Site Servicing and Stormwater Management Report
Proposed Apartment Building
151 Greenbank Road
Ottawa, Ontario

Prepared for:

Phoenix Homes
18 Bentley Avenue
Ottawa, Ontario
K2E 6T8

Attention: Paul Skvor, Vice President

LRL Associates Ltd.
1-2884 Chamberland Street
Rockland, Ontario
K4K 1M6
Tel: (613) 446-7777 or (877) 632-5664
Website: www.LRL.ca
Fax: (613) 446-1427

LRL File No.: 10498

March 1 , 2013

TABLE OF CONTENTS

APPENDICES

1 INTRODUCTION

LRL Associates Ltd. has been retained by Phoenix Homes to prepare a site servicing and stormwater management report in support of the site plan application for the proposed development. The proposed 0.29ha property is located at 151 Greenbank Road in the north east quadrant of the intersection of Greenbank Road and Craig Henry Drive in the City of Ottawa.

The existing property is currently developed with three separate residential dwellings with its own gravel driveways accessed from Greenbank Road and surrounding landscaping in the form of grass and some trees. The existing dwellings are also serviced individually by the existing municipal watermain, storm and sanitary sewers along Greenbank Road as presumed from the information provided by the client; however, in view of the age of the dwellings, the existing services will be abandoned and capped at the property line since the existing services will not meet the current City of Ottawa standards.

The proponent intends to demolish the existing dwellings and construct a proposed 60-unit apartment building comprising of 5-storey and 3-storey structures equalling to a building footprint area of 1118.5m^2 with underground residential parking, above ground visitors parking, 5.0m landscape buffer along the east property line and some landscaping along the perimeter of the building. Since the existing dwellings are presumed to be serviced off of Greenbank Road, the proposed building will also be serviced from Greenbank Road by the existing 406mm municipal watermain and 675mm sanitary sewer, except for the storm sewer where the proposed building will be serviced from Craig Henry Drive by the existing 1220mm municipal storm sewer. The existing 1350mm municipal storm sewer on Greenbank Road is approximately 8.0m deep from the road grade and therefore it was feasible and easier to connect off of Craig Henry where the existing 1220mm storm sewer is only about 5.5m deep.

This report documents the proposed method of servicing the site with municipal water, storm and sanitary service, and includes the means by which stormwater management will be provided.

This report has been prepared in consideration of the terms and conditions noted above and with the site plan prepared by Morris Melamed Architect for the proposed development. Should there be any changes in the design features, which may relate to site servicing considerations, LRL should be advised in order to review the report recommendations. This report should be read in conjunction with the site servicing, grading and drainage plans prepared by LRL Associates Ltd.

2 WATER SUPPLY AND FIRE FLOW PROTECTION

Currently, the existing houses on the property are each serviced by a 25mm water service from the information provided by client; these services will be abandoned and capped at the property line as previously mentioned. A new 150mm diameter water connection off of an existing 406mm diameter watermain is proposed to service the development to provide both the domestic and the firefighting demands. The subject property lies within the City of Ottawa's 2W pressure zone.

Domestic Water Demand for the new building has been determined in accordance with Section 4.28 of the City of Ottawa Water Distribution Guidelines:

Average day Demand Residential	= 350 L/cap/day
For 37 units- 2 bedrooms	= 2.1 ppu
For 23 units- 1 bedrooms	= 1.4 ppu
Average daily flow	= 350x ((37x2.1ppu) + (23x1.4ppu))
	= 38,465 L/day = 0.45 L/s
Maximum daily demand	= 2.5 x average day
	= 2.5 x 38,465
	= 96,163 L /day = 1.12 L/s
Maximum hour demand	= 2.2 x Maximum day
	= 2.2 x 96,163
	= 211,558 L/day = 2.47 L/s

The fire flow requirements for the proposed building shall be as follows:

1. Fire flow based on Fire Underwriters Survey is calculated below for the proposed building as per the City of Ottawa requirements:

An estimate of the fire flow required for a given area is determined by the formula:

F = 220 C √ A

Where F = the required flow in litres per minute.
C = coefficient related to the type of construction
= 1.5 for wood frame construction (structure essentially all combustible)
= 1.0 for ordinary construction (brick or other masonry wall, combustible floor and interior).
= 0.8 for non-combustible construction (unprotected metal structural components, masonry or metal walls).
= 0.6 for fire resistive construction (fully protected frame, floors, and roof).

Gross floor area = 4768.64 m^2 – 5 storeys (provided by the Architect)
Gross floor area = 484.8 m^2 – 3 storeys (provided by the Architect)

C = 1.5 for wood frame construction

1. F = 220 x 1.5 x √ 5253.4
   = 23,918.6 L/min = 24,000 L/min

The building is combustible: No charge

The building is sprinklered: 50% reduction, 12,000 L/min

Exposure distances for the proposed building are as follows:

North = 16.2m from the existing dwelling property, therefore fire flow will increase by 15%
West = 47.8m from existing church, no charge
East = 20m from the existing dwelling property, therefore fire flow will increase by 15%
South = 39.8m from the existing dwelling, therefore fire flow will increase by 5%

Fire flow adjustment factor = 0.15+ 0.15 + 0.05 = 0.35

2. Total required fire flow, F = 12,000 L/min * 1.35,
= 16,200 L/min = **270 L/s**

2. The required fire flows for the proposed site were also calculated based on the Ontario Building Code for a building requiring on-site water supply:

The following equation from the latest version of the Ontario Building Code (2006) was used for calculation of the on-site supply rates required to be supplied by the hydrants. The following equation form the Ontario Building Code was used:

$Q = k\ V\ S_{tot}$ (Section A-3.2.5.7)

Where

Q = minimum supply of water in litres
K = water supply coefficient
V = total building volume
S_{tot} = total of special coefficients

Item	**5 Storey building**	**3 Storey building**
Building Classification	Group C	Group C
Building Height (m)	15.59	9.54
Building Area (m^2)	954.14	164.3
Total Building Volume, V (m^3)	16,442.4	
Water Supply Coefficient, k	18	
Total Spatial Coefficient, S_{tot}	1+(0+0.2+0+0) = 1.2	
Q (L) = kVS_{tot}	355,156	
Required Fire Supply Rate , L/min, (L/s) – Table 2	**9,000 (150)**	

Boundary conditions were provided by the City of Ottawa for the proposed development in an email dated January 24, 2013 based on the demands calculated above. (See appendix A).

Max Day + FF = 124.7 m assuming a fire flow of 270L/s

Max Day + FF = 128.0 m assuming a fire flow of 150L/s

Minimum HGL = 126.7 m

Maximum HGL = 134.2 m

The site has been analysed to ensure all the City of Ottawa minimum criteria for water pressures are met using EPANET hydraulic and water quality analysis and the output results are included in the appendix A.

With respect to maximum day demand and fire flow of 270L/s, the boundary conditions provided by the City of Ottawa indicated the hydraulic grade line of 124.7m which corresponds to an available static pressure of 54.6psi at the street. With static pressure of 54.6psi and a 150 mm pipe to service the property, resulted in the pressure of 31.6psi at the hydrant H068 located at the southeast quadrant of the intersection of Greenbank and Craig Henry and a pressure of 50.8psi at the building using EPANET hydraulic and water quality analysis. As per City's guidelines, during the periods of maximum day and fire flow demand, the residual pressure at any point in the distribution system shall not be less than 20psi and therefore, the pressure drop and the velocity in the pipe during maximum day plus fire flow demand were within the City's requirement.

With respect to maximum day demand and fire flow of 150L/s, the boundary conditions provided by the City of Ottawa indicated the hydraulic grade line of 128m which corresponds to an available static pressure of 59.4psi at the street. With static pressure of 59.4psi and a 150 mm pipe to service the property, resulted in the pressure of 51.6psi at the hydrant H068 located at the southeast quadrant of the intersection of Greenbank and Craig Henry and a pressure of 55.6psi at the building using EPANET hydraulic and water quality analysis. The pressure drop and the velocity in the pipe during maximum day plus fire flow demand of 150L/s were within the City's requirement.

With respect to minimum HGL during peak hour, the boundary conditions provided by the City of Ottawa indicated the hydraulic grade line of 126.7m which corresponds to an available static pressure of 57.6psi at the street. With static pressure of 57.6psi and a 150 mm pipe to service the property, the pressure at the building was calculated to be 53.8psi and velocities through the pipe remain within the tolerable range based on EPANET hydraulic and water quality analysis. As per City's guidelines the minimum allowable pressure is 40psi and therefore, the proposed building has adequate capacity during peak hourly demand.

In view of the above, a 150mm watermain is proposed to connect to the existing 406mm watermain on Greenbank Road which should be adequate enough to meet both the domestic and firefighting demands of the proposed development.

3 SANITARY SERVICE

The existing houses on the property are each serviced by a 75mm sanitary service; these services will also be abandoned and capped at the property line. The proposed development will be connected by a 200mm sanitary service to convey the sanitary discharge from the proposed building to the existing 675mm diameter municipal main located on the west side of the median on Greenbank Road.

The sanitary flow from the development was estimated according to the City of Ottawa Sewer Design Guidelines – 2004 as follows:

Average Flow = 350L/p/day

Population Density
For 37 units- 2 bedrooms = 2.1 ppu
For 23 units- 1 bedrooms = 1.4 ppu

Peak Factor = 4.2 – Use maximum 4.0 as per guidelines.

Average Day Waste Flow = 350x ((37x2.1ppu) + (23x1.4ppu)) = 38,465 L/d
Peak Waste Flow = Avg. Day x 4.0
= 38,465x 4.0 = 153,860 L/d = 1.8 L/s

Infiltration
Q Infiltration = 0.28 L/ha/sec x 0.29 ha = 0.08 L/sec

Total Peak Sanitary Flow = 1.8 + 0.08 = 1.88 L/sec

The peak sanitary flow rate from the proposed development is 1.88 L/sec, which can easily be conveyed by a proposed service of 200mm at minimum 1.0% slope. The hydraulic analysis of the pipe demonstrated that the capacity of the pipe while not under pressure is 34.2L/s. Correspondence with the City of Ottawa did not identify any capacity issues for the existing 675mm sanitary sewer system in the area and therefore the proposed 200mm sewer service should be adequate to convey the calculated peak flows.

4 STORMWATER DESIGN

4.1 Stormwater Criteria

The peak 1:100 year stormwater flow rate arising from the site under post-development condition must not exceed the 1:5 year pre-development peak flow rate. Post-development flows from both the 5-year and 100-year event from the proposed 0.29ha site will be controlled to the 5-year pre-development release rate via installation of inlet controls on the roof.

The major system has been designed to accommodate on-site detention with sufficient capacity to attenuate the 100-year design storm. Flows in excess of allowable runoff will be detained on-site using on-site storage for up to the 100-year storm event with maximum ponding of 150mm on the roof. The depth and the extent of surface storage will be illustrated on the grading and drainage plan. Excess runoff above the 100-year event from the building roofs will flow via scuppers and downspouts and overland onto the adjacent street, and excess runoff from the visitors parking area roof will overland towards Greenbank Road via an entrance way.

4.2 Pre-Development Flows

The allowable release rate from the site was determined for the 5-year and 100-year storms using runoff coefficient C-value of 0.5 and a time of concentration (Tc) of 10 minutes as provided by the City of Ottawa staff. Using the Rational Method, the pre-development flows from the subject site are determined to be 42.0L/s for the 5-year and 72.0L/s for the 100-year events. (Appendix B).

4.3 Post-Development Flows

Post development flows have been calculated using the rational method and based on a time of concentration of 10 minutes. Runoff coefficients for the 100-year storm were increased by 25% to a maximum of 1.0 as per City of Ottawa Guidelines. For 5-year event, runoff coefficients for asphalt, concrete sidewalk and roof areas were taken as 0.90 and for grassed areas as 0.20.

The storm drainage areas are illustrated in the drawing C.003. A total of fourteen (14) sub-drainage areas are outlined in this drawing. Stormwater runoff from drainage areas WS-01 to WS-08 will be controlled by the roof drain restrictors prior to discharging into the existing municipal main on Craig Henry Drive and flows from drainage areas WS-09 to WS-14 will sheet drain uncontrolled. The weighted average runoff coefficient for each drainage area is shown on drawing C.003.

The total 5-year and 100-year post development flows are 58.6L/sec and 115.3L/sec. These flows will be restricted to 42.0L/sec for 5-year and 100-year using roof drain restrictors on the roof. However, as a portion of the site is uncontrolled, the allowable release rate from the storm sewer system (controlled areas) equals the allowable release rate minus the release rate from the 100-yr uncontrolled portion of the site. The total uncontrolled release rate from drainage areas WS-09 to WS-14 for 100-year storm is 26.2L/s. Therefore, the allowable release rate from the controlled areas for a 100-year storm is 15.8L/s.

Runoff from the building roof and parking area roof (WS-01 to WS-08) will be restricted to a total rate of 9.4L/sec for the 5-year and 12.7L/sec for the 100-year storms using roof drain restrictors RD-100-CP by WATTS's drainage placed in each rooftop drain. Specification for roof drain is attached in Appendix C, with an estimated 1 weir per roof drain opening. The estimated ponding depths vary between 40.0mm to 114.5mm for the 5-year event and between 75mm to 148.7mm for the 100-year event. Total storage required on the rooftop based on the total captured rate for each storm event is 26.8m^3 for the 5-year event and 62.3m^3 for the 100-year event (Appendix B).

Based on a building roof area of 1118.5m^2 an effective (useable) roof area of 895m^2 (or 80%) was estimated as available for storage and the available storage on the parking areas was estimated by the ponding areas based on the proposed grading. The total storage available on the roofs of the building as well as the parking surface at 100-year elevation is 68.6m^3. Therefore, it can be concluded that the storage available on the roof is sufficient to provide adequate storage for up to the 100-year event. The roof drain from the building will outlet from the south east corner of the building and discharge into the existing 1220mm municipal storm sewer via a proposed 250mm storm service.

It is understood that the proposed building will have an underground parking; therefore it will be necessary to provide a weeping tile along the perimeter of the building foundation. The weeping tile will be connected to a 250mm storm service to outlet into the existing municipal storm sewer on Craig Henry Drive.

Storm discharge to the existing 1220mm storm sewer on Craig Henry Drive will be controlled upon redevelopment. The release rate will be less than under the current uncontrolled condition therefore the redevelopment can be accommodated by the existing municipal storm sewer network.

5 Conclusions and Recommendations

This analysis concluded that the existing municipal infrastructures have sufficient capacity to support the proposed development. During construction best management practices related to sediment and erosion control are recommended in order to reduce impact on downstream watercourses.

6 Limitations and Use of Report

The report conclusions are applicable only to the project described in the report. Any changes will require a review by LRL Associates Ltd. to insure compatibility with the recommendations contained in this report.

We trust the information presented in this report meets your current requirements. Please do not hesitate to contact us should you have any questions or concerns.

Yours truly,

LRL Associates Ltd.

Prepared by:

LICENSED PROFESSIONAL ENGINEER
L M. JAFFERJEE
100164153
March 1, 2013
PROVINCE OF ONTARIO

Ishaque Jafferjee, P.Eng.

APPENDIX A

Watermain Boundary Conditions EPANET output results

Ishaque Jafferjee

From: Robertson, Syd <Syd.Robertson@ottawa.ca>
Sent: January-24-13 1:35 PM
To: ijafferjee@lrl.ca
Subject: Greenbank Rd_149, 151 & 153 - Request for boundary condtions
Attachments: 151 Greenbank Jan 2013.pdf

Hi Ishaque:

The following are boundary conditions, HGL, for hydraulic analysis at 151 Greenbank (Pressure Zone 2W), assumed to be connected to the existing 406mm on Greenbank, approximately 35m north of Canfield (see attached PDF for location).

Max Day + FF = 124.7 m assuming a fire flow of 270L/s

Max Day + FF = 128.0 m assuming a fire flow of 150L/s

Minimum HGL = 126.7 m

Maximum HGL = 134.2 m

These are for current conditions and are based on computer model simulation.

Disclaimer: The boundary condition information is based on current operation of the city water distribution system. The computer model simulation is based on the best information available at the time. The operation of the water distribution system can change on a regular basis, resulting in a variation in boundary conditions. The physical properties of watermains deteriorate over time, as such must be assumed in the absence of actual field test data. The variation in physical watermain properties can therefore alter the results of the computer model simulation.

Syd Robertson, C.E.T.
Project Manager, Infrastructure Approvals
Development Review Branch, Urban Services, Outer Core
Planning & Growth Management Department
110 Laurier Ave. W., 4th Floor E
Ottawa, ON K1P 1J1
(613) 580-2424 ext/poste 27916
Syd.Robertson@ottawa.ca
www.ottawa.ca

From: Ishaque Jafferjee [mailto:ijafferjee@lrl.ca]
Sent: January 21, 2013 8:54 AM
To: Robertson, Syd
Cc: 'Paul Skvor'
Subject: 10498 - Proposed development 151 Greenbank Road

Syd,

Please find below the information required for watermain pressures for the sizing of water lateral:

1. Type of development – 60-units five and three storey apartment building, and the amount of fire flow required - 270 L/s based on Fire Underwriter's Survey and 150L/s using Ontario Building code.
2. Average daily demand: 0.45 L/s.
3. Maximum daily demand: 1.12 L/s.

4. Maximum hourly daily demand: 2.47 L/s.

Please provide watermain boundary pressures at your earliest convenience so we can adequately size the service required for the proposed development.
Thanks

Ishaque Jafferjee, P. Eng.
Project Engineer

ASSOCIATES • ASSOCIÉS
ENGINEERS INGÉNIEURS

LRL Associates Ltd.
1-2884 Chamberland Street
Rockland, Ontario K4K 1M6
Tel: (613) 446-7777 or (877) 632-5664
Cell: (613) 913-1030
Fax: (613) 446-1427
Website: www.LRL.ca

Boundary Condition for 151 Greenbank Rd

```
**********************************************************************
*                            E P A N E T                             *
*                    Hydraulic and Water Quality                     *
*                    Analysis for Pipe Networks                      *
*                           Version 2.0                              *
**********************************************************************
```

Input File: 10498 max day+ff 270.net

Link - Node Table:

Link ID	Start Node	End Node	Length m	Diameter mm
1	1	2	57.83	406
2	2	3	13.42	150
3	2	4	35.87	406
4	4	5	11.70	406
5	5	6	8.37	150
6	5	7	59.83	406
7	7	8	5.70	600
8	1	9	3.70	600

Node Results:

Node ID	Demand LPS	Head m	Pressure m	Quality	
1	0.00	124.70	38.95	0.00	
2	0.00	124.61	38.38	0.00	
3	1.12	124.61	35.73	0.00	
4	0.00	124.59	38.09	0.00	
5	0.00	124.58	38.33	0.00	
6	270.00	108.48	22.23	0.00	
7	0.00	124.70	39.30	0.00	
8	-176.52	124.70	0.00	0.00	Reservoir
9	-94.60	124.70	0.00	0.00	Reservoir

Link Results:

Link ID	Flow LPS	Velocity m/s	Unit Headloss m/km	Status
1	94.60	0.73	1.54	Open
2	1.12	0.06	0.07	Open
3	93.48	0.72	0.59	Open
4	93.48	0.72	0.58	Open
5	270.00	15.28	1923.87	Open
6	-176.52	1.36	1.90	Open
7	-176.52	0.62	0.73	Open
8	-94.60	0.33	0.23	Open

Page 2

Page 1 25/01/2013 11:58:37 AM

```
**********************************************************************
*                             E P A N E T                            *
*                     Hydraulic and Water Quality                    *
*                     Analysis for Pipe Networks                     *
*                            Version 2.0                             *
**********************************************************************
```

Input File: 10498 peak demand.net

Link - Node Table:

Link ID	Start Node	End Node	Length m	Diameter mm
1	1	2	57.83	406
2	2	3	13.42	150
3	2	4	35.87	406
4	4	5	11.70	406
5	5	6	8.37	150
6	5	7	59.83	406
7	7	8	5.70	600
8	1	9	3.70	600

Node Results:

Node ID	Demand LPS	Head m	Pressure m	Quality	
1	0.00	134.20	48.45	0.00	
2	0.00	134.20	47.97	0.00	
3	0.00	134.20	45.32	0.00	
4	0.00	134.20	47.70	0.00	
5	0.00	134.20	47.95	0.00	
6	0.00	134.20	47.95	0.00	
7	0.00	134.20	48.80	0.00	
8	0.00	134.20	0.00	0.00	Reservoir
9	0.00	134.20	0.00	0.00	Reservoir

Link Results:

Link ID	Flow LPS	VelocityUnit m/s	Headloss m/km	Status
1	0.00	0.00	0.00	Open
2	0.00	0.00	0.00	Open
3	0.00	0.00	0.00	Open
4	0.00	0.00	0.00	Open
5	0.00	0.00	0.00	Open
6	0.00	0.00	0.00	Open
7	0.00	0.00	0.00	Open
8	0.00	0.00	0.00	Open

Page 2

```
**********************************************************************
*                            E P A N E T                             *
*                    Hydraulic and Water Quality                     *
*                    Analysis for Pipe Networks                      *
*                           Version 2.0                              *
**********************************************************************
```

Input File: 10498 max day+ff.net

Link - Node Table:

Link ID	Start Node	End Node	Length m	Diameter mm
1	1	2	57.83	406
2	2	3	13.42	150
3	2	4	35.87	406
4	4	5	11.70	406
5	5	6	8.37	150
6	5	7	59.83	406
7	7	8	5.70	600
8	1	9	3.70	600

Node Results:

Node ID	Demand LPS	Head m	Pressure m	Quality	
1	0.00	128.00	42.25	0.00	
2	0.00	127.97	41.74	0.00	
3	1.12	127.97	39.09	0.00	
4	0.00	127.96	41.46	0.00	
5	0.00	127.96	41.71	0.00	
6	150.00	122.54	36.29	0.00	
7	0.00	128.00	42.60	0.00	
8	-98.31	128.00	0.00	0.00	Reservoir
9	-52.81	128.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow LPS	Velocity m/s	Unit Headloss m/km	Status
1	52.81	0.41	0.52	Open
2	1.12	0.06	0.07	Open
3	51.69	0.40	0.20	Open
4	51.69	0.40	0.19	Open
5	150.00	8.49	647.76	Open
6	-98.31	0.76	0.64	Open
7	-98.31	0.35	0.25	Open
8	-52.81	0.19	0.08	Open

Page 2

```
**********************************************************************
*                           E P A N E T                              *
*                   Hydraulic and Water Quality                      *
*                   Analysis for Pipe Networks                       *
*                         Version 2.0                                *
**********************************************************************
```

Input File: 10498 minimum hgl.net

Link - Node Table:

Link ID	Start Node	End Node	Length m	Diameter mm
1	1	2	57.83	406
2	2	3	13.42	150
3	2	4	35.87	406
4	4	5	11.70	406
5	5	6	8.37	150
6	5	7	59.83	406
7	7	8	5.70	600
8	1	9	3.70	600

Node Results:

Node ID	Demand LPS	Head m	Pressure m	Quality	
1	0.00	126.70	40.95	0.00	
2	0.00	126.70	40.47	0.00	
3	2.47	126.70	37.82	0.00	
4	0.00	126.70	40.20	0.00	
5	0.00	126.70	40.45	0.00	
6	0.00	126.70	40.45	0.00	
7	0.00	126.70	41.30	0.00	
8	-1.34	126.70	0.00	0.00	Reservoir
9	-1.13	126.70	0.00	0.00	Reservoir

Link Results:

Link ID	Flow LPS	VelocityUnit m/s	Headloss m/km	Status
1	1.13	0.01	0.00	Open
2	2.47	0.14	0.32	Open
3	-1.34	0.01	0.00	Open
4	-1.34	0.01	0.00	Open
5	0.00	0.00	0.00	Open
6	-1.34	0.01	0.00	Open
7	-1.34	0.00	0.00	Open
8	-1.13	0.00	0.00	Open

Page 2

APPENDIX B

Stormwater Management Calculations Sheets

LRL Associates Ltd.

Storm Water Management Design Sheet

TABLE 1 - ALLOWABLE RUNOFF

			Storm = 5 yr			Storm = 100 yr		
Area Description	Area (ha)	Time of Conc, Tc (min)	I_5 (mm/hr)	Cavg	Q_5 (L/sec)	I_{100} (mm/hr)	Cavg	Q_{100}(L/sec)
Existing site	0.2900	10	104.19	0.50	**42.0**	178.56	0.50	72.0
Allowable Capture Rate is based on 5-year storm at Tc=10 mins								
Q_5 (L/sec) = 2.78 C I A								

5-year Storm $C_{ASPH/ROOF/CONC}$ = 0.90 C_{GRASS} = 0.20

100-year Storm $C_{ASPH/ROOF/CONC}$ = 1.00 C_{GRASS} = 0.25

$C_{(100\text{-}yr)}$ for post development flows is increased by 25% to a maximum of 1.00

TABLE 2- POST DEVELOPMENT AVERAGE RUNOFF COEFFICIENTS

Area No.	Asphalt/Roof /Conc Areas (m^2)	A * C_{ASPH}	Grassed Areas (m^2)	A * C_{GRASS}	Sum AC	Total Area (m^2)	$C_{5\text{-}yr}$	$C_{100\text{-}yr}$
WS-01	284.2	255.8	0.0	0.0	255.8	284.2	0.90	1.00
WS-02	280.3	252.3	0.0	0.0	252.3	280.3	0.90	1.00
WS-03	392.3	353.0	0.0	0.0	353.0	392.3	0.90	1.00
WS-04	161.6	145.4	0.0	0.0	145.4	161.6	0.90	1.00
WS-05	122.1	109.9	21.6	4.3	114.2	143.6	0.79	0.99
WS-06	342.6	308.3	18.6	3.7	312.0	361.1	0.86	1.00
WS-07	103.8	93.4	138.5	27.7	121.1	242.3	0.50	0.62
WS-08	0.0	0.0	81.7	16.3	16.3	81.7	0.20	0.25
WS-09**	259.1	233.2	0.0	0.0	233.2	259.1	0.90	1.00
WS-10**	47.1	42.4	0.0	0.0	42.4	47.1	0.90	1.00
WS-11**	21.6	19.4	78.3	15.7	35.1	99.9	0.35	0.44
WS-12**	33.8	30.4	181.9	36.4	66.7	215.6	0.31	0.39
WS-13**	0.0	0.0	294.0	58.8	58.8	294.0	0.20	0.25
WS-14**	14.1	12.7	22.0	4.4	17.1	36.1	0.47	0.59
Total	1,687		260		1,570	1,947		
**Total	376		576		453	952		
Average Runoff Coefficient (Post Development-Controlled flows)								
	$C_{AVG(5yr)}$ =	**1,570 / 1,947**	**=**	**0.81**			**$C_{AVG(100yr)}$ =**	**1.00**
**Average Runoff Coefficient (Post Development-Uncontrolled flows)								
	$C_{AVG(5yr)}$ =	**453 / 952**	**=**	**0.48**			**$C_{AVG(100yr)}$ =**	**0.60**

TABLE 3- POST DEVELOPMENT RUNOFF

		Storm = 5 yr				Storm = 100 yr			
Area No	Area (ha)	I_5 (mm/hr)	C_{AVG}	Q_{UNCONT} (l/s)	Q_{CONT} (l/s)	I_{100} (mm/hr)	C_{AVG}	Q_{UNCONT} (l/s)	Q_{CONT} (l/s)
WS-01	0.028	104.19	0.90	7.4	**15.8**	178.56	1.00	14.1	**15.8**
WS-02	0.028	104.19	0.90	7.3		178.56	1.00	13.9	
WS-03	0.039	104.19	0.90	10.2		178.56	1.00	19.5	
WS-04	0.016	104.19	0.90	4.2		178.56	1.00	8.0	
WS-05	0.014	104.19	0.79	3.3		178.56	0.99	7.1	
WS-06	0.036	104.19	0.86	9.0		178.56	1.00	17.9	
WS-07	0.024	104.19	0.50	3.5		178.56	0.62	7.5	
WS-08	0.008	104.19	0.20	0.5		178.56	0.25	1.0	
WS-09**	0.026	104.19	0.90	6.8	6.8	178.56	1.00	12.9	12.9
WS-10**	0.005	104.19	0.90	1.2	1.2	178.56	1.00	2.3	2.3
WS-11**	0.010	104.19	0.35	1.0	1.0	178.56	0.44	2.2	2.2
WS-12**	0.022	104.19	0.31	1.9	1.9	178.56	0.39	4.1	4.1
WS-13**	0.029	104.19	0.20	1.7	1.7	178.56	0.25	3.6	3.6
WS-14**	0.004	104.19	0.47	0.5	0.5	178.56	0.59	1.1	1.1
Totals	0.290			58.6	28.9			115.3	42.0
Q_{CONT} (l/s) = Q_5 - Sum of $Q_{100\text{-}yr}$ uncontrolled (WS-09 to WS-14)									
$I_5 = 998.071 / (Tc + 6.053)^{0.814}$									
$I_{100} = 1735.688 / (Tc + 6.014)^{0.820}$									
Time of Concentration (min), Tc =			10 mins						

** Uncontrolled areas

Table 4 - 5-year & 100-year ROOF STORAGE REQUIREMENT

Roof Drain #	Runoff Coeff (C-5yr)	Runoff Coeff (C-100yr)	Drainage Area (ha)	5-year Event			100-year Event			Storage Required		Maximum storage available		
				Runoff Rate (L/sec)	Ponding Depth (mm)	Roof Drain Capacity (L/sec)	Runoff Rate (L/sec)	Ponding Depth (mm)	Roof Drain Capacity (L/sec)	5-year (m^3)	100-year (m^3)	Area (m^2)	Depth (m)	Volume (m^3)
RD1	0.90	1.00	0.028	7.4	109.5	1.38	14.1	143.3	1.81	4.4	9.9	227.4	0.150	11.4
RD2	0.90	1.00	0.028	7.3	109.3	1.38	13.9	143.1	1.80	4.3	9.7	224.3	0.150	11.2
RD3	0.90	1.00	0.039	10.2	114.5	1.44	19.5	148.7	1.87	7.0	15.3	313.8	0.150	15.7
RD4	0.90	1.00	0.016	4.2	99.9	1.26	8.0	132.8	1.67	1.9	4.5	129.3	0.150	6.5
RD5	0.79	0.99	0.014	3.3	84.9	1.07	7.1	119.1	1.50	1.4	3.9	117.8	0.130	5.1
RD6	0.86	1.00	0.036	9.0	106.2	1.34	17.9	130.0	1.64	6.0	14.3	255.0	0.130	11.0
RD7	0.50	0.62	0.024	3.5	80.2	1.01	7.5	112.1	1.41	1.6	4.4	159.8	0.130	6.9
RD8	0.20	0.25	0.008	0.5	40.0	0.50	1.0	75.0	0.95	0.0	0.1	24.0	0.100	0.8
Totals			**0.195**			**9.4**			**12.7**	**26.8**	**62.3**			**68.6**

Runoff Based on the Following:

Time of Conc (mins) =	10	10
Storm Frequency (years) =	5	100
Storm Intensity (mm/hr) =	104.19	178.56

Estimated Effective Building Roof Area for Storage

Total Roof Area (m2) = 1118.5

Effective Roof Area (m2) = 894.8

Effective Area (%) = 80.0%

Roof Drains have following Flow Rates:

Head (mm)	25	50	75	100	125	150
No Weir Slots	1	1	1	1	1	1
Flow per Weir	5	10	15	20	25	30
Flow Rate (uspgm)	5	10	15	20	25	30
Flow Rate (L/sec)	0.32	0.63	0.95	1.26	1.58	1.89
Eqn for Flow, Q at depth, d		Q =0.0126 * d				

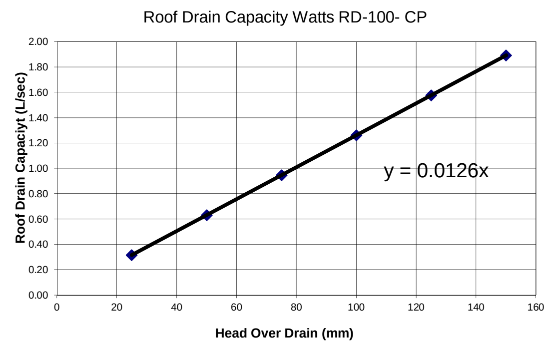


TABLE 5 - STORAGE VOLUME REQUIRED (5-YEAR and 100-YEAR STORMS)
(RD1)

C_{AVG} = 0.90 (5-year)
C_{AVG} = 1.00 (100-year)
Time Interval = 5 (mins)
Drainage Area = 0.02842 (hectares)

	5-year					100-year				
	Release Rate = 1.38 (L/sec)					Release Rate = 1.81 (L/sec)				
	Return Period = 5 (years)					Return Period = 100 (years)				
	IDF Parameters, A = 998.071, B = 0.814					IDF Parameters, A = 1735.688, B = 0.820				
	(I = A/(T_c+C), C = 6.053					(I = A/(T_c+C), C = 6.014				
Time (min)	**Intensity, I (mm/hr)**	**Peak Flow (L/s)**	**Release Rate (L/s)**	**Storage Rate (L/s)**	**Storage Volume (m^3)**	**Intensity, I (mm/hr)**	**Peak Flow (L/s)**	**Release Rate (L/s)**	**Storage Rate (L/s)**	**Storage Volume (m^3)**
0	230.5	16.4	1.38	15.0	0.00	398.6	31.5	1.806	29.7	0.00
5	141.2	10.0	1.38	8.7	2.60	242.7	19.2	1.806	17.4	5.21
10	104.2	7.4	1.38	6.0	3.62	178.6	14.1	1.806	12.3	7.38
15	83.6	5.9	1.38	4.6	4.11	142.9	11.3	1.806	9.5	8.54
20	70.3	5.0	1.38	3.6	4.34	120.0	9.5	1.806	7.7	9.21
25	60.9	4.3	1.38	3.0	4.43	103.8	8.2	1.806	6.4	9.60
30	53.9	3.8	1.38	2.5	4.42	91.9	7.3	1.806	5.5	9.82
35	48.5	3.5	1.38	2.1	4.35	82.6	6.5	1.806	4.7	9.91
40	44.2	3.1	1.38	1.8	4.23	75.1	5.9	1.806	4.1	9.92
45	40.6	2.9	1.38	1.5	4.08	69.1	5.5	1.806	3.7	9.86
50	37.7	2.7	1.38	1.3	3.89	64.0	5.1	1.806	3.2	9.74
55	35.1	2.5	1.38	1.1	3.69	59.6	4.7	1.806	2.9	9.59
60	32.9	2.3	1.38	1.0	3.47	55.9	4.4	1.806	2.6	9.40
65	31.0	2.2	1.38	0.8	3.23	52.6	4.2	1.806	2.4	9.18
70	29.4	2.1	1.38	0.7	2.98	49.8	3.9	1.806	2.1	8.94
75	27.9	2.0	1.38	0.6	2.72	47.3	3.7	1.806	1.9	8.68
80	26.6	1.9	1.38	0.5	2.44	45.0	3.6	1.806	1.7	8.40
85	25.4	1.8	1.38	0.4	2.16	43.0	3.4	1.806	1.6	8.10
90	24.3	1.7	1.38	0.3	1.88	41.1	3.2	1.806	1.4	7.79
95	23.3	1.7	1.38	0.3	1.58	39.4	3.1	1.806	1.3	7.47
100	22.4	1.6	1.38	0.2	1.28	37.9	3.0	1.806	1.2	7.14
105	21.6	1.5	1.38	0.2	0.98	36.5	2.9	1.806	1.1	6.79
110	20.8	1.5	1.38	0.1	0.67	35.2	2.8	1.806	1.0	6.44
115	20.1	1.4	1.38	0.1	0.35	34.0	2.7	1.806	0.9	6.08
120	19.5	1.4	1.38	0.0	0.03	32.9	2.6	1.806	0.8	5.71
Max =					**4.43**					**9.92**

Notes
1) Peak flow is equal to 2.78 x C x I x A
2) Intensity, I = $A/(Tc+C)^B$
3) Release Rate = Min (Release Rate, Peak Flow)
4) Storage Rate = Peak Flow - Release Rate
5) Storage = Time x Storage Rate
6) Maximum Storage = Max Storage Over Time

TABLE 6 - STORAGE VOLUME REQUIRED (5-YEAR and 100-YEAR STORMS)
(RD 2)

C_{AVG} = 0.90 (5-year)
C_{AVG} = 1.00 (100-year)
Time Interval = 5 (mins)
Drainage Area = 0.02803 (hectares)

	5-year					100-year				
	Release Rate = **1.38** (L/sec); Return Period = 5 (years); IDF Parameters, A = 998.071, B = 0.814, C = 6.053; ($I = A/(T_c+C)$)					Release Rate = **1.80** (L/sec); Return Period = 100 (years); IDF Parameters, A = 1735.688, B = 0.820, C = 6.014; ($I = A/(T_c+C)$)				
Time (min)	**Intensity, I (mm/hr)**	**Peak Flow (L/s)**	**Release Rate (L/s)**	**Storage Rate (L/s)**	**Storage Volume (m^3)**	**Intensity, I (mm/hr)**	**Peak Flow (L/s)**	**Release Rate (L/s)**	**Storage Rate (L/s)**	**Storage Volume (m^3)**
0	230.5	16.2	1.38	14.8	0.00	398.6	31.1	1.803	29.3	0.00
5	141.2	9.9	1.38	8.5	2.56	242.7	18.9	1.803	17.1	5.13
10	104.2	7.3	1.38	5.9	3.56	178.6	13.9	1.803	12.1	7.27
15	83.6	5.9	1.38	4.5	4.04	142.9	11.1	1.803	9.3	8.40
20	70.3	4.9	1.38	3.6	4.26	120.0	9.3	1.803	7.5	9.05
25	60.9	4.3	1.38	2.9	4.34	103.8	8.1	1.803	6.3	9.44
30	53.9	3.8	1.38	2.4	4.33	91.9	7.2	1.803	5.4	9.64
35	48.5	3.4	1.38	2.0	4.25	82.6	6.4	1.803	4.6	9.73
40	44.2	3.1	1.38	1.7	4.13	75.1	5.9	1.803	4.1	9.73
45	40.6	2.8	1.38	1.5	3.98	69.1	5.4	1.803	3.6	9.66
50	37.7	2.6	1.38	1.3	3.79	64.0	5.0	1.803	3.2	9.54
55	35.1	2.5	1.38	1.1	3.59	59.6	4.6	1.803	2.8	9.38
60	32.9	2.3	1.38	0.9	3.36	55.9	4.4	1.803	2.6	9.19
65	31.0	2.2	1.38	0.8	3.12	52.6	4.1	1.803	2.3	8.97
70	29.4	2.1	1.38	0.7	2.87	49.8	3.9	1.803	2.1	8.72
75	27.9	2.0	1.38	0.6	2.61	47.3	3.7	1.803	1.9	8.46
80	26.6	1.9	1.38	0.5	2.33	45.0	3.5	1.803	1.7	8.18
85	25.4	1.8	1.38	0.4	2.05	43.0	3.3	1.803	1.5	7.88
90	24.3	1.7	1.38	0.3	1.76	41.1	3.2	1.803	1.4	7.56
95	23.3	1.6	1.38	0.3	1.47	39.4	3.1	1.803	1.3	7.24
100	22.4	1.6	1.38	0.2	1.17	37.9	3.0	1.803	1.2	6.91
105	21.6	1.5	1.38	0.1	0.86	36.5	2.8	1.803	1.0	6.56
110	20.8	1.5	1.38	0.1	0.55	35.2	2.7	1.803	0.9	6.21
115	20.1	1.4	1.38	0.0	0.23	34.0	2.7	1.803	0.8	5.85
120	19.5	1.4	1.38	0.0	-0.08	32.9	2.6	1.803	0.8	5.48
Max =					**4.34**					**9.73**

Notes

1) Peak flow is equal to 2.78 x C x I x A
2) Intensity, $I = A/(Tc+C)^B$
3) Release Rate = Min (Release Rate, Peak Flow)
4) Storage Rate = Peak Flow - Release Rate
5) Storage = Time x Storage Rate
6) Maximum Storage = Max Storage Over Time

TABLE 7 - STORAGE VOLUME REQUIRED (5-YEAR and 100-YEAR STORMS)
(RD 3)

C_{AVG} = 0.90 (5-year)

C_{AVG} = 1.00 (100-year)

Time Interval = 5 (mins)

Drainage Area = 0.03923 (hectares)

	5-year					100-year				
	Release Rate = 1.44 (L/sec)					Release Rate = 1.87 (L/sec)				
	Return Period = 5 (years)					Return Period = 100 (years)				
	IDF Parameters, A = 998.071, B = 0.814					IDF Parameters, A = 1735.688, B = 0.820				
	($I = A/(T_c+C)$), C = 6.053					($I = A/(T_c+C)$), C = 6.014				
Time (min)	**Intensity, I (mm/hr)**	**Peak Flow (L/s)**	**Release Rate (L/s)**	**Storage Rate (L/s)**	**Storage Volume (m^3)**	**Intensity, I (mm/hr)**	**Peak Flow (L/s)**	**Release Rate (L/s)**	**Storage Rate (L/s)**	**Storage Volume (m^3)**
0	230.5	22.6	1.44	21.2	0.00	398.6	43.5	1.874	41.6	0.00
5	141.2	13.9	1.44	12.4	3.72	242.7	26.5	1.874	24.6	7.38
10	104.2	10.2	1.44	8.8	5.27	178.6	19.5	1.874	17.6	10.56
15	83.6	8.2	1.44	6.8	6.08	142.9	15.6	1.874	13.7	12.34
20	70.3	6.9	1.44	5.5	6.54	120.0	13.1	1.874	11.2	13.45
25	60.9	6.0	1.44	4.5	6.80	103.8	11.3	1.874	9.5	14.18
30	53.9	5.3	1.44	3.9	6.93	91.9	10.0	1.874	8.1	14.66
35	48.5	4.8	1.44	3.3	6.97	82.6	9.0	1.874	7.1	14.98
40	44.2	4.3	1.44	2.9	6.95	75.1	8.2	1.874	6.3	15.17
45	40.6	4.0	1.44	2.5	6.87	69.1	7.5	1.874	5.7	15.27
50	37.7	3.7	1.44	2.3	6.76	64.0	7.0	1.874	5.1	15.30
55	35.1	3.4	1.44	2.0	6.62	59.6	6.5	1.874	4.6	15.27
60	32.9	3.2	1.44	1.8	6.45	55.9	6.1	1.874	4.2	15.20
65	31.0	3.0	1.44	1.6	6.26	52.6	5.7	1.874	3.9	15.08
70	29.4	2.9	1.44	1.4	6.05	49.8	5.4	1.874	3.6	14.93
75	27.9	2.7	1.44	1.3	5.83	47.3	5.2	1.874	3.3	14.76
80	26.6	2.6	1.44	1.2	5.59	45.0	4.9	1.874	3.0	14.55
85	25.4	2.5	1.44	1.0	5.34	43.0	4.7	1.874	2.8	14.33
90	24.3	2.4	1.44	0.9	5.08	41.1	4.5	1.874	2.6	14.09
95	23.3	2.3	1.44	0.8	4.81	39.4	4.3	1.874	2.4	13.83
100	22.4	2.2	1.44	0.8	4.54	37.9	4.1	1.874	2.3	13.56
105	21.6	2.1	1.44	0.7	4.26	36.5	4.0	1.874	2.1	13.27
110	20.8	2.0	1.44	0.6	3.97	35.2	3.8	1.874	2.0	12.97
115	20.1	2.0	1.44	0.5	3.67	34.0	3.7	1.874	1.8	12.66
120	19.5	1.9	1.44	0.5	3.37	32.9	3.6	1.874	1.7	12.33
Max =					**6.97**					**15.30**

Notes

1) Peak flow is equal to 2.78 x C x I x A
2) Intensity, $I = A/(Tc+C)^B$
3) Release Rate = Min (Release Rate, Peak Flow)
4) Storage Rate = Peak Flow - Release Rate
5) Storage = Time x Storage Rate
6) Maximum Storage = Max Storage Over Time

TABLE 8 - STORAGE VOLUME REQUIRED (5-YEAR and 100-YEAR STORMS)
(RD 4)

C_{AVG} = 0.90 (5-year)
C_{AVG} = 1.00 (100-year)
Time Interval = 5 (mins)
Drainage Area = 0.01616 (hectares)

	5-year					100-year				
	Release Rate = **1.26** (L/sec)					Release Rate = **1.67** (L/sec)				
	Return Period = 5 (years)					Return Period = 100 (years)				
	IDF Parameters, A = 998.071, B = 0.814					IDF Parameters, A = 1735.688, B = 0.820				
	(I = A/(T_c+C)), C = 6.053					(I = A/(T_c+C)), C = 6.014				
Time (min)	**Intensity, I (mm/hr)**	**Peak Flow (L/s)**	**Release Rate (L/s)**	**Storage Rate (L/s)**	**Storage Volume (m^3)**	**Intensity, I (mm/hr)**	**Peak Flow (L/s)**	**Release Rate (L/s)**	**Storage Rate (L/s)**	**Storage Volume (m^3)**
0	230.5	9.3	1.26	8.1	0.00	398.6	17.9	1.673	16.2	0.00
5	141.2	5.7	1.26	4.4	1.33	242.7	10.9	1.673	9.2	2.77
10	104.2	4.2	1.26	3.0	1.77	178.6	8.0	1.673	6.3	3.81
15	83.6	3.4	1.26	2.1	1.91	142.9	6.4	1.673	4.7	4.27
20	70.3	2.8	1.26	1.6	1.90	120.0	5.4	1.673	3.7	4.46
25	60.9	2.5	1.26	1.2	1.81	103.8	4.7	1.673	3.0	4.49
30	53.9	2.2	1.26	0.9	1.66	91.9	4.1	1.673	2.5	4.42
35	48.5	2.0	1.26	0.7	1.48	82.6	3.7	1.673	2.0	4.28
40	44.2	1.8	1.26	0.5	1.27	75.1	3.4	1.673	1.7	4.09
45	40.6	1.6	1.26	0.4	1.04	69.1	3.1	1.673	1.4	3.86
50	37.7	1.5	1.26	0.3	0.79	64.0	2.9	1.673	1.2	3.60
55	35.1	1.4	1.26	0.2	0.53	59.6	2.7	1.673	1.0	3.32
60	32.9	1.3	1.26	0.1	0.26	55.9	2.5	1.673	0.8	3.02
65	31.0	1.3	1.26	0.0	-0.01	52.6	2.4	1.673	0.7	2.70
70	29.4	1.2	1.26	-0.1	-0.30	49.8	2.2	1.673	0.6	2.37
75	27.9	1.1	1.26	-0.1	-0.59	47.3	2.1	1.673	0.4	2.02
80	26.6	1.1	1.26	-0.2	-0.89	45.0	2.0	1.673	0.3	1.67
85	25.4	1.0	1.26	-0.2	-1.19	43.0	1.9	1.673	0.3	1.31
90	24.3	1.0	1.26	-0.3	-1.49	41.1	1.8	1.673	0.2	0.94
95	23.3	0.9	1.26	-0.3	-1.80	39.4	1.8	1.673	0.1	0.56
100	22.4	0.9	1.26	-0.4	-2.12	37.9	1.7	1.673	0.0	0.18
105	21.6	0.9	1.26	-0.4	-2.43	36.5	1.6	1.673	0.0	-0.21
110	20.8	0.8	1.26	-0.4	-2.75	35.2	1.6	1.673	-0.1	-0.61
115	20.1	0.8	1.26	-0.4	-3.07	34.0	1.5	1.673	-0.1	-1.00
120	19.5	0.8	1.26	-0.5	-3.40	32.9	1.5	1.673	-0.2	-1.41
Max =					**1.91**					**4.49**

Notes
1) Peak flow is equal to 2.78 x C x I x A
2) Intensity, I = $A/(Tc+C)^B$
3) Release Rate = Min (Release Rate, Peak Flow)
4) Storage Rate = Peak Flow - Release Rate
5) Storage = Time x Storage Rate
6) Maximum Storage = Max Storage Over Time

TABLE 9 - STORAGE VOLUME REQUIRED (5-YEAR and 100-YEAR STORMS)
(RD 5)

C_{AVG} = 0.79 (5-year)

C_{AVG} = 0.99 (100-year)

Time Interval = 5 (mins)

Drainage Area = 0.01436 (hectares)

	Release Rate = **1.07** (L/sec); Return Period = 5 (years); IDF Parameters, A = 998.071, B = 0.814, C = 6.053 ($I = A/(T_c+C)$)					Release Rate = **1.50** (L/sec); Return Period = 100 (years); IDF Parameters, A = 1735.688, B = 0.820, C = 6.014 ($I = A/(T_c+C)$)				
Time (min)	**Intensity, I (mm/hr)**	**Peak Flow (L/s)**	**Release Rate (L/s)**	**Storage Rate (L/s)**	**Storage Volume (m^3)**	**Intensity, I (mm/hr)**	**Peak Flow (L/s)**	**Release Rate (L/s)**	**Storage Rate (L/s)**	**Storage Volume (m^3)**
0	230.5	7.3	1.07	6.2	0.00	398.6	15.8	1.501	14.3	0.00
5	141.2	4.5	1.07	3.4	1.02	242.7	9.6	1.501	8.1	2.44
10	104.2	3.3	1.07	2.2	1.34	178.6	7.1	1.501	5.6	3.35
15	83.6	2.7	1.07	1.6	1.42	142.9	5.7	1.501	4.2	3.75
20	70.3	2.2	1.07	1.2	1.39	120.0	4.8	1.501	3.3	3.91
25	60.9	1.9	1.07	0.9	1.29	103.8	4.1	1.501	2.6	3.93
30	53.9	1.7	1.07	0.6	1.16	91.9	3.6	1.501	2.1	3.86
35	48.5	1.5	1.07	0.5	0.99	82.6	3.3	1.501	1.8	3.73
40	44.2	1.4	1.07	0.3	0.80	75.1	3.0	1.501	1.5	3.55
45	40.6	1.3	1.07	0.2	0.59	69.1	2.7	1.501	1.2	3.34
50	37.7	1.2	1.07	0.1	0.38	64.0	2.5	1.501	1.0	3.11
55	35.1	1.1	1.07	0.0	0.15	59.6	2.4	1.501	0.9	2.85
60	32.9	1.0	1.07	0.0	-0.09	55.9	2.2	1.501	0.7	2.58
65	31.0	1.0	1.07	-0.1	-0.33	52.6	2.1	1.501	0.6	2.29
70	29.4	0.9	1.07	-0.1	-0.58	49.8	2.0	1.501	0.5	1.99
75	27.9	0.9	1.07	-0.2	-0.83	47.3	1.9	1.501	0.4	1.68
80	26.6	0.8	1.07	-0.2	-1.09	45.0	1.8	1.501	0.3	1.36
85	25.4	0.8	1.07	-0.3	-1.35	43.0	1.7	1.501	0.2	1.04
90	24.3	0.8	1.07	-0.3	-1.61	41.1	1.6	1.501	0.1	0.70
95	23.3	0.7	1.07	-0.3	-1.88	39.4	1.6	1.501	0.1	0.36
100	22.4	0.7	1.07	-0.4	-2.15	37.9	1.5	1.501	0.0	0.02
105	21.6	0.7	1.07	-0.4	-2.42	36.5	1.4	1.501	-0.1	-0.33
110	20.8	0.7	1.07	-0.4	-2.70	35.2	1.4	1.501	-0.1	-0.69
115	20.1	0.6	1.07	-0.4	-2.98	34.0	1.3	1.501	-0.2	-1.05
120	19.5	0.6	1.07	-0.5	-3.25	32.9	1.3	1.501	-0.2	-1.41
Max =					**1.42**					**3.93**

Notes

1) Peak flow is equal to 2.78 x C x I x A

2) Intensity, $I = A/(Tc+C)^B$

3) Release Rate = Min (Release Rate, Peak Flow)

4) Storage Rate = Peak Flow - Release Rate

5) Storage = Time x Storage Rate

6) Maximum Storage = Max Storage Over Time

TABLE 10 - STORAGE VOLUME REQUIRED (5-YEAR and 100-YEAR STORMS)
(RD 6)

C_{AVG} = 0.86 (5-year)

C_{AVG} = 1.00 (100-year)

Time Interval = 5 (mins)

Drainage Area = 0.03611 (hectares)

	5-year: Release Rate = **1.34** (L/sec); Return Period = 5 (years); IDF Parameters, A = 998.071, B = 0.814, C = 6.053; ($I = A/(T_c+C)$)					100-year: Release Rate = **1.64** (L/sec); Return Period = 100 (years); IDF Parameters, A = 1735.688, B = 0.820, C = 6.014; ($I = A/(T_c+C)$)				
Time (min)	**Intensity, I (mm/hr)**	**Peak Flow (L/s)**	**Release Rate (L/s)**	**Storage Rate (L/s)**	**Storage Volume (m^3)**	**Intensity, I (mm/hr)**	**Peak Flow (L/s)**	**Release Rate (L/s)**	**Storage Rate (L/s)**	**Storage Volume (m^3)**
0	230.5	20.0	1.34	18.7	0.00	398.6	40.0	1.638	38.4	0.00
5	141.2	12.2	1.34	10.9	3.27	242.7	24.4	1.638	22.7	6.82
10	104.2	9.0	1.34	7.7	4.62	178.6	17.9	1.638	16.3	9.77
15	83.6	7.2	1.34	5.9	5.32	142.9	14.3	1.638	12.7	11.44
20	70.3	6.1	1.34	4.8	5.71	120.0	12.0	1.638	10.4	12.49
25	60.9	5.3	1.34	3.9	5.92	103.8	10.4	1.638	8.8	13.18
30	53.9	4.7	1.34	3.3	6.01	91.9	9.2	1.638	7.6	13.65
35	48.5	4.2	1.34	2.9	6.03	82.6	8.3	1.638	6.7	13.97
40	44.2	3.8	1.34	2.5	5.99	75.1	7.5	1.638	5.9	14.17
45	40.6	3.5	1.34	2.2	5.90	69.1	6.9	1.638	5.3	14.29
50	37.7	3.3	1.34	1.9	5.78	64.0	6.4	1.638	4.8	14.35
55	35.1	3.0	1.34	1.7	5.64	59.6	6.0	1.638	4.3	14.35
60	32.9	2.9	1.34	1.5	5.47	55.9	5.6	1.638	4.0	14.30
65	31.0	2.7	1.34	1.4	5.28	52.6	5.3	1.638	3.6	14.22
70	29.4	2.5	1.34	1.2	5.08	49.8	5.0	1.638	3.4	14.11
75	27.9	2.4	1.34	1.1	4.86	47.3	4.7	1.638	3.1	13.98
80	26.6	2.3	1.34	1.0	4.64	45.0	4.5	1.638	2.9	13.82
85	25.4	2.2	1.34	0.9	4.40	43.0	4.3	1.638	2.7	13.64
90	24.3	2.1	1.34	0.8	4.15	41.1	4.1	1.638	2.5	13.44
95	23.3	2.0	1.34	0.7	3.90	39.4	4.0	1.638	2.3	13.23
100	22.4	1.9	1.34	0.6	3.63	37.9	3.8	1.638	2.2	13.00
105	21.6	1.9	1.34	0.5	3.36	36.5	3.7	1.638	2.0	12.76
110	20.8	1.8	1.34	0.5	3.09	35.2	3.5	1.638	1.9	12.51
115	20.1	1.7	1.34	0.4	2.81	34.0	3.4	1.638	1.8	12.25
120	19.5	1.7	1.34	0.4	2.52	32.9	3.3	1.638	1.7	11.98
Max =					**6.03**					**14.35**

Notes

1) Peak flow is equal to 2.78 x C x I x A
2) Intensity, $I = A/(Tc+C)^B$
3) Release Rate = Min (Release Rate, Peak Flow)
4) Storage Rate = Peak Flow - Release Rate
5) Storage = Time x Storage Rate
6) Maximum Storage = Max Storage Over Time

TABLE 11 - STORAGE VOLUME REQUIRED (5-YEAR and 100-YEAR STORMS)
(RD 7)

C_{AVG} = 0.50 (5-year)
C_{AVG} = 0.62 (100-year)
Time Interval = 5 (mins)
Drainage Area = 0.02423 (hectares)

	5-year					100-year				
	Release Rate = 1.01 (L/sec); Return Period = 5 (years); IDF Parameters, A = 998.071, B = 0.814, C = 6.053 ($I = A/(T_c+C)$)					Release Rate = 1.41 (L/sec); Return Period = 100 (years); IDF Parameters, A = 1735.688, B = 0.820, C = 6.014 ($I = A/(T_c+C)$)				
Time (min)	**Intensity, I (mm/hr)**	**Peak Flow (L/s)**	**Release Rate (L/s)**	**Storage Rate (L/s)**	**Storage Volume (m^3)**	**Intensity, I (mm/hr)**	**Peak Flow (L/s)**	**Release Rate (L/s)**	**Storage Rate (L/s)**	**Storage Volume (m^3)**
0	230.5	7.8	1.01	6.8	0.00	398.6	16.8	1.412	15.4	0.00
5	141.2	4.8	1.01	3.7	1.12	242.7	10.2	1.412	8.8	2.64
10	104.2	3.5	1.01	2.5	1.50	178.6	7.5	1.412	6.1	3.66
15	83.6	2.8	1.01	1.8	1.62	142.9	6.0	1.412	4.6	4.14
20	70.3	2.4	1.01	1.4	1.63	120.0	5.0	1.412	3.6	4.36
25	60.9	2.1	1.01	1.0	1.56	103.8	4.4	1.412	3.0	4.44
30	53.9	1.8	1.01	0.8	1.45	91.9	3.9	1.412	2.5	4.42
35	48.5	1.6	1.01	0.6	1.31	82.6	3.5	1.412	2.1	4.33
40	44.2	1.5	1.01	0.5	1.15	75.1	3.2	1.412	1.8	4.20
45	40.6	1.4	1.01	0.4	0.97	69.1	2.9	1.412	1.5	4.03
50	37.7	1.3	1.01	0.3	0.77	64.0	2.7	1.412	1.3	3.84
55	35.1	1.2	1.01	0.2	0.57	59.6	2.5	1.412	1.1	3.62
60	32.9	1.1	1.01	0.1	0.36	55.9	2.4	1.412	0.9	3.38
65	31.0	1.0	1.01	0.0	0.14	52.6	2.2	1.412	0.8	3.13
70	29.4	1.0	1.01	0.0	-0.09	49.8	2.1	1.412	0.7	2.87
75	27.9	0.9	1.01	-0.1	-0.32	47.3	2.0	1.412	0.6	2.59
80	26.6	0.9	1.01	-0.1	-0.56	45.0	1.9	1.412	0.5	2.31
85	25.4	0.9	1.01	-0.2	-0.80	43.0	1.8	1.412	0.4	2.02
90	24.3	0.8	1.01	-0.2	-1.04	41.1	1.7	1.412	0.3	1.72
95	23.3	0.8	1.01	-0.2	-1.29	39.4	1.7	1.412	0.2	1.41
100	22.4	0.8	1.01	-0.3	-1.54	37.9	1.6	1.412	0.2	1.10
105	21.6	0.7	1.01	-0.3	-1.79	36.5	1.5	1.412	0.1	0.78
110	20.8	0.7	1.01	-0.3	-2.04	35.2	1.5	1.412	0.1	0.46
115	20.1	0.7	1.01	-0.3	-2.30	34.0	1.4	1.412	0.0	0.13
120	19.5	0.7	1.01	-0.4	-2.56	32.9	1.4	1.412	0.0	-0.20
Max =					**1.63**					**4.44**

Notes
1) Peak flow is equal to 2.78 x C x I x A
2) Intensity, $I = A/(Tc+C)^B$
3) Release Rate = Min (Release Rate, Peak Flow)
4) Storage Rate = Peak Flow - Release Rate
5) Storage = Time x Storage Rate
6) Maximum Storage = Max Storage Over Time

TABLE 12 - STORAGE VOLUME REQUIRED (5-YEAR and 100-YEAR STORMS)
(RD 8)

C_{AVG} = 0.20 (5-year)
C_{AVG} = 0.25 (100-year)
Time Interval = 5 (mins)
Drainage Area = 0.00817 (hectares)

	Release Rate = 0.50 (L/sec)					Release Rate = 0.95 (L/sec)				
	Return Period = 5 (years)					Return Period = 100 (years)				
	IDF Parameters, A = 998.071			, B = 0.814		IDF Parameters, A = 1735.688				, B = 0.820
	(I = A/(T_c+C)			, C = 6.053		(I = A/(T_c+C)				, C = 6.014
Time (min)	**Intensity, I (mm/hr)**	**Peak Flow (L/s)**	**Release Rate (L/s)**	**Storage Rate (L/s)**	**Storage Volume (m^3)**	**Intensity, I (mm/hr)**	**Peak Flow (L/s)**	**Release Rate (L/s)**	**Storage Rate (L/s)**	**Storage Volume (m^3)**
0	230.5	1.0	0.50	0.5	0.00	398.6	2.3	0.945	1.3	0.00
5	141.2	0.6	0.50	0.1	0.04	242.7	1.4	0.945	0.4	0.13
10	104.2	0.5	0.50	0.0	-0.02	178.6	1.0	0.945	0.1	0.04
15	83.6	0.4	0.50	-0.1	-0.11	142.9	0.8	0.945	-0.1	-0.12
20	70.3	0.3	0.50	-0.2	-0.22	120.0	0.7	0.945	-0.3	-0.32
25	60.9	0.3	0.50	-0.2	-0.34	103.8	0.6	0.945	-0.4	-0.53
30	53.9	0.2	0.50	-0.3	-0.47	91.9	0.5	0.945	-0.4	-0.76
35	48.5	0.2	0.50	-0.3	-0.60	82.6	0.5	0.945	-0.5	-1.00
40	44.2	0.2	0.50	-0.3	-0.73	75.1	0.4	0.945	-0.5	-1.24
45	40.6	0.2	0.50	-0.3	-0.86	69.1	0.4	0.945	-0.6	-1.49
50	37.7	0.2	0.50	-0.3	-1.00	64.0	0.4	0.945	-0.6	-1.75
55	35.1	0.2	0.50	-0.3	-1.14	59.6	0.3	0.945	-0.6	-2.00
60	32.9	0.1	0.50	-0.4	-1.28	55.9	0.3	0.945	-0.6	-2.26
65	31.0	0.1	0.50	-0.4	-1.42	52.6	0.3	0.945	-0.6	-2.52
70	29.4	0.1	0.50	-0.4	-1.56	49.8	0.3	0.945	-0.7	-2.78
75	27.9	0.1	0.50	-0.4	-1.70	47.3	0.3	0.945	-0.7	-3.04
80	26.6	0.1	0.50	-0.4	-1.84	45.0	0.3	0.945	-0.7	-3.31
85	25.4	0.1	0.50	-0.4	-1.98	43.0	0.2	0.945	-0.7	-3.58
90	24.3	0.1	0.50	-0.4	-2.13	41.1	0.2	0.945	-0.7	-3.84
95	23.3	0.1	0.50	-0.4	-2.27	39.4	0.2	0.945	-0.7	-4.11
100	22.4	0.1	0.50	-0.4	-2.41	37.9	0.2	0.945	-0.7	-4.38
105	21.6	0.1	0.50	-0.4	-2.56	36.5	0.2	0.945	-0.7	-4.65
110	20.8	0.1	0.50	-0.4	-2.70	35.2	0.2	0.945	-0.7	-4.92
115	20.1	0.1	0.50	-0.4	-2.85	34.0	0.2	0.945	-0.8	-5.19
120	19.5	0.1	0.50	-0.4	-2.99	32.9	0.2	0.945	-0.8	-5.46
Max =					**0.04**					**0.13**

Notes
1) Peak flow is equal to 2.78 x C x I x A
2) Intensity, I = $A/(Tc+C)^B$
3) Release Rate = Min (Release Rate, Peak Flow)
4) Storage Rate = Peak Flow - Release Rate
5) Storage = Time x Storage Rate
6) Maximum Storage = Max Storage Over Time

APPENDIX C

Specification for Roof Control

WATTS® DRAINAGE

RD-100-CP

Tag: ____________

Large Area IRMA Roof Drain with 12"x12" Promenade Top

Components:

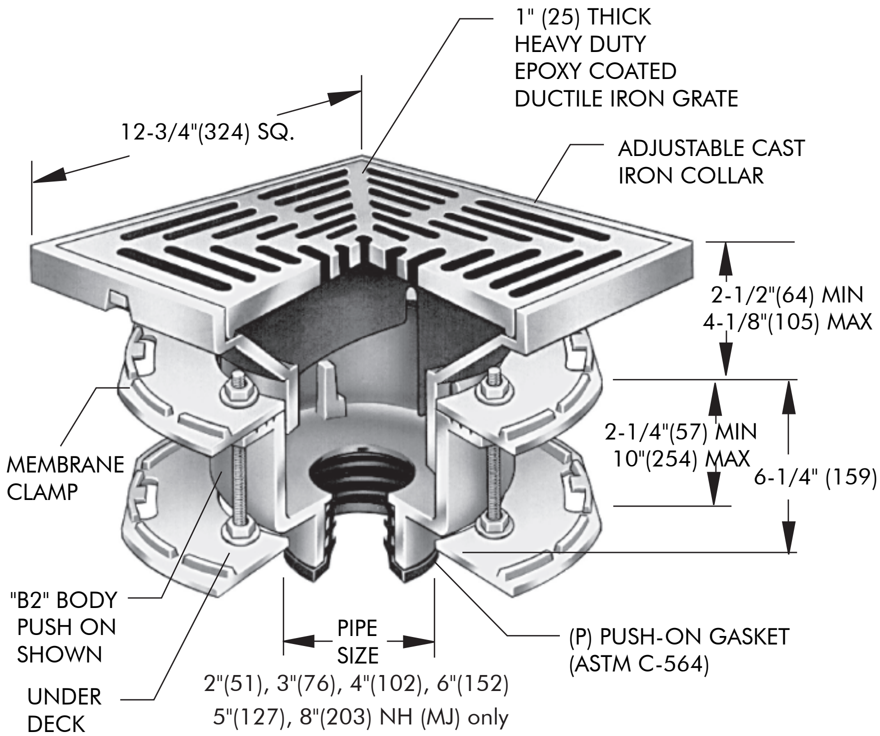

B2


FD-460-AF


B2-FLG


FC-1

SPECIFICATION: Watts Drainage Products RD-100-CP epoxy coated ductile iron roof drain with deep sump and wide serrated flashing flange, membrane clamp, square adjustable lacquered cast iron collar with square epoxy coated locking type ductile iron grate with 3/8"(10) maximum width drainage slots.



Deck opening 10" (254) with sump receiver 13-1/4" (337)

Order Code: RD-10☐☐-CP-☐-☐-☐

Ex. RD-102P-CP-3

Pipe Sizing (Select One)

Suffix	Description	
2	2"(51) Pipe Size	☐
3	3"(76) Pipe Size	☐
4	4"(102) Pipe Size	☐
5	5"(127) Pipe Size	☐
6	6"(152) Pipe Size	☐
8	8"(203) Pipe Size	☐

Outlet Type (Select One)

Suffix	Description	
NH	No Hub (MJ)	☐
P	Push On	☐
T	Threaded Outlet	☐
X	Inside Caulk	☐

Grate (Select One)

Suffix	Description	
-1	Nickel Bronze	☐
-3	Stainless Steel	☐
-4	Ductile Iron	☐

Options (Select One or More)

Suffix	Description	
-B	Sump Receiver Flange	☐
-C	Secondary Membrane Clamp	☐
-D	Underdeck Clamp	☐
-E	Adjustable Extension	☐
-GSS	Stainless Steel Ballast Guard	☐
-H	Adj. to 6" IRMA Ballast Guard	☐
-SIFC	Flow Control (2", 3", 4" Outlets only) Specify flow required	☐
-SO	Side Outlet**	☐
-V	Fixed Extension (1-1/2",2",3",4")	☐
-W-1	Waterproofing Flange	☐
-Z	Extended Integral Wide Flange	☐
-5	Sediment Bucket	☐
-6	Vandal Proof Top	☐
-9	Hinged Grate	☐
-10	Secured Top	☐
-12	Galvanized Top	☐
-13	All Galvanized	☐
-26	Hinged Locking Grate	☐
-113M	Special Epoxy from 3M Range	☐

Optional Body Material (NH Only)

Suffix	Description	
-60	PVC Body w/Socket Outlet	☐
-61	ABS Body w/Socket Outlet	☐

Load Rating & Free Area

Suffix	Load Rating	Free Area Sq. In.
CP-1	*XHD	41
CP-3	*XHD	41
CP-4	*XHD	41

* The load classifications are in accordance with the American National Standards ASME A112.21.1M
ASME Ratings are as follows:
XHD - Safe Live Load 7500-10000 lbs.(3375-4500kg)
The above categories are given as a guide only.
Please consult factory.

** Side Outlet (-SO) option only available in 2"(51), 3"(76), 4"(102) pipe sizes.
Underdeck Clamp (-BED and -D options) are not available when -SO is selected.

Job Name ____________ Contractor ____________

Job Location ____________ Contractor's P.O. No. ____________

Engineer ____________ Representative ____________

CANADA

WATTS® DRAINAGE

CANADA: 5435 North Service Road, Burlington, ON, L7L 5H7 TEL: 905-332-6718 TOLL-FREE: 1-888-208-8927 Website: www.wattsdrainage.ca