

PROPOSED
FOUR STOREY LOW-RISE APARTMENT BUILDING SITE
LOT 15 WEST CAMBRIDGE STREET NORTH
SOUTH OF STONE BOUNDARY
R-PLAN 33
370 CAMBRIDGE STREET NORTH
CITY OF OTTAWA

STORM DRAINAGE REPORT
REPORT R-821-155

T.L. MAK ENGINEERING CONSULTANTS LTD.

JULY 2022

REFERENCE FILE NUMBER 821-155

Introduction

The proposed low-rise four storey apartment building site is located on the west side of Cambridge Street North, and situated north of Raymond Street and south of Arlington Avenue. Its legal property description is Lot 15 West Cambridge Street North Registered Plan 33 City of Ottawa in Ward 14 (Somerset). At this time, the residential lot under consideration houses a 2-storey brick sided dwelling. The municipal address of the property is 370 Cambridge Street North.

The lot area of this site under consideration is approximately 628.67 square metres. This property is proposed for the development of a four (4)-storey low-rise residential apartment building plus a basement. The average floor area is approximately 340 m² for a total gross floor area of approximately 1,352.0 square metres excluding basement level.

The building will house a total of twenty (20) units consisting of two (2) bachelor units, ten (10) 1-bedroom units, six (2)-bedroom apartments and two (3)-bedroom units. The storm-water outlet for this site is the existing 375mm diameter combined sewer located within the Cambridge Street 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 two (2)-year pre-development conditions. The allowable pre-development runoff coefficient is the calculated "C" existing value = 0.68 or $C_{allow} = 0.4$ 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 $C = 0.76$, which exceeds the calculated pre-development allowable $C_{allow} = 0.4$ criteria for the Cambridge Street North 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. For Pre and Post site development characteristics, refer to Dwg. No. 821-155 D-1 for details.

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. No. 821-155 G-1), and on the Proposed Rooftop Storm-water Management Plan (Dwg. No. 821-155 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 and requirements.

Because the site is located within a combined sewer shed, therefore, the approval exemption under Ontario Regulation 525/98 would not apply since storm water discharges from this site will outlet flow into a combined sewer and not a storm sewer. Thus, an Environmental Compliance Approval (ECA) application will be required to be submitted to the Ministry.

Site Data

1. Development Property Area

Post-Development Site Area Characteristics

| | |
|----------------------|-------------------------|
| Development Lot Area | = 628.67 m ² |
| Roof Surface Area | = 368.50 m ² |
| Concrete Area | = 7.64 m ² |
| Interlock paver Area | = 65.67 m ² |
| Grass Area | = 131.06 m ² |
| Asphalt Area | = 55.80 m ² |

$$C = \frac{(368.5 \times 0.9) + (65.67 \times 0.9) + (7.64 \times 0.9) + (131.06 \times 0.2) + (55.80 \times 0.9)}{628.67}$$

$$C = \frac{474.061}{628.67}$$

$$C = 0.754$$

Say "C" = 0.76

Therefore, the average post-development "C" for this site is 0.76.

2. Controlled Area Data (NODE #1)

| | |
|-----------------------------------|-------------------------|
| Roof Surface Area | = 368.50 m ² |
| Total Storm-water Controlled Area | = 368.50 m ² |

$$C = \frac{(368.50 \times 0.9)}{368.50}$$

$$C = \frac{331.65}{368.50}$$

$$C = 0.9$$

Say "C" = 0.9

Therefore, the post-development "C" for the controlled storm-water drainage area (flat roof top) is 0.90.

3. Uncontrolled Area Data

i. PROPOSED SITE (NODE #2)

| | |
|-------------------------------------|-------------------------|
| Concrete Area | = 7.64 m ² |
| Grass Area | = 131.06 m ² |
| Interlock Paver Area | = 65.67 m ² |
| Asphalt Area | = 55.80 m ² |
| Total Storm-water Uncontrolled Area | = 260.17 m ² |

$$C = \frac{(65.67 \times 0.9) + (131.06 \times 0.2) + (7.64 \times 0.9) + (55.80 \times 0.9)}{260.17}$$

$$C = \frac{142.321}{260.17}$$

$$C = 0.547$$

$$\text{Say "C"} = 0.55$$

Therefore, the average post-development "C" for the uncontrolled storm-water drainage area of 260.17 m² from this site is 0.55.

The total tributary area consisting of approximately 260.17 square metres will be out-letting off site uncontrolled from the residential apartment building site.

ii. SURFACE AREA DRAINING TO FRONT OF LOT (NODE #2)

| | |
|----------------------|-------------------------|
| Concrete Area | = 7.64 m ² |
| Grass Area | = 131.06 m ² |
| Interlock Paver Area | = 65.67 m ² |
| Asphalt Area | = 55.80 m ² |
| Total Area | = 260.17 m ² |

$$C_2 = \frac{(131.06 \times 0.2) + (7.64 \times 0.9) + (65.67 \times 0.9) + (55.80 \times 0.9)}{260.17}$$

$$C_2 = \frac{142.321}{260.17}$$

$$C_2 = 0.547$$

$$\text{Say "C}_2\text{"} = 0.55 \text{ (NODE #2)}$$

$$C_{100} = \frac{(131.06 \times 0.2 \times 1.25) + (7.64 \times 1.0) + (65.67 \times 1.0) + (55.80 \times 1.0)}{260.17}$$

$$= \frac{161.875}{260.17}$$

$$= 0.622$$

Therefore, $C_{100} = 0.62$ for (NODE #2)

iii. SURFACE AREA DRAINING TO REAR OF LOT

$$\text{Total Area} = 0 \text{ m}^2$$

$$C_2 = 0$$

$$C_{100} = 0$$

The uncontrolled drainage area draining to the rear of the lot is 0 m^2 and the uncontrolled drainage area draining to the front of the lot is 260.17 m^2 .

The SWM area to be controlled is 368.50 m^2 . Refer to the attached "Drainage Area Plan" in Figure 1 of **Appendix A** for further details.

Pre-Development Flow Estimation

Maximum allowable off-site flow: two (2)-year storm

NODE #101

Pre-Development Site Area Characteristics

| | |
|----------------------|------------------------|
| Development Lot Area | = 628.67 m^2 |
| Asphalt Area | = 89.22 m^2 |
| Concrete Area | = 127.31 m^2 |
| Roof Area | = 211.01 m^2 |
| Grass Area | = 201.13 m^2 |

$$C = \frac{(89.22 \times 0.9) + (201.13 \times 0.2) + (127.31 \times 0.9) + (211.01 \times 0.9)}{628.67}$$

$$C = \frac{425.012}{628.67}$$

$$C = 0.676$$

Say $C = 0.68$

Use $C_{pre} = 0.4$ maximum allowable for redevelopment

$T_c = D/V$ where $D = 38.5$ m, $\Delta H = 0.61$ m, $S = 1.6\%$, and $V = 2.8$ feet/second = 0.85 m/s

Therefore,

$$T_c = \frac{38.5\text{m}}{0.85\text{m/s}}$$

$T_c = 0.76$ minutes

Use $T_c = 10$ minutes

$l_2 = 77.10$ mm/hr [City of Ottawa, two (2)-year storm]

Using the Rational Method

$$Q = 2.78 (0.4) (77.10) (0.063)$$

$$Q = 5.40 \text{ L/s}$$

Therefore, the total allowable flow off-site is 5.40 L/s.

The pre-development flow of the two (2)-year and 100-year storm event draining to the **front** of the lot is as follows:

Two (2)-Year Storm Event

Where, $T_c = 10$ min.

Node #101

$$Q_{2pre} = 2.78 (0.68) (77.10) (0.063)$$

$$= 9.18 \text{ L/s}$$

100-Year Storm Event

$$C_{100pre} = \frac{(69.22 \times 1.0) + (201.13 \times 1.25 \times 0.2) + (127.31 \times 1.0) + (211.01 \times 1.0)}{628.67}$$

$$= \frac{477.823}{628.67}$$

$$C_{100pre} = 0.760$$

$$Q_{100pre} = 2.78 (0.76) (178.6) (0.063)$$

$$= 23.77 \text{ L/s}$$

The pre-development flow of the two (2)-year and 100-year storm event draining to the **rear** of the lot is as follows:

Where, $T_c = 10$ min.

$$Q_{2\text{pre}} = 2.78 (0.68) (77.10) (0) \\ = 0 \text{ L/s}$$

$$Q_{100\text{pre}} = 2.78 (0.70) (178.6) (0) \\ = 0 \text{ L/s}$$

A coloured Google image and aerial photography of these current pre-development conditions of the site is provided in **Appendix B** of this report for reference.

Post-Development Flow Estimation

Uncontrolled Drainage Areas

The post-development flow of the two (2)-year and 100-year storm event draining to the **front** of the lot is as follows:

Where, $T_c = 10$ min. ; $A = 260.17 \text{ m}^2$

Node #3

$$Q_{2\text{post}} = 2.78 (0.55) (77.10) (0.026) \\ = 3.07 \text{ L/s}$$

$$Q_{100\text{post}} = 2.78 (0.62) (178.6) (0.026) \\ = 8.00 \text{ L/s}$$

The City of Ottawa requires the entire site to drain only to the front and not to the rear onto the existing "Arthur Lane" which was part of the conditions for development.

The post-development flow of the two (2)-year and 100-year storm event draining to the **rear** of the lot is as follows:

Where, $T_c = 10$ min.

$$Q_{2\text{post}} = 2.78 (0) (77.10) (0) \\ = 0 \text{ L/s}$$

$$Q_{100\text{post}} = 2.78 (0) (178.6) (0) \\ = 0 \text{ L/s}$$

For this site, because 260.17 square meters of the site area are drained uncontrolled off site, the net peak sanitary flow of 0.44 L/s is estimated to discharge into the combined sewer (see Serviceability Report), the net allowable discharge for this site into the existing sewer system using the two(2)-year storm event criteria at C = 0.4 (max) is calculated as follow: $Q = \{2.78 (0.4) (77.10) (0.063) - [2.78 (0.62) (178.6) (0.026)] - [0.44 \text{ L/s}]\} = 5.40 \text{ L/s} - 8.00 \text{ L/s} - 0.44 \text{ L/s} = -3.04 \text{ L/s}$. Therefore, according to this approach, the maximum allowable flow rate off site is 5.40 L/s and the net allowable controlled flow rate off-site is -3.04 L/s is the result.

Storm-Water Management Analysis

At this site for the proposed development, a controlled flow rate of 1.90 L/s for on-site storm water management detention volume storage calculation will be used for this SWM analysis. This is accomplished by proposing two (2) controlled roof drains to restrict flow from the building at a rate of $2 \times 0.95 \text{ L/s} = 1.90 \text{ L/s}$ into the Cambridge Street North combined sewer. Controlled roof drain details are found on Dwg. No. 821-155 SWM-1 entitled Proposed Rooftop Stormwater Management Plan.

For this proposed development site, the total maximum allowable two (2)-year release rate of 5.40 L/s will be exceeded by 4.94 L/s since the control flow of 1.90 L/s from (2) roof drains plus uncontrolled post development 100-year flow to the front is 8.00 L/s and sanitary flow is 0.44 L/s totals to 10.34 L/s which is 4.94 L/s above the allowable. Therefore, a total flow of 10.34 L/s is expected to enter into the existing 375mm dia. Cambridge Street North combined sewer for storm events up to and including 100-year return period. In order to control runoff from this site the building flat roof top will be incorporated to provide stormwater attenuation. Stormwater will therefore be stored on site at the flat rooftop of the proposed apartment building which will be used for stormwater management (SWM) purposes.

The post-development inflow rate during the two (2)-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 for this development property. The roof drain flow rate proposed is at 0.95 L/s (15.0 U.S. gal./min.) for Roof Drain #1 and for Roof Drain #2. The specified roof drain is the Watts "Adjustable Accutrol Weir" (Model # RD-100-A-ADJ) with weir opening in the ¼ exposed position, which will allow a flow of 0.95 L/s under a head of 150 mm water above the drain for Roof Drain #1. At Roof Drain #2, the weir opening is also in the ¼ exposed position which will allow a flow of 0.95 L/s under a head of 150 mm water above the drain. See **Appendix C** for Roof Drain details. Therefore, the stormwater flow that can be controlled from this rooftop and outletted off-site is $0.95 \text{ L/s} + 0.95 \text{ L/s} = 1.90 \text{ L/s}$. Refer to the Proposed Rooftop Stormwater Management Plan Dwg. 821-155 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, $Q_{A1} = 2.78 CIA$

Two (2)-Year Event

$$C_2 = 0.90$$

$$A = 195.64 \text{ m}^2$$

$$I = \text{mm/hr}$$

$$Q_1 = 2.78 (0.90) (0.0196 \text{ ha.}) I = 0.049I$$

100-Year Event

$$C_{100} = 1.0$$

$$A = 195.64 \text{ m}^2$$

$$I = \text{mm/hr}$$

$$Q_1 = 2.78 (1.0) (0.0196 \text{ ha.}) I = 0.055I$$

For Roof Area 2, $Q_{A2} = 2.78 CIA$

Two (2)-Year Event

$$C_2 = 0.90$$

$$A = 172.86 \text{ m}^2$$

$$I = \text{mm/hr}$$

$$Q_2 = 2.78 (0.90) (0.0173 \text{ ha.}) I = 0.044I$$

100-Year Event

$$C_{100} = 1.0$$

$$A = 172.86 \text{ m}^2$$

$$I = \text{mm/hr}$$

$$Q_2 = 2.78 (1.0) (0.0173 \text{ ha.}) I = 0.048I$$

The summary results of the calculated inflow and the storage volume of the site and building's flat rooftop to store the two (2)-year and 100-year storm events are shown in **Tables 1 to 4** inclusive.

Table 5 summarizes the post-development design flows from the building roof top area as well as the type of roof drains, the maximum anticipated ponding depths, storage volumes required, and storage volumes provided for the two (2)-year and 100-year design events.

Table 5: Design Flow and Roof Drain Table

| Roof Drain ID & Drainage Area (ha) | Number of Roof Drains | Watts Roof Drain Model ID (Weir Opening) | Controlled Flow per Drain (L/s) | | Approximate Ponding Depth Above Drains (m) | | Storage Volume Required (m ³) | | Max. Storage Available (m ³) |
|------------------------------------|-----------------------|--|---------------------------------|-------------|--|----------|---|--------------|--|
| | | | 2 YR | 100 YR | 2 YR | 100 YR | 2 YR | 100 YR | |
| RD-1 (0.0196 ha) | 1 | RD-100-A-ADJ (1/4 EXPOSED) | 0.788 | 0.946 | 0.10 | 0.15 | 2.14 | 7.71 | 9.50 |
| RD-2 (0.0173 ha) | 1 | RD-100-A-ADJ (1/4 EXPOSED) | 0.788 | 0.946 | 0.10 | 0.15 | 1.81 | 6.42 | 8.46 |
| Total Roof (0.0182 ha) | 2 | - | 1.58 | 1.90 | - | - | 3.95 | 14.13 | 17.96 |

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 “siltsack” catch basin sediment control device or equal in catch basins as recommended by manufacturer on-site and off-site within the Cambridge Street North road right of way adjacent to this property. Siltsack shall be inspected every 2 to 3 weeks and after every major storm. The deposits will be disposed of as per the requirements of the contract. See Dwg. #821-155 ESC-1 for details.

Conclusion

At this proposed residential site and to develop this lot to house a 20 unit apartment building on a 0.063 ha. parcel of land, the estimated allowable flow off-site is calculated at 5.40 L/s based on City of Ottawa Drainage and Stormwater Management (SWM) criteria controlled to a 2-year pre-development level. For on-site SWM attenuation, the flat roof top of the proposed low rise apartment building will be utilized and (2) controlled roof drains are incorporated each with a controlled release rate of 0.95 L/s (15.0 U.S. gal/min.). The controlled flow from this site totals to 1.90 L/s for the post development condition. The uncontrolled 2 year post development flow from the remainder of the site draining to the front is estimated at 3.07 L/s and 8.00 L/s for the 100 year event.

During the two (2)-year storm event for the flat rooftop storage, the ponding depth of rooftop area 1 and 2 is estimated at 100 mm at the drain and 0mm at the roof perimeter, assuming a 1.5% minimum roof pitch to the drain. The rooftop storage available at Roof Area 1 is 2.67 m³ and the rooftop storage available at Roof Area 2 is 2.47 m³, for a total of 5.14 m³, which is greater than the required volume of 3.95 m³.

During the 100-year storm event for the flat rooftop storage, the ponding depth of Roof Area 1 and 2 is estimated at 150 mm at the drain and 0mm at the roof perimeter, assuming a 1.5% minimum roof pitch to the drain. The rooftop storage available at Roof Area 1 is 9.50 m³ and the rooftop storage available at Roof Area 2 is 8.46 m³, for a total of 17.96 m³, which is greater than the required volume of 14.13 m³.

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. 821-155 G-1 and 821-155 SWM-1 respectively, the desirable two (2)-year storm and 100-year

storm event detention volume of 5.14 m³ and 17.96 m³ respectively will be available on site. Refer to **Appendix D** for detailed calculations of available storage volumes.

At this development site, for storm events up to the 100-year event the maximum post development flow draining off-site is the controlled roof top flow plus the 100-year uncontrolled flow from the site draining to the front and peak sanitary flow totals to 10.34 L/s (1.90 L/s + 8.00 L /s + 0.44 L/s) which is approximately 4.94 L/s greater than the allowable flow of 5.40 L/s.

In comparing the pre-development flow of the current site conditions to the post development flow as shown on Page No. 6 and 7 of this report, the SWM regulated flow plus uncontrolled flow from the proposed site under the post development conditions at the 2-Year event = 5.09 L/s and the 100-Year event = 10.34 L/s whereupon both of the post development flow events are less than current pre-development flow estimate for the site at 2-Year_{Pre} = 9.18 L/s and 100-Year_{Pre} = 23.77 L/s. Therefore with this proposed development, stormwater flow is improved from that of the existing condition.

The building weeping tile drainage will outlet via its separate 150mm diameter PVC storm lateral. The roof drains will be outletted also via a separate 150mm PVC storm lateral, where upon both laterals are connected directly to the existing Cambridge Street North 375mm diameter combined sewer. The City of Ottawa recommends that pressurized drain pipe material be used in the building for the roof drain leader pipe in the event of surcharging in the City combined sewer system. Refer to the proposed site grading and servicing plan Dwg. 821-155 for details.

PREPARED BY T.L. MAK ENGINEERING CONSULTANTS LTD.



TONY L. MAK, P.ENG



PROPOSED 370 CAMBRIDGE STREET NORTH FOUR STOREY APARMENT

DEVELOPMENT SITE

TABLE 1

TWO (2)-YEAR EVENT

REQUIRED BUILDING ROOF AREA 1 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 (m³) |
|---|---------------------------------|-------------------------------|------------------------------|-------------------------------|--|
| 5 | 102.80 | 5.037 | 0.788 | 4.249 | 1.28 |
| 10 | 77.10 | 3.778 | 0.788 | 2.990 | 1.79 |
| 15 | 63.30 | 3.102 | 0.788 | 2.314 | 2.08 |
| 20 | 52.03 | 2.550 | 0.788 | 1.762 | 2.11 |
| 25 | 45.15 | 2.212 | 0.788 | 1.424 | <u>2.14</u> |
| 30 | 39.90 | 1.955 | 0.788 | 1.167 | 2.10 |
| 35 | 36.06 | 1.767 | 0.788 | 0.979 | 2.06 |
| 40 | 32.87 | 1.611 | 0.788 | 0.823 | 1.98 |

Therefore, the required rooftop storage volume is 2.14 m³.

PROPOSED 370 CAMBRIDGE STREET NORTH FOUR STOREY APARTMENT

DEVELOPMENT SITE

TABLE 2

TWO (2)-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 (m³) |
|---|-----------------------------------|-------------------------------|------------------------------|-------------------------------|--|
| 5 | 102.80 | 4.523 | 0.788 | 3.735 | 1.12 |
| 10 | 77.10 | 3.392 | 0.788 | 2.604 | 1.56 |
| 15 | 63.30 | 2.785 | 0.788 | 1.997 | 1.797 |
| 20 | 52.03 | 2.289 | 0.788 | 1.501 | <u>1.81</u> |
| 25 | 45.17 | 1.987 | 0.788 | 1.199 | 1.799 |
| 30 | 39.90 | 1.756 | 0.788 | 0.968 | 1.74 |
| 35 | 36.06 | 1.587 | 0.788 | 0.799 | 1.68 |
| 40 | 32.87 | 1.447 | 0.788 | 0.659 | 1.58 |

Therefore, the required storage volume is 1.81 m³.

PROPOSED 370 CAMBRIDGE STREET NORTH FOUR STOREY APARTMENT

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 (m³) |
|---|-----------------------------------|-------------------------------|------------------------------|-------------------------------|--|
| 10 | 178.6 | 9.823 | 0.946 | 8.877 | 5.33 |
| 15 | 142.9 | 7.860 | 0.946 | 6.914 | 6.22 |
| 20 | 120.0 | 6.600 | 0.946 | 5.654 | 6.79 |
| 25 | 103.9 | 5.715 | 0.946 | 4.769 | 7.15 |
| 30 | 91.90 | 5.055 | 0.946 | 4.109 | 7.40 |
| 35 | 82.60 | 4.543 | 0.946 | 3.597 | 7.55 |
| 40 | 75.10 | 4.131 | 0.946 | 3.185 | 7.64 |
| 45 | 69.10 | 3.801 | 0.946 | 2.855 | <u>7.71</u> |
| 50 | 63.90 | 3.515 | 0.946 | 2.569 | 7.707 |
| 55 | 59.62 | 3.278 | 0.946 | 2.332 | 7.70 |
| 60 | 55.90 | 3.075 | 0.946 | 2.129 | 7.66 |
| 65 | 52.65 | 2.893 | 0.946 | 1.947 | 7.59 |

Therefore, the required storage volume is 7.71 m³.

PROPOSED 370 CAMBRIDGE STREET NORTH FOUR STOREY APARTMENT

DEVELOPMENT SITE

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 (m³) |
|---|-----------------------------------|-------------------------------|------------------------------|-------------------------------|--|
| 10 | 178.6 | 8.591 | 0.946 | 7.645 | 4.59 |
| 15 | 142.9 | 6.874 | 0.946 | 5.928 | 5.34 |
| 20 | 120.0 | 5.772 | 0.946 | 4.826 | 5.79 |
| 25 | 103.9 | 5.000 | 0.946 | 4.054 | 6.08 |
| 30 | 91.90 | 4.421 | 0.946 | 3.475 | 6.26 |
| 35 | 82.60 | 3.973 | 0.946 | 3.027 | 6.36 |
| 40 | 75.10 | 3.612 | 0.946 | 2.666 | 6.40 |
| 45 | 69.10 | 3.324 | 0.946 | 2.378 | <u>6.42</u> |
| 50 | 63.90 | 3.074 | 0.946 | 2.128 | 6.38 |
| 55 | 59.62 | 2.867 | 0.946 | 1.921 | 6.34 |
| 60 | 55.90 | 2.689 | 0.946 | 1.743 | 6.28 |
| 65 | 52.65 | 2.530 | 0.946 | 1.584 | 6.18 |

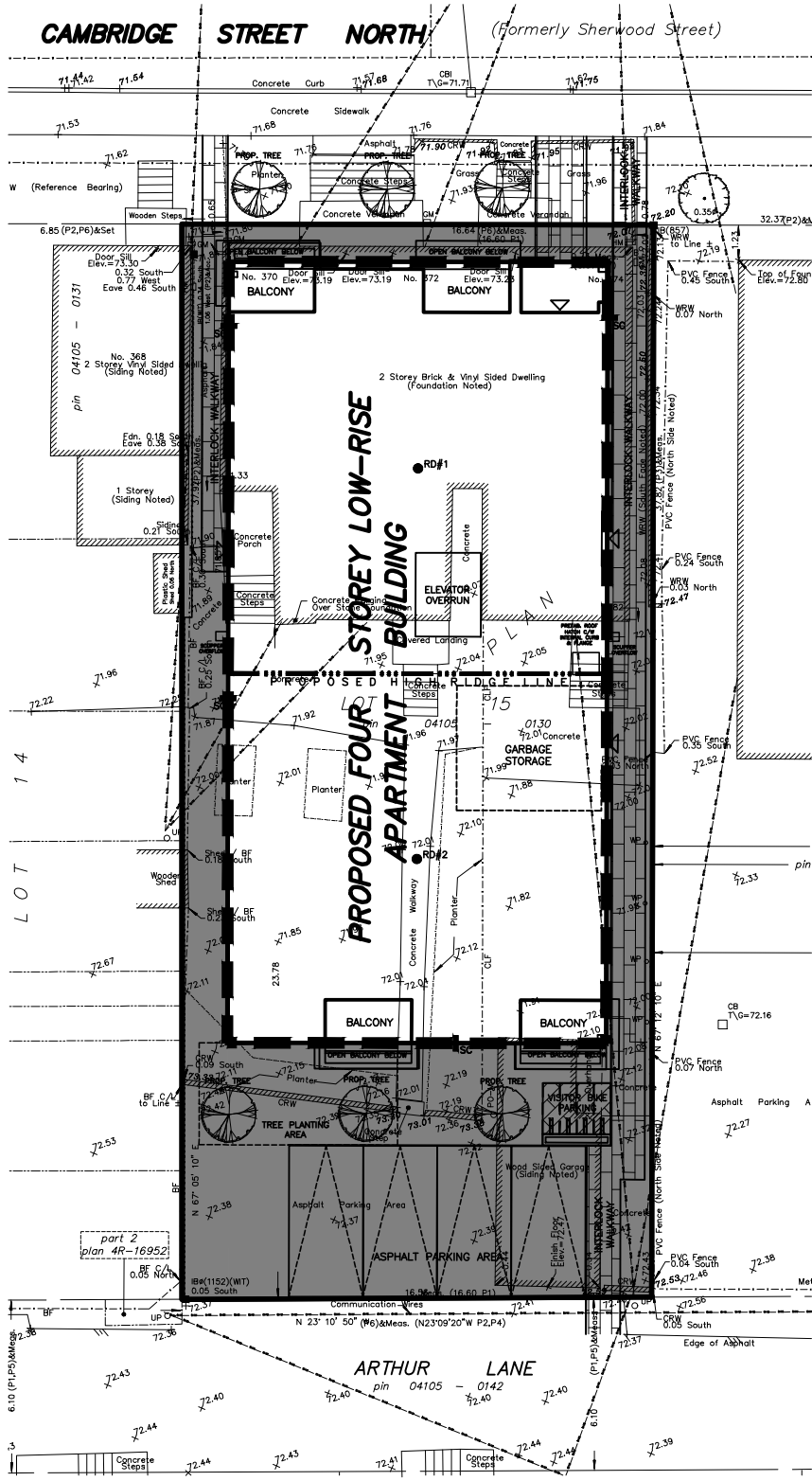
Therefore, the required storage volume is 6.42 m³.

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FOUR STOREY LOW-RISE APARTMENT BUILDING SITE
LOT 15 WEST CAMBRIDGE STREET NORTH
SOUTH OF STONE BOUNDARY
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CITY OF OTTAWA**

**APPENDIX A
STORM DRAINAGE AREA PLAN
FIGURE 1**

**PROPOSED 370 CAMBRIDGE STREET NORTH
SITE DEVELOPMENT
DRAINAGE AREA PLAN**


N.T.S.



LEGEND

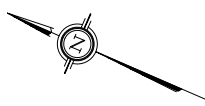
- LIMIT OF CONTROLLED STORM DRAINAGE AREA = 368.50 SQ. M**
- UNCONTROLLED STORM DRAINAGE AREA = 260.17 SQ. M**
- TOTAL AREA = 628.67 SQ. M**

POST-DEVELOPMENT SITE AVERAGE "C" = 0.76



**T.L. MAK ENGINEERING CONSULTANTS LTD.
CONSULTING ENGINEERS**

| | | |
|-------------------------------|--------------------------|--------------------------------|
| PROJECT No. 821-155 | DATE JULY 2022 | DRAWING No. FIGURE 1 |
|-------------------------------|--------------------------|--------------------------------|



**PROPOSED
FOUR STOREY LOW-RISE APARTMENT BUILDING SITE
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370 CAMBRIDGE STREET NORTH
CITY OF OTTAWA**

**APPENDIX B
SITE PRE-DEVELOPMENT CONDITION
GOOGLE IMAGE 2019
AND
AERIAL PHOTOGRAPHY 2021 (GEOOTTAWA)**







**PROPOSED
FOUR STOREY LOW-RISE APARTMENT BUILDING SITE
LOT 15 WEST CAMBRIDGE STREET NORTH
SOUTH OF STONE BOUNDARY
R-PLAN 33
370 CAMBRIDGE STREET NORTH
CITY OF OTTAWA**

**APPENDIX C
PROPOSED ROOF DRAIN
DETAILS**



Adjustable Accutrol Weir

Tag: _____

Adjustable Flow Control for Roof Drains

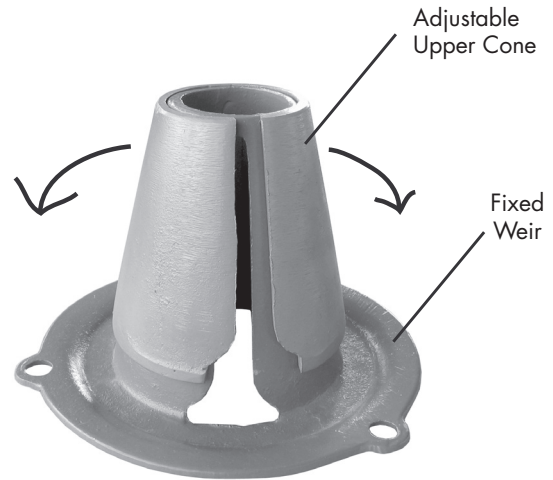
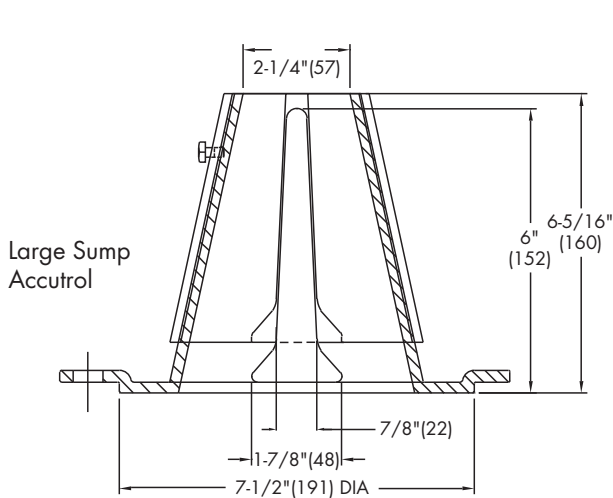
ADJUSTABLE ACCUTROL (for Large Sump Roof Drains only)

For more flexibility in controlling flow with heads deeper than 2", Watts Drainage offers the Adjustable Accutrol. The Adjustable Accutrol Weir is designed with a single parabolic opening that can be covered to restrict flow above 2" of head to less than 5 gpm per inch, up to 6" of head. To adjust the flow rate for depths over 2" of head, set the slot in the adjustable upper cone according to the flow rate required. Refer to Table 1 below.
 Note: Flow rates are directly proportional to the amount of weir opening that is exposed.

EXAMPLE:

For example, if the adjustable upper cone is set to cover 1/2 of the weir opening, flow rates above 2" of head will be restricted to 2-1/2 gpm per inch of head.

Therefore, at 3" of head, the flow rate through the Accutrol Weir that has 1/2 the slot exposed will be:
 [5 gpm (per inch of head) x 2 inches of head] + 2-1/2 gpm (for the third inch of head) = 12-1/2 gpm.



1/2 Weir Opening Exposed Shown Above

TABLE 1. Adjustable Accutrol Flow Rate Settings

| Weir Opening Exposed | 1" | 2" | 3" | 4" | 5" | 6" |
|----------------------|--------------------------------|----|-------|------|-------|----|
| | Flow Rate (gallons per minute) | | | | | |
| Fully Exposed | 5 | 10 | 15 | 20 | 25 | 30 |
| 3/4 | 5 | 10 | 13.75 | 17.5 | 21.25 | 25 |
| 1/2 | 5 | 10 | 12.5 | 15 | 17.5 | 20 |
| 1/4 | 5 | 10 | 11.25 | 12.5 | 13.75 | 15 |
| Closed | 5 | 5 | 5 | 5 | 5 | 5 |

Job Name _____
 Job Location _____
 Engineer _____

Contractor _____
 Contractor's P.O. No. _____
 Representative _____

Watts product specifications in U.S. customary units and metric are approximate and are provided for reference only. For precise measurements, please contact Watts Technical Service. Watts reserves the right to change or modify product design, construction, specifications, or materials without prior notice and without incurring any obligation to make such changes and modifications on Watts products previously or subsequently sold.

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**APPENDIX D
DETAILED CALCULATIONS
FOR TWO (2)-YEAR AND 100-YEAR
AVAILABLE STORAGE VOLUME**

AVAILABLE STORAGE VOLUME CALCULATIONS

Two (2)-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 12.5 U.S.gal./min. or 0.788 L/s under a head of 100mm. Refer to Dwg. 821-155 SWM-1 for roof drain details.

Roof Storage Area 1 (NODE No. 1)

Available flat roof area for storage = 187.02m², C = 0.9, @roof slope of 1.5% minimum or 100 mm of water height above the roof drain. Therefore, the available roof area will store a volume as shown below using the reservoir volume equation.

$$V = \frac{(0.10\text{m})[77.05 + 4 (20.74) + 0]}{6}$$

$$V = \frac{(0.10) (160.01)}{6}$$

$$V = 2.67\text{m}^3$$

The available Roof Area 1 storage volume of 2.67m³ > required two (2)-year storage volume of 2.14 m³ from Table 1.

Roof Storage Area 2 (NODE No.2)

Available flat roof area for storage = 173.62 m², C = 0.9, @roof slope of 1.6% minimum or 100 mm of water height above the roof drain. Therefore, the available roof area will store a volume as shown below using the reservoir volume equation.

$$V = \frac{(0.10\text{m})[74.43 + 4 (18.50) + 0]}{6}$$

$$V = \frac{(0.10) (148.43)}{6}$$

$$V = 2.47\text{m}^3$$

The available Roof Area 2 storage volume of 2.47 m³ > required two (2)-year storage volume of 1.81 m³ from Table 2.

Therefore, the ponding depth at the Roof Drain 1 and 2 locations is approximately 0.10 m (100 mm), and the two (2)-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 two (2)-year storm event volume of 3.95 m³ given it can store up to 5.14 m³.

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 15.0 U.S.gal./min. or 0.946 L/s under a head of 150mm. refer to Dwg. 821-155 SWM-1 for roof drain details.

Roof Storage Area 1 (NODE No. 1)

Available flat roof area for storage = 187.02 m², C = 1.0, @roof slope of 1.5% minimum or 150 mm 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.

$$V = \frac{(0.15\text{m})[187.02 + 4(48.28) + 0]}{6}$$

$$V = \frac{(0.15)(380.14)}{6}$$

$$V = 9.50\text{m}^3$$

The available Roof Area 1 storage volume of 9.50 m³ > required 100-year storage volume of 7.71 m³ from Table 3.

Roof Storage Area 2 (NODE No. 2)

Available flat roof area for storage = 173.62 m², C = 1.0, @roof slope of 1.6 % 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.

$$V = \frac{(0.15\text{m})[173.62 + 4(41.22) + 0]}{6}$$

$$V = \frac{(0.15)(338.50)}{6}$$

$$V = 8.46\text{m}^3$$

The available Roof Area 2 storage volume of 8.46 m³ > required 100-year storage volume of 6.42 m³ 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 0 mm above the roof perimeter surface. Accordingly, it is recommended that four (4) roof scuppers as shown on Dwg. 821-155 G-1 and 821-155 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 build up 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 14.13 m³ given it can store up to 17.96 m³.