

STORMWATER MANAGEMENT REPORT

Ladouceur Street & Merton Street
Townhouses
Ottawa, Ontario

Report No. 13029-SWM

August 16, 2013
Revised May 21, 2014



NOT VALID UNLESS
SIGNED & DATED

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STORMWATER MANAGEMENT REPORT

Ladouceur Street & Merton Street Townhouses Ottawa, Ontario

This report addresses the stormwater management requirements of an 8 unit townhouse residential development located on 698 sq.m. of land at the intersection of Ladouceur Street & Merton Street in Ottawa.

This report forms part of the stormwater management design for the proposed development. Also refer to drawing SG-1, SG-2 & SG-3 prepared by D. B. Gray Engineering Inc.

WATER QUALITY:

During construction, an erosion and sediment control plan has been developed (see notes 2.1 to 2.5 on drawing SG-3). In summary: To filter out construction sediment geotextile fabric will be placed between the grate and frame of all existing catch basins adjacent to the site and all new catch basins as they are installed.

WATER QUANTITY:

As requested by the staff of City of Ottawa Infrastructure Approvals: The stormwater quantity control measures are based on the criteria that the release rate for post-development storm events is equal to or less than the flow produced by a five year storm using a runoff coefficient of 0.50 and a 10 minute time of concentration. The maximum allowable release rate for the site is calculated to be 10.11 l/s.

Calculations are based on the Rational Method. The runoff coefficients for the 100 year event were increased by 25% to maximum 1.00.

Stormwater will be stored within the development on the roofs of the proposed buildings and underground in a catch basin, manhole and sewer pipes.

The runoff from between the proposed building and the sidewalk and driveway entrance (Drainage Area I – 258 sq.m.) will be allowed to flow uncontrolled off the site. The flow from these areas is calculated at the five year event at 10 minutes concentration.

Each of 14 roof drains will be flow control type installed with one parabolic shaped slotted weir (0.0124 l/s per mm per slot - 5 USgpm per inch per slot) causing the storm water to pond on the roofs. Unit 1 roof drains (Drainage Areas II & III – 59 sq.m.) discharge to a storm sewer connection. All other roof drains (Drainage Areas IV to VII – 320 sq.m.) discharge onto the surface and drain to the controlled portion of the storm sewer system (Drainage Area VIII – 61 sq.m.). (A direct connection to the controlled portion of the storm sewer is not desirable. Such an arrangement, if the rainwater leaders were left unvented, could cause an air lock to develop resulting in the water column in the rainwater leader causing failure of cleanouts at the base of the leader and flooding inside the building.) The discharge from the Unit 2 to 8 roof drains (Drainage Areas IV to VII) is added to the flow into Drainage Area VIII.

In addition to the Unit 1 roof drains (Drainage Areas II & III), an inlet control device (ICD) located at the outlet pipe of CB/MH-ST.2 will also control the release of stormwater off the site. The ICD will restrict the flow and force the stormwater to back up into the upstream sewer pipe and manholes.

Stormwater released through the ICD will be conveyed off the site via a 250mm storm sewer connecting to a 375mm storm sewer on Merton Street.

The ICD shall be a Hydrovex "VHV Vertical Vortex Flow Regulator" and shall be sized by the manufacturer for a discharge rate of 1.71 l/s at 1.76 m head. It is calculated that an orifice area of 1963 sq.mm. (50 mm diameter) and a discharge coefficient of 0.148 will restrict the outflow rate to 1.71 l/s at a head of 1.76 m. Based on this orifice the maximum outflow rate for the 1:5 year storm event is calculated to be 0.85 l/s at 0.43 m.

Since the stormwater management facility is located on more than one property it is expected that a Ministry of Environment Environmental Compliance Approval (ECA) will be required.

CONCLUSIONS:

WATER QUALITY:

An erosion and sediment control plan as been developed to be implemented during construction

WATER QUANTITY:

One Hundred Year Storm Event:

The maximum allowable release rate for the site is 10.11 l/s. The maximum post-development release rate for the 100-year storm event is calculated to be 10.11 l/s. Therefore the maximum post development release rate for the 100-year storm event is equal to the maximum allowable release rate. A maximum stored volume of 20.98 cu.m. is required to achieve the post development release rate.

Five Year Storm Event:

The maximum allowable release rate for the site is 10.11 l/s. The maximum post-development release rate for the 5-year storm event is calculated to be 5.42 l/s. Therefore the maximum post-development release rate for the 5-year storm event is less than the maximum allowable release rate. A maximum stored volume of 7.90 cu.m. is required to achieve the post-development release rate.

Summary Tables

ONE HUNDRED YEAR EVENT			
Drainage Area	Maximum Release Rate l/s	Maximum Allowable Release Rate l/s	Maximum Volume Stored cu.m.
AREA I (Uncontrolled flow off site)	6.85	-	-
AREA II (Unit 1 Terrace Roof)	0.85	-	0.71
AREA III (Unit 1 Lower Roof)	0.70	-	0.15
AREA IV (Unit 2 to 6 Terrace Roof) (Drains to Area VIII)	3.55	-	1.44
AREA V (Unit 2 to 6 Lower Roof) (Drains to Area VIII)	4.25	-	1.00
AREA VI (Unit 7 Roof) (Drains to Area VIII)	0.86	-	0.73
AREA VII (Unit 8 Roof) (Drains to Area VIII)	0.88	-	0.82
AREA VIII	1.71	-	16.12
TOTAL FLOWRATE (Areas I + II + III + VIII)	10.11	10.11	-
TOTAL VOLUME	-	-	20.98

Summary Tables

FIVE YEAR EVENT			
Drainage Area	Maximum Release Rate l/s	Maximum Allowable Release Rate l/s	Maximum Volume Stored cu.m.
AREA I (Uncontrolled flow off site)	3.48	-	-
AREA II (Unit 1 Terrace Roof)	0.62	-	0.27
AREA III (Unit 1 Lower Roof)	0.48	-	0.05
AREA IV (Unit 2 to 6 Terrace Roof) (Drains to Area VIII)	2.52	-	0.52
AREA V (Unit 2 to 6 Lower Roof) (Drains to Area VIII)	2.91	-	0.32
AREA VI (Unit 7 Roof) (Drains to Area VIII)	0.63	-	0.28
AREA VII (Unit 8 Roof) (Drains to Area VIII)	0.64	-	0.32
AREA VIII	0.85	-	6.15
TOTAL FLOWRATE (Areas I + II + III + VIII)	5.42	10.11	-
TOTAL VOLUME	-	-	7.90

STORMWATER MANAGEMENT CALCULATIONS

The orifice calculations are based on the following formula:

$$Q = C_d \times A_o \sqrt{2gh} \times 1000$$

where:

Q = flowrate in litres per second

C_d = coefficient of discharge

A_o = orifice area in sq.m.

g = 9.81 m/s²

h = head above orifice in meters

Flow control roof drain calculations are based on the following formula:

$$Q = N \times S \times d \times F$$

where:

Q = flowrate in litres per second

N = number of roof drains

S = slots per weir

d = pond depth at roof drain in mm

F = flowrate through each slot

0.0124 litres per second per mm pond depth (5 USgpm per inch)

Storage calculations on the roof are based on the following formula for volume of a cone:

$$V = (A \times d)/3$$

where:

V = volume in cu.m.

A = ponding area in sq.m.

d = ponding depth in meters

Calculations for sub-surface storage (manholes and sewer pipes) are based on the following formula for volume of a cylinder:

$$V = L \times \text{Pi} \times (d/2)^2$$

where:

V = volume in cu.m.

L = depth of water in manhole or length of pipe in meters

d = diameter of manhole (1.22 m) or pipe in meters

Ladouceur St & Merton St
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STORM WATER MANAGEMENT CALCULATIONS
Rational Method

ONE HUNDRED YEAR EVENT

Maximum Release Rate

Area (A):	698	sq.m.
Time of Concentration:	10	min.
Rainfall Intensity (i):	104	mm/hr (5 year event)
Runoff Coefficient (C):	0.50	
Maximum Release Rate:	10.11	l/s

DRAINAGE AREA I:

(Uncontrolled Flow Off Site - Sheet Flow)

			C
Roof Area:	0	sq.m.	1.00
Asphalt/Concrete Area:	98	sq.m.	1.00
Landscaped:	160	sq.m.	0.25
Total Catchment Area	258	sq.m.	0.53
Area (A):	258	sq.m.	
Time of Concentration:	10	min.	
Rainfall Intensity (i):	179	mm/hr (100 year event)	
Runoff Coefficient (C):	0.53		
Flow Rate (2.78AiC):	6.85	l/s	

DRAINAGE AREA II (Unit 1 Terrace Roof):

(ONE HUNDRED YEAR EVENT)

				C
Roof Area:	41	sq.m.	1.00	
Paved Area:	0	sq.m.	1.00	
Landscaped Areas:	0	sq.m.	0.25	
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Total Catchment Area	41	Ave. C	1.00	
No. of Roof Drains:	1			
Slots per Wier:	1	0.0124 l/s/mm/slot (5 USgpm/in/slot)		
Depth at Roof Drain:	69	mm		
Maximum Release Rate	0.85	l/s	Pond Area:	31 sq.m.
			Achieved Vol:	0.71 cu.m.
			Max. Vol. Required:	0.71 cu.m.

Time	i	2.78AiC	Release	Stored	Stored
min.	mm/hr	l/s	l/s	l/s	cu.m.
5	243	2.77	0.85	1.92	0.57
10	179	2.04	0.85	1.18	0.71
15	143	1.63	0.85	0.78	0.70
20	120	1.37	0.85	0.52	0.62
25	104	1.18	0.85	0.33	0.50
30	92	1.05	0.85	0.20	0.35
35	83	0.94	0.85	0.09	0.19
40	75	0.86	0.85	0.01	0.01
45	69	0.79	0.79	0.00	0.00
50	64	0.73	0.73	0.00	0.00
55	60	0.68	0.68	0.00	0.00
60	56	0.64	0.64	0.00	0.00
65	53	0.60	0.60	0.00	0.00
70	50	0.57	0.57	0.00	0.00
75	47	0.54	0.54	0.00	0.00
80	45	0.51	0.51	0.00	0.00
85	43	0.49	0.49	0.00	0.00
90	41	0.47	0.47	0.00	0.00
95	39	0.45	0.45	0.00	0.00
100	38	0.43	0.43	0.00	0.00
105	36	0.42	0.42	0.00	0.00
110	35	0.40	0.40	0.00	0.00
115	34	0.39	0.39	0.00	0.00
120	33	0.37	0.37	0.00	0.00
125	32	0.36	0.36	0.00	0.00
130	31	0.35	0.35	0.00	0.00
135	30	0.34	0.34	0.00	0.00
140	29	0.33	0.33	0.00	0.00
145	28	0.32	0.32	0.00	0.00
150	28	0.31	0.31	0.00	0.00
180	24	0.27	0.27	0.00	0.00
210	21	0.24	0.24	0.00	0.00
240	19	0.22	0.22	0.00	0.00
270	17	0.20	0.20	0.00	0.00
300	16	0.18	0.18	0.00	0.00

DRAINAGE AREA III (Unit 1 Lower Roof):

(ONE HUNDRED YEAR EVENT)

							C
Roof Area:	18	sq.m.		1.00			
Paved Area:	0	sq.m.		1.00			
Landscaped Areas:	0	sq.m.		0.25			
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Total Catchment Area	18	Ave. C		1.00			
No. of Roof Drains:	1						
Slots per Wier:	1	0.0124 l/s/mm/slot (5 USgpm/in/slot)					
Depth at Roof Drain:	57	mm					
Maximum Release Rate	0.70	l/s			Pond Area:	8	sq.m.
					Achieved Vol:	0.15	cu.m.
					Max. Vol. Required:	0.15	cu.m.

Time	i	2.78AiC	Release	Stored	Stored
min.	mm/hr	l/s	Rate	Rate	Volume
			l/s	l/s	cu.m.
5	243	1.21	0.70	0.51	0.15
10	179	0.89	0.70	0.19	0.11
15	143	0.72	0.70	0.01	0.01
20	120	0.60	0.60	0.00	0.00
25	104	0.52	0.52	0.00	0.00
30	92	0.46	0.46	0.00	0.00
35	83	0.41	0.41	0.00	0.00
40	75	0.38	0.38	0.00	0.00
45	69	0.35	0.35	0.00	0.00
50	64	0.32	0.32	0.00	0.00
55	60	0.30	0.30	0.00	0.00
60	56	0.28	0.28	0.00	0.00
65	53	0.26	0.26	0.00	0.00
70	50	0.25	0.25	0.00	0.00
75	47	0.24	0.24	0.00	0.00
80	45	0.23	0.23	0.00	0.00
85	43	0.21	0.21	0.00	0.00
90	41	0.21	0.21	0.00	0.00
95	39	0.20	0.20	0.00	0.00
100	38	0.19	0.19	0.00	0.00
105	36	0.18	0.18	0.00	0.00
110	35	0.18	0.18	0.00	0.00
115	34	0.17	0.17	0.00	0.00
120	33	0.16	0.16	0.00	0.00
125	32	0.16	0.16	0.00	0.00
130	31	0.15	0.15	0.00	0.00
135	30	0.15	0.15	0.00	0.00
140	29	0.15	0.15	0.00	0.00
145	28	0.14	0.14	0.00	0.00
150	28	0.14	0.14	0.00	0.00
180	24	0.12	0.12	0.00	0.00
210	21	0.11	0.11	0.00	0.00
240	19	0.10	0.10	0.00	0.00
270	17	0.09	0.09	0.00	0.00
300	16	0.08	0.08	0.00	0.00

DRAINAGE AREA IV (Units 2 to 6 Terrace Roof):

(ONE HUNDRED YEAR EVENT)

						C
Roof Area:	120	sq.m.	1.00			
Paved Area:	0	sq.m.	1.00			
Landscaped Areas:	0	sq.m.	0.25			
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Total Catchment Area	120	Ave. C	1.00			
No. of Roof Drains:	5					
Slots per Wier:	1	0.0124 l/s/mm/slot	(5 USgpm/in/slot)			
Depth at Roof Drain:	57	mm				
Maximum Release Rate	3.55	l/s		Pond Area:	75	sq.m.
				Achieved Vol:	1.44	cu.m.
				Max. Vol. Required:	1.44	cu.m.

Time	i	2.78AiC	Release	Stored	Stored
min.	mm/hr	l/s	Rate	Rate	Volume
			l/s	l/s	cu.m.
5	243	8.10	3.55	4.54	1.36
10	179	5.96	3.55	2.40	1.44
15	143	4.77	3.55	1.21	1.09
20	120	4.00	3.55	0.45	0.54
25	104	3.46	3.46	0.00	0.00
30	92	3.06	3.06	0.00	0.00
35	83	2.75	2.75	0.00	0.00
40	75	2.51	2.51	0.00	0.00
45	69	2.30	2.30	0.00	0.00
50	64	2.13	2.13	0.00	0.00
55	60	1.99	1.99	0.00	0.00
60	56	1.86	1.86	0.00	0.00
65	53	1.76	1.76	0.00	0.00
70	50	1.66	1.66	0.00	0.00
75	47	1.58	1.58	0.00	0.00
80	45	1.50	1.50	0.00	0.00
85	43	1.43	1.43	0.00	0.00
90	41	1.37	1.37	0.00	0.00
95	39	1.32	1.32	0.00	0.00
100	38	1.26	1.26	0.00	0.00
105	36	1.22	1.22	0.00	0.00
110	35	1.17	1.17	0.00	0.00
115	34	1.13	1.13	0.00	0.00
120	33	1.10	1.10	0.00	0.00
125	32	1.06	1.06	0.00	0.00
130	31	1.03	1.03	0.00	0.00
135	30	1.00	1.00	0.00	0.00
140	29	0.97	0.97	0.00	0.00
145	28	0.95	0.95	0.00	0.00
150	28	0.92	0.92	0.00	0.00
180	24	0.80	0.80	0.00	0.00
210	21	0.71	0.71	0.00	0.00
240	19	0.63	0.63	0.00	0.00
270	17	0.58	0.58	0.00	0.00
300	16	0.53	0.53	0.00	0.00

DRAINAGE AREA V (Units 2 to 6 Lower Roof):

(ONE HUNDRED YEAR EVENT)

				C
Roof Area:	113	sq.m.	1.00	
Paved Area:	0	sq.m.	1.00	
Landscaped Areas:	0	sq.m.	0.25	
Total Catchment Area	113	Ave. C	1.00	
No. of Roof Drains:	5			
Slots per Wier:	1	0.0124 l/s/mm/slot (5 USgpm/in/slot)		
Depth at Roof Drain:	69	mm		
Maximum Release Rate	4.25	l/s	Pond Area:	44 sq.m.
				Achieved Vol:
				1.00 cu.m.
				Max. Vol. Required:
				1.00 cu.m.

Time	i	2.78AiC	Release	Stored	Stored
min.	mm/hr	l/s	Rate	Rate	Volume
			l/s	l/s	cu.m.
5	243	7.59	4.25	3.34	1.00
10	179	5.58	4.25	1.33	0.80
15	143	4.47	4.25	0.22	0.20
20	120	3.75	3.75	0.00	0.00
25	104	3.25	3.25	0.00	0.00
30	92	2.87	2.87	0.00	0.00
35	83	2.58	2.58	0.00	0.00
40	75	2.35	2.35	0.00	0.00
45	69	2.16	2.16	0.00	0.00
50	64	2.00	2.00	0.00	0.00
55	60	1.86	1.86	0.00	0.00
60	56	1.75	1.75	0.00	0.00
65	53	1.65	1.65	0.00	0.00
70	50	1.56	1.56	0.00	0.00
75	47	1.48	1.48	0.00	0.00
80	45	1.41	1.41	0.00	0.00
85	43	1.34	1.34	0.00	0.00
90	41	1.29	1.29	0.00	0.00
95	39	1.23	1.23	0.00	0.00
100	38	1.19	1.19	0.00	0.00
105	36	1.14	1.14	0.00	0.00
110	35	1.10	1.10	0.00	0.00
115	34	1.06	1.06	0.00	0.00
120	33	1.03	1.03	0.00	0.00
125	32	1.00	1.00	0.00	0.00
130	31	0.97	0.97	0.00	0.00
135	30	0.94	0.94	0.00	0.00
140	29	0.91	0.91	0.00	0.00
145	28	0.89	0.89	0.00	0.00
150	28	0.86	0.86	0.00	0.00
180	24	0.75	0.75	0.00	0.00
210	21	0.66	0.66	0.00	0.00
240	19	0.59	0.59	0.00	0.00
270	17	0.54	0.54	0.00	0.00
300	16	0.50	0.50	0.00	0.00

DRAINAGE AREA VI (Unit 7 Roof):

(ONE HUNDRED YEAR EVENT)

				C
Roof Area:	42	sq.m.	1.00	
Paved Area:	0	sq.m.	1.00	
Landscaped Areas:	0	sq.m.	0.25	
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Total Catchment Area	42	Ave. C	1.00	
No. of Roof Drains:	1			
Slots per Wier:	1	0.0124 l/s/mm/slot (5 USgpm/in/slot)		
Depth at Roof Drain:	70	mm		
Maximum Release Rate	0.86	l/s		
			Pond Area:	32 sq.m.
			Achieved Vol:	0.73 cu.m.
			Max. Vol. Required:	0.73 cu.m.

Time	i	2.78AiC	Release	Stored	Stored
min.	mm/hr	l/s	Rate	Rate	Volume
			l/s	l/s	cu.m.
5	243	2.83	0.86	1.97	0.59
10	179	2.08	0.86	1.22	0.73
15	143	1.67	0.86	0.81	0.73
20	120	1.40	0.86	0.54	0.65
25	104	1.21	0.86	0.35	0.53
30	92	1.07	0.86	0.21	0.38
35	83	0.96	0.86	0.10	0.22
40	75	0.88	0.86	0.02	0.04
45	69	0.81	0.81	0.00	0.00
50	64	0.75	0.75	0.00	0.00
55	60	0.70	0.70	0.00	0.00
60	56	0.65	0.65	0.00	0.00
65	53	0.61	0.61	0.00	0.00
70	50	0.58	0.58	0.00	0.00
75	47	0.55	0.55	0.00	0.00
80	45	0.53	0.53	0.00	0.00
85	43	0.50	0.50	0.00	0.00
90	41	0.48	0.48	0.00	0.00
95	39	0.46	0.46	0.00	0.00
100	38	0.44	0.44	0.00	0.00
105	36	0.43	0.43	0.00	0.00
110	35	0.41	0.41	0.00	0.00
115	34	0.40	0.40	0.00	0.00
120	33	0.38	0.38	0.00	0.00
125	32	0.37	0.37	0.00	0.00
130	31	0.36	0.36	0.00	0.00
135	30	0.35	0.35	0.00	0.00
140	29	0.34	0.34	0.00	0.00
145	28	0.33	0.33	0.00	0.00
150	28	0.32	0.32	0.00	0.00
180	24	0.28	0.28	0.00	0.00
210	21	0.25	0.25	0.00	0.00
240	19	0.22	0.22	0.00	0.00
270	17	0.20	0.20	0.00	0.00
300	16	0.19	0.19	0.00	0.00

DRAINAGE AREA VII (Unit 8 Roof):

(ONE HUNDRED YEAR EVENT)

				C
Roof Area:	45	sq.m.	1.00	
Paved Area:	0	sq.m.	1.00	
Landscaped Areas:	<u>0</u>	sq.m.	<u>0.25</u>	
Total Catchment Area	45	Ave. C	1.00	
No. of Roof Drains:	1			
Slots per Wier:	1	0.0124 l/s/mm/slot (5 USgpm/in/slot)		
Depth at Roof Drain:	71	mm		
Maximum Release Rate	0.88	l/s	Pond Area:	35 sq.m.
			Achieved Vol:	0.82 cu.m.
			Max. Vol. Required:	0.82 cu.m.

Time	i	2.78AiC	Release	Stored	Stored
min.	mm/hr	l/s	Rate	Rate	Volume
			l/s	l/s	cu.m.
5	243	3.04	0.88	2.16	0.65
10	179	2.23	0.88	1.36	0.81
15	143	1.79	0.88	0.91	0.82
20	120	1.50	0.88	0.62	0.75
25	104	1.30	0.88	0.42	0.63
30	92	1.15	0.88	0.27	0.49
35	83	1.03	0.88	0.16	0.33
40	75	0.94	0.88	0.06	0.15
45	69	0.86	0.86	0.00	0.00
50	64	0.80	0.80	0.00	0.00
55	60	0.75	0.75	0.00	0.00
60	56	0.70	0.70	0.00	0.00
65	53	0.66	0.66	0.00	0.00
70	50	0.62	0.62	0.00	0.00
75	47	0.59	0.59	0.00	0.00
80	45	0.56	0.56	0.00	0.00
85	43	0.54	0.54	0.00	0.00
90	41	0.51	0.51	0.00	0.00
95	39	0.49	0.49	0.00	0.00
100	38	0.47	0.47	0.00	0.00
105	36	0.46	0.46	0.00	0.00
110	35	0.44	0.44	0.00	0.00
115	34	0.43	0.43	0.00	0.00
120	33	0.41	0.41	0.00	0.00
125	32	0.40	0.40	0.00	0.00
130	31	0.39	0.39	0.00	0.00
135	30	0.38	0.38	0.00	0.00
140	29	0.36	0.36	0.00	0.00
145	28	0.35	0.35	0.00	0.00
150	28	0.35	0.35	0.00	0.00
180	24	0.30	0.30	0.00	0.00
210	21	0.26	0.26	0.00	0.00
240	19	0.24	0.24	0.00	0.00
270	17	0.22	0.22	0.00	0.00
300	16	0.20	0.20	0.00	0.00

DRAINAGE AREA VIII

(ONE HUNDRED YEAR EVENT)

			C
Roof Area:	0	sq.m.	1.00
Asphalt/Concrete Area:	60	sq.m.	1.00
Landscaped:	1	sq.m.	0.25
<hr/>			
Total Catchment Area	61	sq.m.	0.99

				Storage in MH's & CB's			
Water Elevation:	60.61	m		Invert	Depth		
				m	m		
ICD Invert:	58.85	m		MH-2	58.85	1.76	3.11 cu.m.
(Outlet Pipe OF MH-2)				CB/MH-3	58.86	1.75	3.09 cu.m.
				CB/MH-4	58.87	1.74	3.07 cu.m.

				Storage in Sewer Pipes			
Head:	1.76	m					
Orifice Diameter	50	mm		Diam.	Length		
				mm	m		
Orifice Area:	1963	sq.mm.		750	10.7	4.06	cu.m.
				750	7.8	2.78	cu.m.
Coefficient of Discharge:	0.148						

Max. Release Rate:	1.71	l/s		Achieved Vol:	16.12	cu.m.
				Max. Vol. Required:	16.12	cu.m.

Time min.	i mm/hr	2.78AiC l/s	Inflow from Roofs (Except Unit 1)		Total Inflow l/s	Release Rate l/s	Stored Rate l/s	Stored Volume cu.m.
			l/s	l/s				
5	243	4.07	9.54	13.61	1.71	11.90	3.57	
10	179	2.99	10.25	13.24	1.71	11.53	6.92	
15	143	2.39	10.25	12.64	1.71	10.93	9.84	
20	120	2.01	9.64	11.65	1.71	9.95	11.93	
25	104	1.74	8.97	10.71	1.71	9.00	13.50	
30	92	1.54	8.14	9.68	1.71	7.97	14.34	
35	83	1.38	7.49	8.87	1.71	7.17	15.05	
40	75	1.26	6.97	8.23	1.71	6.52	15.66	
45	69	1.16	6.48	7.64	1.71	5.93	16.01	
50	64	1.07	6.00	7.07	1.71	5.36	16.09	
55	60	1.00	5.59	6.59	1.71	4.89	16.12	
60	56	0.94	5.24	6.18	1.71	4.47	16.10	
65	53	0.88	4.94	5.82	1.71	4.11	16.05	
70	50	0.83	4.67	5.51	1.71	3.80	15.95	
75	47	0.79	4.43	5.23	1.71	3.52	15.83	
80	45	0.75	4.22	4.97	1.71	3.27	15.68	
85	43	0.72	4.03	4.75	1.71	3.04	15.52	
90	41	0.69	3.86	4.55	1.71	2.84	15.33	
95	39	0.66	3.70	4.36	1.71	2.65	15.12	
100	38	0.63	3.56	4.19	1.71	2.48	14.90	
105	36	0.61	3.42	4.04	1.71	2.33	14.67	
110	35	0.59	3.30	3.89	1.71	2.19	14.42	
115	34	0.57	3.19	3.76	1.71	2.05	14.17	
120	33	0.55	3.09	3.64	1.71	1.93	13.90	
125	32	0.53	2.99	3.52	1.71	1.82	13.62	
130	31	0.52	2.90	3.42	1.71	1.71	13.33	
135	30	0.50	2.81	3.32	1.71	1.61	13.04	
140	29	0.49	2.74	3.22	1.71	1.52	12.74	
145	28	0.47	2.66	3.14	1.71	1.43	12.43	
150	28	0.46	2.59	3.05	1.71	1.35	12.11	
180	24	0.40	2.24	2.64	1.71	0.94	10.11	
210	21	0.35	1.98	2.34	1.71	0.63	7.95	
240	19	0.32	1.78	2.10	1.71	0.39	5.68	
270	17	0.29	1.62 ₁₅	1.91	1.71	0.21	3.32	
300	16	0.27	1.49	1.76	1.71	0.05	0.90	

FIVE YEAR EVENT

Desired Maximum Release Rate

Area (A):	698	sq.m.
Time of Concentration:	10	min.
Rainfall Intensity (i):	104	mm/hr (5 year event)
Runoff Coefficient (C):	0.50	
Maximum Release Rate:	10.11	l/s

DRAINAGE AREA I:

(Uncontrolled Flow Off Site - Sheet Flow)

			C
Roof Area:	0	sq.m.	0.90
Asphalt/Concrete Area:	98	sq.m.	0.90
Landscaped:	<u>160</u>	<u>sq.m.</u>	<u>0.20</u>
Total Catchment Area	258	sq.m.	0.47
Area (A):	258	sq.m.	
Time of Concentration:	10	min.	
Rainfall Intensity (i):	104	mm/hr (5 year event)	
Runoff Coefficient (C):	0.47		
Flow Rate (2.78AiC):	3.48	l/s	

DRAINAGE AREA II (Unit 1 Terrace Roof):

(FIVE YEAR EVENT)

				C
Roof Area:	41	sq.m.		0.90
Paved Area:	0	sq.m.		0.90
Landscaped Areas:	0	sq.m.		0.20
 Total Catchment Area	 41	 Ave. C		 0.90
 No. of Roof Drains:	 1			
Slots per Wier:	1	0.0124 l/s/mm/slot (5 USgpm/in/slot)		
 Depth at Roof Drain:	 50	mm		
 Maximum Release Rate	 0.62	l/s		
			Pond Area:	16 sq.m.
			Achieved Vol:	0.27 cu.m.
			Max. Vol. Required:	0.27 cu.m.

Time	i	2.78AiC	Release	Stored	Stored
min.	mm/hr	l/s	l/s	l/s	cu.m.
5	141	1.45	0.62	0.83	0.25
10	104	1.07	0.62	0.45	0.27
15	84	0.86	0.62	0.24	0.22
20	70	0.72	0.62	0.10	0.12
25	61	0.62	0.62	0.01	0.01
30	54	0.55	0.55	0.00	0.00
35	49	0.50	0.50	0.00	0.00
40	44	0.45	0.45	0.00	0.00
45	41	0.42	0.42	0.00	0.00
50	38	0.39	0.39	0.00	0.00
55	35	0.36	0.36	0.00	0.00
60	33	0.34	0.34	0.00	0.00
65	31	0.32	0.32	0.00	0.00
70	29	0.30	0.30	0.00	0.00
75	28	0.29	0.29	0.00	0.00
80	27	0.27	0.27	0.00	0.00
85	25	0.26	0.26	0.00	0.00
90	24	0.25	0.25	0.00	0.00
95	23	0.24	0.24	0.00	0.00
100	22	0.23	0.23	0.00	0.00
105	22	0.22	0.22	0.00	0.00
110	21	0.21	0.21	0.00	0.00
115	20	0.21	0.21	0.00	0.00
120	19	0.20	0.20	0.00	0.00
125	19	0.19	0.19	0.00	0.00
130	18	0.19	0.19	0.00	0.00
135	18	0.18	0.18	0.00	0.00
140	17	0.18	0.18	0.00	0.00
145	17	0.17	0.17	0.00	0.00
150	16	0.17	0.17	0.00	0.00
180	14	0.15	0.15	0.00	0.00
210	13	0.13	0.13	0.00	0.00
240	11	0.12	0.12	0.00	0.00
270	10	0.11	0.11	0.00	0.00
300	9	0.10	0.10	0.00	0.00

DRAINAGE AREA III (Unit 1 Lower Roof):

(FIVE YEAR EVENT)

						C
Roof Area:	18	sq.m.		0.90		
Paved Area:	0	sq.m.		0.90		
Landscaped Areas:	0	sq.m.		0.20		
<hr/>						
Total Catchment Area	18	Ave. C		0.90		
No. of Roof Drains:	1					
Slots per Wier:	1	0.0124 l/s/mm/slot (5 USgpm/in/slot)				
Depth at Roof Drain:	39	mm				
Maximum Release Rate	0.48	l/s		Pond Area:	4	sq.m.
				Achieved Vol:	0.05	cu.m.
				Max. Vol. Required:	0.05	cu.m.

Time	i	2.78AiC	Release	Stored	Stored
min.	mm/hr	l/s	Rate	Rate	Volume
			l/s	l/s	cu.m.
5	141	0.64	0.48	0.16	0.05
10	104	0.47	0.47	0.00	0.00
15	84	0.38	0.38	0.00	0.00
20	70	0.32	0.32	0.00	0.00
25	61	0.27	0.27	0.00	0.00
30	54	0.24	0.24	0.00	0.00
35	49	0.22	0.22	0.00	0.00
40	44	0.20	0.20	0.00	0.00
45	41	0.18	0.18	0.00	0.00
50	38	0.17	0.17	0.00	0.00
55	35	0.16	0.16	0.00	0.00
60	33	0.15	0.15	0.00	0.00
65	31	0.14	0.14	0.00	0.00
70	29	0.13	0.13	0.00	0.00
75	28	0.13	0.13	0.00	0.00
80	27	0.12	0.12	0.00	0.00
85	25	0.11	0.11	0.00	0.00
90	24	0.11	0.11	0.00	0.00
95	23	0.10	0.10	0.00	0.00
100	22	0.10	0.10	0.00	0.00
105	22	0.10	0.10	0.00	0.00
110	21	0.09	0.09	0.00	0.00
115	20	0.09	0.09	0.00	0.00
120	19	0.09	0.09	0.00	0.00
125	19	0.08	0.08	0.00	0.00
130	18	0.08	0.08	0.00	0.00
135	18	0.08	0.08	0.00	0.00
140	17	0.08	0.08	0.00	0.00
145	17	0.08	0.08	0.00	0.00
150	16	0.07	0.07	0.00	0.00
180	14	0.06	0.06	0.00	0.00
210	13	0.06	0.06	0.00	0.00
240	11	0.05	0.05	0.00	0.00
270	10	0.05	0.05	0.00	0.00
300	9	0.04	0.04	0.00	0.00

DRAINAGE AREA IV (Units 2 to 6 Terrace Roof):

(FIVE YEAR EVENT)

					C
Roof Area:	120	sq.m.		0.90	
Paved Area:	0	sq.m.		0.90	
Landscaped Areas:	0	sq.m.		0.20	
<hr/>					
Total Catchment Area	120	Ave. C		0.90	
No. of Roof Drains:	5				
Slots per Wier:	1	0.0124 l/s/mm/slot (5 USgpm/in/slot)			
Depth at Roof Drain:	41	mm			
Maximum Release Rate	2.52	l/s		Pond Area:	38 sq.m.
				Achieved Vol:	0.52 cu.m.
				Max. Vol. Required:	0.52 cu.m.

Time	i	2.78AiC	Release	Stored	Stored
min.	mm/hr	l/s	Rate	Rate	Volume
			l/s	l/s	cu.m.
5	141	4.24	2.52	1.72	0.52
10	104	3.13	2.52	0.61	0.36
15	84	2.51	2.51	0.00	0.00
20	70	2.11	2.11	0.00	0.00
25	61	1.83	1.83	0.00	0.00
30	54	1.62	1.62	0.00	0.00
35	49	1.46	1.46	0.00	0.00
40	44	1.33	1.33	0.00	0.00
45	41	1.22	1.22	0.00	0.00
50	38	1.13	1.13	0.00	0.00
55	35	1.05	1.05	0.00	0.00
60	33	0.99	0.99	0.00	0.00
65	31	0.93	0.93	0.00	0.00
70	29	0.88	0.88	0.00	0.00
75	28	0.84	0.84	0.00	0.00
80	27	0.80	0.80	0.00	0.00
85	25	0.76	0.76	0.00	0.00
90	24	0.73	0.73	0.00	0.00
95	23	0.70	0.70	0.00	0.00
100	22	0.67	0.67	0.00	0.00
105	22	0.65	0.65	0.00	0.00
110	21	0.63	0.63	0.00	0.00
115	20	0.60	0.60	0.00	0.00
120	19	0.58	0.58	0.00	0.00
125	19	0.57	0.57	0.00	0.00
130	18	0.55	0.55	0.00	0.00
135	18	0.53	0.53	0.00	0.00
140	17	0.52	0.52	0.00	0.00
145	17	0.50	0.50	0.00	0.00
150	16	0.49	0.49	0.00	0.00
180	14	0.43	0.43	0.00	0.00
210	13	0.38	0.38	0.00	0.00
240	11	0.34	0.34	0.00	0.00
270	10	0.31	0.31	0.00	0.00
300	9	0.28	0.28	0.00	0.00

DRAINAGE AREA V (Units 2 to 6 Lower Roof):

(FIVE YEAR EVENT)

				C
Roof Area:	113	sq.m.	0.90	
Paved Area:	0	sq.m.	0.90	
Landscaped Areas:	0	sq.m.	0.20	
<hr/>				
Total Catchment Area	113	Ave. C	0.90	
No. of Roof Drains:	5			
Slots per Wier:	1	0.0124 l/s/mm/slot (5 USgpm/in/slot)		
Depth at Roof Drain:	47	mm		
Maximum Release Rate	2.91	l/s	Pond Area:	21 sq.m.
			Achieved Vol:	0.32 cu.m.
			Max. Vol. Required:	0.32 cu.m.

Time	i	2.78AiC	Release	Stored	Stored
min.	mm/hr	l/s	Rate	Rate	Volume
			l/s	l/s	cu.m.
5	141	3.97	2.91	1.07	0.32
10	104	2.93	2.91	0.03	0.02
15	84	2.35	2.35	0.00	0.00
20	70	1.98	1.98	0.00	0.00
25	61	1.71	1.71	0.00	0.00
30	54	1.52	1.52	0.00	0.00
35	49	1.37	1.37	0.00	0.00
40	44	1.24	1.24	0.00	0.00
45	41	1.14	1.14	0.00	0.00
50	38	1.06	1.06	0.00	0.00
55	35	0.99	0.99	0.00	0.00
60	33	0.93	0.93	0.00	0.00
65	31	0.87	0.87	0.00	0.00
70	29	0.83	0.83	0.00	0.00
75	28	0.78	0.78	0.00	0.00
80	27	0.75	0.75	0.00	0.00
85	25	0.71	0.71	0.00	0.00
90	24	0.68	0.68	0.00	0.00
95	23	0.66	0.66	0.00	0.00
100	22	0.63	0.63	0.00	0.00
105	22	0.61	0.61	0.00	0.00
110	21	0.59	0.59	0.00	0.00
115	20	0.57	0.57	0.00	0.00
120	19	0.55	0.55	0.00	0.00
125	19	0.53	0.53	0.00	0.00
130	18	0.51	0.51	0.00	0.00
135	18	0.50	0.50	0.00	0.00
140	17	0.49	0.49	0.00	0.00
145	17	0.47	0.47	0.00	0.00
150	16	0.46	0.46	0.00	0.00
180	14	0.40	0.40	0.00	0.00
210	13	0.35	0.35	0.00	0.00
240	11	0.32	0.32	0.00	0.00
270	10	0.29	0.29	0.00	0.00
300	9	0.27	0.27	0.00	0.00

DRAINAGE AREA VI (Unit 7 Roof):

(FIVE YEAR EVENT)

				C
Roof Area:	42	sq.m.	0.90	
Paved Area:	0	sq.m.	0.90	
Landscaped Areas:	0	sq.m.	0.20	
<hr/>	<hr/>	<hr/>	<hr/>	
Total Catchment Area	42	Ave. C	0.90	
No. of Roof Drains:	1			
Slots per Wier:	1	0.0124 l/s/mm/slot (5 USgpm/in/slot)		
Depth at Roof Drain:	51	mm		
Maximum Release Rate	0.63	l/s		
			Pond Area:	17 sq.m.
			Achieved Vol:	0.28 cu.m.
			Max. Vol. Required:	0.28 cu.m.

Time min.	i mm/hr	2.78AiC l/s	Release Rate l/s	Stored Rate l/s	Stored Volume cu.m.
5	141	1.48	0.63	0.86	0.26
10	104	1.09	0.63	0.47	0.28
15	84	0.88	0.63	0.25	0.23
20	70	0.74	0.63	0.11	0.13
25	61	0.64	0.63	0.01	0.02
30	54	0.57	0.57	0.00	0.00
35	49	0.51	0.51	0.00	0.00
40	44	0.46	0.46	0.00	0.00
45	41	0.43	0.43	0.00	0.00
50	38	0.40	0.40	0.00	0.00
55	35	0.37	0.37	0.00	0.00
60	33	0.35	0.35	0.00	0.00
65	31	0.33	0.33	0.00	0.00
70	29	0.31	0.31	0.00	0.00
75	28	0.29	0.29	0.00	0.00
80	27	0.28	0.28	0.00	0.00
85	25	0.27	0.27	0.00	0.00
90	24	0.26	0.26	0.00	0.00
95	23	0.24	0.24	0.00	0.00
100	22	0.24	0.24	0.00	0.00
105	22	0.23	0.23	0.00	0.00
110	21	0.22	0.22	0.00	0.00
115	20	0.21	0.21	0.00	0.00
120	19	0.20	0.20	0.00	0.00
125	19	0.20	0.20	0.00	0.00
130	18	0.19	0.19	0.00	0.00
135	18	0.19	0.19	0.00	0.00
140	17	0.18	0.18	0.00	0.00
145	17	0.18	0.18	0.00	0.00
150	16	0.17	0.17	0.00	0.00
180	14	0.15	0.15	0.00	0.00
210	13	0.13	0.13	0.00	0.00
240	11	0.12	0.12	0.00	0.00
270	10	0.11	0.11	0.00	0.00
300	9	0.10	0.10	0.00	0.00

DRAINAGE AREA VII (Unit 8 Roof):

(FIVE YEAR EVENT)

									C
Roof Area:	45	sq.m.							0.90
Paved Area:	0	sq.m.							0.90
Landscaped Areas:	0	sq.m.							0.20
<hr/>									
Total Catchment Area	45		Ave. C						0.90
No. of Roof Drains:	1								
Slots per Wier:	1	0.0124 l/s/mm/slot	(5 USgpm/in/slot)						
Depth at Roof Drain:	52	mm							
Maximum Release Rate	0.64	l/s				Pond Area:	19	sq.m.	
						Achieved Vol:	0.32	cu.m.	
						Max. Vol. Required:	0.32	cu.m.	

Time	i	2.78AiC	Release	Stored	Stored
min.	mm/hr	l/s	Rate	Rate	Volume
			l/s	l/s	cu.m.
5	141	1.59	0.64	0.95	0.28
10	104	1.17	0.64	0.53	0.32
15	84	0.94	0.64	0.30	0.27
20	70	0.79	0.64	0.15	0.18
25	61	0.69	0.64	0.04	0.07
30	54	0.61	0.61	0.00	0.00
35	49	0.55	0.55	0.00	0.00
40	44	0.50	0.50	0.00	0.00
45	41	0.46	0.46	0.00	0.00
50	38	0.42	0.42	0.00	0.00
55	35	0.40	0.40	0.00	0.00
60	33	0.37	0.37	0.00	0.00
65	31	0.35	0.35	0.00	0.00
70	29	0.33	0.33	0.00	0.00
75	28	0.31	0.31	0.00	0.00
80	27	0.30	0.30	0.00	0.00
85	25	0.29	0.29	0.00	0.00
90	24	0.27	0.27	0.00	0.00
95	23	0.26	0.26	0.00	0.00
100	22	0.25	0.25	0.00	0.00
105	22	0.24	0.24	0.00	0.00
110	21	0.23	0.23	0.00	0.00
115	20	0.23	0.23	0.00	0.00
120	19	0.22	0.22	0.00	0.00
125	19	0.21	0.21	0.00	0.00
130	18	0.21	0.21	0.00	0.00
135	18	0.20	0.20	0.00	0.00
140	17	0.19	0.19	0.00	0.00
145	17	0.19	0.19	0.00	0.00
150	16	0.18	0.18	0.00	0.00
180	14	0.16	0.16	0.00	0.00
210	13	0.14	0.14	0.00	0.00
240	11	0.13	0.13	0.00	0.00
270	10	0.12	0.12	0.00	0.00
300	9	0.11	0.11	0.00	0.00

DRAINAGE AREA VIII

(FIVE YEAR EVENT)

			C
Roof Area:	0	sq.m.	0.90
Asphalt/Concrete Area:	60	sq.m.	0.90
Landscaped:	1	sq.m.	0.20
	<hr/>		
Total Catchment Area	61	sq.m.	0.89

				Storage in MH's & CB's			
Water Elevation:	59.28	m		Invert	Depth		
				m	m		
ICD Invert:	58.85	m		MH-2	58.85	0.43	0.76 cu.m.
(Outlet Pipe OF MH-2)				CB/MH-3	58.86	0.42	0.74 cu.m.
				CB/MH-4	58.87	0.41	0.73 cu.m.

Head:	0.43	m		Storage in Sewer Pipes			
Orifice Diameter	50	mm		Diam.	Length		
				mm	m		
Orifice Area:	1963	sq.mm.		750	10.7	2.36	cu.m.
				750	7.8	1.56	cu.m.

Coefficient of Discharge:	0.148			<hr/>			
Max. Release Rate:	0.85	l/s		Max. Vol. Required:	6.15	cu.m.	

			Inflow from Roofs (Except Unit		Max. Vol. Required:	6.15	cu.m.
			1)	Total	Release	Stored	Stored
Time	i	2.78AiC	Total	Inflow	Rate	Rate	Volume
min.	mm/hr	l/s	l/s	l/s	l/s	l/s	cu.m.
5	141	2.13	6.70	8.82	1.71	7.12	2.13
10	104	1.57	6.70	8.26	1.71	6.56	3.93
15	84	1.26	6.13	7.39	1.71	5.68	5.11
20	70	1.06	5.35	6.41	1.71	4.70	5.65
25	61	0.92	4.81	5.73	1.71	4.02	6.03
30	54	0.81	4.31	5.12	1.71	3.42	6.15
35	49	0.73	3.88	4.61	1.71	2.90	6.09
40	44	0.67	3.53	4.20	1.71	2.49	5.98
45	41	0.61	3.25	3.86	1.71	2.15	5.81
50	38	0.57	3.01	3.58	1.71	1.87	5.61
55	35	0.53	2.81	3.34	1.71	1.63	5.38
60	33	0.50	2.63	3.13	1.71	1.42	5.12
65	31	0.47	2.48	2.95	1.71	1.24	4.84
70	29	0.44	2.35	2.79	1.71	1.08	4.55
75	28	0.42	2.23	2.65	1.71	0.94	4.24
80	27	0.40	2.12	2.52	1.71	0.82	3.92
85	25	0.38	2.03	2.41	1.71	0.70	3.59
90	24	0.37	1.94	2.31	1.71	0.60	3.24
95	23	0.35	1.86	2.21	1.71	0.51	2.89
100	22	0.34	1.79	2.13	1.71	0.42	2.53
105	22	0.33	1.73	2.05	1.71	0.34	2.16
110	21	0.31	1.66	1.98	1.71	0.27	1.79
115	20	0.30	1.61	1.91	1.71	0.20	1.41
120	19	0.29	1.56	1.85	1.71	0.14	1.03
125	19	0.28	1.51	1.79	1.71	0.08	0.64
130	18	0.28	1.46	1.74	1.71	0.03	0.24
135	18	0.27	1.42	1.69	1.69	0.00	0.00
140	17	0.26	1.38	1.64	1.64	0.00	0.00
145	17	0.25	1.34	1.60	1.60	0.00	0.00
150	16	0.25	1.31	1.55	1.55	0.00	0.00
180	14	0.21	1.13	1.35	1.35	0.00	0.00
210	13	0.19	1.00	1.19	1.19	0.00	0.00
240	11	0.17	0.90	1.07	1.07	0.00	0.00
270	10	0.15	0.82	0.98	0.98	0.00	0.00
300	9	0.14	0.76 ₂₃	0.90	0.90	0.00	0.00

POST DEVELOPMENT DRAINAGE AREAS

