PROPOSED

THREE AND ONE-HALF STOREY RESIDENTIAL APARTMENT BUILDING SITE

LOT B

R-PLAN 282

701 CHURCHILL AVENUE NORTH

CITY OF OTTAWA

STORM DRAINAGE REPORT

REPORT R-819-15

T.L. MAK ENGINEERING CONSULTANTS LTD.

MAY 2019

REFERENCE FILE NUMBER 819-15

Introduction

The proposed three and one-half storey apartment building site is located on the east side of Churchill Avenue North, and situated north of Robin Lane and south of Currell Avenue. Its legal property description is part of Lot B Registered Plan 282 City of Ottawa. At this time, the residential lot under consideration houses a 1½-storey stucco-sided dwelling. The municipal address of the property is 701 Churchill Avenue North.

The lot area under consideration is approximately 463.9 square metres. This property is proposed for the development of a three and one-half (3 ½)-storey residential apartment building plus a basement. The average floor area of the proposed building is 2143.23 square feet (199.0 square metres).

The building will house a total of eleven(11) units of one(1) and two(2)-bedroom apartments. The storm-water outlet for this site is the existing 375mm diameter storm sewer located within the Churchill Avenue North road right of way.

From storm-drainage criteria set by the staff at the City of Ottawa's Engineering Department, the allowable post-development runoff release rates shall not exceed the five(5)-year pre-development conditions. The allowable pre-development runoff coefficient is the calculated "C" existing value or C=0.4 maximum. If the uncontrolled storm-water runoff exceeds the specified requirements, then on-site storm-water management (SWM) control measures are necessary. The post-development runoff coefficient for this site is estimated at C=0.64, which exceeds the calculated pre-development allowable C=0.4 criteria for the Bronson Avenue combined sewer without on-site SWM control. Therefore, SWM measures are required. Refer to the attached Drainage Area Plan (Figure 1) as detailed in Appendix A.

This report will address and detail the grading, drainage, and storm-water management control measures required to develop this property. Based on the Proposed Site Grading and Servicing Plan (Dwg. 819-15 G-1), and on the Proposed Rooftop Storm-water Management Plan (Dwg. 819-15 SWM-1), the storm water of this lot will be controlled on site only by the building's flat rooftop.

The storm-water management calculations that follow will detail the extent of on-site SWM control to be implemented and the storage volume required on site to attain the appropriate runoff release that will conform to the City's established drainage criteria.

Site Data

1. <u>Development Property Area</u>

Post-Development Site Area Characteristics

Development Lot Area	=463.9m^2
Roof Surface Area	=198.5m^2
Concrete paver Area	=108.4m^2
Grass Area	=157.0m^2

$$C = \frac{(198.5 \times 0.9) + (108.4 \times 0.8) + (157.0 \times 0.2)}{463.9}$$

$$C = \frac{296.77}{463.9}$$

$$C = 0.6397$$

Say "C"=0.64

Therefore, the average post-development "C" for this site is 0.64.

2. Controlled Area Data

Roof Surface Area =198.5m^2
Total Storm-water Controlled Area =198.5m^2

$$C = \frac{(198.5 \times 0.9)}{198.5}$$

$$C = \frac{178.65}{198.5}$$

$$C = 0.9$$

Say "C"=0.9

Therefore, the post-development "C" for the controlled storm-water drainage area is 0.90.

3. Uncontrolled Area Data

Grass Area =157.0m^2
Concrete paver Area =108.4m^2
Total Storm-water Uncontrolled Area =265.4m^2

$$C = \frac{(12.7 \times 0.8) + (121.0 \times 0.2) + (35.9 \times 0.5)}{265.4}$$

$$C = \frac{118.12}{265.4}$$

$$C = 0.445$$

Say "C"=0.45

Therefore, the post-development "C" for the uncontrolled storm-water drainage area of the site is 0.45.

The tributary area consisting of approximately 265.4 square metres will be out-letting off site uncontrolled from the residential apartment building site.

The SWM area to be controlled is 198.5m^2. Refer to the attached "Drainage Area Plan" in Figure 1 for details.

Pre-Development Flow Estimation

Maximum allowable off-site flow: five(5)-year storm

Pre-Development Site Area Characteristics

Development Lot Area	=463.9m^2
Grass Area	=311.0m^2
Concrete Area	=68.2m^2
Roof Area	=84.7m^2

$$C = \frac{(84.7 \times 0.9) + (68.2 \times 0.8) + (311.0 \times 0.2)}{463.9}$$

$$C = \frac{192.99}{463.9}$$

$$C = 0.416$$

Say C=0.42

Use C_{pre}=0.4 maximum allowable for redevelopment

T_c=D/V where D=30.5m, ΔH=0.26m, S=0.85%, and V=0.7feet/second=0.21m/s
Therefore,

$$T_c = \frac{30.5\text{m}}{0.21\text{m/s}}$$

T_c=2.42 minutes
Use T_c=10 minutes
I_5=104.2mm/hr [City of Ottawa, five(5)-year storm]

Using the Rational Method

Q=2.78 (0.4) (104.2) (0.0464)

Q=5.38L/s

Because 265.4 square metres of the site area are drained uncontrolled off site, the **net** allowable discharge for this site into the existing sewer system is Q={2.78 (0.4) (104.2) (0.0464)−[2.78 (0.45) (120.0) (0.02654)] = 5.38L/s – 3.98 = 1.4L/s. Therefore, the maximum allowable flow rate off site is 5.38L/s and the net allowable controlled flow rate off site is 1.40L/s.

Storm-Water Management Analysis

The calculated flow rate of 1.40L/s for on-site storm-water management detention volume storage will be used for this SWM analysis. Two(2) controlled roof drains are proposed to restrict flow from the building at a rate of 2×0.63=1.26L/s into the Churchill Avenue North storm sewer. Controlled roof drain details are found on Dwg. 819-15 SWM-1 entitled Proposed Rooftop Stormwater Management Plan.

Therefore, the total allowable five(5)-year release rate of 5.38L/s will be entering into the existing 375mm diameter Churchill Avenue North storm sewer for storms up to and including the 100 year event. The runoff that is greater than the allowable release rate will be stored on site at the flat rooftops of the proposed apartment building, all of which will be used for storm-water detention purposes.

The post-development inflow rate during the five(5)-year and 100-year storms for the (2) two rooftop areas can be calculated as follows.

Design Discharge Computation

Flat Rooftop Areas

To Calculate Roof Storage Requirements

The proposed flat roof of the apartment building on the property will incorporate two(2) roof drains to control flow off site. The smallest standard roof drain flow rate is each at 0.63L/s (10 USgal./min.). Therefore, the minimum storm-water flow that can be controlled from this rooftop and outletted off site is 0.63L/s× 2=1.26L/s<1.40L/s, which is the net allowable. Refer to the Proposed Rooftop Stormwater Management Plan Dwg. 819-15 SWM-1 for roof drain details.

C=0.9 will be used for sizing roof storage volume in this case.

Inflow rate (Q_A)=2.78 CIA, where C=0.9, A=surface area of roof, I=mm/hr

For Roof Area 1, Q_{A1}=2.78 CIA
Five(5)-Year Event
C_5=0.90
A=99.25m^2
I=mm/hr

Q_1=2.78 (0.90)(0.0099ha.)I=0.02483I

100-Year Event
C_{100}=1.0
A=99.25m^2
I=mm/hr

Q_1=2.78 (1.0)(0.0099ha.)I=0.0276I

For Roof Area 2, Q=2.78 CIA
Five(5)-Year Event
C_5=0.90
A=99.25m^2
I=mm/hr

Q_2=2.78 (0.90)(0.0099ha.)I=0.02483I

100-Year Event
C_{100}=1.0
A=99.25m^2
I=mm/hr

Q_2=2.78 (1.0)(0.0099ha.)I=0.0276I

The summary results of the calculated inflow and the storage volume of the site and building's flat rooftop to store the five(5)-year and 100-year storm events are shown in Tables 1 to 4 inclusive.

Erosion and Sediment Control

The contractor shall implement Best Management Practices to provide for protection of the receiving storm sewer during construction activities. These practices are required to ensure no sediment and/or associated pollutants are released to the receiving watercourse. These practices include installation of a silt fence barrier (as per OPSD 219.110 and associated specifications) along Bronson Avenue and all other areas that sheet drain off site. Maintenance hole sediment barriers to be AMOCO 4555 non-woven geotextile or approved equivalent.

Conclusion

For development of this residential site (±0.0464ha.) and in controlling the five(5)-year storm-water release rate off site to a net allowable rate of 1.40L/s, a site storage volume of approximately 2.70m^3 minimum is required during the five(5)-year event. For this site, two(2) flat rooftop storage areas will be used for storm-water management attenuation.

During the five-year storm event for the flat rooftop storage, the ponding depth of Roof Area 1 and 2 is estimated at 100mm at the drain and 0mm at the roof perimeter, assuming a 2.0% minimum roof pitch to the drain. The rooftop storage available at Roof Area 1 is 1.45m^3 and the rooftop storage available at Roof Area 2 is 1.45m^3, for a total of 2.90m^3, which is greater than the required volume of 2.70m^3.

To control the 100-year storm-water release rate off site to a net allowable rate of 1.40L/s, a site storage volume of approximately 6.94m^3 minimum is required during the 100-year event.

During the 100-year storm event for the flat rooftop storage, the ponding depth of Roof Area 1 and 2 is estimated at 150mm at the drain and 0mm at the roof perimeter, assuming a 2.0% minimum roof pitch to the drain. The rooftop storage available at Roof Area 1 is 4.96m^3 and the rooftop storage available at Roof Area 2 is 4.96m^3, for a total of 9.92m^3, which is greater than the required volume of 6.94m^3.

Therefore, by means of flat building rooftop storage and grading the site to the proposed grades as shown on the Proposed Grading and Servicing Plan and Proposed Rooftop Stormwater Management Plan Dwg. 819-15 G-1 and 819-15 SWM-1 respectively, the desirable five(5)-year storm and 100-year storm event detention volume of 2.90m^3 and 9.92m^3 respectively will be available on site.

The building weeping tile drainage will outlet via its separate 150mm diameter PVC storm lateral. The roof drains will be outletted via a proposed 125mm PVC storm lateral, where up on both laterals are connected directly to the existing Churchill Avenue North 375mm diameter storm sewer. Refer to the proposed grading and servicing plan Dwg. 819-15 G-1 for details.

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TABLE 1

FIVE(5)-YEAR EVENT

REQUIRED BUILDING ROOF AREA 1 STORAGE VOLUME

t_c **TIME** (minutes)	**I** **FIVE(5)-YEAR** (mm/hr)	**Q** **ACTUAL** (L/s)	**Q** **ALLOW** (L/s)	**Q** **STORED** (L/s)	**VOLUME** **STORED** (m^3)
5	141.20	3.57	0.63	2.88	0.86
10	104.20	2.59	0.63	1.96	1.18
15	83.50	2.07	0.63	1.44	1.30
20	70.30	1.75	0.63	1.12	1.35
25	60.90	1.51	0.63	0.88	1.32
30	53.93	1.34	0.63	0.71	1.28

Therefore, the required storage volume is 1.35m^3.

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TABLE 2

FIVE(5)-YEAR EVENT

REQUIRED BUILDING ROOF AREA 2 STORAGE VOLUME

t_c TIME (minutes)	**I 5-YEAR** (mm/hr)	**Q ACTUAL** (L/s)	**Q ALLOW** (L/s)	**Q STORED** (L/s)	**VOLUME STORED** (m^3)
5	141.20	3.57	0.63	2.88	0.86
10	104.20	2.59	0.63	1.96	1.18
15	83.50	2.07	0.63	1.44	1.30
20	70.30	1.75	0.63	1.12	1.35
25	60.90	1.51	0.63	0.88	1.32
30	53.93	1.34	0.63	0.71	1.28

Therefore, the required rooftop storage volume is 1.35m^3.

PROPOSED 701 CHURCHILL AVENUE NORTH RESIDENTIAL DEVELOPMENT SITE

TABLE 3

100-YEAR EVENT

REQUIRED BUILDING ROOF AREA 1 STORAGE VOLUME

t_c **TIME** (minutes)	**I** **100-YEAR** (mm/hr)	**Q** **ACTUAL** (L/s)	**Q** **ALLOW** (L/s)	**Q** **STORED** (L/s)	**VOLUME** **STORED** (m^3)
10	178.6	4.93	0.63	4.30	2.58
15	142.9	3.95	0.63	3.32	2.99
20	120.0	3.31	0.63	2.68	3.22
25	103.9	2.87	0.63	2.24	3.36
30	91.9	2.54	0.63	1.91	3.44
35	82.6	2.28	0.63	1.65	3.47
40	75.1	2.07	0.63	1.44	3.46
45	69.1	1.91	0.63	1.28	3.456
50	63.9	1.76	0.63	1.13	3.39

Therefore, the required storage volume is 3.47m^3.

TABLE 4

100-YEAR EVENT

REQUIRED BUILDING ROOF AREA 2 STORAGE VOLUME

t_c TIME (minutes)	**I 100-YEAR** (mm/hr)	**Q ACTUAL** (L/s)	**Q ALLOW** (L/s)	**Q STORED** (L/s)	**VOLUME STORED** (m^3)
10	178.6	4.93	0.63	4.30	2.58
15	142.9	3.95	0.63	3.32	2.99
20	120.0	3.31	0.63	2.68	3.22
25	103.9	2.87	0.63	2.24	3.36
30	91.9	2.54	0.63	1.91	3.44
35	82.6	2.28	0.63	1.65	3.47
40	75.1	2.07	0.63	1.44	3.46
45	69.1	1.91	0.63	1.28	3.456
50	63.9	1.76	0.63	1.13	3.39

Therefore, the required rooftop storage volume is 3.47m^3.

PROPOSED THREE AND ONE-HALF (3 ½)-STOREY RESIDENTIAL APARTMENT BUILDING SITE

LOT B

R-PLAN 282

701 CHURCHILL AVENUE NORTH

CITY OF OTTAWA

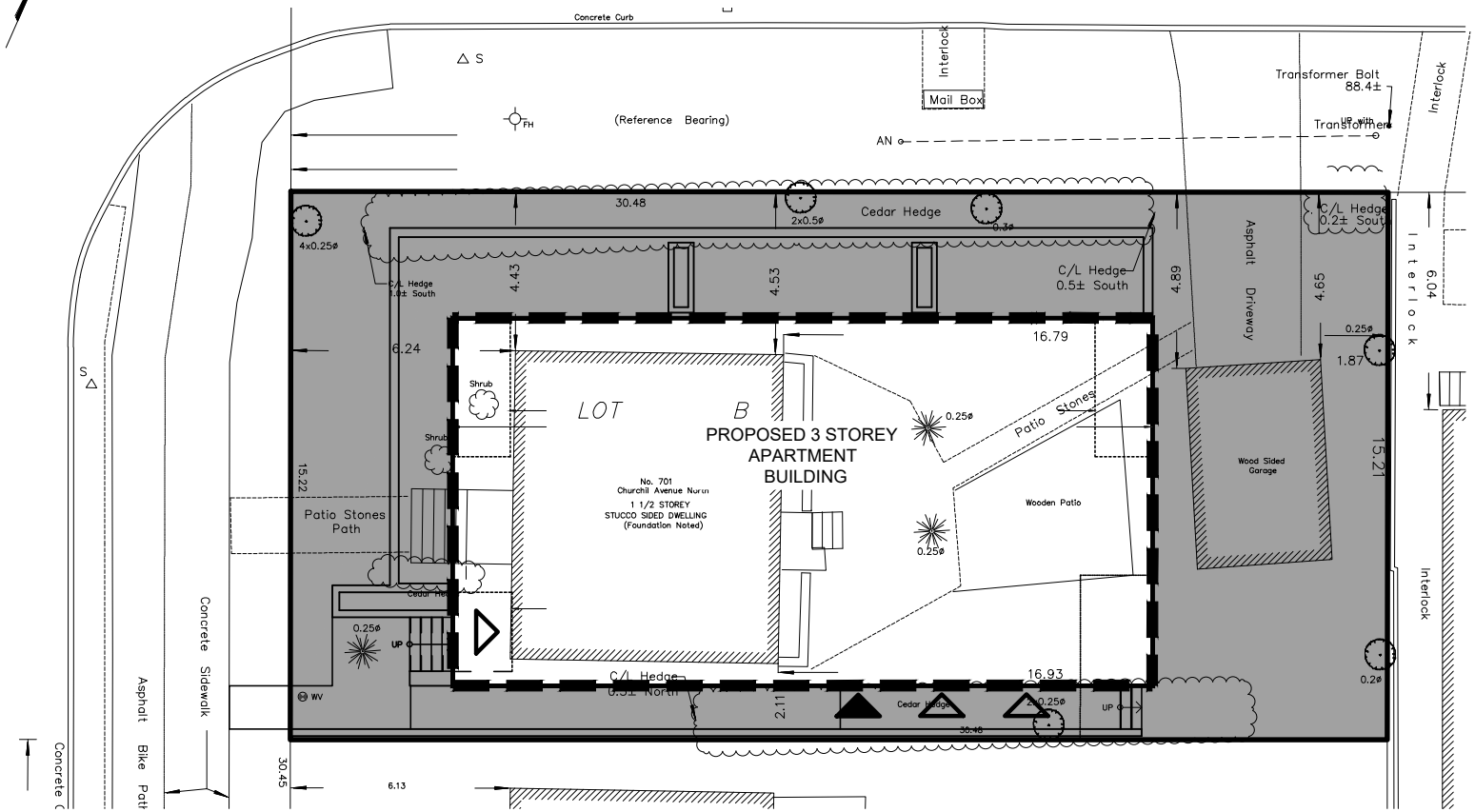
APPENDIX A

STORM DRAINAGE AREA PLAN

FIGURE 1

PROPOSED 701 Churchill Ave.
SITE DEVELOPMENT
DRAINAGE AREA PLAN

N.T.S.



LEGEND

LIMIT OF CONTROLLED STORM
DRAINAGE AREA = 198.5 SQ. M

UNCONTROLLED STORM
DRAINAGE AREA = 265.4 SQ. M

TOTAL AREA = 463.9 SQ. M

POST-DEVELOPMENT SITE
AVERAGE "C" = 0.64

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CONSULTING ENGINEERS

PROJECT No.	DATE	DRAWING No.
819-15	MAY 2019	FIGURE 1

PROPOSED THREE AND ONE-HALF (3 ½) STOREY RESIDENTIAL APARTMENT BUILDING SITE

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701 CHURCHILL AVENUE NORTH

CITY OF OTTAWA

APPENDIX B

DETAILED CALCULATIONS

FOR FIVE(5)-YEAR AND 100-YEAR

AVAILABLE STORAGE VOLUME

AVAILABLE STORAGE VOLUME CALCULATIONS

Five(5)-Year Event

Roof Storage at Flat Roof Building

The flat Roof Area 1 and Roof Area 2 will be used for storm-water detention. Each roof area will be drained by a controlled drain designed for a release rate of 10U.S.gal./min. or 0.63L/s. Refer to Dwg. 819-15 SWM-1 for roof drain details.

Roof Storage Area 1

Available flat roof area for storage =99.25m^2 @roof slope of 2.0% minimum or 100mm of water height above the roof drain. Therefore, the available roof area will store a volume as shown below using the reservoir volume equation.

$$V = \frac{(0.10\text{m})[43.55 + 4(10.88) + 0]}{6}$$

$$V = \frac{(0.10)(87.07)}{6}$$

$$V = 1.45\text{m}^3$$

The available Roof Area 1 storage volume of 1.45m^3 >required five(5)-year storage volume of 1.35m^3 from Table 1.

Roof Storage Area 2

Available flat roof area for storage =99.25m^2 @roof slope of 2.0% minimum or 100mm of water height above the roof drain. Therefore, the available roof area will store a volume as shown below using the reservoir volume equation.

$$V = \frac{(0.10\text{m})[43.55 + 4(10.88) + 0]}{6}$$

$$V = \frac{(0.10)(87.07)}{6}$$

$$V = 1.45\text{m}^3$$

The available Roof Area 2 storage volume of 1.45m^3 >required five(5)-year storage volume of 1.35m^3 from Table 2.

Therefore, the ponding depth at the Roof Drain 1 and 2 locations is approximately 0.10m (100mm), and the five(5)-year level is estimated not to reach the roof perimeter of the building.

Hence, Roof Area 1 and Roof Area 2 of the proposed residential building flat rooftop storage are adequate to store the minimum required five(5)-year storm event volume of 2.70m^3 given it can store up to 2.90m^3.

AVAILABLE STORAGE VOLUME CALCULATIONS

100-Year Event

Roof Storage at Flat Roof Building

The flat Roof Area 1 to Roof Area 2 will be used for storm-water detention. Each roof area will be drained by a controlled drain designed for a release rate of 10U.S.gal./min. or 0.63L/s. Refer to Dwg. 819-15 SWM-1 for roof drain details.

Roof Storage Area 1

Available flat roof area for storage =99.25m^2 @roof slope of 2.0% minimum or 150mm of fall from roof perimeter to roof drain. Therefore, the available roof area will store a volume as shown below using the reservoir volume equation.

$$V = \frac{(0.15\text{m})[99.25 + 4(24.75) + 0]}{6}$$

$$V = \frac{(0.15)(198.25)}{6}$$

$$V = 4.96\text{m}^3$$

The available Roof Area 1 storage volume of 4.96m^3 >required 100-year storage volume of 3.47m^3 from Table 3.

Roof Storage Area 2

Available flat roof area for storage =99.25m^2 @roof slope of 2.0% minimum or 150mm of fall from roof perimeter to roof drain. Therefore, the available roof area will store a volume as shown below using the reservoir volume equation.

$$V = \frac{(0.15\text{m})[99.25 + 4(24.75) + 0]}{6}$$

$$V = \frac{(0.15)(198.25)}{6}$$

$$V = 4.96\text{m}^3$$

The available Roof Area 2 storage volume of 4.96m^3 >required 100-year storage volume of 3.47m^3 from Table 4.

Therefore, the ponding depth at the Roof Drain 1 and 2 locations is approximately 0.15m (150mm), and at the perimeter of the flat roof area is 0mm above the roof perimeter surface. Accordingly, it is recommended that four(4) roof scuppers as shown on Dwg. 819-15 G-1 and 819-15 SWM-1 and the architect's roof plan be installed at the perimeter height of the rooftop for emergency overflow purposes in case of blockage from debris buildup at the roof drain.

Hence, Roof Area 1 and Roof Area 2 of the proposed residential building flat rooftop storage are adequate to store the minimum required 100-year storm event volume of 6.94m^3 given it can store up to 9.92m^3.