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PROPOSED RESIDENTIAL DEVELOPMENT
5219 UPPER MIDDLE ROAD
CITY OF BURLINGTON, ONTARIO

FUNCTIONAL SERVICING AND STORM WATER MANAGEMENT REPORT

Prepared For:

BLOOMFIELD DEVELOPMENT INC.

Original: March 15th, 2017

Revised: October 27th, 2017

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1. BACKGROUND

The property under study is a 0.5053 Ha (1.25 acre) parcel of land on the north side of Upper Middle Road in Burlington, Ontario. It is proposed to develop the parcel as a residential development comprising two freehold residential detached lots, two sets of semi-detached houses and 12 condominium townhouses. The detached and semi-detached lots will front to an extension of the Georgina Court public Right of Way which terminates in a proposed cul-de-sac. A private laneway serving the proposed Condominium Townhouses extends westerly from the proposed cul-de-sac. The development is bordered by Upper Middle Road to the south, an existing stormwater management pond to the west, and existing detached houses to the north and east. Refer to the Development Concept plan by Weston Consulting in Appendix A for the proposed layout including building location and curbing etc.

The subject lands fall within the catchment area of the adjacent stormwater management pond to the west. The lands were otherwise originally anticipated to be serviced in the sanitary and water servicing of the adjacent subdivision.

This report will evaluate the serviceability of the site with respect to sanitary, water and storm services. The report evaluates the anticipated sanitary flows from the site as well as domestic water demand. Further, the report outlines the manner in which the subject development complies with the design criteria for the existing subdivision.

2. SCOPE OF WORK

The Odan/Detech Group Inc. was retained by the Owner, Bloomfield Developments Inc., to review the site and provide a Functional Servicing & Stormwater Management Report for the subject Development in support of a Rezoning application.

3. DESIGN CONSIDERATIONS

A. SANITARY WASTE WATER DISPOSAL

i) Existing Conditions

There is an existing 200mm sanitary sewer which commences at an existing maintenance hole at the southerly limit of Georgina Court. The sewer drains northerly beneath Georgina Court and ultimately drains into a municipal sanitary sewer flowing easterly beneath Upper Middle Road at Quinte Street.

The subject property in-part appears in City of Burlington Drawing No. B-9873, External Sanitary Drainage Plan, as an external tributary sanitary drainage area. This catchment plan allows a population of 25 for the subject property.

The subject property in-part appears in Region of Halton Drawing No. 10-08006-SA1 or B-11922, Georgina Court Sanitary Drainage Plan. This catchment plan similarly allows a population of 25.

ii) Proposed Drainage

The subject development will drain sanitary flows in-part via a proposed 200mm municipal sanitary sewer which is an extension of the existing 200mm municipal sanitary sewer beneath Georgina Court. Upstream of this proposed municipal sewer, a proposed private sanitary sewer internal of the townhouses will provide sanitary drainage to the proposed townhouse condominium. Refer to the General Servicing Plan for the proposed sanitary sewer layout. Refer to the proposed sewer design sheet on the following pages for the proposed sewer design rationale.

A Servicing Agreement will be established for the extension of services within the proposed Georgina Court road allowance.

The sanitary sewer design criteria and unit flow is provided in the Regional Municipality of Halton's *Water and Wastewater Linear Design Manual* (April 2015), 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^3/cap/day
- I/I = Unit of peak inflow/infiltration = 0. 286 L/s/ha
- Single Family, P=55 P/Ha
- Semi-detached/duplex/4-plex Unit population, P = 100 P/Ha
- Townhouse Unit population, P = 135 P/Ha

The subject development, comprising single family houses, semi-detached houses and townhouses, produces the following sanitary flow based on municipal criteria. Detailed calculations are provided on the following page. The development area statistics are provided in Appendix A.

Table 1 – Calculated Sanitary Sewage Flows for Proposed Development by Municipal Criteria

	From Land Use (L/s)	*From Infiltration (L/s)*	*Total (L/s)*
Proposed Semi-Detached Houses – Population 8	0.11	0.14	0.73
Proposed Single Family Houses – Population 6	0.07		
Proposed Condominium Townhouses – Population 29	0.40		

SANITARY & WATER FLOW CALCULATIONS **SCENARIO:** PROPOSED DEVELOPMENT

This program calculates the sanitary discharge from various land use

FILL IN COLOURED CELLS AS REQUIRED

COMMERCIAL SITE AREA (ha) =

RESIDENTIAL SITE AREA (ha) = 0.5024

TOTAL SITE AREA (ha) = 0.5024

NOTE:

LAND USE	NUMBER OF UNITS	SITE AREA, (ha)	GROSS FLOOR AREA, m2	TOTAL POPULATION	TOTAL DAILY FLOW (LITERS)	AVERAGE DAILY FLOW l/sec	PEAKING FACTOR, M	TOTAL FLOW FROM LAND USE, l/sec
RESIDENTIAL Detached, using 55 person/site area		0.07		6	1445	0.02	4.43	0.07
RESIDENTIAL Semi Houses, using 100 persons/site area		0.08		8	1920	0.03	4.42	0.11
RESIDENTIAL Townhouses, using 135 persons/site area		0.21		29	6879	0.09	4.36	0.40
RESIDENTIAL Density 3, using 2.7 persons/unit				0	0	0.00	4.50	0.00
COMMERCIAL, Using 90 persons/ha				0	0	0.00	4.50	0.00
COMMERCIAL, Using 0.60 L/sec per ha				0	0	0.00	2.50	0.00

TOTAL V1= 10243 Q1= 0.58
Q2= 0.00
Qinfil 0.14
Qtot 0.73

Q = (MqP/86400) + A * I (L/sec)

Q1= total flow from Residential Land Use (L/sec)
Q2= total flow from Commercial Land Use (L/sec)
Qinfil = total flow from infiltration (L/sec)
Qtot = total flow (Land use + infiltration)

V1= Total Volume from Land Use in liters

where : P is population
q = 0.275 m3/d/p = 0.004 L/sec/person for residential and
q = 0.60 L/sec/ha for commercial and offices
A = gross site area
i = 0.286 L/sec/ha (infiltration rate)
Peaking Factor M = 1 + [14 / (4 + (P/1000,1/2))] (for residential)
Peaking Factor M = 2.5 (for Commercial)

The development sanitary flow rate is additionally summarized as follows, based on the following OBC flow calculation. The townhouses were assumed to be 3-bedroom dwellings, and the semi-detached houses 4-bedroom, for this calculation.

Table 2 – Calculated Sanitary Sewage Flows for Proposed Development by OBC

	From Land Use (L/s)	*From Infiltration (L/s)*	*Total (L/s)*
Proposed Semi-Detached Houses	0.14	0.14	0.54
Proposed Condominium Townhouses	0.26		

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PROJECT: ***Proposed Residential Development***
5219 Upper Middle Road

CLIENT: Bloomfield Developments
DATE: 3-Oct-17
PROJECT No.: 17213
DRAWING REF.: SET A

	A	B	C	D	E	F	G	H	I	J
	Area (sq.m.)	**Units**	**Establishment Type (OBC 8.2.1.3.A.)**	**Based on Floor Area**	**Volume (litres)**	**Total Volume (litres) (B x E)**	**Volume (litres)**	**Establishment Type (OBC 8.2.1.3.B.)**	**Based on Employees/Service Chairs/Patrons (ea.)**	**Volume (litres) (G x I)**
Proposed Development										
Freehold Single Family & Semi-Detached Houses		6	4 Bedroom House	per 4 BR House	2000	*12000*				*0*
Condominium Townhouses		14	3 Bedroom House	per 3 BR House	1600	*22400*				
Total Floor Area	***0***	***20***	***Total Based on Unit Count***			**34400**	***Total Based on Person/Hours/Service Chairs***			**0**
Total Volume (Average per day)										***34400***
Total (l/sec)										***0.40***

SANITARY SEWER DESIGN SHEET (PROPOSED SANITARY SEWERS)

Site location: Proposed Development - 5219 Upper Middle Road, Burlington

Ref# PN 17213

ODAN·DETECH CONSULTING ENGINEERS

															Pipe						
Location				Proposed Residential				Inflow/ Infiltration	Residential P/F	Peak Residential Sanitary Flow	Unit Inflow/ Infiltration	Segment Inflow/ Infiltration	Accumulative Inflow/ Infiltration	Accumulative Sanitary Flow	Length	Size	Slope	Shape	Full Flow Capacity	Full Flow Velocity	% Full
Segment SAN Trib ID	Street Name	US Node	DS Node	Townhouse (Ha)	Semi-Detached (Ha)	Segment Population (Cap)	Acc've Pop'n (Cap)	Area (ha)	M	Q(p) (275 L/c/d) (L/s)	I/I (0.28 L/Sec/ha)	Q(i) (L/s)	Q(i) (L/s)	Q(d) (L/s)	L (m)	D (mm)	S (%)		Qcap (L/s)	V (m/s)	Q(d)/Qcap
1 (Townhouse Condo)	Private Lane	SAN MH 1	SAN MH 2	0.21		28.66	28.66	0.29	4.36	0.40	0.280	0.08	0.08	0.48	38.52	200	1.00	circle	32.80	1.04	1.46%
2 (Freehold Semi-Detached)	Georgina Court	SAN MH 2	SAN MH 3			-	28.66	-	4.36	0.40	0.280	-	0.08	0.48	13.89	200	1.30	circle	37.40	1.19	1.28%
2 (Freehold Semi-Detached)	Georgina Court	SAN MH 3	EX SAN MH 1		0.15	15.09	43.75	0.22	4.33	0.60	0.280	0.06	0.14	0.74	16.26	200	1.00	circle	32.80	1.04	2.27%

Flow Calculation Criteria
(Unit Flow from Table 3-1 and 3-2, Regional Municipality of Halton, Water and Wastewater Linear Design Manual, April 2015)
q = average daily residential per capita dry weather unit flow = 0.275 m3/cap/d
q = average daily commercial dry weather unit flow = 24.750m3/ha/d or 0.28646 L/ha/s
I/I = Unit of peak inflow/infiltration allowance = 0.286 (L/s/ha)
Q(p) = peak population flow (L/s)
Q(I) = peak extraneous flow (L/s)
Q(d) = peak design flow (L/s)

Mannings Equation:
Qcap=(D/1000)^2.667*(S/100)^0.5/(3.211*n)*1000(L/s)
D: pipe size (mm)
S: slope (grade) of pipe (%)
n = Manning roughness coefficient = 0.013

(Unit Population from Table 3-1 and 3-2, Regional Municipality of Halton, Water and Wastewater Linear Design Manual, April 2015)

Single Family Population Density	55 P/ha
Semi-detached/duplex/4-plex	100 P/ha
Townhouse, Maisonette	135 P/ha
Apartment (Over 6 Stories High)	285 P/ha
Commercial	90 P/ha

(Peaking Factor from Section 3.2.3., Regional Municipality of Halton, Water and Wastewater Linear Design Manual, April 2015)

PEAKING FACTOR (Residential)	M =1 + 14/(4+(P/1000^0.5))
PEAKING FACTOR (Commercial)	M =0.8[1 + 14/(4+(P/1000^0.5))]
PEAK DESIGN FLOW,	Q(d) = Q(p) + Q(i) L / Sec.
PIPE ROUGHGNESS,	n = 0.013 For Manning's Equation

Vmin. = 0.6m/s and Vmax. = 3m/s

B. WATER DISTRIBUTION

i) Domestic Water

The subject development will be served for domestic water service from the existing 200mm PVC watermain beneath Georgina Court. This existing municipal watermain will be extended southerly into the subject proposed development to provide domestic service to the proposed freehold semi-detached houses. A private water service will be extended beneath the private laneway.

A Servicing Agreement will be established for the proposed extension of the region water services within the Georgina Court road allowance.

The proposed Georgina Court watermain will be connected to the existing 400mm watermain beneath Upper Middle Road for redundancy via a proposed easement. Refer to the General Servicing Plan.

The domestic water demand for the freehold semi-detached houses and townhouse condominium is 0.6 L/s, as per Table 1.

ii) Fire Service

The subject development will be served for fire service from the existing 200mm PVC watermain beneath Georgina Court. This existing municipal watermain will be extended southerly into the subject proposed development to provide fire service to the proposed freehold semi-detached houses. A private water service will be extended beneath the private laneway.

There is an existing hydrant near the mid-point of Georgina Court which is within 90m of all proposed townhouses and semi-detached houses. There is also an existing hydrant on Upper Middle Road which is within 90m of all southern townhouse unit entrances.

The pressures and volumes must be sufficient for Peak hour conditions and under fire conditions as established by the Ministry of Environment and the Fire Underwriters Survey booklet (1999). The minimal residual pressure under fire conditions is 140 kPa (20.3 psi).

The allowable pressures are as follows:

Condition	**Allowable Pressures (kpa)**	
	min.	**max.**
1) Min. Hour	275	700
2) Peak Hour	275	700
3) Peak Day + Fire Flow	140	700

The water demand for redeveloped Building is calculated as follows:

a) Average Day domestic demand - 0.61 L/s

b) Peak day demand - 2.25 x average daily demand 1.37 L/s

c) Fire flow as per FUS 1999 manual 217.0 L/s

Table 3 – Fire Flow Demand for Proposed Development

	L/s	USGM
Peak Day Demand	1.37	22
Fire Flow (per FUS) Demand	283	4491
Total Development Water Demand	284	4513

In the following FUS calculations, the following assumptions were made:

a) The proposed townhouses and semi-detached houses will not be sprinklered
b) The buildings will be of combustible construction (wood frame)
c) The building's contents will be of non-combustible nature
d) The proposed buildings' footprints appear on the statistics in Appendix A. The largest townhouse block has a footprint of 631m^2.
e) The foregoing Fire Flow demand is based on the largest of the townhouse blocks being considered as a single building for fire protection. The largest townhouse block has 8 units, and a footpring of 631m^2 – refer to the architectural statistics in Appendix A. This produces a fire flow demand of 283 L/s, which is taken as the fire flow demand, above.

WATER SUPPLY FOR PUBLIC FIRE PROTECTION , FIRE UNDERWRITERS SURVEY
GUIDE FOR DETERMINATION OF REQUIRED FIRE FLOWS

$F = 220 \times C \times \sqrt{A}$
Where:
F = required fire flow in liters per minute
C= Coefficient related to the type of construction
A = the total floor area in square meters (excluding basements) in the building considered

Coefficient related to type of construction	
1.5	Wood Frame
1	Ordinary
0.8	Non combustible
0.6	Fire Resistive

LOCATION: Burlington - 5219 Upper Middle Road
PROJECT: Proposed Residential Development
OBC OCCUPANCY: Residential
PROJECT No 17213
BUILDING FOOT PRINT (m2): 948
OF STOREYS: TBD

Contents	Charge
Non-Combustible	-25%
limited Combustible	-15%
Combustible	0%
Free Burning	15%
Rapid Buring	25%

CONSTRUCTION CLASS: Wood Frame

AUTOMATED SPRINKLER PROTECTION		Credit	Total
NFPA 13 sprinkler standard	no	0%	
Standard Water Supply	no	0%	0%
Fully Supervised System	no	0%	
		0%	

CONTENTS FACTOR: Non-Combustible CHARGE: -20%

EXPOSURE 1 (south) NA - UMR	Distance to Exposure Building (m) / Length - Height	>45	0%
EXPOSURE 2 (east) Prop Semi House	Distance to Exposure Building (m) / Length - Height	4	20%
EXPOSURE 3 (west) NA	Distance to Exposure Building (m) / Length - Height	>45	0%
EXPOSURE 4 (north) Prop TH Block	Distance to Exposure Building (m) / Length - Height	17	15%
		Total:	35%

no more than 75%

Separation	Charge
0-3 m	25%
3.1 -10 m	20%
10.1 - 20 m	15%
20.1 - 30 m	10%
30.1 - 45	5%
> 45 m	0%

ARE BUILDINGS CONTIGUOUS: Yes

FIRE RESISTANT BUILDING Are vertical openings and exterior vertical communications protected with a minimum one (1) h: No

CALCULATIONS

	C =	1.5		Wood Frame
	A =	1893	m2	
	F =	14358	L/min	
Round to Nearest 1000 L/min	F =	15000	L/min	must be > 2000 L/min

STOREY AREAS m2	
631	TH Block Flr 1
631	TH Block Flr 2
631	TH Block Flr 3

CORRECTION FACTORS:

OCCUPANCY	-3000	L/min
FIRE FLOW ADJUSTED FOR OCCUPANCY	12000	L/min
REDUCTION FOR SPRINKLER	0	L/min
EXPOSURE CHARGE	4200	L/min

REQUIRED FIRE FLOW

	F =	16200	L/min	
Round to Nearest 1000 L/min	**F =**	17000	L/min	4491 usgm
	F =	283	L/sec	

C. STORM WATER MANAGEMENT

i) Existing Conditions & Design Criteria

The subject development falls within the catchment area of the existing stormwater management pond to the west. In pre-development conditions, runoff from the subject site drains as follows:

- Southeast area: drains uncontrolled via overland flow southerly to Upper Middle Road; runoff from Upper Middle Road drains thereafter into the adjacent stormwater management pond to the west
- Southwest area: drains uncontrolled via overland flow into the adjacent stormwater management pond and to Upper Middle Road, and subsequently the adjacent pond
- North area (including Georgina Court and houses fronting Georgina Court): drains via existing swale to existing CB adjacent to southwest corner of site; drains into pond thereafter

The pre-development drainage patterns are illustrated in the excerpt from the subdivision storm drainage plans, Figures 1 and 2, which are provided on the following pages. The extents of the subject site are outlined therein; note that external areas such as 6 and 7 Georgina Court drain through the subject site pre-development.

The pre-development drainage patterns are also illustrated on the original Pre-Development Drainage Plan by The Odan/Detech Group on the following page.

The subdivision storm drainage plan on the following page shows that stormwater management capacity was allocated to the subject property based on a runoff coefficient of 0.45. The report shows, as follows, how storm drainage and stormwater management will be designed in compliance with the existing subdivision design.

Burlington Standard S-3D identifies the runoff coefficient for townhouses as C=0.75.

Design storm data for the City of Burlington 2-year, 5-year and 100-year storms are shown below.

$$I_2 = 592.60 / (6 + t)^{0.780}$$
$$I_5 = 697.40 / (5 + t)^{0.764}$$
$$I_{100} = 1114.20 / (5 + t)^{0.761}$$

When time of concentration, *t*, is 10 minutes, the 2-year, 5-year and 100-year rainfall intensities are as follows.

$$I_2 = 68.2 \text{ mm/hr}$$
$$I_5 = 88.1 \text{ mm/hr}$$
$$I_{100} = 141.9 \text{ mm/hr}$$

In the following stormwater calculations, it is assumed that the existing pond provides stormwater quality control (by settling in the forebay) and quantity control, for up to the 100-year storm based on the characteristics outlined on the subdivision storm drainage plan.

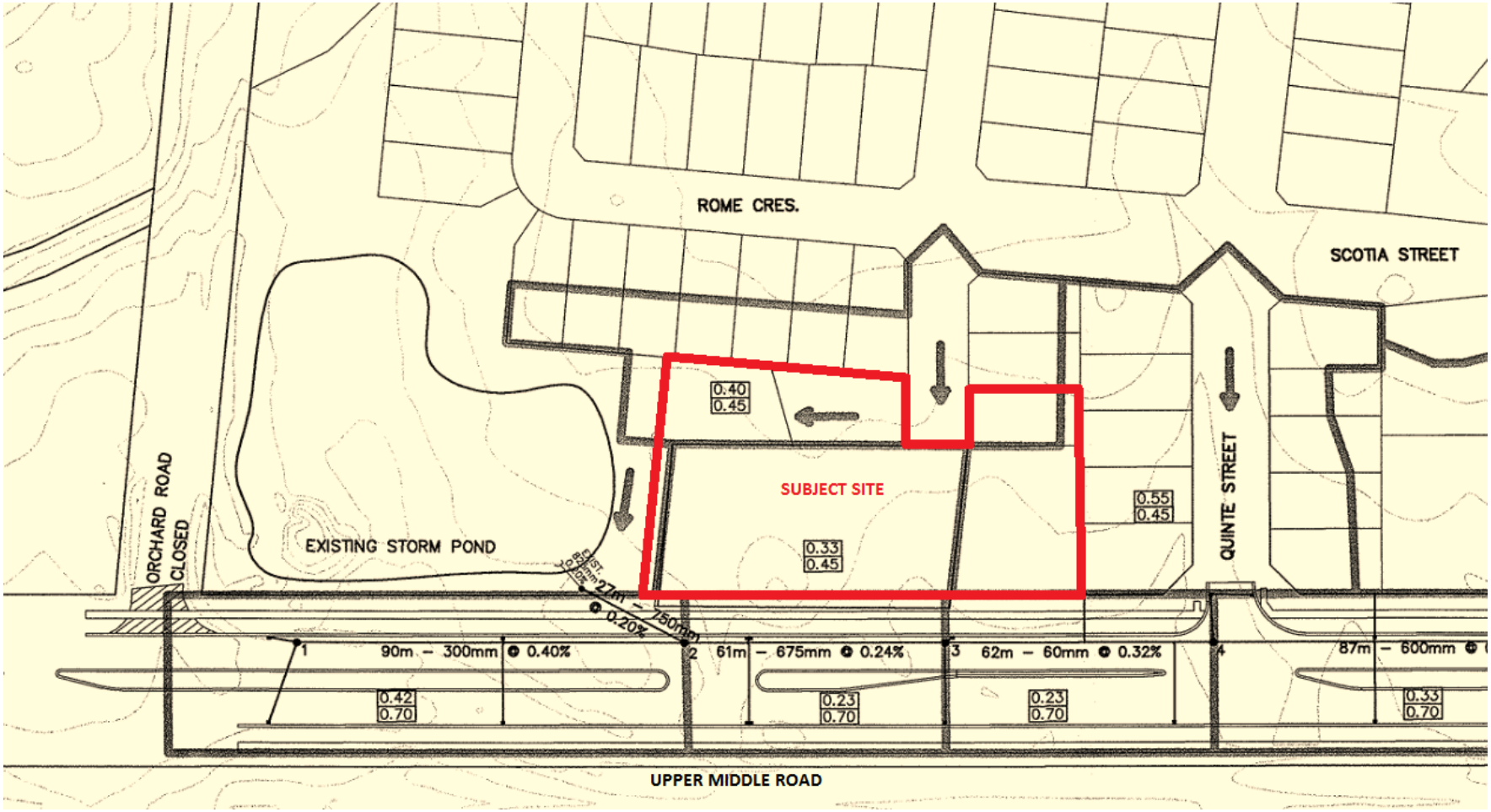


Figure 1 - Subdivision Storm Catchment Plan - Excerpt from drawing Municipal Drawing MDR-254 showing extents of subject site therein

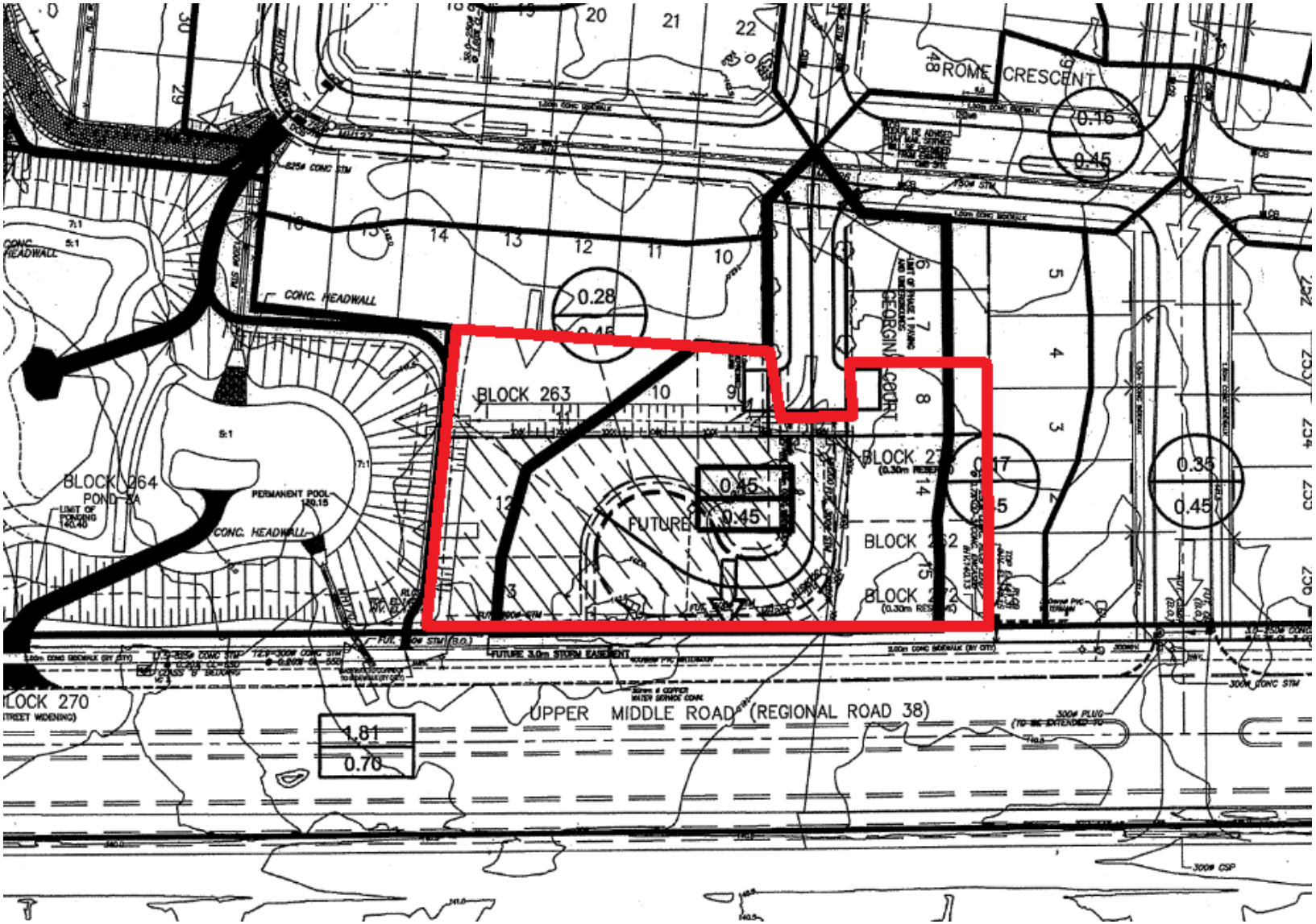
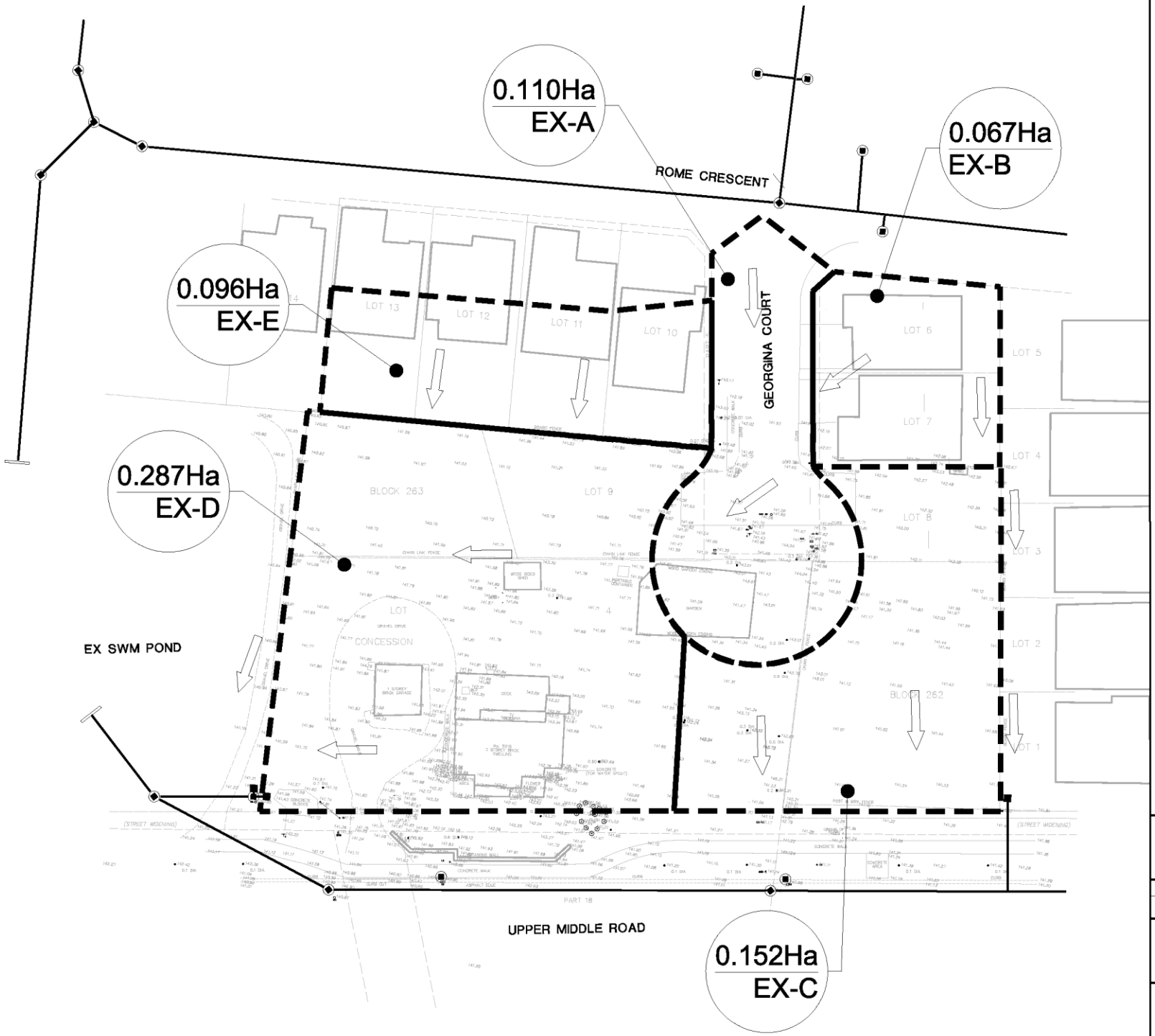


Figure 2 - Subdivision Storm Catchment Plan - Excerpt from Municipal Drawing B-11921 showing extents of subject site and adjacent tributary drainage sheds



LEGEND

0.412Ha / A — CATCHMENT ID & AREA

DRAWING :

PRE-DEVELOPMENT
DRAINAGE PLAN

DATE:	PROJ. NO.:	SCALE:
MARCH 2017	17213	1: 750

PROJECT :

PROPOSED RESIDENTIAL
DEVELOPMENT
5219 UPPER MIDDLE ROAD
BURLINGTON, ON

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5230 SOUTH SERVICE ROAD, BURLINGTON, ONTARIO, L7L 5K2

ii) Storm Sewer & Stormwater Management Design Criteria

Storm drainage from the subject development will in-part follow the existing drainage patterns and in-part drain via the existing storm sewer draining westerly beneath Rome Crescent to the north.

In pre-development conditions, the following catchment areas drained via the overland flow through the subject site to the SWM pond to the west:

- Subject site (Catchment Area's EX-C and EX-D in the Pre-Development Drainage Plan)
- Georgina Court (Catchment Area's EX-A and EX-B)
- External lots bordering the subject site (Catchment Area EX-E)

Refer to the Pre-Development Drainage Plan on the prior page for the pre-development drainage patterns. This is quantified in Table 3, as follows, based on the C-Value identified in the subdivision Drainage Plan.

Table 4 –Pre-Development Runoff Rate

						Q (l/s)
Existing Catchment	ID	Ex. Area (ha)	Pre-Dev't C-Value	Equivalent % Imperviousness (%)	5-Year Intensity (10-minute t_c)	5-Year
Subject Site	EX-C; EX-D	0.47	0.45	36	88.1 mm/hr	51.7 L/s
External Tributary Catchment	EX-A; EX-B; EX-E	0.27	0.45	36	88.1 mm/hr	29.8 L/s

The proposed development comprises a private townhouse condominium corporation in the western half of the subject site (in the area of EX-D) which previously conveyed runoff from EX-A, EX-B, EX-C and EX-D via overland flow to the pond. The development's proposed configuration does not lend itself to drainage via the pre-development drainage patterns wherein EX-A and EX-B drain via overland flow through EX-C and EX-D. This is because it is not feasible to convey drainage from the public Right-of-Way (Georgina Court), to and through the private townhouse condominium. It is therefore proposed to drain Georgina Court and the tributary lots northerly to the existing Rome Crescent 750mm storm sewer via a proposed municipal storm sewer beneath Georgina Court. Refer to the Functional Servicing Plan for the layout of the receiving existing municipal storm sewer beneath Rome Crescent.

A prior iteration of this development's storm drainage design saw the major overland flow route for the proposed Georgina Court ROW drain to and through the private townhouse condominium corporation. It is now instead proposed that the major overland flow route for Georgina Court is via an easement southerly to Upper Middle Road, rather than through private property. Refer to the Grading Plan.

The area of the subject site (EX-C and EX-D) fell within a drainage area in the subdivision's design which was intended to receive runoff based on a future runoff coefficient of 0.45. The proposed townhouse condominium component of the subject development has a runoff coefficient of 0.75 in accordance with City of Burlington Standard S-3D. City staff stated in a memorandum dated June 27, 2017 that the private townhouse condominium component of the

development should provide stormwater quantity controls such that the post-development impact of the townhouse component is equal to or less than the allocated impact (C=0.45).

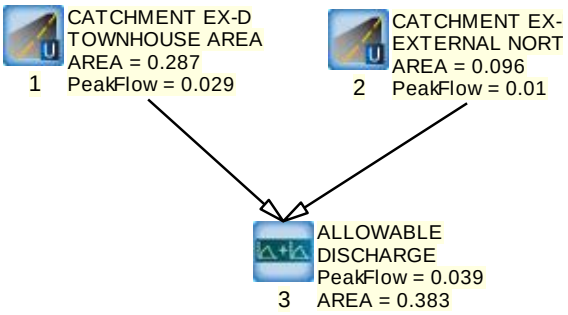
In post-development conditions, Catchment Area's D (Subject Townhouses) and EX-E (adjacent detached houses to north) will drain via the proposed townhouses storm drainage conveyances and stormwater management measures to the SWM Pond to the west by an outlet to STM CBMH 4. The allowable release rate to STM CBMH 4 is given by the following pre-development runoff rate of these catchment areas in Table 5. This is calculated both using the Rational Method and Visual OTTHYMO, as follows.

The allocated release rate was modelled as follows using Visual OTTHYMO 2.3.2. The catchment was modelled using Visual OTTHYMO's *StandHYD* routine for urban watersheds. Refer to the detailed Visual OTTHYMO Output in Appendix A.

Table 5 – Pre-Development/Allocated Discharge (Allowable Release Rate) from Townhouse Area

						Q (l/s)
Calculation Scenario	ID	Ex. Area (ha)	Pre-Dev't C-Value	Equivalent % Imperviousness (%)	5-Year Intensity (10-minute t_c)	5-Year ***100-Year***
Rational Method (Q=2.78CiA)	EX-D & EX-E	0.383	0.45	36	88.1 mm/hr	42.2 L/s ***68.0 L/s***
Visual OTTHYMO (Figure 2)					88.1 mm/hr	39 L/s ***79 L/s***

Figure 3 - Pre-Development Townhouse Area Visual OTTHYMO Model (Showing 5-Y Flows)



Post-development discharge from the townhouse area will therefore be controlled based on the foregoing pre-development/allocated flow rates.

The existing 750mm storm sewer beneath Rome Crescent presently conveys runoff from the subdivision to the north via four pipe segments into the existing storm pond to the west. The subject proposed Georgina Court municipal storm sewer will drain into EX MH 126 at the intersection of Georgina Court and Rome Crescent. The sewer then drains via EX MH 126, 127, 133 and 162 to the pond inlet. The design criteria and storm sewer design sheets for this storm sewer system are provided in the *Block 223 Woodlot and External Drainage Area Detailed Drainage Analysis* (Marshall Macklin Monaghan Ltd., October 2002), provided here in Appendix B. Refer to the Storm Sewer Design sheets therein which show that the existing sewers are flowing at no more than 63% in any downstream segment in a 5-year storm.

Note that the storm sewer design sheet pipe specifications (slopes) in the appended report do not always correspond with the as-built drawings. The as-built plan profile drawings have been assumed to be correct in such cases in the following storm sewer design sheets.

The existing storm sewer design sheets are recreated on the following pages, in pre-development and post-development conditions, to show that the existing Rome Crescent storm sewers have capacity to convey the additional flow from Georgina Court (Catchment Area's 'A' and 'C') in a 5-year storm. Post-development, no existing receiving storm sewers are flowing at more than 65 % of their capacity, as shown on the following pages.

The private townhouse condominium will drain as per existing drainage conditions via a proposed sewer connection to the existing headwall via EX CB 6. Refer to the Functional Servicing Plan. Because the existing drainage condition and subdivision storm catchment plans reflect this drainage pattern, it is assumed that the existing conveyances serving the townhouse condominium have capacity for the development. A storm sewer design sheet is provided on the following pages to show that the proposed private storm sewers have adequate capacity for the subject development.

A portion of the back yards of the proposed semi-detached houses fronting the Georgina Court roundabout as well as adjacent external lots (Catchment 'E') will drain to Upper Middle Road via a proposed rear-yard swale and RLCB 1. It is not feasible to collect runoff from these areas in the proposed Georgina Court storm sewers because the site falls southerly and there is not adequate cover to extend the proposed Georgina Court storm sewer southerly into Catchment 'E'. It is anticipated that the Upper Middle Road storm sewers, which ultimately drain to the adjacent storm pond, have capacity for this flow as it is representitive of the existing condition.

Refer to the Post-Development Drainage Plan for the proposed drainage patterns.

It is anticipated that the receiving storm pond to the west will provide stormwater quantity and quality control for the Georgina Court portion subject development given that it falls within the subdivision storm catchment plans and that it appears to include a settling forebay and orifice for quantity control. The following design sheets are therefore provided to demonstrate the manner in which stormwater conveyances will be provided to the pond.

iii) Major System Conveyance

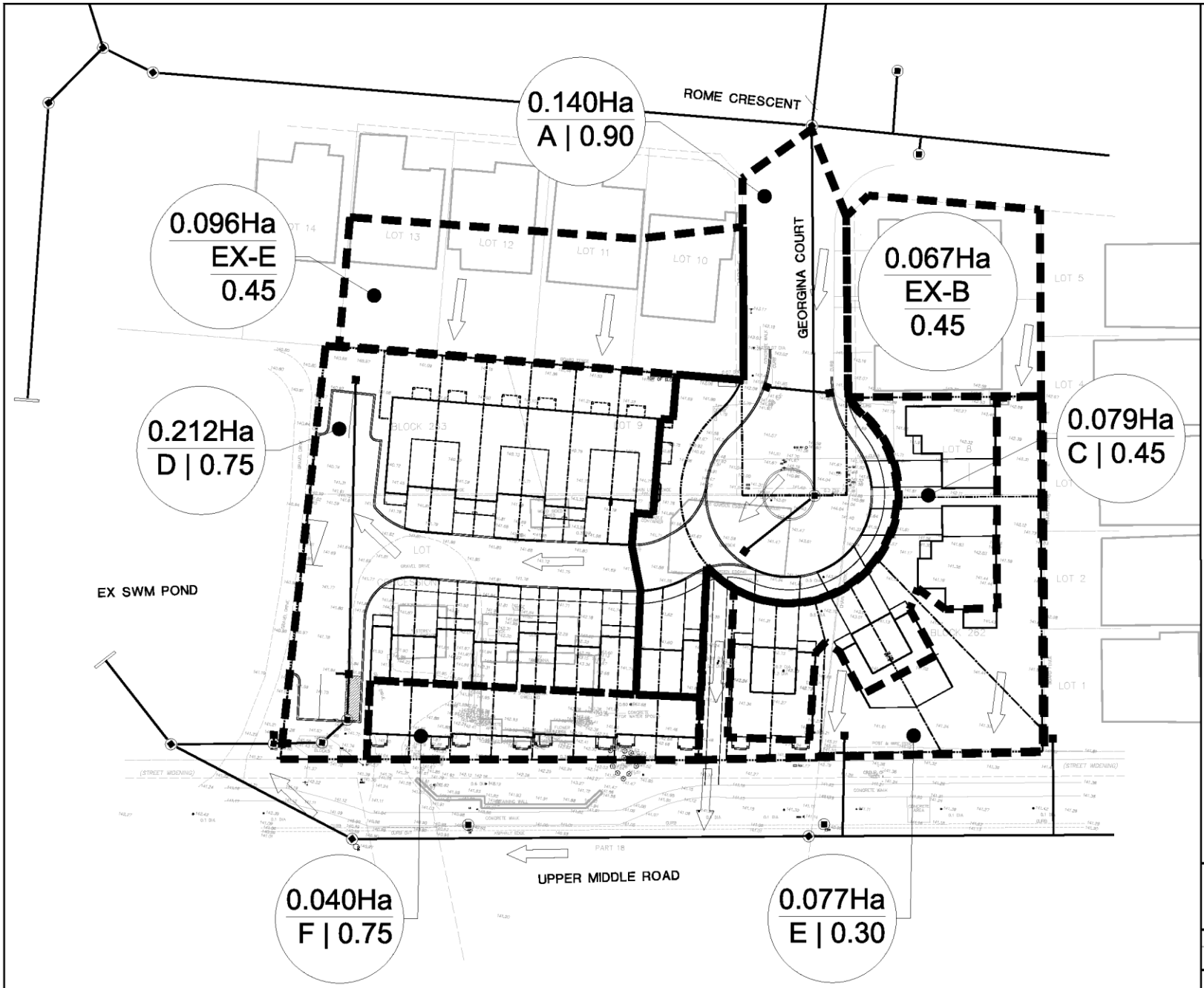
Stormwater conveyance is provided for the minor system (5-year) storm in the proposed Georgina Court storm sewers, as shown in the following storm sewer design sheets. Storm events greater than 5-year in intensity will spillover off the site, via a channel created by the pedestrian pathway to Upper Middle Road.

The proposed catchbasins on Georgina Court (PROP CB1, CB2 and CB3) are at a lower grate elevation (~141.85) than the storm sewers on Rome Crescent (rim elevation ~143.10), therefore water will spill out of CB1, CB2 and CB3 in major storm. The water will spillover at the south end of the Georgina Court cul-de-sac onto the pedestrian walkway, and thereafter flow onto Upper Middle Road.

The eastern frontage of the proposed townhouse is graded such that it is ~0.20m higher than the spillover point to Upper Middle Road, to ensure that the Georgina Court major overland flow route is towards Upper Middle Road. This necessitates that a portion of the private townhouse lands drains via overland flow onto the Georgina Court road allowance, rather than internally. This is an unavoidable consequence of ensuring that the major overland flow from Georgina Court does not enter the townhouse component. This area is considered as part of Catchment ‘A’.

The top of foundation wall elevation for the townhouse units shall be a minimum of 300mm above the top of curb in the laneway. Further, building openings shall be 500mm above the top of curb elevation.

City staff have stated that there may be restrictions on the top of foundation wall and building opening elevations for the semi-detached units as well, which may be determined at the detailed design stage.



LEGEND

0.412Ha
A|0.65
CATCHMENT ID, C-VALUE & AREA

DRAWING :
POST-DEVELOPMENT DRAINAGE PLAN

DATE:	PROJ. NO.:	SCALE:
MARCH 2017	17213	1: 750

PROJECT :
PROPOSED RESIDENTIAL DEVELOPMENT
5219 UPPER MIDDLE ROAD
BURLINGTON, ON

ODAN·DETECH
CONSULTING ENGINEERS
The Odan/Detech Group Inc. P: (905) 632-3811 F: (905) 632-3363
5230 SOUTH SERVICE ROAD, BURLINGTON, ONTARIO, L7L 5K2

PRE-DEVELOPMENT STORM SEWER DESIGN SHEET - EXISTING ROME CRESCENT STORM SEWERS

Site location: 5219 Upper Middle Road

Ref# PN 17213

Location				Segment Tributary Area	Accumulative Tributary Area	Time of Concentration	5-year Rainfall Intensity	Segment Catchment Area C-Value	Segment A x C	Accumulative A x C	Accumulative 5-Year Storm Flow	Pipe						
Segment Storm Trib ID	Street Name	US Node	DS Node	(Ha)	(Ha)	(minutes)	(mm/hr)		(Ha)	(Ha)	(L/s)	Length L (m)	Size D (mm)	Slope S (%)	Shape	Full Flow Capacity Qcap (L/s)	Full Flow Velocity V (m/s)	% Full Q(d)/Qcap
External	Rome Crescent	EX MH 126	EX MH 127	0.150	10.040	55.970	30	0.45	0.07	4.19	351	91.60	750	0.25	circle	556.64	1.26	63.14%
External	Rome Crescent	EX MH 127	EX MH 133	0.650	10.590	57.182	30	0.45	0.29	4.48	370	8.60	750	0.61	circle	869.50	1.97	42.58%
External	Rome Crescent	EX MH 133	EX MH 162	0.000	11.240	57.254	30	0.45	0.00	4.73	391	11.00	825	1.00	circle	1,435.44	2.69	27.21%
External	EX SWM Pond	EX MH 162	Pond Headwall	0.000	27.590	57.323	30	0.45	0.00	14.34	1183	36.50	1200	0.40	circle	2,465.77	2.18	47.97%

Flow Calculation Criteria

Q=2.78CiA

5-Year Storm IDF data:

Intensity (5-year) = 697.40 / (5 + t) $^{0.764}$

n = 0.013

POST-DEVELOPMENT STORM SEWER DESIGN SHEET - EXISTING ROME CRESCENT STORM SEWERS & PROPOSED GEORGINA COURT STORM SEWER

Site location: 5219 Upper Middle Road

Ref# PN 17213

Location				Segment Tributary Area	Accumulative Tributary Area	Time of Concentration	5-year Rainfall Intensity	Segment Catchment Area C-Value	Segment A x C	Accumulative A x C	Accumulative 5-Year Storm Flow	Pipe						
Segment Storm Trib ID	Street Name	US Node	DS Node	(Ha)	(Ha)	(minutes)	(mm/hr)		(Ha)	(Ha)	(L/s)	Length L (m)	Size D (mm)	Slope S (%)	Shape	Full Flow Capacity Qcap (L/s)	Full Flow Velocity V (m/s)	% Full Q(d)/Qcap
A, EX-B, C	Georgina Court	STM MH 1	EX MH 126	0.286	0.286	10	88	0.67	0.19	0.19	47	49.59	300	0.45	circle	64.87	0.92	72.37%
External	Rome Crescent	EX MH 126	EX MH 127	0.150	10.040	55.970	30	0.45	0.07	4.38	368	91.60	750	0.25	circle	556.64	1.26	66.03%
External	Rome Crescent	EX MH 127	EX MH 133	0.650	10.590	57.182	30	0.45	0.29	4.67	386	8.60	750	0.61	circle	869.50	1.97	44.40%
External	Rome Crescent	EX MH 133	EX MH 162	0.000	11.240	57.254	30	0.45	0.00	4.92	406	11.00	825	1.00	circle	1,435.44	2.69	28.31%
External	EX SWM Pond	EX MH 162	Pond Headwall	0.000	27.590	57.323	30	0.45	0.00	14.53	1199	36.50	1200	0.40	circle	2,465.77	2.18	48.62%

Flow Calculation Criteria

Q=2.78CiA

5-Year Storm IDF data:

Intensity (5-year) = 697.40 / (5 + t) $^{0.764}$

n = 0.013

Note: Composite C-value for Tributary Areas A, B & C is 0.67

iv) Townhouse Component Stormwater Management Quantity Control

Stormwater quantity controls are required for the subject townhouse development as described in Section 3.0 C) ii). The release rate from the townhouse component of the development will be controlled in accordance with Table 5.

A portion of the private townhouse component – Catchment 'F' – will drain uncontrolled onto the Upper Middle Road ROW by sheet flow. The site layout and grading design precludes draining this area internally of the townhouses drainage conveyances. This catchment area has C=0.75 given that it is part of the townhouse component, however, as outlined above, the receiving storm drainage infrastructure has capacity allocated based on C=0.45.

The Catchment 'F' uncontrolled runoff is therefore considered in the following stormwater management quantity control design such that the runoff from the remainder of the townhouse component is "over-controlled" to offset the uncontrolled flow. Notwithstanding the uncontrolled runoff from Catchment 'F', the overall discharge rate from the townhouse entity is within the allowable/allocated flow rate.

A portion of the external single-family lots adjacent to the townhouses' north property line – Catchment 'EX-E' – drains into the subject townhouse development. This area will drain via the TH units' rear-lot swale into DI1 and is thus considered in stormwater quantity calculations. The allowable/allocated discharge rate given in Table 5 considers this external catchment area. Catchment 'EX-E' comprises detached houses with C=0.45, therefore stormwater quantity controls are not required. The runoff if simply conveyed through the site's SWM system.

Visual OTTHYMO 2.3.2 is used herein to model the storm drainage and determine the stormwater storage volume up to the 100-year event. City of Burlington design storm data is provided above.

The subject site's catchment areas are characterised as follows using Visual OTTHYMO.

Table 6 - Catchment Characteristics for the Post-Developed Site

Area I.D.	Area (ha)	Hydrograph Method	% impervious	imperviousness directly connected %	Loss Method for Pervious Area	CN for Pervious Area	Initial Abstraction for Pervious (mm)	Time to peak (T_p)
Catchment EX-E (External)	0.096	StandHyd	36	36	SCS	80	1	-
Catchment D (Subject TH)	0.212	StandHyd	79	79	SCS	80	1	-
Catchment F (Uncontrolled TH)	0.040	StandHyd	79	79	SCS	80	1	-

The visual OTTHYMO model is as follows in Figure 4.

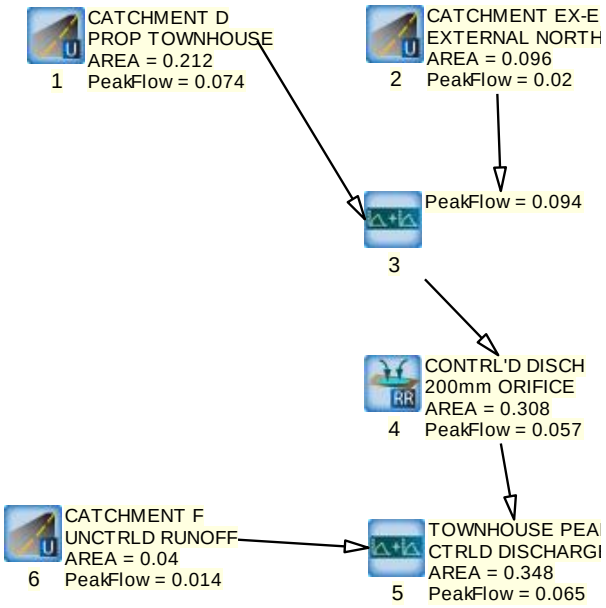


Figure 4 - Post-Development Visual OTTHYMO Model (Showing 100-Y Flow)

Controlled discharge is provided by a 200mm orifice tube at the outlet from STM MH4. The stage/storage/discharge relationship for the orifice tube is as follows.

The 200mm orifice pipe invert elevation is 139.56m to allow flow by gravity to the downstream storm pond in minor storm events. In the following orifice calculations determining storage requirement in the critical 100-Y storm, however, the downstream water level is taken as 140.40m. This is because this is the maximum storage water elevation in the downstream stormwater management pond according to subdivision drawing MDR-260 – Refer to Figure 5. Thus, in major storm events (5-year and 100-year) for which the site's stormwater quantity control measures have been designed, the driving head across the orifice considers backwater effects from stored stormwater in the receiving storm pond.

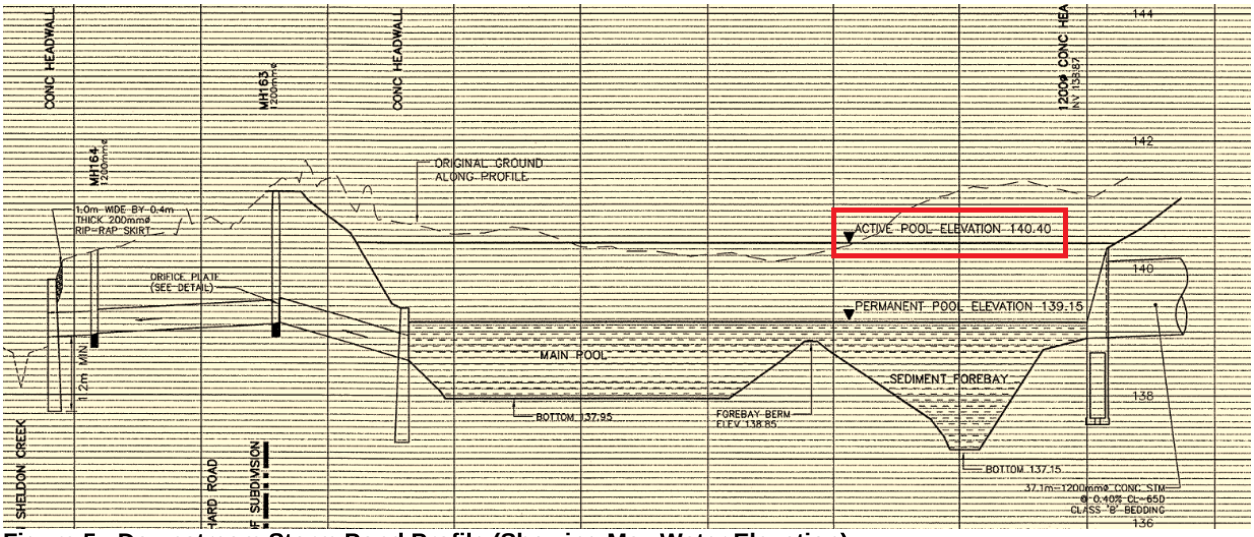


Figure 5 - Downstream Storm Pond Profile (Showing Max Water Elevation)

The stage/storage/discharge relationship for the orifice is therefore as follows.

Table 7 – Stage/Storage/Discharge Relationship for 200mm orifice pipe

Head (m)	Elevation (m)	Provided Volume (m^3)	Discharge (l/s)	Description
0	139.56	0	0	Invert of Orifice at STM MH 4
0	140.40	0	0	Downstream storage elevation
0.50	140.90	9.6 + 42 = 51.6	78.7	Roof of Forterra System
0.71	141.11	51.6	93.1	Spillover via DI 1
Total Discharge: ***100 Year = 57 l/s (Table 1)***				

The controlled discharge is thus provided as follows. Note that the peak site controlled discharge is not the sum of the attenuated discharge from the orifice, added to the uncontrolled discharge from Catchment 'F'. Rather, the Visual OTTHYMO considers the different peaking times occurring between the attenuated discharge and the uncontrolled discharge. The peak discharge rate, therefore, is 65 L/s, not 57 L/s + 14 L/s = 71 L/s.

Table 8 - Summary of Flows from Site

Storm Sewer System	**5 Yr. Storm** (L/s)	**100 Yr. Storm** (L/s)
Attenuated discharge from 200mm Orifice	33	57
Catchment 'F' Uncontrolled Runoff	8	14
Peak Site Controlled Discharge	***38***	***65***
Allowable Flow Rate (Table 4)	***68***	

The stormwater storage requirements are as follows. Refer to the detailed storage tables in Appendix B for detailed provided storage volume. Refer to the Visual OTTHYMO Output in Appendix B for detailed required storage calculation. Note that there is adequate volume in the site's pipes and manholes for the required storage in a 100-year storm.

Table 9 - Stormwater Storage

	2 Yr. Storm (m^3)	**100 Yr. Storm** (m^3)
Required Storage Volume	23	40
Provided Volume (Forterra – Appendix A)	42	
Provided Volume – 2 x 1200mm MH	2.4	
Provided Volume – 45m x 450mm pipe	7.2	

v) Stormwater Quality

City staff have identified the stormwater quality control criteria applying to private developments such as the subject proposed condominium townhouse development as 80% Total Suspended Solids removal. City staff further requested a treatment-train approach to stormwater quality.

A treatment-train approach is proposed for stormwater quality on the townhouse component comprising filtration by a clear-stone-filled trench and subsequently an Oil/Grit Separator. Refer to the General Servicing Plan for the layout of the quality-treatment measures.

A Stormceptor model STC 300 has accordingly been specified. Based on the catchment area served, it will provide 78% TSS Removal. The clear stone trench surrounding DI 1 will provide the remaining 2% of TSS Removal to address the requirement. Refer to the Stormceptor design report on the following pages.

Stormceptor®

Stormceptor Design Summary

PCSWMM for Stormceptor

Project Information

Date	10/4/2017
Project Name	5219 Upper Middle Road
Project Number	17213
Location	Burlington

Designer Information

Company	The Odan/Detech Group
Contact	N/A

Notes

N/A

Drainage Area

Total Area (ha)	0.287
Imperviousness (%)	79

The Stormceptor System model STC 300 achieves the water quality objective removing 78% TSS for a City of Toronto (clay, silt and sand) particle size distribution.

Rainfall

Name	TORONTO CENTRAL
State	ON
ID	100
Years of Records	1982 to 1999
Latitude	45°30'N
Longitude	90°30'W

Water Quality Objective

TSS Removal (%)	70

Upstream Storage

Storage (ha-m)	Discharge (L/s)
0	0

Stormceptor Sizing Summary

Stormceptor Model	TSS Removal %
STC 300	**78**
STC 750	85
STC 1000	85
STC 1500	86
STC 2000	90
STC 3000	91
STC 4000	93
STC 5000	93
STC 6000	94
STC 9000	96
STC 10000	96
STC 14000	97

Stormceptor Design Summary - 1/2

Stormceptor®

Particle Size Distribution

Removing silt particles from runoff ensures that the majority of the pollutants, such as hydrocarbons and heavy metals that adhere to fine particles, are not discharged into our natural water courses. The table below lists the particle size distribution used to define the annual TSS removal.

City of Toronto (clay, silt and sand)

Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s		Particle Size µm	Distribution %	Specific Gravity	Settling Velocity m/s
10	20	2.65	0.0004					
30	10	2.65	0.0008					
50	10	2.65	0.0022					
95	20	2.65	0.0063					
265	20	2.65	0.0366					
1000	20	2.65	0.1691					

Stormceptor Design Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor version 1.0
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal.
- Only the STC 300 is adaptable to function with a catch basin inlet and/or inline pipes.
- Only the Stormceptor models STC 750 to STC 6000 may accommodate multiple inlet pipes.
- Inlet and outlet invert elevation differences are as follows:

Inlet and Outlet Pipe Invert Elevations Differences

Inlet Pipe Configuration	STC 300	STC 750 to STC 6000	STC 9000 to STC 14000
Single inlet pipe	75 mm	25 mm	75 mm
Multiple inlet pipes	75 mm	75 mm	Only one inlet pipe.

- Design estimates are based on stable site conditions only, after construction is completed.
- Design estimates assume that the storm drain is not submerged during zero flows. For submerged applications, please contact your local Stormceptor representative.
- Design estimates may be modified for specific spills controls. Please contact your local Stormceptor representative for further assistance.
- For pricing inquiries or assistance, please contact Imbrium Systems Inc., 1-800-565-4801.

Stormceptor Design Summary - 2/2

4. CONCLUSIONS

The foregoing report has demonstrated that there are existing mains available to provide sanitary, storm and water service to the subject development.

Stormwater calculations are provided to show that the receiving infrastructure has capacity to receive flows from the subject development.

Table 10 – Summary Information

Storm Drainage	
5-Y Storm Discharge to Rome Crescent STM Sewer	43 L/s
5-Y Storm Discharge from Townhouse Condo	38 L/s
Sanitary & Water Servicing	
Total Fire-Domestic Flow Required	4513 USGM
Peak Sanitary Discharge Rate	0.73 L/s

Respectfully Submitted;
The Odan Detech Group Inc.



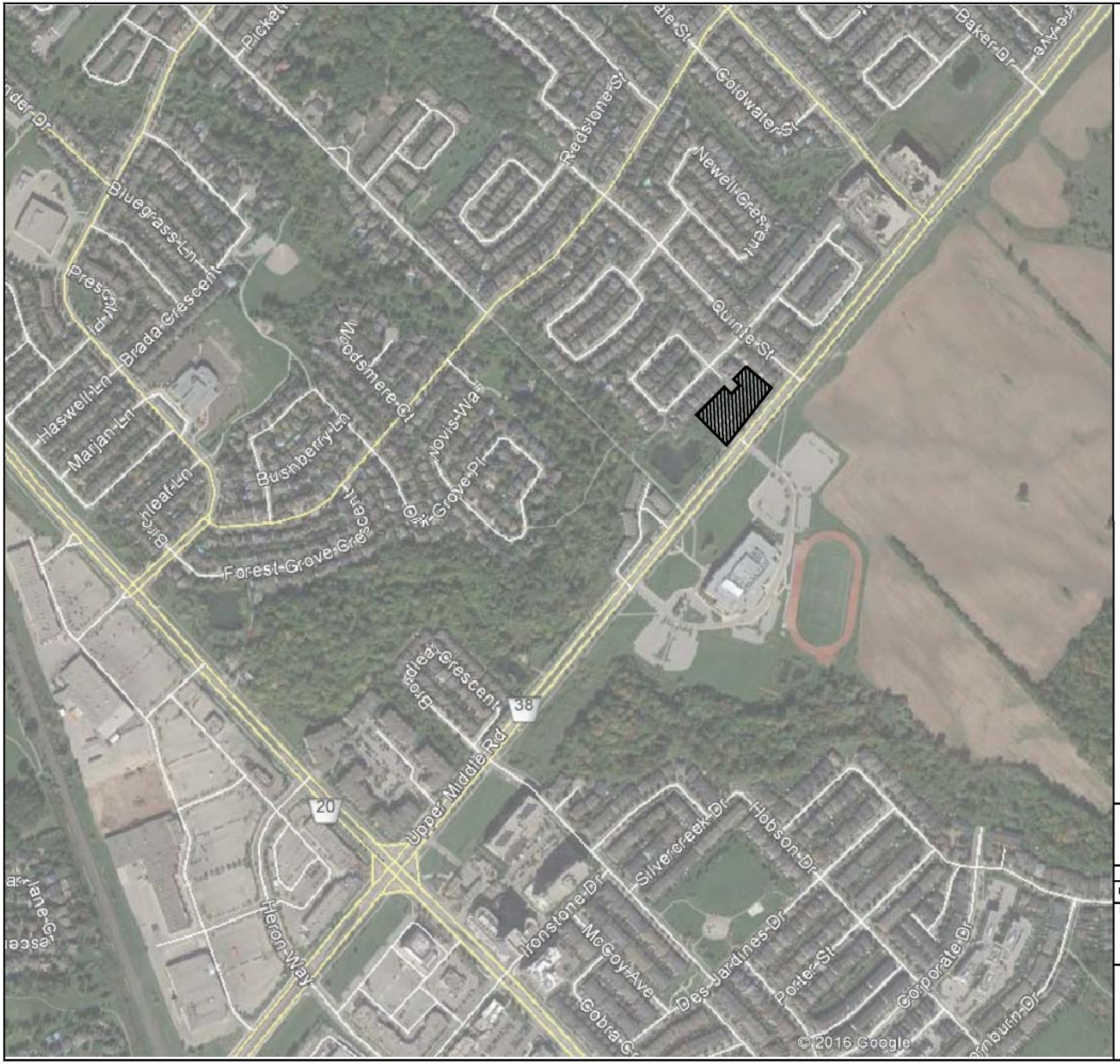


John Krpan, M.S.C.E., P.Eng.

Daniel Bancroft, P.Eng.

APPENDIX A

Aerial Photo of Site
Site Plan prepared by Weston Consulting



LEGEND

PROPERTY LINE

DRAWING :

KEY PLAN

DATE:	PROJ. NO.:	SCALE:
MARCH 2017	17213	N.T.S.

PROJECT :

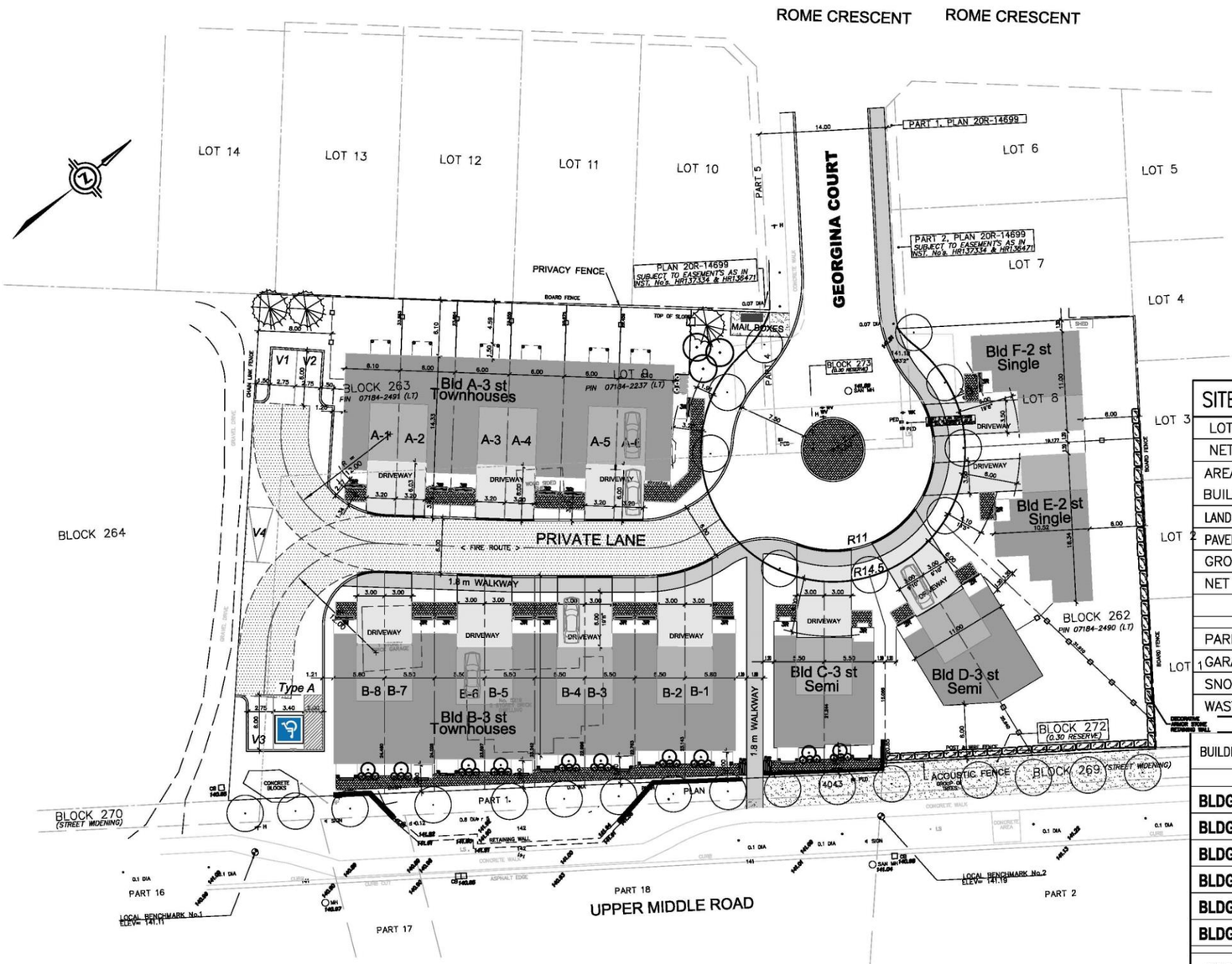
PROPOSED RESIDENTIAL DEVELOPMENT
6219 UPPER MIDDLE ROAD
BURLINGTON, ON

ODAN·DETECH
CONSULTING ENGINEERS
The Odan/Detech Group Inc. P: (905) 632-3811 F: (905) 632-3363
5230 SOUTH SERVICE ROAD, BURLINGTON, ONTARIO, L7L 5K2

No. 5219 UPPERMIDDLE ROAD
CITY OF BURLINGTON
REGIONAL MUNICIPALITY OF HALTON



KEY PLAN N.T.S.



SITE ANALYSIS		ZONE Orchard Residential 2(RO2)	
LOT AREA	0.50 (5000 SM) HA	100.00 %	
NET SITE AREA	0.44 HA	0.74 %	
AREA COVERED BY ALL BUILDING AND STRUCTURES	1,616.89 SM	32.34 %	INCLUDE PORCHES/VERANDAS
LAND. AREA	3,123.11 SM	62.46 %	INC. WALKS
PAVED AREA	1,260.47 SM	25.20 %	
GROSS RESIDENTIAL DENSITY	20/0.50 = 40 UPH		
NET RESIDENTIAL DENSITY	20/0.44 = 45 UPH		
PARKING PROVIDED	40+5 VISITOR = 45 (INCLUDE 1 TYPE A ACCESSIBLE SPACE)		
GARAGE	MIN. CLEAR GARAGE SIZE 3MX6MX2M		
SNOW STORAGE	TO BE REMOVED FROM SITE		
WASTE COLLECTION	PRIVATE CURB SIDE COLLECTION GARBAGE AND RECYCLING AT EACH UNIT		

BUILDING ID	LAND USE	# OF UNITS	AMENITY AREA		COVERAGE		HEIGTH (STOREY/M)
			REQUIRED	PROVIDED			
BLDG."A"	TOWNHOUSE	6	120 SM	284 SM	469.47 SM	5053.32 SF	3 STOREY 11.50 M
BLDG."B"	TOWNHOUSES	8	160 SM	207 SM	631.07 SM	6792.73 SF	3 STOREY 11.50 M
BLDG."C"	SEMI-DETACHED	2	N/A	N/A	145.42 SM	1565.27 SF	3 STOREY 12.70 M
BLDG."D"	SEMI-DETACHED	2	N/A	N/A	133.72 SM	1439.30 SF	3 STOREY 12.70 M
BLDG."E"	SINGLE	1	N/A	N/A	130.12 SM	1400.62 SF	2 STOREY 8.80 M
BLDG."F"	SINGLE	1	N/A	N/A	107.09 SM	1152.67 SF	2 STOREY 8.80 M
TOTAL		20 UNITS			1616.89 SM	17403.91 SF	

FOR GRADING SEE
ODAN/DETECH
Consulting Engineers

FOR LANDSCAPE SEE
GEOMETRIC STUDIO INC.

SITE INFORMATION

5 4 3 2 1 0 5 10 15
SCALE

LEGEND

- SINGLE CATCHBASIN
- DOUBLE CATCHBASIN
- SANITARY MH
- STORM MH
- SANITARY CONNECTION
- FDC/STORM CONNECTION
- WATER CONNECTION
- HYDRANT AND VALVE
- VALVE AND BOX
- DOWNSPOUT
- FLOW DIRECTION
- OVERLAND FLOW
- (000.00) EXISTING ELEVATION
- 000.00 PROPOSED ELEVATION
- FFF FINISHED 1ST FLOOR
- TW TOP OF FOUNDATION WALL
- FS FINISHED SLAB
- USF UNDERSIDE OF FOOTING
- BELL PEDESTAL
- CABLE PEDESTAL
- HYDRO TRANSFORMER
- HYDRO SERVICE
- LIGHT STANDARD
- MB SUPER MAILBOX

REVISIONS

#		DATE
1	ISSUED FOR SITE PLAN APPROVAL	OC 26 17

NOTES

ALL SLOPES TO BE 3:1 MAXIMUM

THE BUILDER SHALL BE RESPONSIBLE FOR THE VERIFICATION OF HOUSE TYPE AND FRONT ELEVATION, PRIOR TO COMMENCEMENT OF CONSTRUCTION

ONTARIO ASSOCIATION OF ARCHITECTS
LEO ARIEMMA
LICENCE
7061

ALL DRAWINGS & SPECIFICATIONS ARE THE PROPERTY OF THE ARCHITECT AND CANNOT BE USED OR REPRODUCED WITHOUT HIS APPROVAL.

THE CONTRACTORS SHALL CHECK AND VERIFY ALL DIMENSIONS ON THE SITE AND REPORT ANY DISCREPANCY TO THE ARCHITECT.

ALL DRAWINGS MUST NOT BE SCALED.

ARCHITECTURAL DESIGN INC.
56 PENNSYLVANIA AVE. UNIT 1
CONCORD, ONT. L4K 3V9
TEL 905 660-9393
FAX 905 660-9419

PROJECT
PROPOSED DEVELOPMENT
FOR: UPPER MIDDLE ROAD ENCLAVE INC.
AT: 5219 UPPER MIDDLE ROAD
CITY OF BURLINGTON

DRAWING
SITE PLAN FOR

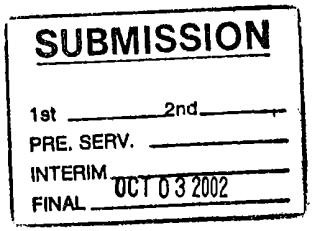
DATE	AUG '17	PROJECT NO	17-074
DRAWN	L.A.		
CHECKED		DRAWING NO	A-1
SCALE	1:250		

APPENDIX B

Block 223 Woodlot and External Drainage Area Detailed Drainage Analysis by Marshall Macklin Monaghan Ltd. (October 2002)

APPENDIX A

BLOCK 223 WOODLOT AND EXTERNAL DRAINAGE AREA
DETAILED DRAINAGE ANALYSIS



10-94022
Metrontario Bronte Woods Phase2

DETAILED DRAINAGE ANALYSIS

We have examined the photogrammetric existing point data for the site and adjacent areas to confirm grading variations than occur between the contour intervals shown on the drawings. Our review of the existing grades in the wood lot (Block 223) and the adjacent properties to the north and west reveals:

- approximately 1.07 ha is tributary to the DICB between lots 45B and 46B, however, several ponding/infiltration areas exist in low areas along the overland flow route
- an area of 0.24 ha, primarily on the rear of the Waldorf school property, may be draining onto the Lisani property to the south or to the woodlot (inconclusive from the existing grades)
- a ridge exists in the southwest corner of the wood lot, reducing the total area draining to the DICB in the parkette (Block 222) to 0.41 ha.

Drainage boundaries and flow paths are illustrated on the enclosed plan.

Due to the significant length of flow path through the woodlot for the area tributary to the DICB between lots 45B and 46B, we have calculated the time of concentration (T_C) via the upland method.

Considering the drainage area for the woodlot and external drainage area to the north, as shown on **MMM Dwg. No. 10-94022-ST3** and on the **Design Sheet that considers the full contributing area of the woodlot**, a T_C of 53 minutes is calculated as derived below

Flow path A-C-D		= 234 m	
A-C-D average grade	$\frac{147.40 - 145.39}{234m}$	$= \frac{2.01}{234}$	= 0.86%
Velocity from uplands method	0.24 ft/s	= 0.073 m/s	
T_C to DICB	234m/0.73m/s	53 min.	

The design sheet demonstrates that the downstream sewer system has adequate capacity.

2. However, due to the impact the large T_C in no. 1 has on the downstream sections of the design sheet using the rational method, we have prepared an alternative design sheet which considers the nominal starting T_C of 10 minutes which is expected to provide typical conservative sizing of the storm sewers. To account for the woodlot at this time interval, we derived an approximate corresponding area for the **Woodlot Contribution at T_C = 10 minutes** as follows.

Velocity from uplands	0.24 ft/s	= 0.073 m/s
Distance travelled in 10 min	0.073 m/s x 10min x 60 s/min	= 44m
Approximate area	0.34 ha	

Based on a 44m flow path, we estimate an are of 0.34ha contributes run-off to the receiving RLCB, the design sheet demonstrates that the downstream sewer system has adequate capacity.

3. Our review of the grades indicates that a 0.24 area of the Waldorf school property may drain to Lisani or to the woodlot. We have investigated the impact on the storm sewer system if flows were to be conveyed to the DICB in the woodlot.

Flow path B-C-D		= 218 m	
B-C-D average grade	$\frac{147.20 - 145.39}{218m}$	$= \frac{2.01}{218}$	= 0.83%
Velocity from uplands	0.24 ft/s	= 0.073 m/s	
T_C to DICB	218/0.073	= 49 min	

A design sheet indicating the **Full Woodlot Contribution and Waldorf** demonstrates that the downstream sewer system has adequate capacity.

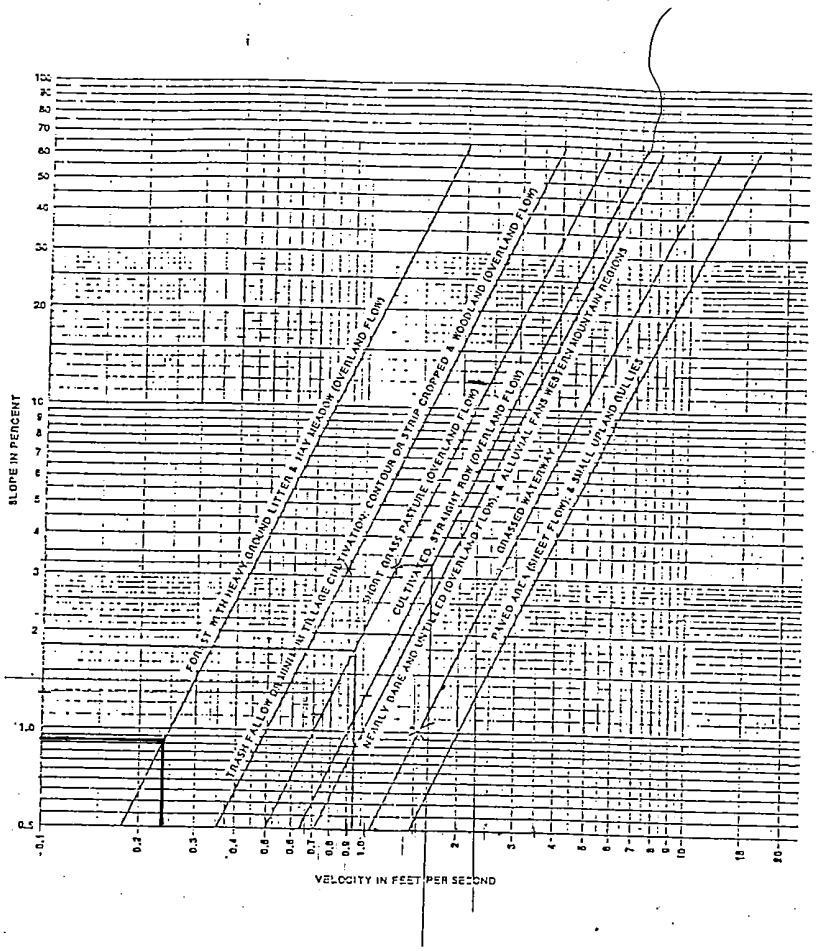


Figure 15.2.--Velocities for upland method of estimating T_c

SUBDIVISION: BRONTE WOODS COMMUNITY SUBDIVISION

CITY OF BURLINGTON

STORM SEWER DESIGN SHEET

$I_{5yr} = \frac{697.4}{(tc+5)^{0.764}}$

Runoff Coefficient :

Single/Semi Family Residential	0.45
Townhouses	0.75
Commercial & Industrial	0.85
Parks & Open Space	0.30
School	0.75
Conc./Asph. Pavement	0.90

n= 0.013

Phase 1

Future Phase

CONSULTANT : MARSHALL MACKLIN MONAGHAN LTD.

PROJECT NO.: 10-94022

DRAINAGE AREA PLAN NO.: 10-94022-ST1,ST3

DESIGNED BY: WYC DATE REVISED: October 2/02

LICENSED PROFESSIONAL ENGINEER T. M. WIEDOW PROVINCE OF ONTARIO

LOCATION	FROM MH	TO MH	AREA (ha)	ACCUM AREA (ha)	RUNOFF CO-EFFICIENT	AxR	ACCUM. AxR	Tc minutes	INTENSITY (mm/hr)	EXPECTED FLOW (m^3/s)	MH DROP (m)	LENGTH (m)	GRADIENT (%)	NOMINAL PIPE SIZE (mm)	CAPACITY (m^3/s)	FULL VELOCITY (m/s)	TIME OF FLOW (min)	% OF FULL FLOW
Jardine Crescent	101		0.28		0.30	0.08												
		102	0.64	0.92	0.45	0.29	0.372	10.00	88.09	0.091	0.06	62.0	1.00	300	0.101	1.38	0.75	90.24%
[redacted]	102		1.07		0.30	0.32		53.00										
[redacted]		103	0.39	2.38	0.45	0.18	0.87	53.00	31.35	0.076	0.06	58.2	0.50	450	0.210	1.28	0.76	35.96%
	103	104	0.07	2.45	0.45	0.03	0.90	53.76	31.04	0.078	0.075	9.6	0.50	450	0.210	1.28	0.13	36.90%
	104	105	0.00	2.45	0.45	0.00	0.90	53.88	30.99	0.077	0.075	29.7	0.50	450	0.210	1.28	0.39	36.84%
	105	106	0.00	2.45	0.45	0.00	0.90	54.27	30.83	0.077	0.06	11.0	0.50	450	0.210	1.28	0.14	36.65%
	106	107	0.40	2.85	0.45	0.18	1.08	54.41	30.78	0.092	0.075	80.3	0.50	525	0.317	1.42	0.94	29.10%
Redstone St.	107	109	0.00	2.85	0.45	0.00	1.08	55.35	30.41	0.091	0.03	31.0	0.50	525	0.317	1.42	0.36	28.76%
Parkette	DICB	CBMH	0.41	0.85	0.38	0.16	0.16	10.00	88.09	0.038	0.03	47.2	0.40	375	0.116	1.01	0.78	32.96%
	CBMH	108	0.28	1.13	0.45	0.13	0.28	10.78	84.77	0.066	0.03	29.0	0.40	375	0.116	1.01	0.48	57.36%
	108	109	0.03	1.16	0.45	0.01	0.30	11.25	82.86	0.068	0.075	6.7	0.40	375	0.116	1.01	0.11	58.75%
	109	116	0.11	4.12	0.45	0.05	1.42	55.72	30.27	0.120	0.075	11.5	0.50	525	0.317	1.42	0.14	37.76%
Crescent 'C'	110	111	0.27	0.27	0.45	0.12	0.12	10.00	88.09	0.030	0.06	43.6	1.00	300	0.101	1.38	0.53	29.47%
	111	112	0.00	0.27	0.45	0.00	0.12	10.53	85.81	0.029	0.075	12.5	0.50	300	0.071	0.98	0.21	40.60%
	112	115	0.46	0.73	0.45	0.21	0.33	10.74	84.92	0.077	0.075	62.1	0.50	375	0.129	1.13	0.91	59.91%
	114	115	0.00	0.50	0.45	0.27	0.27	10.00	88.09	0.066	0.15	70.5	1.00	300	0.101	1.38	0.85	65.49%
Crescent 'K'	115	116	0.22	1.55	0.45	0.10	0.70	11.66	81.34	0.158	0.15	44.7	0.50	450	0.210	1.28	0.58	74.93%
Quinte Street	116	118	0.29	5.96	0.45	0.13	2.25	55.85	30.22	0.189	0.075	71.5	0.50	600	0.453	1.55	0.77	41.75%
Blue Spruce Avenue	117	118	0.51	0.51	0.45	0.23	0.23	10.00	88.09	0.056	0.375	54.1	1.00	300	0.101	1.38	0.65	55.67%
Quinte Street	118	119	0.17	6.64	0.45	0.08	2.56	56.62	29.93	0.213	0.03	73.8	0.50	675	0.620	1.68	0.73	34.31%
	119	120	0.91	7.55	0.45	0.41	2.97	57.35	29.66	0.245	0.075	110.4	0.50	675	0.620	1.68	1.10	39.44%
	120	123	0.91	8.46	0.45	0.41	3.38	58.45	29.27	0.275	0.06	97.9	0.50	750	0.821	1.80	0.90	33.44%
Scotia Street	122	123	0.55	0.55	0.70	0.39	0.39	10.00	88.09	0.094	0.375	78.9	0.50	375	0.129	1.13	1.16	72.84%
																0.00		

SUBDIVISION: BRONTE WOODS COMMUNITY SUBDIVISION

$I_{5yr} = \frac{697.4}{(tc+5)^{0.764}}$

CITY OF BURLINGTON

STORM SEWER DESIGN SHEET

CONSULTANT : MARSHALL MACKLIN MONAGHAN LTD.

PROJECT NO.: 10-94022

DRAINAGE AREA PLAN NO.: 10-94022-ST1,ST3

DESIGNED BY: WYC DATE REVISED: October 2/02

Phase 1

Future Phase

Runoff Coefficient :			n=	0.013
	Single/Semi Family Residential	0.45		
	Townhouses	0.75		
	Commercial & Industrial	0.85		
	Parks & Open Space	0.30		
	School	0.75		
	Conc./Asph. Pavement	0.90		

LOCATION	FROM MH	TO MH	AREA (ha)	ACCUM AREA (ha)	RUNOFF CO-EFFICIENT	AxR	ACCUM. AxR	Tc minutes	INTENSITY (mm/hr)	EXPECTED FLOW (m^3/s)	MH DROP (m)	LENGTH (m)	GRADIENT (%)	NOMINAL PIPE SIZE (mm)	CAPACITY (m^3/s)	FULL VELOCITY (m/s)	TIME OF FLOW (min)	% OF FULL FLOW
Scotia Street	123	126	0.16	9.17	0.45	0.07	3.83	59.35	28.96	0.308	0.03	67.0	0.50	750	0.821	1.80	0.62	37.56%
Rome Crescent	125	126	0.48	0.48	0.45	0.22	0.22	10.00	88.09	0.053	0.45	41.1	0.50	300	0.071	0.96	0.70	74.10%
Rome Crescent	126	127	0.15	9.80	0.45	0.07	4.12	59.97	28.74	0.329	0.06	89.2	0.50	750	0.821	1.80	0.83	40.04%
	127	133	0.65	10.45	0.45	0.29	4.41	60.80	28.47	0.349	0.075	7.5	0.50	750	0.821	1.80	0.07	42.47%
Rome Crescent	128	129	0.19	0.19	0.45	0.09	0.09	10.00	88.09	0.021	0.03	31.2	1.00	300	0.101	1.38	0.38	20.74%
	129	130	0.36	0.55	0.45	0.16	0.25	10.38	86.45	0.059	0.06	29.5	0.50	300	0.071	0.98	0.50	83.31%
	130	131	0.00	0.55	0.45	0.00	0.25	10.88	84.35	0.058	0.06	13.1	0.50	300	0.071	0.98	0.22	81.29%
	131	132	0.00	0.55	0.45	0.00	0.25	11.10	83.45	0.057	0.03	56.9	0.50	300	0.071	0.98	0.97	80.43%
	132	133	0.00	0.55	0.45	0.00	0.25	12.07	79.80	0.055	0.075	7.5	0.50	300	0.071	0.98	0.13	76.91%
																0.00		
	133	162	0.00	11.00	0.45	0.00	4.66	60.87	28.45	0.368	0.5	10.2	0.50	825	1.059	1.92	0.09	34.76%
					Assumed			Assumed										
North Storm Easement	RLCB	CBMH139	0.05	0.05	0.45	0.02	0.02	10.00	88.09	0.006	0.05	45.8	0.50	250	0.042	0.86	0.88	13.09%
	CBMH139	CBMH140	0.08	0.13	0.45	0.04	0.06	10.88	84.34	0.014	0.03	71.6	0.50	300	0.071	0.98	1.22	19.21%
	CBMH140	141	0.08	0.21	0.45	0.04	0.09	12.10	79.70	0.021	0.525	38.7	1.20	375	0.200	1.76	0.37	10.44%
Orchard Road North	External	141	3.69	3.69	0.75	2.77	2.77											
			3.02	3.02	0.75	2.27	2.27											
			3.89	3.89	0.45	1.75	1.75											
			0.80	0.80	0.75	0.60	0.60											
Orchard Road	141	142	0.62	12.23	0.45	0.28	7.76	15.00	70.71	1.524	0.04	150.0	0.50	975	1.653	2.15	1.17	92.16%
Blue Spruce Avenue	142	146	0.38	12.61	0.45	0.17	7.93	16.17	67.70	1.491	0.02	22.5	0.30	1050	1.560	1.76	0.21	95.64%
Blue Spruce Avenue	143	144	0.60	0.58	0.45	0.26	0.26	10.00	88.09	0.064	0.15	67.2	0.90	300	0.096	1.31	0.85	66.73%
	144	145	0.75	1.33	0.45	0.34	0.60	10.85	84.45	0.140	0.04	94.8	0.40	450	0.188	1.15	1.38	74.63%
	145	146	0.00	1.33	0.45	0.00	0.60	12.23	79.23	0.132	0.225	9.6	0.35	525	0.265	1.19	0.13	49.63%
Off-Orchard Road	146	147	0.00	13.94	0.45	0.00	8.53	16.39	67.18	1.591	0.02	21.5	0.35	1050	1.685	1.89	0.19	94.40%
	147	148	0.00	13.94	0.45	0.00	8.53	16.58	66.73	1.580	0.02	43.6	0.35	1050	1.685	1.89	0.39	93.77%
	148	156	0.00	13.94	0.45	0.00	8.53	16.96	65.84	1.559	0.02	33.6	0.35	1050	1.685	1.89	0.30	92.61%

SUBDIVISION: BRONTE WOODS COMMUNITY SUBDIVISION

$I_{5yr} = \frac{697.4}{(tc+5)^{0.764}}$

CITY OF BURLINGTON

STORM SEWER DESIGN SHEET

CONSULTANT : MARSHALL MACKLIN MONAGHAN LTD.

PROJECT NO.: 10-94022

DRAINAGE AREA PLAN NO.: 10-94022-ST1,ST3

DESIGNED BY: WYC DATE REVISED: October 2/02

Runoff Coefficient :

		n= 0.013
Single/Semi Family Residential	0.45	
Townhouses	0.75	
Commercial & Industrial	0.85	
Parks & Open Space	0.30	
School	0.75	
Conc./Asph. Pavement	0.90	

Phase 1

Future Phase

LOCATION	FROM MH	TO MH	AREA (ha)	ACCUM AREA (ha)	RUNOFF CO-EFFICIENT	AxR	ACCUM. AxR	Tc minutes	INTENSITY (mm/hr)	EXPECTED FLOW (m^3/s)	MH DROP (m)	LENGTH (m)	GRADIENT (%)	NOMINAL PIPE SIZE (mm)	CAPACITY (m^3/s)	FULL VELOCITY (m/s)	TIME OF FLOW (min)	% OF FULL FLOW
Nova Crescent	134	149	0.30	0.30	0.45	0.14	0.14	10.00	88.09	0.033	0.06	31.1	1.50	300	0.124	1.69	0.31	26.74%
	149	150	0.00	0.30	0.45	0.00	0.14	10.31	86.74	0.033	0.06	20.8	0.50	300	0.071	0.98	0.35	45.60%
	150	151	0.00	0.30	0.45	0.00	0.14	10.66	85.24	0.032	0.06	12.9	0.50	300	0.071	0.98	0.22	44.81%
	151	152	0.00	0.30	0.45	0.00	0.14	10.88	84.34	0.032	0.15	31.7	0.50	300	0.071	0.98	0.54	44.34%
	152	153	0.76	1.06	0.45	0.34	0.48	11.42	82.21	0.109	0.03	40.5	0.50	450	0.210	1.28	0.53	51.79%
	153	154	0.24	1.30	0.45	0.11	0.59	11.95	80.25	0.130	0.06	48.2	0.50	450	0.210	1.28	0.63	62.00%
	154	155	0.00	1.30	0.45	0.00	0.59	12.58	78.05	0.127	0.06	13.1	0.50	450	0.210	1.28	0.17	60.31%
	155	156	0.42	1.72	0.45	0.19	0.77	12.75	77.48	0.167	0.9	23.0	0.50	450	0.210	1.28	0.30	79.20%
Nova Crescent	156	157	0.00	15.66	0.45	0.00	9.30	17.26	65.16	1.683	0.02	31.5	0.40	1050	1.802	2.02	0.26	93.43%
	157	159	0.23	15.89	0.45	0.10	9.40	17.52	64.59	1.687	0.02	11.1	0.40	1050	1.802	2.02	0.09	93.63%
Nova Crescent	158	159	0.30	0.30	0.45	0.14	0.14	10.00	88.09	0.033	0.675	54.0	1.00	300	0.101	1.38	0.65	32.75%
Easement	159	160	0.00	15.19	0.45	0.00	9.54	17.61	64.39	1.706	0.02	31.7	0.40	1050	1.802	2.02	0.26	94.68%
2:1	160	161	0.16	16.35	0.45	0.07	9.61	17.87	63.82	1.704	0.02	116.8	0.40	1050	1.802	2.02	0.97	94.56%
	161	162	0.00	16.35	0.45	0.00	9.61	18.84	61.84	1.651	0.02	31.4	0.40	1050	1.802	2.02	0.26	91.62%
Pond 3A	162	Pond Inlet	0.00	27.35	0.45	0.00	14.27	60.96	28.42	1.126		36.5	0.40	1200	2.572	2.20	0.28	43.78%

SUBDIVISION: BRONTE WOODS COMMUNITY SUBDIVISION

$I_{5yr} = \frac{697.4}{(tc+5)^{0.764}}$

CITY OF BURLINGTON

STORM SEWER DESIGN SHEET

CONSULTANT : MARSHALL MACKLIN MONAGHAN LTD.

PROJECT NO.: 10-94022

DRAINAGE AREA PLAN NO.: 10-94022-ST1,ST3

DESIGNED BY: WYC DATE REVISED: October 2/02

Runoff Coefficient :

Single/Semi Family Residential	0.45	n= 0.013
Townhouses	0.75	
Commercial & Industrial	0.85	
Parks & Open Space	0.30	
School	0.75	
Conc./Asph. Pavement	0.90	

Phase 1

Future Phase

LICENSED PROFESSIONAL ENGINEER T. M. WIEDOW PROVINCE OF ONTARIO

LOCATION	FROM MH	TO MH	AREA (ha)	ACCUM AREA (ha)	RUNOFF CO-EFFICIENT	AxR	ACCUM. AxR	Tc minutes	INTENSITY (mm/hr)	EXPECTED FLOW (m^3/s)	MH DROP (m)	LENGTH (m)	GRADIENT (%)	NOMINAL PIPE SIZE (mm)	CAPACITY (m^3/s)	FULL VELOCITY (m/s)	TIME OF FLOW (min)	% OF FULL FLOW
Jardine Crescent	101		0.28		0.30	0.08												
		102	0.64	0.92	0.45	0.29	0.372	10.00	88.09	0.091	0.06	60.0	1.00	300	0.101	1.38	0.72	90.24%
Woodlot contribution	102		0.34		0.30	0.10		10.72										
at Tc = 10min		103	0.39	1.65	0.45	0.18	0.65	10.72	84.98	0.153	0.06	58.2	0.50	450	0.210	1.28	0.76	72.90%
	103	104	0.07	1.72	0.45	0.03	0.68	11.48	81.98	0.155	0.075	9.6	0.50	450	0.210	1.28	0.13	73.74%
	104	105	0.00	1.72	0.45	0.00	0.68	11.61	81.51	0.154	0.075	29.7	0.50	450	0.210	1.28	0.39	73.31%
	105	106	0.00	1.72	0.45	0.00	0.68	11.99	80.09	0.152	0.06	11.0	0.50	450	0.210	1.28	0.14	72.04%
	106	107	0.40	2.12	0.45	0.18	0.86	12.13	79.58	0.190	0.075	80.3	0.50	525	0.317	1.42	0.94	59.99%
Redstone St.	107	109	0.00	2.12	0.45	0.00	0.86	13.08	76.39	0.183	0.03	31.0	0.50	525	0.317	1.42	0.36	57.59%
Parkette	DICB	CBMH	0.41	0.85	0.38	0.16	0.16	10.00	88.09	0.038	0.03	47.2	0.40	375	0.116	1.01	0.78	32.96%
	CBMH	108	0.28	1.13	0.45	0.13	0.28	10.78	84.77	0.066	0.03	29.0	0.40	375	0.116	1.01	0.48	57.36%
	108	109	0.03	1.16	0.45	0.01	0.30	11.25	82.86	0.068	0.075	6.7	0.40	375	0.116	1.01	0.11	58.75%
	109	116	0.11	3.39	0.45	0.05	1.21	13.44	75.23	0.252	0.075	11.5	0.50	525	0.317	1.42	0.14	79.43%
Crescent 'K'	110	111	0.27	0.27	0.45	0.12	0.12	10.00	88.09	0.030	0.06	43.6	1.00	300	0.101	1.38	0.53	29.47%
	111	112	0.00	0.27	0.45	0.00	0.12	10.53	86.81	0.029	0.075	12.8	0.50	300	0.071	0.98	0.21	40.60%
	112	115	0.46	0.73	0.45	0.21	0.33	10.74	84.92	0.077	0.075	62.1	0.50	375	0.129	1.13	0.91	59.91%
	114	115	0.60	0.60	0.45	0.27	0.27	10.00	88.09	0.066	0.15	70.5	1.00	300	0.101	1.38	0.85	65.49%
Crescent 'K'	115	116	0.22	1.55	0.45	0.10	0.70	11.65	81.34	0.158	0.15	44.7	0.50	450	0.210	1.26	0.58	74.93%
Quinte Street	116	118	0.29	5.23	0.45	0.13	2.03	13.58	74.81	0.423	0.075	71.5	0.50	600	0.453	1.55	0.77	93.31%
Blue Spruce Avenue	117	118	0.51	0.51	0.45	0.23	0.23	10.00	88.09	0.056	0.375	54.1	1.00	300	0.101	1.38	0.65	55.67%
Quinte Street	118	119	0.17	5.91	0.45	0.08	2.34	14.35	72.53	0.471	0.03	73.8	0.50	675	0.620	1.68	0.73	76.03%
	119	120	0.91	6.82	0.45	0.41	2.75	15.08	70.50	0.538	0.075	110.4	0.50	675	0.620	1.68	1.10	86.83%
	120	123	0.91	7.73	0.45	0.41	3.16	16.17	67.70	0.594	0.06	97.5	0.50	750	0.821	1.80	0.90	72.33%
Scotia Street	122	123	0.55	0.55	0.70	0.39	0.39	10.00	88.09	0.094	0.375	78.0	0.50	375	0.129	1.13	1.16	72.84%
																0.00		

SUBDIVISION: BRONTE WOODS COMMUNITY SUBDIVISION

$I_{5yr} = \frac{697.4}{(tc+5)^{0.764}}$

CITY OF BURLINGTON

CONSULTANT : MARSHALL MACKLIN MONAGHAN LTD.

STORM SEWER DESIGN SHEET

PROJECT NO.: 10-94022

DRAINAGE AREA PLAN NO.: 10-94022-ST1,ST3

DESIGNED BY: WYC DATE REVISED: October 2/02

Runoff Coefficient :

Single/Semi Family Residential	0.45	n= 0.013
Townhouses	0.75	
Commercial & Industrial	0.85	
Parks & Open Space	0.30	
School	0.75	
Conc./Asph. Pavement	0.90	

Phase 1

Future Phase

LOCATION	FROM MH	TO MH	AREA (ha)	ACCUM AREA (ha)	RUNOFF CO-EFFICIENT	AxR	ACCUM. AxR	Tc minutes	INTENSITY (mm/hr)	EXPECTED FLOW (m^3/s)	MH DROP (m)	LENGTH (m)	GRADIENT (%)	NOMINAL PIPE SIZE (mm)	CAPACITY (m^3/s)	FULL VELOCITY (m/s)	TIME OF FLOW (min)	% OF FULL FLOW
Scotia Street	123	126	0.16	8.44	0.45	0.07	3.62	17.08	65.57	0.658	0.03	67.0	0.50	750	0.821	1.80	0.62	80.20%
Rome Crescent	125	126	0.48	0.48	0.45	0.22	0.22	10.00	88.09	0.053	0.45	41.1	0.50	300	0.071	0.98	0.70	74.10%
Rome Crescent	126	127	0.15	9.07	0.45	0.07	3.90	17.70	64.20	0.695	0.06	89.2	0.50	750	0.821	1.80	0.83	84.67%
	127	133	0.65	9.72	0.45	0.29	4.19	18.52	62.47	0.727	0.075	7.5	0.50	750	0.821	1.80	0.07	88.58%
Rome Crescent	128	129	0.19	0.19	0.45	0.09	0.09	10.00	88.09	0.021	0.03	31.2	1.00	300	0.101	1.38	0.38	20.74%
	129	130	0.36	0.55	0.45	0.16	0.25	10.38	86.45	0.059	0.06	29.5	0.50	300	0.071	0.98	0.50	83.31%
	130	131	0.00	0.55	0.45	0.00	0.25	10.88	84.35	0.058	0.06	13.1	0.50	300	0.071	0.98	0.22	81.29%
	131	132	0.00	0.55	0.45	0.00	0.25	11.10	83.45	0.057	0.03	56.9	0.50	300	0.071	0.98	0.97	80.43%
	132	133	0.00	0.55	0.45	0.00	0.25	12.07	79.80	0.055	0.525	7.5	0.50	300	0.071	0.98	0.13	76.91%
																0.00		
	133	162	0.00	10.27	0.45	0.00	4.44	18.59	62.33	0.769	0.6	10.2	0.50	825	1.059	1.92	0.09	72.69%
					Assumed			Assumed										
North Storm Easement	RLCB	CBMH139	0.05	0.05	0.45	0.02	0.02	10.00	88.09	0.006	0.05	45.3	0.50	250	0.042	0.86	0.88	13.09%
	CBMH139	CBMH140	0.08	0.13	0.45	0.04	0.06	10.88	84.34	0.014	0.03	71.0	0.50	300	0.071	0.98	1.22	19.21%
	CBMH140	141	0.08	0.21	0.45	0.04	0.09	12.10	79.70	0.021	0.525	38.7	1.20	375	0.200	1.76	0.37	10.44%
Orchard Road North	External	141	3.69	3.69	0.75	2.77	2.77											
			3.02	3.02	0.75	2.27	2.27											
			3.89	3.89	0.45	1.75	1.75											
			0.80	0.80	0.75	0.60	0.60											
Orchard Road	141	142	0.62	12.23	0.45	0.28	7.76	15.00	70.71	1.524	0.04	150.9	0.50	975	1.653	2.15	1.17	92.16%
Blue Spruce Avenue	142	146	0.38	12.61	0.45	0.17	7.93	16.17	67.70	1.491	0.02	22.5	0.30	1050	1.560	1.76	0.21	95.54%
Blue Spruce Avenue	143	144	0.58	0.58	0.45	0.26	0.26	10.00	88.09	0.064	0.15	67.2	0.90	300	0.096	1.31	0.85	66.73%
	144	145	0.75	1.33	0.45	0.34	0.60	10.85	84.45	0.140	0.04	94.8	0.40	450	0.188	1.15	1.38	74.63%
	145	146	0.00	1.33	0.45	0.00	0.60	12.23	79.23	0.132	0.225	9.6	0.35	525	0.265	1.19	0.13	49.63%
Off-Orchard Road	146	147	0.00	13.94	0.45	0.00	8.53	16.39	67.18	1.591	0.02	21.3	0.35	1050	1.685	1.89	0.19	94.40%
	147	148	0.00	13.94	0.45	0.00	8.53	16.58	66.73	1.580	0.02	43.6	0.35	1050	1.685	1.89	0.38	93.77%
	148	156	0.00	13.94	0.45	0.00	8.53	16.96	65.84	1.559	0.02	33.6	0.35	1050	1.685	1.89	0.30	92.61%

SUBDIVISION: BRONTE WOODS COMMUNITY SUBDIVISION

$I_{5yr} = \frac{697.4}{(tc+5)^{0.764}}$

CITY OF BURLINGTON

STORM SEWER DESIGN SHEET

CONSULTANT : MARSHALL MACKLIN MONAGHAN LTD.

PROJECT NO.: 10-94022

DRAINAGE AREA PLAN NO.: 10-94022-ST1,ST3

DESIGNED BY: WYC DATE REVISED: October 2/02

Runoff Coefficient :

		n=
Single/Semi Family Residential	0.45	0.013
Townhouses	0.75	
Commercial & Industrial	0.85	
Parks & Open Space	0.30	
School	0.75	
Conc./Asph. Pavement	0.90	

Phase 1

Future Phase

LOCATION	FROM MH	TO MH	AREA (ha)	ACCUM AREA (ha)	RUNOFF CO-EFFICIENT	AxR	ACCUM. AxR	Tc minutes	INTENSITY (mm/hr)	EXPECTED FLOW (m^3/s)	MH DROP (m)	LENGTH (m)	GRADIENT (%)	NOMINAL PIPE SIZE (mm)	CAPACITY (m^3/s)	FULL VELOCITY (m/s)	TIME OF FLOW (min)	% OF FULL FLOW
Nova Crescent	134	149	0.30	0.30	0.45	0.14	0.14	10.00	88.09	0.033	0.06	31.1	1.50	300	0.124	1.69	0.31	26.74%
	149	150	0.00	0.30	0.45	0.00	0.14	10.31	86.74	0.033	0.06	20.8	0.50	300	0.071	0.98	0.35	46.60%
	150	151	0.00	0.30	0.45	0.00	0.14	10.66	85.24	0.032	0.06	12.9	0.50	300	0.071	0.98	0.22	44.81%
	151	152	0.00	0.30	0.45	0.00	0.14	10.88	84.34	0.032	0.15	31.7	0.50	300	0.071	0.98	0.54	44.34%
	152	153	0.76	1.06	0.45	0.34	0.48	11.42	82.21	0.109	0.03	40.5	0.50	450	0.210	1.28	0.53	51.79%
	153	154	0.24	1.30	0.45	0.11	0.59	11.95	80.25	0.130	0.06	48.2	0.50	450	0.210	1.28	0.63	62.00%
	154	155	0.00	1.30	0.45	0.00	0.59	12.58	78.05	0.127	0.06	13.1	0.50	450	0.210	1.28	0.17	60.31%
	155	156	0.42	1.72	0.45	0.19	0.77	12.75	77.48	0.167	0.8	23.0	0.50	450	0.210	1.28	0.30	79.20%
Nova Crescent	156	157	0.00	15.66	0.45	0.00	9.30	17.26	65.16	1.683	0.02	31.5	0.40	1050	1.802	2.02	0.26	93.43%
	157	159	0.23	15.89	0.45	0.10	9.40	17.52	64.59	1.687	0.02	11.1	0.40	1050	1.802	2.02	0.09	93.63%
Nova Crescent	158	159	0.30	0.30	0.45	0.14	0.14	10.00	88.09	0.033	0.675	54.0	1.00	300	0.101	1.38	0.65	32.75%
Easement	159	160	0.00	16.19	0.45	0.00	9.54	17.61	64.39	1.706	0.02	31.7	0.40	1050	1.802	2.02	0.26	94.66%
2:1	160	161	0.16	16.35	0.45	0.07	9.61	17.87	63.82	1.704	0.02	116.8	0.40	1050	1.802	2.02	0.97	94.56%
	161	162	0.00	16.35	0.45	0.00	9.61	18.84	61.84	1.651	0.02	31.4	0.40	1050	1.802	2.02	0.26	91.62%
Pond 3A	162	Pond Inlet	0.00	26.62	0.45	0.00	14.05	19.10	61.33	2.393		36.5	0.40	1200	2.572	2.20	0.28	93.04%

SUBDIVISION: BRONTE WOODS COMMUNITY SUBDIVISION

$I_{5yr} = \frac{697.4}{(tc+5)^{0.764}}$

CITY OF BURLINGTON

STORM SEWER DESIGN SHEET

CONSULTANT : MARSHALL MACKLIN MONAGHAN LTD.

PROJECT NO.: 10-94022

DRAINAGE AREA PLAN NO.: 10-94022-ST1,ST3

DESIGNED BY: WYC DATE REVISED: October 2/02

LICENSED PROFESSIONAL ENGINEER T. M. WIEDOW PROVINCE OF ONTARIO

Runoff Coefficient :

		n=
Single/Semi Family Residential	0.45	0.013
Townhouses	0.75	
Commercial & Industrial	0.85	
Parks & Open Space	0.30	
School	0.75	
Conc./Asph. Pavement	0.90	

Phase 1

Future Phase

LOCATION	FROM MH	TO MH	AREA (ha)	ACCUM AREA (ha)	RUNOFF CO-EFFICIENT	AxR	ACCUM. AxR	Tc minutes	INTENSITY (mm/hr)	EXPECTED FLOW (m^3/s)	MH DROP (m)	LENGTH (m)	GRADIENT (%)	NOMINAL PIPE SIZE (mm)	CAPACITY (m^3/s)	FULL VELOCITY (m/s)	TIME OF FLOW (min)	% OF FULL FLOW
Jardine Crescent	101		0.28		0.30	0.08												
		102	0.64	0.92	0.45	0.29	0.372	10.00	88.09	0.091	0.06	62.0	1.00	300	0.101	1.38	0.75	90.24%
Full Woodlot contribution and Waldorf	102		1.31		0.30	0.39		49.00										
		103	0.39	2.62	0.45	0.18	0.94	49.00	33.11	0.086	0.06	58.2	0.50	450	0.210	1.28	0.76	41.13%
	103	104	0.07	2.69	0.45	0.03	0.97	49.76	32.76	0.088	0.075	9.6	0.50	450	0.210	1.28	0.13	42.05%
	104	105	0.00	2.69	0.45	0.00	0.97	49.88	32.70	0.088	0.075	29.7	0.50	450	0.210	1.28	0.39	41.98%
	105	106	0.00	2.69	0.45	0.00	0.97	50.27	32.53	0.088	0.06	11.0	0.50	450	0.210	1.28	0.14	41.76%
	106	107	0.40	3.09	0.45	0.18	1.15	50.41	32.46	0.104	0.075	80.3	0.50	525	0.317	1.42	0.94	32.74%
Redstone St.	107	109	0.00	3.09	0.45	0.00	1.15	51.35	32.05	0.103	0.03	31.0	0.50	525	0.317	1.42	0.36	32.32%
Parkette	DICB	CBMH	0.41	0.85	0.38	0.16	0.16	10.00	88.09	0.038	0.03	47.2	0.40	375	0.116	1.01	0.78	32.96%
	CBMH	108	0.28	1.13	0.45	0.13	0.28	10.78	84.77	0.066	0.03	29.0	0.40	375	0.116	1.01	0.48	57.36%
	108	109	0.03	1.16	0.45	0.01	0.30	11.25	82.86	0.068	0.075	6.7	0.40	375	0.116	1.01	0.11	58.75%
	109	116	0.11	4.36	0.45	0.05	1.50	51.72	31.89	0.133	0.075	11.5	0.50	525	0.317	1.42	0.14	41.79%
Crescent 'K'	110	111	0.27	0.27	0.45	0.12	0.12	10.00	88.09	0.030	0.06	43.6	1.00	300	0.101	1.38	0.53	29.47%
	111	112	0.00	0.27	0.45	0.00	0.12	10.53	85.81	0.029	0.075	12.5	0.50	300	0.071	0.98	0.21	40.60%
	112	115	0.46	0.73	0.45	0.21	0.33	10.74	84.92	0.077	0.075	62.1	0.50	375	0.129	1.13	0.91	59.91%
	114	115	0.60	0.60	0.45	0.27	0.27	10.00	88.09	0.066	0.15	70.5	1.00	300	0.101	1.38	0.85	65.49%
Crescent 'K'	115	116	0.22	1.55	0.45	0.10	0.70	11.65	81.34	0.158	0.15	44.7	0.50	450	0.210	1.28	0.58	74.93%
Quinte Street	116	118	0.29	6.20	0.45	0.13	2.32	51.85	31.83	0.206	0.075	71.5	0.50	600	0.453	1.55	0.77	45.38%
Blue Spruce Avenue	117	118	0.51	0.51	0.45	0.23	0.23	10.00	88.09	0.056	0.375	54.1	1.00	300	0.101	1.38	0.65	55.67%
Quinte Street	118	119	0.17	6.88	0.45	0.08	2.63	52.62	31.51	0.230	0.03	73.8	0.50	675	0.620	1.68	0.73	37.13%
	119	120	0.91	7.79	0.45	0.41	3.04	53.35	31.20	0.264	0.075	110.4	0.50	675	0.620	1.68	1.10	42.50%
	120	123	0.01	8.70	0.45	0.41	3.45	54.45	30.76	0.295	0.06	97.5	0.50	750	0.821	1.80	0.90	35.90%
Scotia Street	122	123	0.55	0.55	0.70	0.39	0.39	10.00	88.09	0.094	0.375	78.9	0.50	375	0.129	1.13	1.16	72.84%
																	0.00	

SUBDIVISION: BRONTE WOODS COMMUNITY SUBDIVISION

$I_{5yr} = \frac{697.4}{(tc+5)^{0.764}}$

CITY OF BURLINGTON

STORM SEWER DESIGN SHEET

CONSULTANT : MARSHALL MACKLIN MONAGHAN LTD.

PROJECT NO.: 10-94022

DRAINAGE AREA PLAN NO.: 10-94022-ST1,ST3

DESIGNED BY: WYC DATE REVISED: October 2/02

Runoff Coefficient :

Single/Semi Family Residential	0.45	n= 0.013
Townhouses	0.75	
Commercial & Industrial	0.85	
Parks & Open Space	0.30	
School	0.75	
Conc./Asph. Pavement	0.90	

Phase 1

Future Phase

LOCATION	FROM MH	TO MH	AREA (ha)	ACCUM AREA (ha)	RUNOFF CO-EFFICIENT	AxR	ACCUM. AxR	Tc minutes	INTENSITY (mm/hr)	EXPECTED FLOW (m^3/s)	MH DROP (m)	LENGTH (m)	GRADIENT (%)	NOMINAL PIPE SIZE (mm)	CAPACITY (m^3/s)	FULL VELOCITY (m/s)	TIME OF FLOW (min)	% OF FULL FLOW
Scotia Street	123	126	0.16	9.41	0.45	0.07	3.91	55.35	30.41	0.330	0.03	67.0	0.50	750	0.821	1.80	0.62	40.19%
Rome Crescent	125	126	0.48	0.48	0.45	0.22	0.22	10.00	88.09	0.053	0.45	41.1	0.50	300	0.071	0.98	0.70	74.10%
Rome Crescent	126	127	0.15	10.04	0.45	0.07	4.19	55.97	30.17	0.351	0.06	89.2	0.50	750	0.821	1.80	0.83	42.77%
	127	133	0.65	10.69	0.45	0.29	4.48	56.80	29.87	0.372	0.075	7.5	0.50	750	0.821	1.80	0.07	45.28%
Rome Crescent	128	129	0.19	0.19	0.45	0.09	0.09	10.00	88.09	0.021	0.03	31.2	1.00	300	0.101	1.38	0.38	20.74%
	129	130	0.36	0.55	0.45	0.16	0.25	10.38	86.45	0.059	0.06	29.5	0.50	300	0.071	0.98	0.50	83.31%
	130	131	0.00	0.55	0.45	0.00	0.25	10.88	84.35	0.058	0.06	13.1	0.50	300	0.071	0.98	0.22	81.29%
	131	132	0.00	0.55	0.45	0.00	0.25	11.10	83.45	0.057	0.03	56.9	0.50	300	0.071	0.98	0.97	80.43%
	132	133	0.00	0.55	0.45	0.00	0.25	12.07	79.80	0.055	0.525	7.5	0.50	300	0.071	0.98	0.13	76.91%
																	0.00	
	133	162	0.00	11.24	0.45	0.00	4.73	56.87	29.84	0.392	0.5	10.2	0.50	825	1.059	1.92	0.09	37.03%
					Assumed			Assumed										
North Storm Easement	RLCB	CBMH139	0.05	0.05	0.45	0.02	0.02	10.00	88.09	0.006	0.05	45.3	0.50	250	0.042	0.86	0.88	13.09%
	CBMH139	CBMH140	0.09	0.13	0.45	0.04	0.06	10.88	84.34	0.014	0.03	71.6	0.50	300	0.071	0.98	1.22	19.21%
	CBMH140	141	0.08	0.21	0.45	0.04	0.09	12.10	79.70	0.021	0.525	38.7	1.20	375	0.200	1.76	0.37	10.44%
Orchard Road North	External	141	3.69	3.69	0.75	2.77	2.77											
			3.02	3.02	0.75	2.27	2.27											
			3.89	3.89	0.45	1.75	1.75											
			0.80	0.80	0.75	0.60	0.60											
Orchard Road	141	142	0.62	12.23	0.45	0.28	7.76	15.00	70.71	1.524	0.04	150.9	0.50	975	1.653	2.15	1.17	92.16%
Blue Spruce Avenue	142	146	0.38	12.61	0.45	0.17	7.93	16.17	67.70	1.491	0.02	22.5	0.30	1050	1.560	1.76	0.21	95.54%
Blue Spruce Avenue	143	144	0.58	0.58	0.45	0.26	0.26	10.00	88.09	0.064	0.15	67.2	0.90	300	0.096	1.31	0.86	66.73%
	144	145	0.75	1.33	0.45	0.34	0.60	10.85	84.45	0.140	0.04	94.8	0.40	450	0.188	1.15	1.38	74.63%
	145	146	0.00	1.33	0.45	0.00	0.60	12.23	79.23	0.132	0.225	9.6	0.35	525	0.265	1.19	0.13	49.63%
Off-Orchard Road	146	147	0.00	13.94	0.45	0.00	8.53	16.39	67.18	1.591	0.02	21.3	0.35	1050	1.685	1.89	0.19	94.40%
	147	148	0.00	13.94	0.45	0.00	8.53	16.58	66.73	1.580	0.02	43.6	0.35	1050	1.685	1.89	0.39	93.77%
	148	156	0.00	13.94	0.45	0.00	8.53	16.96	65.84	1.559	0.02	33.6	0.35	1050	1.685	1.89	0.30	92.51%

SUBDIVISION: BRONTE WOODS COMMUNITY SUBDIVISION

$I_{5yr} = \frac{697.4}{(tc+5)^{0.764}}$

CITY OF BURLINGTON

STORM SEWER DESIGN SHEET

CONSULTANT : MARSHALL MACKLIN MONAGHAN LTD.

PROJECT NO.: 10-94022

DRAINAGE AREA PLAN NO.: 10-94022-ST1,ST3

DESIGNED BY: WYC DATE REVISED: October 2/02

Runoff Coefficient :

		n= 0.013
Single/Semi Family Residential	0.45	
Townhouses	0.75	
Commercial & Industrial	0.85	
Parks & Open Space	0.30	
School	0.75	
Conc./Asph. Pavement	0.90	

Phase 1

Future Phase

LOCATION	FROM MH	TO MH	AREA (ha)	ACCUM AREA (ha)	RUNOFF CO-EFFICIENT	AxR	ACCUM. AxR	Tc minutes	INTENSITY (mm/hr)	EXPECTED FLOW (m^3/s)	MH DROP (m)	LENGTH (m)	GRADIENT (%)	NOMINAL PIPE SIZE (mm)	CAPACITY (m^3/s)	FULL VELOCITY (m/s)	TIME OF FLOW (min)	% OF FULL FLOW
Nova Crescent	134	149	0.30	0.30	0.45	0.14	0.14	10.00	88.09	0.033	0.06	31.1	1.50	300	0.124	1.69	0.31	26.74%
	149	150	0.00	0.30	0.45	0.00	0.14	10.31	86.74	0.033	0.05	20.8	0.50	300	0.071	0.98	0.35	45.60%
	150	151	0.00	0.30	0.45	0.00	0.14	10.66	85.24	0.032	0.06	12.9	0.50	300	0.071	0.98	0.22	44.81%
	151	152	0.00	0.30	0.45	0.00	0.14	10.88	84.34	0.032	0.15	31.7	0.50	300	0.071	0.98	0.54	44.34%
	152	153	0.76	1.06	0.45	0.34	0.48	11.42	82.21	0.109	0.03	40.5	0.50	450	0.210	1.28	0.53	51.79%
	153	154	0.24	1.30	0.45	0.11	0.59	11.95	80.25	0.130	0.06	48.2	0.50	450	0.210	1.28	0.63	62.00%
	154	155	0.00	1.30	0.45	0.00	0.59	12.58	78.05	0.127	0.06	13.1	0.50	450	0.210	1.28	0.17	60.31%
	155	156	0.42	1.72	0.45	0.19	0.77	12.75	77.46	0.167	0.6	23.0	0.50	450	0.210	1.28	0.30	79.20%
Nova Crescent	156	157	0.00	15.66	0.45	0.00	9.30	17.26	65.16	1.683	0.02	31.5	0.40	1050	1.802	2.02	0.26	93.43%
	157	159	0.23	15.89	0.45	0.10	9.40	17.52	64.59	1.687	0.02	11.1	0.40	1050	1.802	2.02	0.09	93.63%
Nova Crescent	158	159	0.30	0.30	0.45	0.14	0.14	10.00	88.09	0.033	0.675	54.0	1.00	300	0.101	1.38	0.65	32.75%
Easement	159	160	0.00	16.19	0.45	0.00	9.54	17.61	64.39	1.706	0.02	31.7	0.40	1050	1.802	2.02	0.26	94.68%
2:1	160	161	0.16	16.35	0.45	0.07	9.61	17.87	63.82	1.704	0.02	116.6	0.40	1050	1.802	2.02	0.97	94.56%
	161	162	0.00	16.35	0.45	0.00	9.61	18.84	61.84	1.651	0.02	31.4	0.40	1050	1.802	2.02	0.26	91.62%
Pond 3A	162	Pond Inlet	0.00	27.59	0.45	0.00	14.34	56.96	29.81	1.187		36.5	0.40	1200	2.572	2.20	0.28	46.18%

APPENDIX C

Townhouse Component Pre-Development Visual OTTHYMO Model Output
Townhouse Component Post-Development Visual OTTHYMO Model Output
Forterra System Design Sheet

Townhouse Component Pre-Development Visual OTTHYMO Model Output

```
================================================================================================================

       V    V   I    SSSSS  U   U    A    L
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO

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                  *****  D E T A I L E D   O U T P U T *****


  Input   filename: C:\Program Files (x86)\Visual OTTHYMO 2.3.3\voin.dat
  Output  filename: P:\2017\17213\Visual OTTHYMO\Rev0\17213 V02\Pre-Dev.out
  Summary filename: P:\2017\17213\Visual OTTHYMO\Rev0\17213 V02\Pre-Dev.sum


DATE: 10/4/2017                           TIME: 4:00:37 PM

USER:


COMMENTS: _____________________________________________________

----------------------------------------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   1 **
  ****************************

--------------------
| CHICAGO STORM    |    IDF curve parameters: A= 697.400
| Ptotal= 41.69 mm |                          B=   5.000
--------------------                          C=    .764
                       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
                 .17    2.98 |  1.17   21.37 |  2.17    6.78 |  3.17    3.52
                 .33    3.40 |  1.33   88.09 |  2.33    5.81 |  3.33    3.28
                 .50    3.97 |  1.50   27.73 |  2.50    5.11 |  3.50    3.08
                 .67    4.84 |  1.67   15.03 |  2.67    4.57 |  3.67    2.90
                 .83    6.29 |  1.83   10.53 |  2.83    4.15 |  3.83    2.74
                1.00    9.36 |  2.00    8.21 |  3.00    3.81 |  4.00    2.60


--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0002) |   Area    (ha)=    .10
|ID= 1 DT= 5.0 min |   Total Imp(%)=  36.00   Dir. Conn.(%)=  36.00
--------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .03          .06
     Dep. Storage     (mm)=       1.00         1.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      25.30        40.00
     Mannings n             =       .013         .250

         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    2.98 | 1.083   21.37 | 2.083    6.78 |  3.08    3.52
                .167    2.98 | 1.167   21.37 | 2.167    6.78 |  3.17    3.52
                .250    3.40 | 1.250   88.09 | 2.250    5.81 |  3.25    3.28
                .333    3.40 | 1.333   88.09 | 2.333    5.81 |  3.33    3.28
                .417    3.97 | 1.417   27.73 | 2.417    5.11 |  3.42    3.08
                .500    3.97 | 1.500   27.73 | 2.500    5.11 |  3.50    3.08
                .583    4.84 | 1.583   15.03 | 2.583    4.57 |  3.58    2.90
                .667    4.84 | 1.667   15.03 | 2.667    4.57 |  3.67    2.90
                .750    6.29 | 1.750   10.53 | 2.750    4.15 |  3.75    2.74
                .833    6.29 | 1.833   10.53 | 2.833    4.15 |  3.83    2.74
                .917    9.36 | 1.917    8.21 | 2.917    3.81 |  3.92    2.60
               1.000    9.36 | 2.000    8.21 | 3.000    3.81 |  4.00    2.60

     Max.Eff.Inten.(mm/hr)=      88.09        24.33
               over (min)        5.00        15.00
     Storage Coeff.  (min)=       1.18 (ii)   13.60 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=        .33          .08
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .01          .00           .010 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.50          1.33
     RUNOFF VOLUME    (mm)=      40.69        15.89         24.75
     TOTAL RAINFALL   (mm)=      41.69        41.69         41.69
     RUNOFF COEFFICIENT   =        .98          .38           .59

***** 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  (0001) |   Area    (ha)=    .29
|ID= 1 DT= 5.0 min |   Total Imp(%)=  36.00   Dir. Conn.(%)=  36.00
--------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .10          .18
     Dep. Storage     (mm)=       1.00         1.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      43.70        40.00
     Mannings n           =       .013         .250

     Max.Eff.Inten.(mm/hr)=      88.09        24.33
               over (min)        5.00        15.00
     Storage Coeff.  (min)=       1.64 (ii)   14.06 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=        .32          .08
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .03          .01           .029 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.50          1.33
     RUNOFF VOLUME    (mm)=      40.69        15.89         24.79
     TOTAL RAINFALL   (mm)=      41.69        41.69         41.69
     RUNOFF COEFFICIENT   =        .98          .38           .59

***** 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.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (0003) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0002):      .10    .010     1.33    24.75
        + ID2= 2 (0001):      .29    .029     1.33    24.79
          ================================================
          ID = 3 (0003):      .38    .039     1.33    24.78

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
  ***************************
```

```
  ** SIMULATION NUMBER:   2 **
  ****************************

--------------------
| CHICAGO STORM    |    IDF curve parameters: A=1114.200
| Ptotal= 67.72 mm |                          B=   5.000
--------------------                          C=    .761
                       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
                 .17    4.90 |  1.17   34.69 |  2.17   11.09 |  3.17    5.78
                 .33    5.58 |  1.33  141.89 |  2.33    9.51 |  3.33    5.39
                 .50    6.52 |  1.50   44.96 |  2.50    8.37 |  3.50    5.05
                 .67    7.92 |  1.67   24.46 |  2.67    7.49 |  3.67    4.76
                 .83   10.29 |  1.83   17.17 |  2.83    6.80 |  3.83    4.50
                1.00   15.27 |  2.00   13.40 |  3.00    6.24 |  4.00    4.28


--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0002) |   Area    (ha)=    .10
|ID= 1 DT= 5.0 min |   Total Imp(%)=  36.00   Dir. Conn.(%)=  36.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .03          .06
     Dep. Storage     (mm)=       1.00         1.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      25.30        40.00
     Mannings n           =       .013         .250

         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    4.90 | 1.083   34.69 | 2.083   11.09 |  3.08    5.78
                .167    4.90 | 1.167   34.69 | 2.167   11.09 |  3.17    5.78
                .250    5.58 | 1.250  141.89 | 2.250    9.51 |  3.25    5.39
                .333    5.58 | 1.333  141.89 | 2.333    9.51 |  3.33    5.39
                .417    6.52 | 1.417   44.96 | 2.417    8.37 |  3.42    5.05
                .500    6.52 | 1.500   44.96 | 2.500    8.37 |  3.50    5.05
                .583    7.92 | 1.583   24.46 | 2.583    7.49 |  3.58    4.76
                .667    7.92 | 1.667   24.46 | 2.667    7.49 |  3.67    4.76
                .750   10.29 | 1.750   17.17 | 2.750    6.80 |  3.75    4.50
                .833   10.29 | 1.833   17.17 | 2.833    6.80 |  3.83    4.50
                .917   15.27 | 1.917   13.40 | 2.917    6.24 |  3.92    4.28
               1.000   15.27 | 2.000   13.40 | 3.000    6.24 |  4.00    4.28

     Max.Eff.Inten.(mm/hr)=     141.89        67.55
               over (min)          5.00        10.00
     Storage Coeff.  (min)=         .97 (ii)    9.23 (ii)
     Unit Hyd. Tpeak (min)=        5.00        10.00
     Unit Hyd. peak  (cms)=         .34          .12
                                                      *TOTALS*
     PEAK FLOW       (cms)=         .01          .01          .020 (iii)
     TIME TO PEAK    (hrs)=        1.33         1.42         1.33
     RUNOFF VOLUME    (mm)=       66.72        34.18        45.83
     TOTAL RAINFALL   (mm)=       67.72        67.72        67.72
     RUNOFF COEFFICIENT   =         .99          .50          .68

***** 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  (0001) |   Area    (ha)=    .29
|ID= 1 DT= 5.0 min |   Total Imp(%)=  36.00   Dir. Conn.(%)=  36.00
--------------------
```

```
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .10          .18
     Dep. Storage     (mm)=       1.00         1.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      43.70        40.00
     Mannings n           =       .013         .250

     Max.Eff.Inten.(mm/hr)=     141.89        67.55
               over (min)         5.00        10.00
     Storage Coeff.  (min)=       1.35 (ii)    9.61 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=        .33          .11
                                                        *TOTALS*
     PEAK FLOW       (cms)=        .04          .02          .059 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.42          1.33
     RUNOFF VOLUME    (mm)=      66.72        34.18         45.88
     TOTAL RAINFALL   (mm)=      67.72        67.72         67.72
     RUNOFF COEFFICIENT   =        .99          .50           .68

***** 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.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (0003) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)      (mm)
          ID1= 1 (0002):      .10    .020     1.33    45.83
        + ID2= 2 (0001):      .29    .059     1.33    45.88
          ================================================
          ID = 3 (0003):      .38    .079     1.33    45.87

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------

 FINISH
================================================================================================================================
```

Townhouse Component Pre-Development Visual OTTHYMO Model Output

```
================================================================================================================

       V    V   I    SSSSS  U   U    A    L
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO

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                  *****  D E T A I L E D   O U T P U T *****


  Input   filename: C:\Program Files (x86)\Visual OTTHYMO 2.3.3\voin.dat
  Output  filename: P:\2017\17213\Visual OTTHYMO\Rev0\17213 V02\Post-Dev.out
  Summary filename: P:\2017\17213\Visual OTTHYMO\Rev0\17213 V02\Post-Dev.sum


DATE: 10/4/2017                           TIME: 4:01:15 PM

USER:


COMMENTS: _____________________________________________________


----------------------------------------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   1 **
  ****************************

--------------------
| CHICAGO STORM    |    IDF curve parameters: A= 697.400
| Ptotal= 41.69 mm |                          B=   5.000
--------------------                          C=    .764
                       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
                 .17    2.98 |  1.17   21.37 |  2.17    6.78 |  3.17    3.52
                 .33    3.40 |  1.33   88.09 |  2.33    5.81 |  3.33    3.28
                 .50    3.97 |  1.50   27.73 |  2.50    5.11 |  3.50    3.08
                 .67    4.84 |  1.67   15.03 |  2.67    4.57 |  3.67    2.90
                 .83    6.29 |  1.83   10.53 |  2.83    4.15 |  3.83    2.74
                1.00    9.36 |  2.00    8.21 |  3.00    3.81 |  4.00    2.60


--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0006) |   Area    (ha)=    .04
|ID= 1 DT= 5.0 min |   Total Imp(%)=  79.00   Dir. Conn.(%)=  79.00
--------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .03          .01
     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.


                          ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
```

```
                .083    2.98 | 1.083   21.37 | 2.083    6.78 |  3.08    3.52
                .167    2.98 | 1.167   21.37 | 2.167    6.78 |  3.17    3.52
                .250    3.40 | 1.250   88.09 | 2.250    5.81 |  3.25    3.28
                .333    3.40 | 1.333   88.09 | 2.333    5.81 |  3.33    3.28
                .417    3.97 | 1.417   27.73 | 2.417    5.11 |  3.42    3.08
                .500    3.97 | 1.500   27.73 | 2.500    5.11 |  3.50    3.08
                .583    4.84 | 1.583   15.03 | 2.583    4.57 |  3.58    2.90
                .667    4.84 | 1.667   15.03 | 2.667    4.57 |  3.67    2.90
                .750    6.29 | 1.750   10.53 | 2.750    4.15 |  3.75    2.74
                .833    6.29 | 1.833   10.53 | 2.833    4.15 |  3.83    2.74
                .917    9.36 | 1.917    8.21 | 2.917    3.81 |  3.92    2.60
               1.000    9.36 | 2.000    8.21 | 3.000    3.81 |  4.00    2.60

     Max.Eff.Inten.(mm/hr)=      88.09       102.93
               over (min)        5.00        10.00
     Storage Coeff.  (min)=       .91 (ii)    5.28 (ii)
     Unit Hyd. Tpeak (min)=      5.00        10.00
     Unit Hyd. peak  (cms)=       .34          .16
                                                        *TOTALS*
     PEAK FLOW       (cms)=       .01          .00          .008 (iii)
     TIME TO PEAK    (hrs)=      1.33         1.42         1.33
     RUNOFF VOLUME    (mm)=     40.69        15.89        35.45
     TOTAL RAINFALL   (mm)=     41.69        41.69        41.69
     RUNOFF COEFFICIENT   =       .98          .38          .85

***** 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) |   Area    (ha)=    .10
|ID= 1 DT= 5.0 min |   Total Imp(%)=  36.00   Dir. Conn.(%)=  36.00
--------------------
                           IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       .03          .06
     Dep. Storage     (mm)=      1.00         1.00
     Average Slope     (%)=      1.00         2.00
     Length            (m)=     25.30        40.00
     Mannings n           =      .013         .250

     Max.Eff.Inten.(mm/hr)=      88.09        24.33
               over (min)        5.00        15.00
     Storage Coeff.  (min)=      1.18 (ii)   13.60 (ii)
     Unit Hyd. Tpeak (min)=      5.00        15.00
     Unit Hyd. peak  (cms)=       .33          .08
                                                        *TOTALS*
     PEAK FLOW       (cms)=       .01          .00          .010 (iii)
     TIME TO PEAK    (hrs)=      1.33         1.50         1.33
     RUNOFF VOLUME    (mm)=     40.69        15.89        24.75
     TOTAL RAINFALL   (mm)=     41.69        41.69        41.69
     RUNOFF COEFFICIENT   =       .98          .38          .59

***** 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  (0001) |   Area    (ha)=    .21
|ID= 1 DT= 5.0 min |   Total Imp(%)=  79.00   Dir. Conn.(%)=  79.00
--------------------
                           IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       .17          .04
     Dep. Storage     (mm)=      1.00         1.00
     Average Slope     (%)=      1.00         2.00
     Length            (m)=     37.60        40.00
     Mannings n           =      .013         .250

     Max.Eff.Inten.(mm/hr)=      88.09        45.72
               over (min)        5.00        10.00
```

```
     Storage Coeff.  (min)=       1.49 (ii)    5.86 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=        .33          .15
                                                        *TOTALS*
     PEAK FLOW       (cms)=        .04          .00          .043 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.42         1.33
     RUNOFF VOLUME    (mm)=      40.69        15.89        35.47
     TOTAL RAINFALL   (mm)=      41.69        41.69        41.69
     RUNOFF COEFFICIENT   =        .98          .38          .85

***** 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.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (0003) |
|   1 +  2 =  3    |          AREA    QPEAK    TPEAK     R.V.
--------------------          (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0002):      .10    .010     1.33    24.75
        + ID2= 2 (0001):      .21    .043     1.33    35.47
          ================================================
          ID = 3 (0003):      .31    .053     1.33    32.13

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| RESERVOIR (0004) |
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |    (cms)     (ha.m.)
                           .0000      .0000   |    .0787       .0052

                                  AREA      QPEAK       TPEAK       R.V.
                                  (ha)      (cms)       (hrs)       (mm)
     INFLOW : ID= 2 (0003)        .308       .053        1.33       32.13
     OUTFLOW: ID= 1 (0004)        .308       .033        1.42       32.09

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 61.12
                   TIME SHIFT OF PEAK FLOW         (min)=  5.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=   .0023

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--------------------
| ADD HYD   (0005) |
|   1 +  2 =  3    |          AREA    QPEAK    TPEAK     R.V.
--------------------          (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0006):      .04    .008     1.33    35.45
        + ID2= 2 (0004):      .31    .033     1.42    32.09
          ================================================
          ID = 3 (0005):      .35    .038     1.33    32.47

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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  ****************************
  ** SIMULATION NUMBER:   2 **
  ****************************

--------------------
| CHICAGO STORM    |    IDF curve parameters: A=1114.200
| Ptotal= 67.72 mm |                          B=   5.000
--------------------                          C=    .761
                        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
                 .17    4.90 |  1.17   34.69 |  2.17   11.09 |  3.17    5.78
                 .33    5.58 |  1.33  141.89 |  2.33    9.51 |  3.33    5.39
                 .50    6.52 |  1.50   44.96 |  2.50    8.37 |  3.50    5.05
```

```
                .67    7.92 |  1.67   24.46 |  2.67    7.49 |  3.67    4.76
                .83   10.29 |  1.83   17.17 |  2.83    6.80 |  3.83    4.50
               1.00   15.27 |  2.00   13.40 |  3.00    6.24 |  4.00    4.28


--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0006) |   Area    (ha)=    .04
|ID= 1 DT= 5.0 min |   Total Imp(%)=  79.00   Dir. Conn.(%)=  79.00
--------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .03          .01
     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.


                          ---- TRANSFORMED HYETOGRAPH ----
               TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
               .083    4.90 | 1.083   34.69 | 2.083   11.09 |  3.08    5.78
               .167    4.90 | 1.167   34.69 | 2.167   11.09 |  3.17    5.78
               .250    5.58 | 1.250  141.89 | 2.250    9.51 |  3.25    5.39
               .333    5.58 | 1.333  141.89 | 2.333    9.51 |  3.33    5.39
               .417    6.52 | 1.417   44.96 | 2.417    8.37 |  3.42    5.05
               .500    6.52 | 1.500   44.96 | 2.500    8.37 |  3.50    5.05
               .583    7.92 | 1.583   24.46 | 2.583    7.49 |  3.58    4.76
               .667    7.92 | 1.667   24.46 | 2.667    7.49 |  3.67    4.76
               .750   10.29 | 1.750   17.17 | 2.750    6.80 |  3.75    4.50
               .833   10.29 | 1.833   17.17 | 2.833    6.80 |  3.83    4.50
               .917   15.27 | 1.917   13.40 | 2.917    6.24 |  3.92    4.28
              1.000   15.27 | 2.000   13.40 | 3.000    6.24 |  4.00    4.28

     Max.Eff.Inten.(mm/hr)=     141.89        67.55
                over (min)        5.00         5.00
     Storage Coeff.  (min)=        .75 (ii)    4.36 (ii)
     Unit Hyd. Tpeak (min)=       5.00         5.00
     Unit Hyd. peak  (cms)=        .34          .23
                                                      *TOTALS*
     PEAK FLOW       (cms)=        .01          .00          .014 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.33          1.33
     RUNOFF VOLUME    (mm)=      66.72        34.18         59.86
     TOTAL RAINFALL   (mm)=      67.72        67.72         67.72
     RUNOFF COEFFICIENT   =        .99          .50           .88

***** 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) |   Area    (ha)=    .10
|ID= 1 DT= 5.0 min |   Total Imp(%)=  36.00   Dir. Conn.(%)=  36.00
--------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .03          .06
     Dep. Storage     (mm)=       1.00         1.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      25.30        40.00
     Mannings n           =       .013         .250

     Max.Eff.Inten.(mm/hr)=     141.89        67.55
                over (min)        5.00        10.00
     Storage Coeff.  (min)=        .97 (ii)    9.23 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=        .34          .12
                                                      *TOTALS*
     PEAK FLOW       (cms)=        .01          .01          .020 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.42          1.33
     RUNOFF VOLUME    (mm)=      66.72        34.18         45.83
     TOTAL RAINFALL   (mm)=      67.72        67.72         67.72
     RUNOFF COEFFICIENT   =        .99          .50           .68
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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.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0001) |   Area    (ha)=    .21
|ID= 1 DT= 5.0 min |   Total Imp(%)=  79.00   Dir. Conn.(%)=  79.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .17          .04
     Dep. Storage     (mm)=       1.00         1.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      37.60        40.00
     Mannings n           =       .013         .250

     Max.Eff.Inten.(mm/hr)=     141.89       102.93
               over (min)         5.00         5.00
     Storage Coeff.  (min)=       1.24 (ii)    4.85 (ii)
     Unit Hyd. Tpeak (min)=       5.00         5.00
     Unit Hyd. peak  (cms)=        .33          .22
                                                        *TOTALS*
     PEAK FLOW       (cms)=        .07          .01          .074 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.33          1.33
     RUNOFF VOLUME    (mm)=      66.72        34.18         59.88
     TOTAL RAINFALL   (mm)=      67.72        67.72         67.72
     RUNOFF COEFFICIENT   =        .99          .50           .88

***** 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.

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (0003) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)      (mm)
          ID1= 1 (0002):      .10    .020     1.33    45.83
        + ID2= 2 (0001):      .21    .074     1.33    59.88
          ================================================
          ID = 3 (0003):      .31    .094     1.33    55.50

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| RESERVOIR (0004) |
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           .0000      .0000   |    .0787       .0052

                                  AREA      QPEAK       TPEAK       R.V.
                                  (ha)      (cms)       (hrs)       (mm)
     INFLOW : ID= 2 (0003)        .308       .094        1.33       55.50
     OUTFLOW: ID= 1 (0004)        .308       .057        1.42       55.46

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 60.72
                   TIME SHIFT OF PEAK FLOW          (min)=  5.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=   .0040

--------------------------------------------------------------------------------

--------------------
| ADD HYD   (0005) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)      (mm)
          ID1= 1 (0006):      .04    .014     1.33    59.86
        + ID2= 2 (0004):      .31    .057     1.42    55.46
          ================================================
```

```
          ID = 3 (0005):      .35    .065     1.33    55.97

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

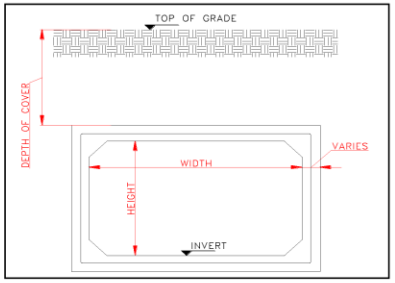
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 FINISH
================================================================================================================
```

FORTERRA

Job Name :		
Volume Requirement :	38.0	m^3
Top of Grade :	141.70	m
Culvert invert height :	139.70	m
% Volume Fill :	100.00	%
Available Site Length :	14.0	m
Available Site Width :	14.0	m
Horizontal or vertical Culvert :	Horizontal	
Culvert alignment :	Culvert length aligned with site length	
Number of MH Tees :	1/2 x No. of Bulkheads	

Manual Pricing Entries			
	Quantity		
Bulkheads :			
MH Tees :			
	Branch Size	Qty.	Price
Branch 1 :			
Branch 2 :			
Branch 3 :			
Branch 4 :			
Branch 5 :			
Branch 6 :			



Other Options	Number of Boxes	Cost of Culvert	Precast Mass (tons)	Retention Vol. (m^3)	Depth of Cover (m)	No. of Bulkheads	Cost for Bulkheads	Number of MH Tees	Cost of MH Tees	Tee/Wye Connections	TOTAL COST
1800x900	10	$ 41,600.00	82	38.5	0.9	4	$ 6,656.00	2	$ 2,167.00		$ 50,423.00
==> 1800x1200	8	$ 36,328.00	71	41.6	0.6	4	$ 7,265.60	2	$ 2,167.00		$ 45,760.60
2400x1200	6	$ 34,764.00	62	42.0	0.6	4	$ 9,270.40	2	$ 2,167.00		$ 46,201.40
2400x1500	5	$ 39,321.25	56	44.0	0.3	2	$ 6,291.40	1	$ 1,083.50		$ 46,696.15
2438x1829											
3000x1500	4	$ 44,594.00	65	43.8	0.3	2	$ 8,918.80	1	$ 1,083.50		$ 54,596.30
3000x1800											
3000x2100											
3048x2438											

Optimal Layout Preview	1800x1200

% Volume Fill	100.0	haunch	0.2	Int. width	1.8	Int. height	1.2	Cover	0.6	Int. Culvert Area	2.08

SITE LENGTH

Volume Table (m3) for size 1800x1200

Culvert Width	Culvert Length	12.5	10.0	7.5	5.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Pieces
	Pieces	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
13.2	6	156	125	94	62																				6
11.0	5	130	104	78	52																				5
8.8	4	104	83	62	42																				4
6.6	3	78	62	47																					3
4.4	2	52	42																						2
2.2	1																								1
0.0	0																								0
0.0	0																								0
0.0	0																								0
0.0	0																								0
0.0	0																								0
0.0	0																								0
0.0	0																								0
0.0	0																								0
0.0	0																								0
0.0	0																								0
0.0	0																								0
0.0	0																								0

SITE WIDTH