 .77 (ii) Unit Hyd. Tpeak (min) = 5.00 5.00 .32 Unit Hyd. peak (cms) = .34 \*TOTALS\* PEAK FLOW TIME TO PEAK .04 1.33 .039 (iii) 1.33 (cms) =.00 1.33 (hrs)= (mm) = RUNOFF VOLUME 74.20 39.99 73.86 TOTAL RAINFALL (mm) =75.20 75.20 75.20 RUNOFF COEFFICIENT .99 .53 .98 \*\*\*\*\* WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP! (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES: (1) CN\* = 80.0 Ia = Dep. Storage (Above
 (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL THAN THE STORAGE COEFFICIENT. (Above) (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY. | CALIB STANDHYD (0001) | (ha) = .20 Area |ID= 1 DT= 5.0 min | Total Imp(%) = 99.00 Dir. Conn.(%) = 99.00 -----IMPERVIOUS PERVIOUS (i) .20 1.00 .00 Surface Area (ha) = (mm) = Dep. Storage Average Slope (%)= 1.00 2.00 (m) = Length 36.50 40.00 Mannings n .013 .250 Max.Eff.Inten.(mm/hr)= 200.80 103.62 over (min) Storage Coeff. (min)= 5.00 1.06 (ii) 5.00 1.91 (ii) (min) = Unit Hyd. Tpeak (min) = 5.00 5.00 Unit Hyd. peak (cms)= .34 .32 \*TOTALS\* 11 0.0 .111 (iii) 1.33 PEAK FLOW (cms) =TIME TO PEAK 1.33 1.33 (hrs)= (mm) = (mm) = RUNOFF VOLUME 74.20 39.99 73.86 TOTAL RAINFALL 75.20 75.20 75.20 RUNOFF COEFFICIENT = .99 .98 .53 \*\*\*\*\* WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP! (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES: (i) CN\* = 80.0 Ia = Dep. Storage (Above (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL THAN THE STORAGE COEFFICIENT. (Above) (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY. ------| CALIB STANDHYD (0002) | .07 Area (ha) = |ID= 1 DT= 5.0 min | Total Imp(%) = 99.00 Dir. Conn.(%) = 99.00 ------IMPERVIOUS PERVIOUS (i)

Surface Area (ha) = .07 1.00 .00 1.00 Dep. Storage (mm) =Average Slope (%)= 1.00 2.00 (m) = 21.60 40.00 Length .013 Mannings n .250 Max.Eff.Inten.(mm/hr)= 200.80 103.62 5.00 .77 (ii) 5.00 1.62 (ii) over (min) Storage Coeff. (min)= Unit Hyd. Tpeak (min)= 5.00 5.00 Unit Hyd. peak (cms)= .34 .32 \*TOTALS\* .04 1.33 .00 1.33 PEAK FLOW TIME TO PEAK (cms) = .039 (iii) 1.33 (hrs) = RUNOFF VOLUME (mm) = TOTAL RAINFALL (mm) = 74.20 75.20 39.99 75.20 73.86 75.20 RUNOFF COEFFICIENT = .99 .53 .98 \*\*\*\*\* WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP! (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES: CN\* = 80.0 Ia = Dep. Storage (Above) (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL THAN THE STORAGE COEFFICIENT. (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY. L CALTB STANDHYD (0004) | (ha) = .00 Area Total Imp(%) = 99.00 Dir. Conn.(%) = 99.00 |ID= 1 DT= 5.0 min | \_\_\_\_\_ IMPERVIOUS PERVIOUS (i) .00 1.00 .00 1.00 Surface Area (ha) = (mm) = Dep. Storage 1.00 Average Slope (%)= 2.00 (m) = 40.00 Length Mannings n .013 .250 Max.Eff.Inten.(mm/hr)= 200.80 103.62 5.00 .33 (ii) 5.00 5.00 1.18 (ii) over (min) Storage Coeff. (min) = Unit Hyd. Tpeak (min) = 5.00 .34 Unit Hyd. peak (cms)= .34 \*TOTALS\* .00 .00 .002 (iii) 1.33 (cms) = PEAK FLOW TIME TO PEAK (hrs)= 1.33 1.33 ,...s) = ....sr VOLUME (mm) = TOTAL RAINFALL (mm) = RUNOFF COTT 74.20 39.99 65.29 75.20 75.20 75.20 RUNOFF COEFFICIENT .99 .53 .87 \*\*\*\*\* WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP! (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES: (i) CN\* = 80.0 Ia = Dep. Storage (Above)
 (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL THAN THE STORAGE COEFFICIENT. (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY. \_\_\_\_\_ | ADD HYD (0013) | | 1 + 2 = 3 | R.V. AREA QPEAK TPEAK (ha) .07 (cms) (hrs) (mm) ID1= 1 (0012): + ID2= 2 (0001): .039 1.33 73.86 .20 .111 1.33 73 86 \_\_\_\_\_ \_\_\_\_ .27 ID = 3 (0013):.150 1.33 73.86 NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY. \_\_\_\_\_ RESERVOIR (0007) | IN= 2---> OUT= 1 | DT= 5.0 min | STORAGE 1 OUTFLOW STORAGE | OUTFLOW (cms) .0401 (cms) (ha.m.) (ha.m.) .0001 .0136 .0000 - L .0400 .0002 | .0000 .0000 AREA QPEAK TPEAK R.V. (cms) .150 .040 (hrs) 1.33 1.50 (mm) 73.86 73.51 (ha) INFLOW : ID= 2 (0013) .270 OUTFLOW: ID= 1 (0007) .270

PEAK FLOW REDUCTION [Qout/Qin](%)= 26.70

	TIME SHI MAXIMUM	FT OF PE STORAGE	AK FLOW USED	(n (ha.	m.)= 10.00 m.)= .0068	3	
ADD HYD (0005	)						
1 + 2 = 3	I	AREA	QPEAK	TPEAK	R.V.		
TD1= 1	(0007) •	(na) 27	(CIIIS)	(nrs) 1 50	(IIIII) 73 51		
+ ID2= 2	(0002):	.07	.039	1.33	73.86		
	(0005)						
1D = 3	(0005):	.34	.079	1.33	/3.58		
NOTE: PEAK	FLOWS DO N	OT INCLU	DE BASEFL	OWS IF AN	ΙΥ.		
ADD HYD (0006	)						
1 + 2 = 3	I	AREA	QPEAK	TPEAK	R.V.		
TD1= 1	(0003) •	(na) 03	(Cms)	(nrs) 1 50	(mm) 35.89		
+ ID2= 2	(0005):	.34	.079	1.33	73.58		
ID = 3	(0006):	.37	.083	1.33	70.52		
NOTE: PEAK	FLOWS DO N	OT INCLU	DE BASEFL	OWS IF AN	IY.		
ADD HYD (0008	)						
1 + 2 = 3	I	AREA	QPEAK	TPEAK	R.V.		
TD1- 1	(0006)	(ha)	(cms)	(hrs)	(mm)		
+ TD2= 2	(0006):	. 0 0	.002	1.33	65.29		
======							
ID = 3	(0008):	.37	.085	1.33	70.47		
NOTE · DEAK	FLOWS DO M	OT INCII	DE BASET	OWS TE AN	IV		
NOID. FEAR	110W0 DO N	OI INCLU	DD DAGDFL	OND IF AF			
FINISH							

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### **Hydroworks Sizing Summary**

### Retirement Home 2380 Lakeshore Rd W, Oakville

06-30-2023

### **Recommended Size: HydroDome HD 5**

A HydroDome HD 5 is recommended to provide 80 % annual TSS removal based on a drainage area of .37 (ha) with an imperviousness of 85 % and Toronto Central, Ontario rainfall for the ETV/NJDEP particle size distribution.

The recommended HydroDome HD 5 treats 100 % of the annual runoff and provides 81 % annual TSS removal for the Toronto Central rainfall records and ETV/NJDEP particle size distribution.

The HydroDome has a siphon which creates a discontinuity in headloss. Since a peak flow was not specified, headloss was calculated using the full pipe flow of .07 (m3/s) for the given 300 (mm) pipe diameter at .5% slope. The headloss was calculated to be 261 (mm) above the crown of the 300 (mm) outlet pipe.

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

If you have any questions regarding this sizing summary please do not hesitate to contact Hydroworks at 888-290-7900 or email us at support@hydroworks.com.

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

### **TSS Removal Sizing Summary**

Hydroworks Siphon Separator Sizing Program - HydroDome										
File Product	Units C/	AD Video	Help							
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General Dimensions Rainfall Site TSS PSD TSS Loading Quantity Storage By-Pass Custom CAD Video Other										
Site Parameters										
Area (ba) 37 UILS Toronto Central Ontario										
Imperviousne	ss (%)	85	I Metric	1982 10 1993	9		Rainfall	imestep =	15 min.	
Project Title Re	tirement Home	•			Outlet Pip	e				
(2 lines)	80 Lakeshore	Rd W. Oakville	•		Diam. (mn	n) 300 Pe	eak Design I	Flow (m3/s	)	
Slope (%) .5										
ETV EBB Test	ig nesults	1	Fost freatment fo	echarge						
HydroDome Anr	ual Sizing Re	sults				Particle Size	Distribution			
Model #	Qlow (m3/s)	Qtot (m3/s)	Flow Capture (%)	TSS Removal (%)		Size (um)	%	SG	▲	
Unavailable	.068	.068	100 %	71 %	-	1	5	2.65		
HD 4	.068	.068	100 %	76 %		4	10	2.65		
HD 5	.068	.068	100 %	81 %		18	10	2.65		
HD 6	.068	.068	100 %	84 %		45	10	2.05		
Unavailable	.068	.068	100 %	86 %		70	5	2.65		
HD 8	.068	.068	100 %	87 %		90	10	2.65		
HD 10	.068	.068	100 %	89 %	_	125	15	2.65		
HD 12	.068	.068	100 %	89 %		200	15	2.65		
						400	5	2.65	<b>•</b>	
Note: Results vary significantly based on particle size distribution Simulate										

### **TSS Particle Size Distribution**

Hydroworks Siphon Separator Sizing Program - HydroDome												
F	ile	Product U	nits CAD Vi	deo Help								
l	1	) 🔒 🔜 😧	) 😑 🖄									
G	enera	I Dimensions	Rainfall Site	TSS PSD TSS Loa	ading Quantity Storage By-Pass Custom CAD Video Other							
	TSS	Particle Size Di	stribution									
		Size (um)	%	SG	Notes: TSS Distributions							
	▶	1	5	2.65	1. To change data C ETV Canada / NJDEP							
		4	5	2.65	type in the new O Standard HDS Design							
		7	10	2.65	Value(s) O Alden Laboratory							
		18	15	2.65	go to the bottom of OK110							
		45	10	2.65	the table and start typing. O Toronto							
		70	5	2.65	3. To delete a row, O Ontario Fine							
		90	10	2.65	select the row by clicking on the first Calgary Forebay							
		125	15	2.65	pointer column, O Kitchener							
		200	15	2.65	A To port the table     O User Defined							
		400	5	2.65	click on one of the							
		850	5	2.65	column headings Clear							
	*											
Y	ou m	ust select a pa	nticle size distrib	oution for TSS to sim	ulate TSS removal Water Temp (C) 20							



### **Site Physical Characteristics**

<ul> <li>Hydrow</li> </ul>	orks Sipho	n Separato	or Sizing Pr	ogram - H	HydroDom	e						8 23
File Pr	oduct U	Inits CA	D Vide	o Help								
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General D	imensions	Rainfall	Site TS	S PSD   T	SS Loading	g Quantity	/ Storage	By-Pass   (	Custom   C	CAD Vide	eo Other	
Catchment Parameters												
Width	(m)	61	Im;	perv. Mann	iings n		.015	F	requency	(months)	12	
D	efault Widt	h	Pe	rv Manning	js n		.25					
			Im	p. Depress	. Storage (i	mm)	.51	-				
Slope	(%)	2	Pe	rv. Depres	s. Storage	(mm)	5.08	-				
Daily Eva	poration (m	nm/day)	A==	Mari	h ur	L L I	A	Car	0.4	Neu	Dec	
0	0	0	2.54	2.54	3.81	3.81	3.81	2.54	2.54	0	0	
Infiltratio	n				Cat	tch Basins				-		
Max. Ir	nfiltation Ra	ate (mm/hr)		63.5	=   #	of Catch b	basins		2	Resets al exclud	ll parameters ding input	
Min. In	filtration Ra	ate (mm/hr)	)	10.16						catchr	nent width.	
Infiltra	tion Decay	Rate (1/s)		.00055		ntrolled Ro	ot Runoff -	_		Defau	ult \/alues	
Infiltra	tion Regen.	. Rate (1/s)		.01	R	oof Runoff	(m3/s)			Delau	an values	

### **Dimensions And Capacities**

- Hydroworks	< Hydroworks Siphon Separator Sizing Program - HydroDome 👔 🖾							
File Produ	ct Units CAD	Video Help	)					
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General Dimer	General Dimensions Rainfall Site   TSS PSD   TSS Loading Quantity Storage   By-Pass   Custom   CAD   Video   Other							
Dimensions a	and Capacities							
Model	Diam. (m)	Depth (m)	Float. Vol. (L)	Sediment Vol. (m3)	Total Vol. (m3)			
HD 3	0.91	1.22	123	0.5	0.8			
HD 4	1.22	1.37	266	0.9	1.6			
HD 5	1.52	1.68	483	1.7	3.1			
HD 6	1.83	1.98	803	2.9	5.2			
HD 7	2.13	2.29	1226	4.6	8.2			
HD 8	2.44	2.59	1863	6.8	12.1			
HD 10	3.05	3.2	3617	13	23.3			
HD 12	3.66	3.81	6224	22.2	40			
Depth = Depth	h from outlet invert to	inside bottom of ta	ank					
L								

### **Generic HD 5 CAD Drawing**



### **TSS Buildup And Washoff**

Hydroworks Siphon Separator Sizing Program - HydroDome	? 🛛
File Product Units CAD Video Help	
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General   Dimensions   Rainfall   Site   TSS PSD   TSS Loading   Quantity Storage   By-Pass   Custom   CAD   Video   Other	
TSS Buildup       Street Sweeping       Soil Erosion         Power Linear       Fficiency (%)       30         Exponential       Start Month       May         Michaelis-Menton       Stop Month       Sep         TSS Washoff       Available Fraction       3         Power-Exponential        Available Fraction       3         Rating Curve (limited to buildup)       Reset to Default       Values	
TSS Buildup Parameters       TSS Washoff Parameters         Limit (kg/ha)       28.02         Coeff (kg/ha)       67.25         Exponent       1.1         Exponent       5	

### **Upstream Quantity Storage**

- Hy	ydrow	orks Sip	hon Sep	arator Si	zing Prog	ram - Hydro	oDome				8 23
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Gene	eral C	imensior	ns Rainf	all Site	TSS F	PSD   TSS L	oading	Quantity	Storage	By-Pass Custom CAD Video Other	
	Quar	titv Con	trol Stora	ae						N	
		Sto	rage (m3)		Discharg	ge (m3/s)				Notes.	
	•		0			0				<ol> <li>I o change data just click a cell and type in the new value</li> </ol>	
	*									(s)	
										<ol><li>To add a row just go to the bottom of the table and start twing</li></ol>	
										a Tables and a set	
										<ol> <li>Io delete a row, select the row by clicking on the first pointer column, then press delete</li> </ol>	
										4. To sort the table click on one of the column headings	
										Clear	

#### **Other Parameters**

Hydroworks Siphon Separator Sizing Program - HydroDome	8 33			
File Product Units CAD Video Help				
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General Dimensions Rainfall Site TSS PSD TSS Loading Quantity Storage	By-Pass Custom CAD Video Other			
Scaling Law	HydroDome Design			
✓ Peclet Scaling based on diameter x depth	☑ High Flow Weir			
Peclet Scaling based on surface area (diameter x diameter)	Flow Control (parking lot storage) Must add Quantity Storage Table			
TSS Removal Extrapolation	HD Hydraulics			
Extrapolate TSS Removal for flows lower than tested	HD Model HD 5			
No TSS Removal extrapolation for flows lower than tested	Custom Insert Size			
✓ No TSS Removal extrapoloation for lower flows or inter-event periods				
Lab Testing Use NJDEP Lab Testing Results Vse ETV Canada Lab Testing Results				
TSS Removal Results         Image: Choose Model #         TSS Removal Required         TSS Removal Required         TSS Removal (%)         80.0				

### Flagged Issues

If there is underground detention storage upstream of the HydroDome please contact Hydroworks to ensure it has been modeled correctly.

Hydroworks Sizing Program - Version 5.7 Copyright Hydroworks, LLC, 2022 1-800-290-7900 www.hydroworks.com



# **Verification Statement**



### Hydroworks HydroDome HD3 Oil-Grit Separator Registration number: (V-2021-09-02) Date of issue: 2021-October-04

Technology type	Oil-Grit Separator		
Application	Technology to remove oil, sediment, trash and debris from storm- water and snowmelt runoff as well as other pollutants that attach to sediment particles, such as nutrients and metals.		
Company	Hydroworks, LLC.		
Address	257 Cox St., Roselle, NJ 07203	8 USA	Phone +1-888-290-7900
Website	https://hydroworks.com	E-mail	gbryant@hydroworks.com

### Verified Performance Claims

The Hydroworks HydroDome HD3 Oil-Grit Separator (OGS) was tested by Alden Research Laboratory, Holden, Massachusetts, USA in 2021. The performance test results were verified by 'The Sir Sandford Fleming College of Applied Arts and Technology's Centre for Advancement of Water and Wastewater Technologies' (CAWT) following the requirements of ISO 14034:2016 and the VerifiGlobal Performance Verification Protocol. The following performance claims were verified:

**Sediment removal test:** The Hydroworks HydroDome HD3 OGS device, with a false floor set to 50% of the manufacturer's recommended maximum sediment storage depth and a constant influent test sediment concentration of 200 mg/L and particle size distribution of 1-1000  $\mu$ m, removed 83.9, 77.6, 68.4, 66.9, 59.4, 52.4, and 46.0 percent of influent sediment by mass at surface loading rates of 40, 80, 200, 400, 600, 1000, and 1400 L/min/m<sup>2</sup> respectively.

<u>Scour test:</u> The Hydroworks HydroDome HD3 OGS device with 15.2 cm (6 inch) of test sediment preloaded onto a false floor reaching 50% of the manufacturer's recommended maximum sediment sump storage depth, generated corrected effluent sediment concentrations on average of 0.54, 0.70, 0.0, 0.0, and 0.11 mg/L at 5-min duration surface loading rates of 200, 800, 1400, 2000, and 2600 L/min/m<sup>2</sup>, respectively.

**Light liquid re-entrainment test:** The Hydroworks HydroDome HD3 OGS with surrogate lowdensity polyethylene beads preloaded within the inner chamber, representing a floating light-liquid volume equal to a depth of 50.8 mm (2 inch) over the sedimentation area, retained 100, 100, 100, 100, and 99.7 percent of loaded beads by mass during the 5-minute duration surface loading rates of 200, 800, 1400, 2000, and 2600 L/min/m<sup>2</sup>, respectively.

The above verified claims can be applied to other units smaller or larger than the tested unit, provided that the untested units meet the scaling rule specified in the Procedure for Laboratory Testing of Oil Grit Separators (Version 3.0, June 2014)



### **Technology Application**

HydroDome is a hydrodynamic separator that provides benefits for both water quality and water quantity (i.e., flow control). HydroDome combines the function of separator, hood, and flow control with active storage to provide a multi-purpose stormwater management solution in one structure. HydroDome also functions as an oil separator due to the submerged inlet design and the fact that the design raises the water level with flow to maximize the distance between any floatables (oil, trash) and the discharge entrance to the HydroDome.

### **Technology Description**

HydroDome comes complete and slides into the outlet pipe from a drainage structure and is secured to the wall with anchor bolts. It consists of a siphon with flow control, that regulates the water level in the structure and the flow rate in the outflow, and an optional high flow weir. A schematic of the Hydroworks HydroDone OGS is shown in Figure 1.



### Figure 1: Schematic of the Hydroworks HydroDome Oil-Grit Separator

The siphon raises the water level to a pre-determined level without allowing water to exit the structure. The raised water level provides:

- Greater time for initial total suspended solids (TSS) removal and for floatables to prevent reentrainment in the flow,

- Additional dilution to reduce effluent concentrations of any pollutants, and
- A greater volume, or buffer, of water to prevent scour of previously settled solids.

Water flows into the device through horizontal openings at the bottom of the HydroDome. Water then must travel upwards through the siphon. A foam filter is located at the entrance to the siphon inlet to provide secondary protection from its clogging (the outer housing of the HydroDome and submerged inlet provide primary protection). Once the water level reaches a pre-determined height, the siphon begins to engage, and water flows out of the structure downstream. The siphon flow is controlled by an orifice, whose size can be changed to provide the desired flow control. The water level continues to rise or begins to lower depending on the rate of flow from the orifice compared to the inflow of water to the structure.



An optional weir above the siphon provides a high flow path to prevent the system from surcharging. In cases where parking lot storage is desired, there would not be a high flow weir. A scour protection plate minimizes scour by preventing upward velocities/flow from the structure floor during periods of peak flow. Therefore, HydroDome combines the function of separator, hood, and flow control with active storage to provide a multi-purpose stormwater management solution in one structure.

### **Description of Test Procedure**

For the purposes of this verification, a Hydroworks HydroDome 3-ft diameter (HD3) stormwater treatment unit was tested. The HD3 test unit was a full-scale 3 ft (0.91 m) diameter tank with an internal treatment hood that included a high flow weir. The test tank was fabricated from plastic and included 18-inch (457 mm) diameter inlet and outlet pipes, oriented along the center-line of the tank. The pipe inverts were located 48 inches (1.22 m) above the sump floor and were set with 1% slopes. The 100% and 50% sediment sump storage depths were 12 inches (0.305 m) and 6 inches (0.152 m), respectively. The effective treatment sedimentation area was 7.07 ft<sup>2</sup> (0.656 m<sup>2</sup>).

The test data and results for this verification were obtained from independent testing conducted at Alden Research Laboratory in accordance with the *Procedure for Laboratory Testing of Oil-Grit Separators (Version 3.0, June 2014)*<sup>1</sup>. Use of this procedure is intended to ensure that technologies in this category are subjected to stringent requirements in generating verifiable performance test data.

The verification plan was followed with one minor variance from the *Procedure*. This variance includes the required minimum amount of test sediment to be fed into the test unit for each tested surface loading rate (SLR). Although the *Procedure* requires a minimum of 11.3 kg of test sediment, during the 40 L/min/m<sup>2</sup> SLR test, only 6.45 kg was fed into the unit, which is 4.85 kg less than the specified minimum. This variance to the *Procedure* was agreed to by Toronto and Region Conservation Authority (TRCA), the author of the *Procedure*, based on previous conversations with Alden Labs, noting that the length of time to conduct the test with 11.3 kg of sediment at 40 L/min/m<sup>2</sup> would be over 36 hours.

### **Verification Results**

CAWT verified the performance test data and other information pertaining to the HydroDome HD3 Oil-Grit Separator. A Verification Plan was prepared to guide the verification process based on the requirements of ISO 14034:2016 and the VerifiGlobal Performance Verification Protocol.

The test sediment consisted of ground silica (1 - 1000 micron) with a specific gravity of 2.65, uniformly mixed to meet the particle size distribution specified in the testing procedure.

The "*Procedure for Laboratory Testing of Oil Grit Separators*" (TRCA, 2014) requires that the threesample average of the test sediment particle size distribution (PSD) meet the specified PSD. The allowable tolerance of 6% variation from the specified PSD curve was met at each discrete particle size tested and the d50 was finer than 75  $\mu$ m.

Comparison of the individual sample and average test sediment PSD to the specified PSD is shown in Figure 2. This figure indicates that the test sediment used for the removal and scour tests met the above-mentioned criteria. The median particle size was 64  $\mu$ m.

Samples from test sediment batches used for each run met the specified PSD within the required tolerance thresholds.

The capacity of the HydroDome HD3 device to retain sediment was determined at seven surface loading rates using the modified mass balance method. This method involved measuring the mass and particle size distribution of the injected and retained sediment for each test run.

<sup>&</sup>lt;sup>1</sup> The *Procedure for Laboratory Testing of Oil-Grit Separators (Version 3.0, June 2014)* was originally prepared by the Toronto and Region Conservation Authority (TRCA) in association with a 31 member advisory committee from various stakeholder groups.





# Figure 2 - Average particle size distribution (PSD) of the test sediment used for the sediment removal and scour test compared to the specified PSD

Performance was evaluated with a false floor simulating the technology filled to 50% of the manufacturer's recommended maximum sediment storage depth. The test was carried out with clean water that maintained a sediment concentration below 20 mg/L. Based on these conditions, removal efficiencies for individual particle size classes and for the test sediment, as a whole, were determined for each of the tested surface loading rates (Table 1).

In some instances, the removal efficiencies were above 100% for certain particle size fractions. These discrepancies are not unique to any one test laboratory and are attributed to errors relating to the blending of sediment, collection of representative samples for laboratory submission, and laboratory analysis of PSD. Due to these errors, caution should be exercised in applying the removal efficiencies by particle size fraction for the purposes of sizing the tested device (see Bulletin # CETV 2016-11-0001).

Particle Range (µm)	<b>40</b> L/min/m <sup>2</sup>	<b>80</b> L/min/m <sup>2</sup>	<b>200</b> L/min/m <sup>2</sup>	<b>400</b> L/min/m <sup>2</sup>	600 L/min/m <sup>2</sup>	<b>1000</b> L/min/m <sup>2</sup>	<b>1400</b> L/min/m <sup>2</sup>	Average
>500	100%	125%	140%	140%	200%	200%	180%	155%
250-500	114%	129%	150%	143%	143%	183%	217%	154%
150-250	150%	136%	157%	153%	179%	221%	220%	174%
100-150	116%	126%	129%	148%	157%	162%	139%	140%
75-100	136%	155%	178%	190%	180%	170%	133%	163%
50-75	91%	100%	128%	270%	126%	82%	75%	125%
20-50	111%	97%	93%	51%	58%	42%	73%	75%
8-20	75%	79%	38%	34%	29%	17%	26%	42%
5-8	53%	34%	16%	7%	0%	0%	23%	19%
2-5	37%	29%	14%	0%	0%	0%	1%	12%

 Table 1 - Removal efficiencies (%) of the HydroDome HD3 Oil-Grit Separator for individual particle size classes at specified surface loading rates



Figure 3 compares the particle size distribution (PSD) of the three-sample average of the test sediment to the PSD of the sediment retained by the HydroDome HD3 OGS device at each of the tested surface loading rates. As expected, the capture efficiency for fine particles was generally found to decrease as surface loading rates increased, particularly in the 400 to 1400 L/min/m<sup>2</sup> range.



# Figure 3 - Particle size distribution of sediment retained in the HydroDome HD3 Oil-Grit Separator in relation to the injected test sediment average

Table 2 shows the results of the sediment scour and re-suspension test for the HydroDome HD3 Oil-Grit Separator unit. The scour test involved preloading 15.2 cm (6 inches) of fresh test sediment into the sedimentation sump of the device. The sediment was placed on a false floor to mimic a device filled to 50% of the maximum recommended sediment storage depth.

Measured Concentration at Each surface Loading Rate						
Effluent Sample	200	800	1400	2000	2600	
No.	L/min/m <sup>2</sup>					
1	1.2	0.3	0.0	0.0	0.0	
2	0.7	0.0	0.0	0.0	0.0	
3	0.5	0.0	0.0	0.0	0.5	
4	0.1	3.2	0.0	0.0	0.0	
5	0.3	0.0	0.0	0.0	0.0	
Average	0.5	0.7	0.0	0.0	0.1	





Clean water was run through the device at five surface loading rates over a 30-minute period. Each flow rate was maintained for 5 minutes with a one-minute transition time between flow rates. Effluent samples were collected at one minute sampling intervals and analyzed for suspended solids concentration (SSC) and PSD by recognized methods. The effluent samples were subsequently adjusted based on the background concentration of the influent water.

Results showed average adjusted effluent sediment concentrations below 0.7 mg/L at all surface loading rates. The magnitude of scour is dependent on the internal flow patterns (velocity and turbulence) and water volume within the unit, which is related to the depth below the inlet and outlet. The HD3 possessed a large water volume in the sump and consequently, low velocity, which prevented incipient motion of the sediment of sufficient magnitude for scour to occur.

The average measured effluent scour sediment concentrations (adjusted for background) for each tested SLR were not adjusted for particle size based on the D5 of particles captured for the 40 L/min/m<sup>2</sup> removal efficiency test since there was negligible scour.

The capacity of the device to retain light liquid was determined at five surface loading rates in a range between 200 and 2600 L/min/m<sup>2</sup> using low-density polyethylene beads, Dow Chemical Dowlex<sup>tm</sup> 2517, with a density of 0.917 g/cm<sup>3</sup>. This material was specified as the acceptable surrogate to represent floating liquid for a qualitative assessment of liquid behaviour during operation.

Performance was evaluated with a total of 32.8 litres (18.94 kg) of pellets preloaded into the treatment vault by introducing them into the crown of the influent pipe, to a volume equal to a depth of 50.8 mm (2 inch) over the sedimentation area of 0.66 m<sup>2</sup>. The effluent was collected in flow-designated nets to allow for quantification of any re-entrained pellets for each test SLR. The collected pellets were dried and the mass of collected pellets was quantified for each SLR, as well as the overall test.

The recorded average flow data, as well as quantified volume and mass of collected pellets for each target SLR and overall test, is shown in Table 3. The maximum re-entrainment of 0.3% occurred at 2600 L/min/m<sup>2</sup>. The total retention rate was 99.7%.

Light-liquid	ta	Starting	(Liters)	Starting	(grams)		
Light-liquit	u Ke-Suspen	ISION Da	la	Volume	32.8	Mass	18938
Action	Time Stamp	Meter	Target Flow	Recorded Flow	cov	Collected Mass	Retained Mass
	(minutes)		(L/min/m <sup>2</sup> )	(L/min/m <sup>2</sup> )		(grams)	
Start D.A. Recording	0.0						
Flow set	1.0	4"	200	207	0.057	0	100.0%
Stop Collection	6.0			3.4%			
Flow set	7.0	4"	800	826	0.008	0	100.0%
Stop Collection	12.0			3.2%			
Flow set	13.0	6"	1400	1407	0.009	0	100.0%
Stop Collection	18.0			0.5%			
Flow set	19.0	6"	2000	2022	0.004	0.3	100.0%
Stop Collection	24.0			1.1%			
Flow set	25.0	6"	2600	2599	0.003	54.9	99.7%
Stop Collection	30.0			-0.1%			
	Interim Colle	ection Net	1.3				
Пу		3			Total	56.5	99.7%

Table 3 - Light-liquid	recorded flow and	re-entrainment data
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### **Quality assurance**

Performance testing and verification of the HydroDome HD3 Oil Grit Separator were performed in accordance with the requirements of ISO 14034:2016 and the VerifiGlobal Performance Verification Protocol. The verifier, CAWT, has confirmed that quality assurance requirements were addressed throughout the performance testing process and in the generation of performance test results. This includes reviewing all data sheets and data downloads, as well as overall management of the test system, quality control and data integrity.

In addition, QA/QC measures are documented in the *"Procedure for Laboratory Testing of Oil-Grit Separators"* (TRCA, 2014) to ensure results are accurate and precise, and that testing conducted by multiple vendors of the same category of technology are employing the same test method. The QA/QC measures include the use of certified laboratories, established test methods, calibration of equipment, tolerance limits for results variation, data checks during testing, and stringent documentation requirements.

Table 4 provides a summary of the acceptance criteria for particle size distribution, solids concentration in test water, water temperature, flow measurement equipment, flow rate variation, sediment feed, sediment moisture content, and sample analysis.

QC Parameter	Acceptance Criteria
Particle Size Distribution	Analyzed by a certified laboratory in accordance with ASTM D422-63(2007)e1. Percentages for size ranges vary by <6%, median < 75 um. PSD in water determined by ASTM D422-63(2007)e1 upon prior drying in designated pre-weighed nonferrous trays in compliance with ASTM D4959-07.
Solids concentration in test water	Suspended solids concentration (SSC) concentration of test water of less than 20 mg/L.
Water temperature	Temperature of water less than 25°C.
Flow measurement equipment	Equipment calibration reports submitted to confirm that reported flow rate match actual flow rate. Flow rates from calibrated flow instruments recorded at no longer than 30 second intervals over the duration of the test.
Flow rate variation	Flow rates have COV < 0.04; maintained with ±10% of target flow rate.
Sediment feed	TSS concentration target = 200 mg/L with a tolerance limit of $\pm 25$ mg/L. Injection location is 5 pipe diameters upstream of the inlet to the device, as per the <i>Procedure</i> . Six calibration samples taken over duration of each test run. The allowed Coefficient of Variance (COV) for the measured samples was 0.10.
Sediment moisture content	Determined by ASTM D4959-07 "Standard Test Method for Determination of Water (Moisture) Content of Soil By Direct Heating".
Sample analysis	Conducted by qualified laboratories using standard methods and meeting the requirements of ISO.

### Summary of Verification Results and Verified Performance Claim for Hydroworks HydroDome HD3 Oil-Grit Separator (OGS)

In summary, the HydroDome HD3 Oil Grit Separator is designed to remove oil, sediment, trash and debris from stormwater and snowmelt runoff as well as other pollutants that attach to sediment particles, such as nutrients and metals. Verification of performance claims for the Hydroworks HydroDome HD3 Oil Grit Separator was conducted by CAWT based on independent third-party performance test results provided by Alden Research Laboratory, as well as additional information provided by Hydroworks.

Table 5 summarizes the verification results in relation to the technology performance parameters that were identified to determine the efficacy of the HydroDome HD3 Oil Grit Separator. The claims stated in Table 5 were verified using the modified mass balance method for sediment removal by measuring the total mass of sediment entering the unit and retained by the unit at prescribed surface loading rates. Effluent sampling was conducted every minute over a 30-minute duration for the scour test, using approved sampling methods as per the verification procedure. The light liquid re-entrainment test was conducted using a mass balance methodology which accounted for all the beads input, captured, and scoured from the separator.

Parameters	Verified Claims	Accuracy
Sediment Removal	During the sediment removal test, the Hydroworks HydroDome HD3 OGS device, with a false floor set to 50% of the manufacturer's recommended maximum sediment storage depth and a constant influent test sediment concentration of 200 mg/L and particle size distribution of 1-1000 $\mu$ m, removed 83.9, 77.6, 68.4, 66.9, 59.4, 52.4, and 46.0 percent of influent sediment by mass at surface loading rates of 40, 80, 200, 400, 600, 1000, and 1400 L/min/m <sup>2</sup> respectively	The sediment removal characteristics were quantified at various surface loading rates (SLRs), including particle size fractions, using a modified mass balance methodology. Performance results are presented as the true values.
Sediment Scour	During the scour test, the Hydroworks HydroDome HD3 OGS device with 15.2 cm (6 inch) of test sediment preloaded onto a false floor reaching 50% of the manufacturer's recommended maximum sediment sump storage depth, generated corrected effluent sediment concentrations on average of 0.54, 0.70, 0.0, 0.0, and 0.11 mg/L at 5-min duration surface loading rates of 200, 800, 1400, 2000, and 2600 L/min/m2, respectively.	5 samples analyzed for sediment (n=5) at each flow rate There was negligible scour once corrected for background concentrations.
Light Liquid Re-entrainment	During the light-liquid re-entrainment test, the Hydroworks HydroDome HD3 OGS with surrogate low-density polyethylene beads preloaded within the inner chamber, representing a floating light-liquid volume equal to a depth of 50.8 mm (2 inch) over the sedimentation area, retained 100, 100, 100, 100, and 99.7 percent of loaded beads by mass during the 5- minute duration surface loading rates of 200, 800, 1400, 2000, and 2600 L/min/m <sup>2</sup> , respectively.	Performance results are presented as the true values. Under the "Procedure for Laboratory Testing of Oil-Grit Separators" (TRCA, 2014), the light-liquid re-entrainment test is also not amenable to statistical analysis as the tests were only conducted once at various flow rates following a mass balance procedure.

Table 5. Verified performance claims



### What is ISO 14034?

The purpose of environmental technology verification is to provide a credible and impartial account of the performance of environmental technologies. Environmental technology verification is based on a number of principles to ensure that verifications are performed and reported accurately, clearly, unambiguously and objectively. The International Organization for Standardization (ISO) standard for environmental technology verification (ETV) is ISO 14034, which was published in November 2016.

### Benefits of ETV

ETV contributes to protection and conservation of the environment by promoting and facilitating market uptake of innovative environmental technologies, especially those that perform better than relevant alternatives. ETV is particularly applicable to those environmental technologies whose innovative features or performance cannot be fully assessed using existing standards. Through the provision of objective evidence, ETV provides an independent and impartial confirmation of the performance of an environmental technologies by supporting informed decision-making among interested parties.

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