PARSONS

Site Servicing and Stormwater Management Report
327 Richmond Road
Ottawa, Ontario
December 18, 2020

Prepared for :

Richmond Churchill Limited Partnership

Submitted to :

City of Ottawa

Parsons Project # 477093

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1.0 INTRODUCTION

1.1 Site Description and Proposed Development

Richmond Churchill Limited Partnership has retained Parsons Inc. to prepare a *Site Servicing and Stormwater Management Report* in support of the proposed mixed-use building at 327 Richmond Road. The mixed-use building will consist of residential and commercial space. **Figure 1** shows the site location.

The existing parcels (319, 325 and 327 Richmond Road, 380 Winona Avenue and 381 Churchill Avenue North) will be merged to house the proposed building. The existing parcels house a two storey commercial building, a garage, a single-family home and a two storey residential rental building.

The proposed building will consist of a multi-storey building with commercial space on the first floor and residential units on the remaining floors. There will be 154 residential rental units and three retail spaces for rent. There will be a two-level parking garage under the building, which will be accessed from Churchill Avenue. There will also be a loading aisle at the back of the property, with access from Winona Avenue. The total gross floor area of the building will be 16,540 m^2 (178,040 ft^2).

The total property area is roughly 0.33 ha. The site ground elevation varies between approximately 68.5 m and 67.0 m and generally slopes from south to north.

The 327 Richmond Road property is surrounded by the features described below.

- North: Residential (single family and townhouse)
- East: Winona Avenue –commercial space
- South: Richmond Road – commercial space
- West: Churchill Avenue – commercial space

Figure 1: 327 Richmond Road, Ottawa - Key Plan (Source: geoottawa)

1.2 Guidelines and Background Documents

The 327 Richmond Road design is in accordance with the documents below.

- *Ottawa Design Guidelines – Water Distribution,* 1st Edition, July 2010 (OWG and technical bulletins)
  - *Technical Bulletin ISD-2010-2*, December 15, 2010
  - *Technical Bulletin ISDTB-2014-02*, May 27, 2014
  - *Technical Bulletin ISTB-2018-02*, March 21, 2018
- *Sewer Design Guidelines*, City of Ottawa, 2nd Edition, October 2012 (OSG and technical bulletins)
  - *Technical Bulletin ISDTB-2012-6,* October 31, 2012
  - *Technical Bulletin ISDTB-2014-01,* February 5, 2014
  - *Technical Bulletin PIEDTB-2016-01,* September 6, 2016

  - *Technical Bulletin ISTB-2018-01,* March 21, 2018
  - *Technical Bulletin ISTB-2019-02, July 8, 2019*
- *Water Supply for Public Fire Protection*, Fire Underwrites Survey, 1999 (FUS)
- *City of Ottawa Accessibility Design Standards (2012)*
- *Ottawa Standard Tender Documents (2019)*
- *Ontario Provincial Standards for Roads & Public Works (2019)*

1.3 Existing Infrastructure

The exiting municipal infrastructure surrounding the property is shown in **Figure 2**.

The existing municipal infrastructure on Richmond Road consists of:

- A 300 mm PVC watermain (2004)
- A 300 mm PVC sanitary sewer (2004)
- A 300 mm PVC storm sewer (2004)

The existing municipal infrastructure on Churchill Avenue North consists of:

- A 200/400 mm PVC watermain (2004/2010)
- A 250 mm PVC sanitary sewer (2010)
- A 375 mm PVC storm sewer (2010)

The existing municipal infrastructure on Winona Avenue consists of:

- A 152mm PVC/UCI watermain (2004/1931)
- A 225 mm concrete sanitary sewer (1931)
- A 450 mm concrete storm sewer (1981)

Figure 2: Existing Municipal Infrastructure Surrounding the Site

1.4 Consultation and Permits

The City of Ottawa and other agencies were consulted for this project. A summary of the consultations is provided below; copies of the correspondences and/or minutes are provided in **Appendix A.**

CONSULTATIONS

City of Ottawa

The City of Ottawa provided the following project specific criteria for the proposed development during the pre-application consultation, the minutes are provided in **Appendix A**:

- Concerned about capacity of sanitary. Churchill limited size for services;

- Site contamination is likely. Need full assessment in Phase II ESA. Of particular concern, is ground-water contamination, which if evident, the water needs to be treated and then directed to sanitary. Even treated water is not permitted as storm.
- Make sure the Geotech study and Phase II ESA specifically discuss impacts on ground water, and if contaminated propose solutions;
- The underground parking levels may impact water table and ground water;
- Site servicing connections can occur on any street;
- Water and storm should not have issues;
- Any soil contamination be addressed through safe removal and remediation; and
- Flow and capacity analysis to study area up to trunk connection, and surrounding area developments.

Rideau Valley Conservation Authority (RVCA)

Parsons contacted the RVCA who indicated that no water quality protections will be required, and best management practices are encouraged. The communication with the RVCA is included in **Appendix A**.

Ministry of the Environment, Conservation and Parks (MECP)

An Environmental Compliance Approval (ECA) is not required for this site as the multiple parcels will be merged in to one, there is no industrial use proposed and the sewers in the area are fully separated.

PERMITS AND APPROVALS

The City of Ottawa and the various agencies consulted require the approvals and permits listed below. The City of Ottawa Development Servicing Study Checklist is included in **Appendix B**.

City of Ottawa

- Road Cut Permit
- Commence Work Order
- Water permit
- Water Data Card
- Flow Control Roof Drainage Declaration

1.5 Geotechnical and Environmental Recommendations

GEOTECHNICAL INVESTIGATION

Paterson Group completed a geotechnical report, *Geotechnical Investigation, Proposed Multi-Storey Building, 319-327 Richmond Road, 381 Churchill Avenue, 380 Winona Avenue – Ottawa, Ontario* dated May 22, 2020. The report is submitted separately.

The report's recommendations regarding grading, site servicing, and drainage are described below. These recommendations are integrated in the design.

Site Grading and Preparation

- Line-drilling in conjunction with hoe-ramming or controlled blasting may be required to remove the bedrock. In areas where only a small quantity of bedrock is to be removed, bedrock removal may be possible by hoe-ramming.
    - The effects on the existing services, buildings, and other structures should be addressed prior to considering blasting operations. Should blasting be required, a pre-blast or pre-construction survey of the existing structures located in proximity of the blasting operations should be carried out prior to commencing site activities.
    - Peak particle velocity should not exceed 25 mm/s during the blasting program to reduce the risks of damage to the existing structures.

  - The blasting operations should be planned and conducted under the supervision of a licensed professional engineer who is an experience blasting consultant.
  - Excavation side slopes in sound bedrock could be completed with almost vertical side walls. A minimum of 1m horizontal bench should remain between the bottom of the overburden and the top of the bedrock surface to provide an area for potential sloughing or a stable base for the overburden shoring system.
- Means to reduce vibrations levels caused by construction operations should be incorporated in the construction operations as much as possible. Vibrations caused by blasting or construction operations could cause detrimental vibrations on the adjoining buildings and structures. Recommended that all vibrations be limited.
  - As a guidelines, the peak particle velocity should be less than 15 mm/s between frequencies of 4 to 12 Hz, and 500 mm/s above a frequency of 40 Hz (interpolate between 12 and 40 Hz).
  - These guidelines are perceptible at human level and can be disturbing to some people. Considering there are several sensitive buildings in close proximity to the subject site, consideration to lower these guidelines is recommended.
  - Recommended to carry out a pre-construction survey to minimize the risks of claims during or following construction.
- Topsoil and fill, containing deleterious materials, should be stripped from under any buildings and other settlement sensitive structures.
- Fill used for grading beneath the building areas should consist, unless otherwise specified, of clean imported granular fill, such as OPSS Granular A or Granular B Type II.
  - Fill should be placed in lifts no greater than 300mm thick and compacted using suitable compaction equipment for the lift thickness.
- Non-specified existing fill along with site-excavated soil can be used as general landscaping fill where settlement of the ground surface is of minor concern.
  - These materials should be spread in thin lifts and at least compact by the tracks of the spreading equipment to minimize voids.
  - If these materials are to be used to build up the subgrade level for areas to be paved, they should be compacted in thin lifts to a minimum density of 95% of their respective SPMDD.
  - Non-specified existing fill and site-excavated soils are not suitable for use as backfill against foundation walls unless a composite drainage blanket connected to a perimeter drainage system is provided.

Pavement Structure

- Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project.
- If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with OPSS Granular B Type II material.
- The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 98% of the material's SPMDD using suitable vibratory equipment.

Table 1: Recommended Pavement Structure – Car Only Parking Areas

Thickness (mm)	Material Description
50	WEAR COURSE – HL-3 or Superpave 12.5 Asphaltic Concrete
150	BASE – OPSS Granular A Crushed Stone
300	SUBBASE – OPSS Granular B Type II
SUBGRADE – Either fill, in situ soils or OPSS Granular B Type I or II material placed over in situ soil or fill	

Table 2: Recommended Pavement Structure - Access Lanes and Heavy Truck Parking Areas

Thickness (mm)	Material Description
40	WEAR COURSE – HL-3 or Superpave 12.5 Asphaltic Concrete
50	BINDER COURSE – HL-8 or Superpave 19 Asphaltic Concrete
150	BASE – OPSS Granular A Crushed Stone
450	SUBBASE – OPSS Granular B Type II
SUBGRADE – Either fill, in situ silty clay or OPSS Granular B Type I or II material placed over in situ soil or fill	

Foundation Drainage and Backfill

- A waterproofing membrane will be required to lessen the effect of water infiltration for the underground parking levels starting at 1 m above the observed groundwater level down to the founding level.
- The waterproofing membrane layer shall be placed against the grinded bedrock face. A composite drainage system should be incorporated against the waterproofing membrane system.
    - It is recommended that the composite drainage system (such as Miradrain G100N, Delta Drain 6000 or equivalent) extend down to the footing level. It is recommended that 150 mm diameter sleeves at 3 m centres be cast in the foundation wall at the footing interface to allow the infiltration of water to flow to an interior perimeter drainage pipe. The perimeter drainage pipe should direct water to sump pit(s) within the lower level area.
- Backfill against foundation walls should be free-draining and non-frost susceptible granular materials.
    - The greater part of the site excavated materials will be frost susceptible and, as such, are not recommended for re-use as backfill against the foundation walls, unless used in conjunction with a drainage geocomposite, such as Miradrain G100N or Delta Drain 6000, connected to the perimeter foundation drainage system. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should otherwise be used for this purpose.
- Underfloor drainage will be required to control water infiltration due to groundwater infiltration at the proposed founding elevation.
    - Recommend that 150 mm in diameter perforated pipes be placed along the interior perimeter of the foundation wall and one drainage line within each bay.
    - The spacing of the underfloor drainage system should be confirmed at the time of backfilling the floor completing the excavation when water infiltration can be better assessed.
- A local groundwater lowering is expected under short-term conditions due to construction of the proposed building.
    - The extent of any significant groundwater lowering will take place within a limited range of the subject site due to the minimal groundwater lowering.
    - The lower portion of the foundation walls will be waterproofed which will limit groundwater lowering within the subject site and surroundings.
    - No issues are expected with respect to groundwater lowering that would cause long term damage to adjacent structures surrounding the proposed building.

Excavation Side Slopes

- The excavation side slopes above the groundwater level extending to a maximum depth of 3 m should be cut back at 1H:1V or flatter. The flatter slope is required for excavation below groundwater level.
- Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should maintain safe working distance from the excavation sides.

- Slopes in excess of 3 m in height should be periodically inspected by the geotechnical consultant in order to detect if the slopes are exhibiting signs of distress.
- A trench box is recommended to protect personnel working in trenches with steep or vertical sides. Services are expected to be installed by "cut and cover" methods and excavations should not remain open for extended periods of time.
- Temporary shoring may be required for the overburden soil to complete the required excavations where insufficient room is available for open cut methods. The shoring requirements will depend on the depth of the excavation, the proximity of the adjacent buildings and underground structures and the elevation of the adjacent building foundations and underground services.
    - The design and approval of the shoring system will be the responsibility of the shoring contractor and the shoring designer hired by the shoring contractor.

Pipe Bedding and Backfill

- A minimum of 150 mm of OPSS Granular A should be placed for bedding for sewer or water pipes when placed on soil subgrade. The bedding should extend to the spring line of the pipe. Cover material, from the spring line to a minimum of 300 mm above the obvert of the pipe should consist of OPSS Granular A (concrete or PSM PVC pipes) or sand (concrete pipe). The bedding and cover materials should be placed in maximum 225 mm thick lifts and compacted to 95% of the material's SPMDD.
- Where hard surface areas are considered above the trench backfill, the trench backfill material within the frost zone (about 1.8 m below finished grade) should match the soils exposed at the trench walls to reduce the potential differential frost heaving. The trench backfill should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% of the SPMDD.

Groundwater Control

- It is anticipated that groundwater infiltration into the excavations should be low to moderate and controllable using open sumps.
- For typical ground or surface water volumes being pumped during the construction phase, ranging between 50,000 to 400,000 L/day, there is a requirement to register on the Environmental Activity and Sector Registry (EASR).
- The contractor should be prepared to direct water away from all bearing surfaces and subgrades, regardless of the source, to prevent disturbance to the founding medium.

Winter Construction

- Precautions must be taken if winter construction is considered for this project. The subsoil conditions at this site mostly consist of frost susceptible materials. In presence of water and freezing conditions, ice could form within the soil mass. Heaving and settlement upon thawing could occur.
- In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the use of straw, propane heaters and tarpaulins or other suitable means. In this regard, the base of the excavations should be insulated from sub-zero temperatures immediately upon exposure and until such time as heat is adequately supplied to the building and the footings are protected with sufficient soil cover to prevent freezing at founding level.
- The trench excavations should be carried out in a manner to avoid the introduction of frozen materials, snow or ice into the trenches. As well, pavement construction is difficult during winter. The subgrade consists of frost susceptible soils which will experience total and differential frost heaving as the work takes place. Also, the introduction of frost, snow or ice into the pavement materials, which is difficult to avoid, could adversely affect the performance of the pavement structure.

PHASE II ESA

Paterson Group completed a Phase II Environmental Assessment (ESA) report, *Phase II – Environmental Site Assessment, 381 Churchill Avenue N, 319, 325 and 327 Richmond Road, 380 Winona Avenue – Ottawa, Ontario* dated June 9, 2020. The report is submitted separately.

Soil Analysis

Soil samples from the boreholes and excavations were analyzed. Several sampling locations exceeded the MECP Table 7 Standards for PHCs, BTEX, PAHs and metals.

A remedial program is required to address impacted soil exceeding MECP Table 7 Standards for residential land use.

Groundwater Quality

Impacted groundwater had been identified during the initial field program at 319 Richmond Road and 380 Winona Avenue. Any monitoring wells re-tested by Paterson as part of the Phase II ESA were in compliance with the MECP Table 7 Standards. To further assess and confirm the groundwater quality on the subject site additional groundwater testing is recommended. If two consecutive clean samples can be obtained from the impacted wells, the groundwater quality is considered to be in compliance with the MECP Standards.

2.0 WATER SERVICING

2.1 Proposed Water Servicing

The proposed building will be serviced with two (2) 200 mm diameter water services. A new 406 mm water isolation valve and chamber will be installed on the City's 406 mm watermain to separate the two water services.

Drawing C101, in **Appendix C,** shows the existing and proposed water distribution network.

2.2 Design Criteria

The proposed water servicing has been designed in general conformance with OWG as amended by the City of Ottawa by its technical bulletins.

The system pressure criteria under normal and various operating conditions are listed in the table below.

Table 3: Water System Pressure – Criteria

OPERATING CONDITIONS	PRESSURE CRITERIA	
	KPa	psi
Average Daily Demand		
minimum to maximum	276-552	40-80
Desirable range	350-480	50-70
Peak Hourly Demand		
minimum to maximum	276-552	40-80
Desirable range	350-480	50-70
Maximum Daily Demand + Fire Flow		
minimum	140	20

The City of Ottawa provided the watermain boundary conditions for the existing 406 mm diameter watermain, as shown in the table below. A copy of the correspondence is in **Appendix D**.

Table 4: 406mm Diameter Watermain on Churchill Avenue Boundary Conditions

MINIMUM HGL	MAXIMUM HGL	MAXIMUM DAY + FIRE FLOW
108.5 m	114.7 m	106.0 m
58 psi	66 psi	54 psi
397 KPa	457 KPa	372 KPa

*The associated pressures in psi and kPa are based on a ground elevation at the connection location of 68m.

The boundary conditions provided demonstrate that the available pressure ranges from approximately 58 psi to 66 psi during normal operating conditions.

The fire flow was calculated using the FUS with the following parameters:

Type of construction: non-combustible construction

Occupancy Type: limited combustible

Sprinkler Protection: fully monitored, automatic sprinkler system from standard water supply

The OWG requires that "Service areas with a basic day demand greater than 50 m^3/day (about 50 homes) shall be connected with a minimum of two watermains, separated by an isolation valve, to avoid the creation of a vulnerable service area. Individual residential facilities with a basic day demand greater than 50 m^3/day shall be connected with a minimum of two water services, separated by an isolation valve, to avoid the creation of a vulnerable service area." Therefore, two new 200 mm water services will be provided to the building, connected to the existing 406 mm watermain on Churchill Avenue to provide redundancy. An isolation valve and chamber will be installed on the City's 406 mm watermain to separate the two services.

The new water service will be installed with a minimum cover of 2.4 m. Should there be less than 2.4 m cover or separation from an open structure, the pipes will be insulated as per City Standard Drawings W22 and W23.

High pressure is not an issue on this site as the boundary conditions are below 80 psi. Therefore, pressure reducing valves will not be required.

2.3 Calculations and Simulation Results

The table below summarizes the anticipated maximum water demand for the proposed building. Detailed calculations for the water demand and fire flow are in **Appendix E**. The calculations represent the demand from the 184 units proposed and the rental space on the first floor. The rental space is identified as retail; however, the actual tenants are unknown at this time. Given the outdoor courtyards around the building that can be used as patios, it is envisioned that restaurants or cafes are potential tenants for some or all of the three retail spaces. As restaurant water demand is considerably higher than general retail demand we have assumed all three retail spaces will be used for restaurants to be conservative.

Table 5: Water Demand Rates

BUILDING	AVERAGE DAY DEMAND (ADD)	MAX DAILY DEMAND (MDD)	PEAK HOURLY DEMAND (PHD)	FIRE FLOW DEMAND (FF)	MDD+FF
	L/s	L/s	L/s	L/s	L/s
327 Richmond Road	3.9	8.6	14.0	367.0	375.6

The pressures were determined for the average day demand (ADD), maximum daily demand plus fire flow (MDD+FF), and peak hourly demand (PHD) based on the boundary conditions provided by the City of Ottawa using the Hazen-Williams head loss calculations. The calculations are provided in **Appendix E**. It was determined that a 150 mm diameter service would provide 19 psi (130 kPa) under maximum day plus fire demand which is below the City's allowable pressure. Therefore, a 200 mm diameter service has been proposed.

Table 6: Residual Pressures Under Each Demand with a 200mm Service

	AVERAGE DAY			PEAK HOUR			MAX DAY + FIRE FLOW*		
	(m)	(psi)	(kPa)	(m)	(psi)	(kPa)	(m)	(psi)	(kPa)
327 Richmond Road	40	57	393	40	57	393	33	46	319

2.4 Summary and Conclusions

A 200 mm diameter water service is required to supply the proposed building at 327 Richmond Road. A second 200 mm diameter water service will be provided to ensure redundancy as per the City's Guidelines. A valve and chamber will be provided on the City's 406 mm diameter watermain, between the two proposed services.

The water pressures, under average day demand, peak hour demand and maximum day plus fire flow demand are within the allowable pressure range specified by the City of Ottawa.

The proposed water services are shown on **Drawing C101** in **Appendix C.**

3.0 SANITARY SERVICING

3.1 Proposed Sanitary Servicing

A 150 mm diameter sanitary service is proposed from the building to the existing 250 mm diameter PVC sanitary sewer in Churchill Avenue. A monitoring manhole will be provided just inside the property line.

Drawing C101 in **Appendix C** shows the proposed sanitary service.

3.2 Design Criteria

The proposed sanitary sewer flow has been designed in general conformance with the *OSG* and its technical bulletins.

The sanitary design flow rate is the peak flow plus the peak extraneous flow. The table below presents the values for the average flow, peak factor and peak extraneous flows used in the sanitary servicing calculations for the mixed-use development.

Table 7: Sanitary Design Flows Criteria

DEVELOPMENT TYPE	AVERAGE SANITARY FLOW	UNIT	PEAK FACTOR	PEAK EXTRANEOUS FLOW
Residential	280	L/c/d	Harmon Equation	0.33 L/s/gross ha
Restaurant	125	L/seat/d	1.0/1.5	
Commercial	28,000	L/ha/d	1.0/1.5	

The sanitary service is designed with a pipe roughness coefficient of 0.013.

The proposed service will be installed with a minimum cover of 2.0 m, where this is not possible insulation will be provided.

The pre-application consultation meeting minutes from the City included the following related to the sanitary design:

- Concerned about capacity of sanitary. Churchill limited size for services.
- Flow and capacity analysis to study area up to trunk connection, and surrounding area developments.
- Site contamination is likely. Need full assessment in Phase II ESA. Of particular concern, is ground-water contamination, which if evident, the water needs to be treated and then directed to sanitary. Even treated water not permitted as storm.

Based on these comments we prepared a sewer design sheet of the City's sanitary sewer in Churchill Avenue and Scott Street from the subject site to the collector sewer in Scott Street. We included all the contributing sewers from the side

streets. The flows were estimated based on residential and commercial demands for the existing buildings. We also reviewed the City's development application website and found an application for development at 2070 Scott Street that is currently under review. We included the proposed sanitary flows from this development in the calculations. Based on the "Site Servicing and Stormwater Management Brief – 2070 Scott Street, Ottawa, ON" dated October 2, 2019 prepared by Stantec Consulting Ltd., the proposed peak sanitary flows are 5.78 L/s.

3.3 Calculations and Results

The sewer design sheet, including the proposed development, the downstream analysis and associated sanitary drainage areas, are included in **Appendix F**.

The proposed development consists of mainly residential rental space, with retail rental space on the first floor. The rental space is identified as retail; however, the actual tenants are unknown at this time. Given the outdoor courtyards around the building that can be used as patios, it is envisioned that restaurants or cafes are potential tenants for some or all of the three retail spaces. As sanitary flows from restaurants are considerably higher than those for general retail we have assumed the worst case scenario that all three retail spaces will be used for restaurants to be conservative. The resultant peak flow, including extraneous flows, from the subject site are estimated to be **7.6 L/s**. A 150 mm diameter sanitary service with a slope of 2% will be provided from the building to the existing sanitary sewer in Churchill Avenue.

There will be additional sanitary flows from the parking garage sump which will collect the drains from the parking garage for snow melt off cars, etc. The discharge rate from the sump pump is not known at this time, as it will be designed by the mechanical engineers, but is expected to be negligible compared to the sanitary flows from the domestic use. As the groundwater has not yet been proven to be in compliance with MECP Table 7 Standards, it is assumed that the foundation drain will be directed to a sump and through a treatment process before it is pumped to the sanitary service. The sump, treatment and pump will be designed by the mechanical engineers. Remediation of the site is planned which is expected to improve the groundwater quality. Following remediation and additional sampling if it is demonstrated that the groundwater quality is acceptable for discharge to the storm sewer based on the City's sewer use by-law then the foundation drain will be directed to the storm sewer.

The capacity analysis of the existing City sewers from the subject site to the collector sewer in Scott Street demonstrates that the existing sanitary sewers, including the peak flows from the proposed development, will be operating at a maximum capacity of 46% full at the connection location to the collector sewer. The sewer on Churchill Avenue is at a maximum of 25% full and most of the side streets are less than 10% full. Therefore, it is expected that the existing Churchill Avenue sanitary sewer can accommodate the proposed flows from the subject site.

3.4 Summary and Conclusions

A 150 mm diameter sanitary service is proposed from the subject building to the sanitary sewer in Churchill Avenue. A review of the capacity of the existing City sewers between the subject site and the collector sewer on Scott Street demonstrate that there is sufficient capacity to accommodate the proposed flows.

A backflow preventer will be required for the proposed building.

4.0 STORM SERVICING AND STORMWATER MANAGEMENT

4.1 Existing Storm Servicing

The proposed development area is bordered by City roads on the south, east and west and private property to the north. The Richmond Road border of the site is approximately 1 metre higher than the elevations along the north border of the property. The existing overland flows generally drain to the adjacent roads. There are a couple catch basins on site with connections to the local storm sewers in the adjacent roads.

The existing drainage area for the site is shown in **Appendix G.**

4.2 Proposed Storm Servicing

The site fronting Richmond Road consists of a small sitting area at the corner of Churchill Avenue, widened sidewalks and a courtyard area near the centre of the building. These areas will all drain to Richmond. Along Winona Avenue there will be a slightly wider sidewalk as well as an entrance at the corner with Richmond Road. This area will follow the existing drainage set by the road elevations and drain east.

There is an open courtyard space at the back of the building which will drain north towards the proposed loading aisle and then east along the loading aisle to Winona Avenue. Catchbasins along the north side of the loading aisle will capture the water in this area. An oversized pipe with an inlet control device (ICD) in the downstream manhole will be provided in this area to store stormwater and release it at a controlled rate.

The north border of the site will be green space. There is a retaining wall along a portion of the north border of the loading aisle that is less than 1m high and reduces in height to curb height before it reaches Winona Avenue. There will be a swale between the wall and the north property line to ensure drainage is directed from the back property line through the subject site. Landscape drains and a subdrain will be provided along the swale which will connect to the proposed storm service to Winona Avenue, downstream of the proposed ICD.

The roof will be drained with a combination of controlled and uncontrolled roof drains. There is a penthouse which houses all the mechanical and electrical equipment. The roof of the penthouse will have controlled roof drains to provide storage. The majority of the roof areas will have a raised terrace on pedestals that allows stormwater to be stored to a maximum height of 150 mm below the raised terrace. There are a few smaller roof levels that were determined not to contribute significantly to the storage requirements and therefore will not be controlled. The roof drain service will be directed to the existing 375 mm storm service in Churchill Avenue.

The boundaries of the post-development drainage areas are shown in **Drawing C102** in **Appendix C**.

4.3 Design Criteria

The proposed stormwater system has been designed in general conformance with the *OSG* and its technical bulletins. The minutes of the pre-application consultation meeting did not provide site specific stormwater management criteria, it was noted that the storm should not have issues. We understand that to mean there are no capacity concerns with the existing storm sewers surrounding the site.

The OSG addresses stormwater for infill developments in Section 8.3.7.2. and for commercial/institutional and industrial site plans in Section 8.3.7.3.

The design criteria includes the following:

i. In the absence of a subdivision master servicing study, or if there is an increase in the site's overall runoff coefficient, the designer must ensure that there will be no adverse impact to the existing storm system;
ii. On-site stormwater management measures may be required if the existing system is at or near capacity;
iii. For commercial/institutional and industrial site plans, the runoff must be controlled to the 2-year or 5-year pre-development level depending on the design return period of the receiving sewer, and all flow depth must be controlled on-site;
iv. For commercial/institutional and industrial site plans, in the case of a site re-development, over-controlling may be required if the capacity of the receiving sewer is in question. In such a case the pre-development condition will be determined using the smaller of a runoff coefficient of 0.5 or the actual existing site runoff coefficient.

In order to ensure no adverse impacts to the existing storm system, there will be no increase to the existing storm flows from the site. Given that this is a mixed-use development, the runoff will be controlled to the 5-year storm pre-development flow using the existing runoff coefficient for the site. The existing runoff coefficient is proposed as it is our understanding there is no capacity concerns with the receiving sewer. The 5-year storm was selected based on the storm service

connection being proposed on Churchill Avenue which is a collector street and therefore the sewer would be sized for 5-year flows. The flows to the storm sewer in excess of the 5-year storm release rate, up to and including the 100 year storm event, will be detained on site.

The Rational Method is used to calculate the allowable peak flow.

IDF curve equations used with the Rational formula:

a. 5-year = $998.071/(Tc+6.053)^{0.814}$

b. 100-year = $1735.688/(Tc+6.014)^{0.820}$

The Rational Method uses runoff coefficients for various surfaces. The table below shows the runoff coefficients used in this study. The runoff coefficient for a 100-year storm event is increased by 25% per the OSG.

Table 8: Rational Method Runoff Coefficients

SURFACE	5-YEAR COEFFICIENT	100-YEAR COEFFICIENT
Asphalt/Building/Pavers	0.90	1.00
Grass	0.20	0.25

4.4 Allowable Release Rate

The allowable release rate for the 0.327 ha site developed was calculated using the rational method formula based on the 5-year flow and the existing runoff coefficient of 0.79.

$$Q = 2.78\ CiA$$

where

Q = Flow rate (L/s)

C = Runoff coefficient

i = Rainfall intensity (mm/hr)

A = Area (ha)

The resultant allowable release rate is **74.8 L/s**.

4.5 Stormwater Management

The on-site storm water management has been designed to attenuate the 5-year and 100-year post-development flow rates to the pre-development 5-year flow rate as shown in the stormwater calculations included in **Appendix G** and summarized below.

CONTROLLED ROOF DRAINS (DRAINAGE AREAS WS-09 THROUGH WS-21)

Drainage areas WS-09 through WS-21 will be used to provide stormwater storage through the use of controlled roof drains (Watts Adjustable Accutrol roof drains). With the exception of the penthouse, the storage will be provided under raised terraces using pedestals. The controlled roof drains, including the controlled flow rates, the max ponding depth and the storage volume are summarized below. The associated calculations are included in **Appendix G**.

Table 9: Controlled Roof Drain Flows and Storage

Controlled Roof Drain Area	Drainage Area (sqm)	5-year			100-year		
		Controlled Flow (L/s)	Max Ponding Depth (mm)	Max Storage Volume (m3)	Controlled Flow (L/s)	Max Ponding Depth (mm)	Max Storage Volume (m3)
WS-09	96.52	1.05	85.0	0.9	1.43	114.9	2.2
WS-10	173.28	1.18	95.5	2.2	1.57	126.2	5.2
WS-11	196.03	1.21	97.4	2.7	1.60	128.4	6.1
WS-12	144.23	1.15	92.4	1.7	1.52	122.8	4.0
WS-13	63.86	0.95	76.8	0.4	1.31	105.7	1.1
WS-14	275.42	1.27	102.5	4.4	1.66	134.0	9.8
WS-15	245.06	1.25	100.9	3.7	1.64	132.1	8.4
WS-16	80.21	1.01	81.7	0.6	1.01	118.8	2.0
WS-17	53.99	0.90	72.5	0.3	1.27	102.0	0.8
WS-18	67.61	0.97	78.1	0.5	1.33	106.9	1.2
WS-19	48.02	0.87	70.3	0.2	1.23	99.1	0.7
WS-20	222.02	1.23	99.4	3.2	1.62	130.5	7.3
WS-21	126.67	1.12	90.2	1.4	1.49	120.4	3.3
		14.2		**22.3**	**18.7**		**52.1**

The controlled flow from these drainage areas will be **14.2 L/s** for the 5-year event and **18.7 L/s** for the 100-year event. These flows will be directed to the buildings storm service that drains to the storm sewer in Churchill Avenue.

UNCONTROLLED ROOF DRAINS (DRAINAGE AREAS WS-05 THROUGH WS-08)

Drainage areas WS-05 through WS-08 will be standard roof drains with no storage. The uncontrolled flow for each roof drain area is summarized below.

Table 10: Uncontrolled Roof Drain Flows

Uncontrolled Roof Drain Area	Drainage Area (sqm)	5-year Uncontrolled Flow (L/s)	100-year Uncontrolled Flow (L/s)
WS-05	155.85	4.1	7.7
WS-06	91.51	2.4	4.5
WS-07	70.94	1.8	3.5
WS-08	99.11	2.6	4.9
		10.9	**20.7**

The uncontrolled flow from these drainage areas will be **10.9 L/s** for the 5-year event and **20.7 L/s** for the 100-year event. These flows will be directed to the buildings storm service that drains to the storm sewer in Churchill Avenue.

FRONT ENTRANCES, COURTYARD AND SIDEWALK ON RICHMOND AND WINONA (DRAINAGE AREA WS-22)

The front entrance at Richmond and Churchill will consist of a patio area with landscape features. This area will sheet drain to Richmond Avenue.

Along Richmond Road there will be a widened sidewalk between the building face and the property line as well as courtyard planter boxes. This area will drain south to Richmond Road.

There will be a second, smaller entrance at the corner of Richmond Road and Winona Avenue. This entrance will be at the east side of the building and will consist of stairs and landscape features. This area will follow the existing drainage patterns draining east to Winona Avenue.

Along Winona Avenue there will be a slightly widened sidewalk between the building face and the property line. This area will be an extension of the existing sidewalk. This area will drain east to Winona Avenue.

The combined uncontrolled flow from these drainage areas will be **13.9 L/s** for the 5-year event and **26.5 L/s** for the 100-year event.

BACK COURTYARD AND LOADING AISLE (DRAINAGE AREA WS-02 AND WS-04)

The courtyard at the back of the building will be graded from south to north towards the loading aisle and east along the loading aisle towards Winona Avenue. It will also include the east portion of the swale. There will be a catch basin at the end of the loading aisle to capture these flows. The courtyard and loading aisle water will be directed to catch basins along the north side of the loading aisle. The catch basins will convey flows to an oversized storm sewer (600mm diameter) within the loading aisle. An ICD will be provided in STMH-02 to store the stormater in the oversized pipe which is then released at a controlled release rate.

The controlled flow from this drainage area will be **4.0 L/s** for the 5-year event and **7.3 L/s** for the 100-year event.

NORTH SWALE (DRAINAGE AREA WS-01)

The drainage swale at the back of the property will be used to ensure storm flows from the area between the loading aisle retaining wall and the property line are kept on the subject site. The swale has a high point approximately 10 m from the east property limit. This water will be captured in the swale and diverted to landscape drains and a subdrain. The subdrain will be connected to the storm service to Winona Avenue, downstream of the ICD in STMH-02.

The uncontrolled flow from this drainage area will be **0.4 L/s** for the 5-year event and **0.9 L/s** for the 100-year event.

NORTH PATHWAY (DRAINAGE AREA WS-03)

The pathway from the back courtyard to Winona will drain overland from east to west towards Winona Avenue.

The uncontrolled flow from this drainage area will be **0.4 L/s** for the 5-year event and **0.7 L/s** for the 100-year event.

The combined drainage areas discussed above result in a total flow from the site of **43.8 L/s** for the 5-year event and **74.8 L/s** for the 100-year event. These flows are within the allowable outlet flow of **74.8 L/s.**

4.6 Storm Service Design

A 200 mm storm service will be provided from the building to the existing 375 mm diameter storm sewer on Churchill Avenue for the controlled and uncontrolled roof drains.

An oversized pipe (600 mm diameter) will be provided in the back courtyard with a vortex type ICD in STMH-02. A 250 mm diameter PVC pipe will drain the controlled flow from STMH-02 to the existing 450 mm diameter storm sewer in Winona Avenue.

Calculations showing the storm sewer design are included in **Appendix G**.

4.7 Stormwater Quality

The RVCA has indicated that onsite water quality treatment will not be required for the site.

4.8 Major Overland Flow

The major overland flow routes are to Churchill Avenue, Richmond Road and Winona Avenue.

4.9 Summary and Conclusions

The proposed stormwater system will consist of a combination of controlled and uncontrolled roof drains for the building area, an oversized pipe for the back courtyard and uncontrolled flows from the remaining areas. The stormwater flows are controlled with the post-development 100-year flows being controlled to the pre-development 5-year rate.

5.0 SEDIMENT AND EROSION CONTROL

To mitigate the impacts due to erosion and sedimentation during construction, erosion and sediment control measures shall be installed and maintained throughout the duration of construction. Measures shall only be removed once the construction activities are complete, and the site has stabilized.

The measures will include:

- Siltsack® shall be installed between the frame and cover of existing and new catchbasins and maintenance holes, to minimize sediments entering the storm drainage system. These shall remain in place until construction is complete;
- A mud mat shall be provided where equipment will be leaving the site; and
- Light Duty Silt Fence Barriers shall be placed along the north border of the site. The barriers shall be installed and maintained according to OPSS 577 and OPSD 219.110.

6.0 CONCLUSIONS

This report outlines the proposed servicing and stormwater management design for the proposed mixed-use building at 327 Richmond Road, Ottawa, ON.

The proposed drinking water system will consist of two 200 mm diameter water services from the City watermain in Churchill Avenue. A new line valve and chamber on the City watermain between these two connections will be provided.

The proposed sanitary sewer system will consist of a 150 mm diameter sanitary service from the building to the existing sanitary sewer in Churchill Avenue. The capacity of the downstream sanitary system was investigated as far as the connection to the collector sewer in Scott Street. It was determined that there is sufficient capacity to accommodate the proposed development.

Stormwater runoff from the proposed site for the 100-year event will be controlled to the pre-development 5-year flow of 74.8 L/s.

Prepared by:

Meghan MacSween, M.Eng., P.Eng.

Reviewed by:

Sharra Sterling, P.Eng.

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APPENDIX A | CORRESPONDENCE

Pre-application Consultation Meeting Minutes

Address: 381 Churchill, 319,325, 32, 331 Richmond Road
Formal Pre-consultation File No.: PC2019-0177
Date: July 16, 2019, 3:00-4:30pm
Location: Room 4102E, City Hall, 110 Laurier Ave W
City Contact: Andrew McCreight

City of Ottawa Staff Present:
Andrew McCreight – File Lead, Planner, Development Review Central
John Wu – Infrastructure Project Manager
Mike Giampa – Transportation Project Manager
Christopher Moise – Architect/Urban Designer

Invitees Present:

Evan Johnson, Interrent REIT (CLV Group)
Oz Drewniak, Interrent REIT (CLV Group)
Emilie Coyle, Fotenn
Brian Casagrande, Fotenn
Barry Hobin, Hobin Architecture Inc.
Patrick Bisson, Hobin Architecture Inc.
Chris Gordon, CGH Transportation
Meghan MacSween, Parsons

Note: Westboro Community Association representatives were invited but were unable to attend. Gary Ludington and Karen Johnson will be included in the follow-up and has been requested to provide comments on behalf of the Community Association.

Introductions and Acknowledgements

- Round table introductions

Overview of Proposal (Applicant team)

Evan / Oz

- Overview about Interrent REIT and partnership with CLV Group, as a developer that lead community-oriented projects for rental projects.
- Lots of experience in eastern Ontario and Quebec, with several Ottawa projects.

Barry

- Interesting site context within Westboro historic and Westboro today, with frontage on three streets (Churchill, Westboro, Winona).
- Former City of Nepean City Hall one block west, now part of the Churchill Seniors Centre, and the original Charles Ogilvie Department store (building) a block east. Historic crossroads of Westboro.

- Site located at the bottom of the hill looking north along Churchill with significant grade changes between Byron and Richmond.
- Important intersection site central to the neighbourhood, and the mainstreet of Westboro is one of the most vital in Ottawa.
- The landholding and street frontages are a unique opportunity, and the site is not the traditional grid layout.
- Important to the project was providing a 2.0 metre front yard setback allowing for wider sidewalk treatment, the 2-storey podium treatment to reflect the existing character and enhancing the corner treatments and public realm experience.
- Some key design moves include offset notions, treatment of massing at various points across the site, and where stepping back occurs.
- The podium reflects the existing street scale.
- The site has excellent walkability, and parking provided on this development will be dictated by demand.
- Extending height to high-rise, despite good transit access in proximity to two rapid transit stations, was out of the question. This is not the site for the type of development that is occurring on Scott Street. Density and intensification can occur within a mid-rise built form.
- Emphasizing the corner elements and treatment to complement the surroundings and break down mass.
- Use and enjoyment of the top of building can take advantage of the long views, such as to the Gatineau hills.
- Very top of building designed with a roof-top amenity and terrace. This holds a lot of Urban value and opportunity for additional greening that is not possible at grade on a mainstreet.
- *Questions were raised by City Staff (Christopher/Andrew) concerning the mass and transition.* Response/discussion below.
    - We applied the angular plane and it only clips the top of the 7th storey.
    - We provided a 7.5m rear yard
    - Site is skewed, not a square grid, so you get some interesting building angles, and we strategically buffered and transitioned from the properties to the rear.
    - Angular plane evident in stepbacks shown at levels 7-8-9.
    - Churchill context is not residential, so less stepping here.

Brian

- The applications will be for Site Plan and Zoning By-law amendment (minor, mainly to increase height).
- Planning Rationale will be formulated on the polices in effect at the time of submission.
- Strong focus on the Secondary Plan and polices that allow for taller buildings.
- This is a significant corner site
- Excellent access and opportunity to support transit.
- Reviewed the site, and others have pushed for high-rise buildings, but our assessment is that this is a mid-rise building at its maximum.

- Several examples of 8-9 storey buildings along corridor and within surrounding area.
- We will provide additional images to highlight the proposed transition and massing.

PRELIMINARY COMMENTS FROM THE CITY

Planning / Urban Design Comments (Christopher / Andrew)

- Building height is sensitive, and further analysis of the number of storeys and massing is required.
- The challenge is with the sense of site context and reviewing how the proposal fits within the surrounding context and planned function.
- Transition analysis needs to assess the future context. What does the Richmond Road corridor, Churchill and Winona experience yield?
- Mainstreets encourage density but with the correct built form, and illustrate the relationship context.
- 8/9 storey across the street or replicability of the proposed massing could result in a poor mainstreet condition. What is the surrounding vision supported by policy and zoning, and how does this proposal fit within?
- Review possible canyon effect and further explore those design moves that break down mass, like the corner treatments and stepbacks.
- Public realm treatment and streetscaping is really important. The initial thoughts on this with the wider sidewalk and opening the corners are a good start.
- Transition in mass and built form is more important than the actual number of storeys (relative to where transition is occurring). Assess the appropriate treatment for Winona and Churchill context. Initial assessment is that transition should result in the built form at the rear of the matching a low-rise condition.
- Questions were raised about how the 45 degree angular plane was being applied, and clarification will be provided in the follow-up. Staff do not believe it was applied correctly.
- Concerned about the treatment of the amenity level resulting in a 10-storey building (high-rise as opposed to mid-rise) and what impact that may have from a policy analysis. Explore a more sensitive approach to incorporating roof-top access and upper floor amenity room.
- Several mature trees exist around the perimeter of the site, some of which may be City owned, and others which may straddle property lines or be located on abutting properties, such as along Winona. The development should preserve the existing trees.
- S. 37 may be required. Please review and discuss with the City prior to submitting an application as potential changes resulting from Bill 108 are unknown at this time. Discussion to be included in Planning Rationale.

Infrastructure Comments (John Wu)

- Concerned about capacity of Sanitary. Churchill limited size for services.
- Site contamination is likely. Need full assessment in Phase II ESA. Of particular concern, is ground-water contamination, which if evident, the water needs to be treated and then directed to sanitary. Even treated water not permitted as storm.
- Make sure the Geotech Study and Phase II ESA specifically discuss impacts on ground water, and if contaminated propose solutions.
- The underground parking levels may impact water table and ground water.
- Site Servicing connections can occur on any street.
- Water and Storm should not have issues.
- Any soil contamination be addressed through safe removal and remediation.
- Flow and capacity analysis to study area up to trunk connection, and surrounding area developments.

Transportation Comments (Mike Giampa / Andrew)

Comments recorded as part of discussion with Chris Gordon

- Confirm if any road widening or corner sight-triangle requirements.
  Response:
  - Widening – None required
  - Corner Sight Triangles
    - 5m x 5m sight triangles required at corners Richmond/Churchill and Richmond/Winona. Sight triangle to be unencumbered.
- Step 1 of the TIA process is complete, and all triggers were met. Moving forward to Step 2 (Scoping) the TOD modal shares will be applied, and site access will be evaluated.
- Applicant (Chris Gordon) to propose study area limits for TIA radius and intersection analysis. City will review internally to determine scope.
- Churchill access – Sightlines and private approach by-law to be reviewed. Access on Churchill may have to be restricted if there is excessive queuing at the Richmond/Churchill signal.
- Loading access (Winona) – will review design to determine need for curb returns etc. and travel routes on arterial. Design needs to accommodate the appropriate size of loading/heavy vehicle.
- For garbage / commercial loading area, need to review frequency of activity and type of trucks anticipated.
- Include mitigation measures of loading activity.
- Commercial unit size not yet determined, but if larger units require parking, explain how commercial parking is incorporated into development.
- Garage access proximity to Churchill/Richmond needs to look at potential queuing impacts or feasibility of left-turn egress. Queuing could be a problem.
- Focus on Transit Demand Management Strategies and identify how development is design to maximize active modes of transportation. The bicycle room at grade

shown on the plans is a good start, but more details required to understand function and use.
- Clarify if development will include commercial parking for the ground floor commercial units.
- Explore options to incorporate a car-share service, such as within the access off Winona at grade.

Westboro Community Association Input (Gary and Karen)
Note: comments provided via email after the meeting as representatives were unable to attend.

- Concerned with problems at the intersections and safety issues for pedestrians.
- Concerned about the impact on the R4 neighbourhood behind the site.
- WCA often relies on "global" criteria in reviewing development proposals. These criteria reflect values our community has expressed when reacting to Westboro development applications.These criteria are:

  1. protecting the environment (e.g., freedom from fumes and excessive heat, noise and light generation, stormwater management);
- 2. preserving trees and green space;
  3. enhancing the walkability of our neighbourhoods (e.g., street level interest, podiums and friendly transitions to neighbourhoods, no wind tunnels, dark sidewalks, or "looming" structures);
  4. fostering inclusivity and affordability; and
  5. respecting our built heritage.

- We would like the developer to speak to these criteria: How does the proposal enhance Westboro's streetscape, contribute to an interesting, safe, and comfortable walk, and allow trees to be saved and greenspace to be created?
- The community association objects strenuously to all the parking being proposed for all the huge buildings going up around Scott. We can't have it both ways. Not sure how the city justifies granting additional height for proximity to transit while approving parking for all the units to boot.

Next Steps

- Preliminary/informal meeting with the UDRP recommended.
- Reach out to community and Ward Councillor. If go public with the proposal, please waive the non-disclosure agreement obligations of the Westboro Community Association members.

[EXTERNAL] Re: 327 Richmond Road, Ottawa, ON

Eric Lalande <eric.lalande@rvca.ca>

Thu 2020-05-07 9:26 AM

To: MacSween, Meghan <Meghan.Macsween@parsons.com>
Cc: Sterling, Sharra <Sharra.Sterling@parsons.com>

Hi Megan,

This looks pretty straight forward, for the design proposed the RVCA would not require any quality control measures as rooftop and landscaping are considered clean. Best management practices are encouraged.

Please let me know if you require anything else.

Cheers,

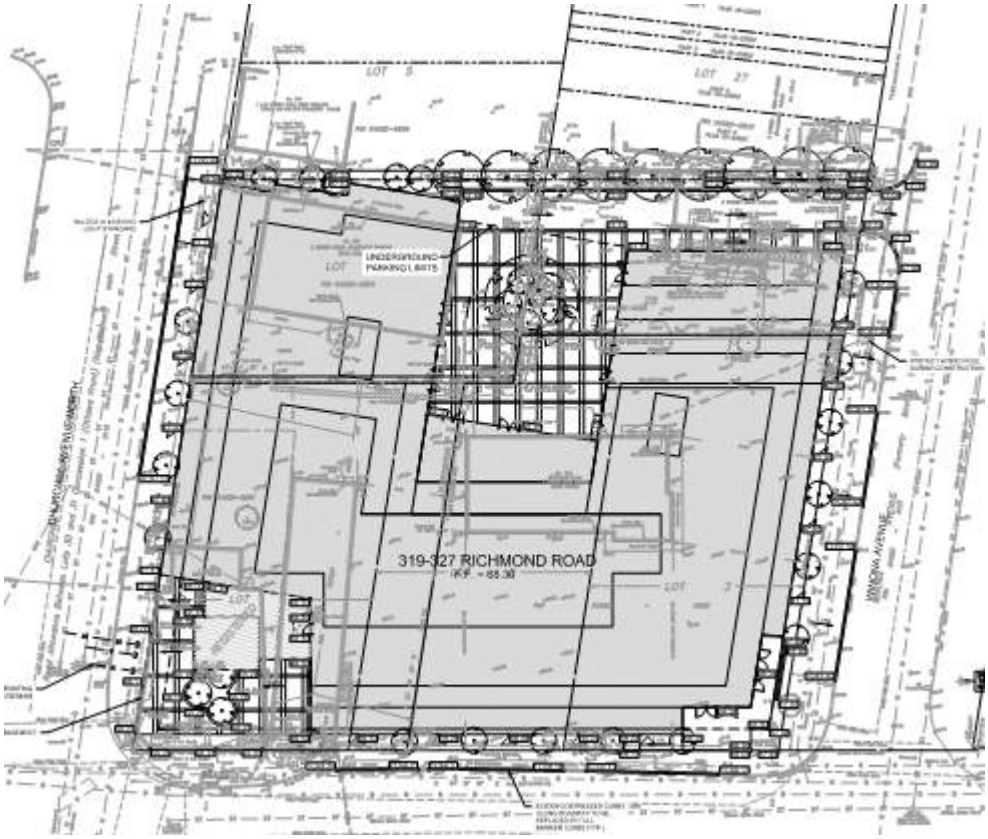
Eric Lalande, MCIP, RPP
Planner, RVCA
613-692-3571 x1137

From: MacSween, Meghan <Meghan.Macsween@parsons.com>
Sent: May 7, 2020 9:22 AM
To: Eric Lalande <eric.lalande@rvca.ca>
Cc: Sterling, Sharra <Sharra.Sterling@parsons.com>
Subject: 327 Richmond Road, Ottawa, ON

Hi Eric,

We would like to request any RVCA requirements or comments related to a proposed development at 327 Richmond Road (the corner of Richmond and Churchill).

We are working for the owner of this building (CLV Group) towards a Site Plan Approval from the City of Ottawa, for a proposed mixed-use building (residential with retail on the first floor). The drawing below gives you an idea of the site layout. Most of the storm water on site will be on the roof. There is a patio space at the front corner of the building, just for pedestrian use, and also a larger courtyard in the back of the building, again just for pedestrian use. There is a vehicle entrance at the north side of the site, from Winona Avenue, shown below. There is no parking in this area but there will be vehicle access for loading (move-in, move-out, deliveries for the retail, etc.). All on site parking is in an underground parking garage accessed by a ramp from Churchill, on the north side of the site, the ramp is not exposed it is covered by the building.



Please feel free to contact me if you have any questions or concerns.

Thanks,

Meghan

Meghan MacSween, M.Eng., P.Eng.
Municipal Engineer
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APPENDIX B | SERVICING CHECKLIST

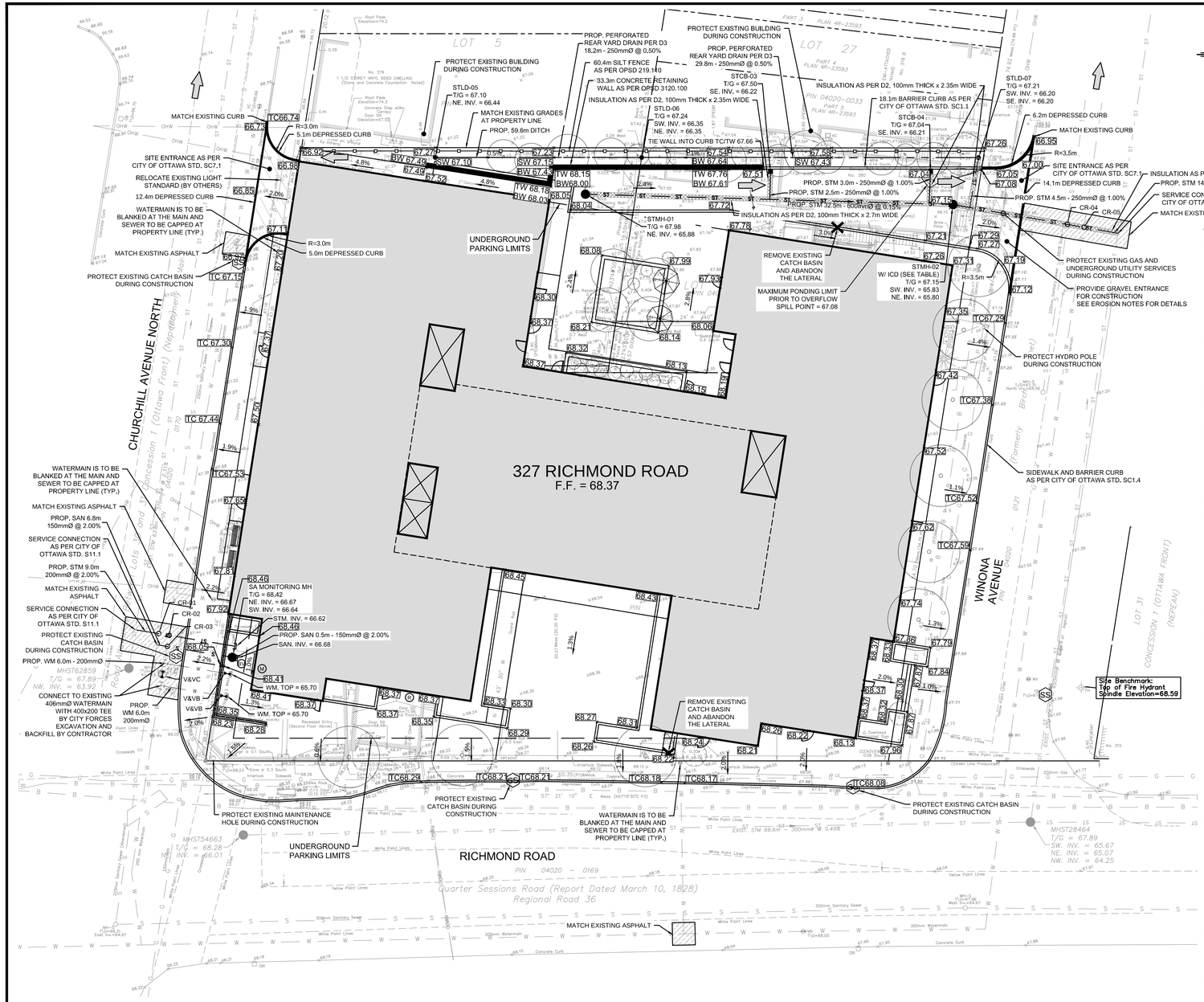
Development Servicing Study Checklist		
1 General Content		**Comments**
NA	Executive Summary (for larger reports only).	
Y	Date and revision number of the report.	Title page
Y	Location map and plan showing municipal address, boundary, and layout of proposed development.	Figure 1 and Drawing C101
Y	Plan showing the site and location of all existing services.	Figure 2 and Drawing C101
NA	Development statistics, land use, density, adherence to zoning and official plan, and reference to applicable subwatershed and watershed plans that provide context to which individual developments must adhere.	
Y	Summary of Pre-consultation Meetings with City and other approval agencies.	Section 1.4
NA	Reference and confirm conformance to higher level studies and reports (Master Servicing Studies, Environmental Assessments, Community Design Plans), or in the case where it is not in conformance, the proponent must provide justification and develop a defendable design criteria.	
Y	Statement of objectives and servicing criteria.	Section 2.2/3.2/4.3
Y	Identification of existing and proposed infrastructure available in the immediate area.	Section 1.3
NA	Identification of Environmentally Significant Areas, watercourses and Municipal Drains potentially impacted by the proposed development (Reference can be made to the Natural Heritage Studies, if available).	
Y	Concept level master grading plan to confirm existing and proposed grades in the development. This is required to confirm the feasibility of proposed storm water management and drainage, soil removal and fill constraints, and potential impacts to neighboring properties. This is also required to confirm that the proposed grading will not impede existing major system flow paths.	Drawing C101
NA	Identification of potential impacts of proposed piped services on private services (such as wells and septic fields on adjacent lands) and mitigation required to address potential impacts.	
NA	Proposed phasing of the development, if applicable	
Y	Reference to geotechnical studies and recommendations concerning servicing.	Section 1.5
	All preliminary and formal site plans submissions should have the following information:	
Y	● Metric Scale	Drawing C101
Y	● North arrow (including construction North)	Drawing C101
Y	● Key Plan	Drawing C101
Y	● Name and contact information of applicant and property owner	Drawing C101
Y	● Property limits including bearing and dimensions	Drawing C101
Y	● Existing and proposed structures and parking areas	Drawing C101
Y	● Easement, road widening and right-of-way	Drawing C101
Y	● Adjacent street names	Drawing C101
2 Development Servicing Report : Water		**Comments**
NA	Confirm consistency with Master Servicing Study, if available.	
Y	Availability of public infrastructure to services proposed development.	Section 2.0
Y	Identification of system constraints.	Section 2.2
Y	Identification of boundary conditions.	Section 2.2
Y	Confirmation of adequate domestic supply and pressure	Section 2.3
Y	Confirmation of adequate fire flow protection and confirmation that fire flow is calculated as per the Fire Underwriter's Survey. Output should show available fire flow at locations throughout the development.	Section 2.3

Development Servicing Study Checklist		
NA	Provided a check of high pressure. If pressure is found to be high, an assessment is required to confirm the application of pressure reducing valves.	Section 2.3
NA	Definition of phasing constraints. Hydraulic modeling is required to confirm servicing for all defined phases of the project including the ultimate design.	
Y	Address reliability requirements such as appropriate location of shut-off valves.	Section 2.2
NA	Check on the necessity of a pressure zone boundary modification.	
Y	Reference to water supply analysis to show that major infrastructure is capable of delivering sufficient water for the proposed land use. This includes data that shows that expected demands under average day, peak hour and fire flow conditions provide water within the required pressure range.	Section 2.3
Y	Description of the proposed water distribution network, including locations of proposed connections to the existing system, provisions for necessary looping, and appurtenances (valves, pressure reducing valves, valve chambers, and fire hydrants) including special metering provisions.	Section 2.1
NA	Description of off-site required feedermains, booster pumping stations, and other water infrastructure that will be ultimately required to service proposed development, including financing, interim facilities, and timing of implementation.	
Y	Confirmation that water demands are calculated based on the City of Ottawa Design Guidelines.	Section 2.2 and 2.3
NA	Provision of model schematic showing the boundary conditions locations, streets, parcels, and building locations for reference.	
3 Development Servicing Report: Wastewater		**Comments**
Y	Summary of proposed design criteria (Note: Wet-weather flow criteria should not deviate from the City of Ottawa Sewer Design Guidelines. Monitoring Flow data from relatively new infrastructure cannot be used to justify capacity requirements	Section 3.2
NA	Confirm consistency with Master Servicing Study and/or justification for deviations.	
NA	Consideration of local conditions that may contribute to extraneous flow that are higher than the recommended flow in the guidelines. This includes groundwater and soil conditions, and age and condition of sewers.	
Y	Description of existing sanitary sewer available for discharge of wastewater from proposed development.	Section 4.1
Y	Verify available capacity in downstream sanitary sewer and/or identification of upgrades necessary to service the proposed development. (Reference can be made to previously completed Master Servicing Study if applicable).	Section 4.3
Y	Calculations related to dry-weather and wet-weather flow rates from the development in standard MOE sanitary sewer design table (Appendix 'C') format.	Appendix F
Y	Description of proposed sewer network including sewers, pumping stations, and forcemains.	Section 4.1
NA	Discussion of previously identified environmental constraints and impact on servicing (environmental constraints are related to limitation imposed on the development in order to preserve the physical condition of watercourse, vegetation, soil cover, as well as protecting against water quantity and quality).	
NA	Pumping stations: impacts of proposed development on existing pumping stations or requirements for new pumping station to services development.	
NA	Forcemain capacity in terms of operational redundancy, surge pressure and maximum flow velocity.	
NA	Identification and implementation of the emergency overflow from sanitary pumping station in relation to the hydraulic grade line to protect against basement	

Development Servicing Study Checklist		
NA	Special considerations such as contamination, corrosive environment etc.	
4 Development Servicing Report: Stormwater Checklist		**Comments**
Y	Description of drainage outlets and downstream constraints including legality of outlets (i.e. municipal drain, right-of-way, watercourse, or private property)	Section 4.1
NA	Analysis of available capacity in existing public infrastructure.	
Y	A drawing showing the subject lands, its surroundings, the receiving watercourse, existing drainage patterns, and proposed drainage patterns.	Figure B in Appendix G and Drawing C101
Y	Water quantity control objective (e.g. controlling post-development peak flows to pre-development level for storm event ranging from the 2 or 5 years event (dependent on the receiving sewer design) to 100 years return period); if other objectives are being applied, a rationale must be included with reference to hydrologic analyses of the potentially affected subwatershed, taking into account long-term cumulative effects.	Section 4.3
Y	Water Quality control objectives (basic, normal or enhanced level of protection based on the sensitivities of the receiving watercourse) and storage requirements.	Section 4.7
Y	Description of the stormwater management concept with facility locations and descriptions with references and supporting information.	Section 4.5
NA	Set-back from private sewage disposal systems.	
NA	Watercourse and hazard lands setbacks.	
Y	Record of pre-consultation with the Ontario Ministry of Environment and the Conservation Authority that has jurisdiction on the affected watershed.	Appendix A
NA	Confirm consistency with sub-watershed and Master Servicing Study, if applicable study exists.	
Y	Storage requirements (complete with calculations) and conveyance capacity for minor events (1:5 years return period) and major events (1:100 years return period).	Section 4.5
NA	Identification of watercourses within the proposed development and how watercourses will be protected, or, if necessary, altered by the proposed development with applicable approvals.	
Y	Calculate pre and post development peak flow rates including a descriptions of existing site conditions and proposed impervious areas and drainage catchments in comparison to existing conditions.	Section 4.4, 4.5 and Appendix G
NA	Any proposed diversion of drainage catchment areas from one outlet to another.	
Y	Proposed minor and major systems including locations and sizes of stormwater trunk sewers, and stormwater management facilities.	Drawing C101
NA	If quantity control is not proposed, demonstration that downstream system has adequate capacity for the post-development flows up to and including the 100-year return period storm event.	
NA	Identification of potential impacts to receiving watercourses.	
NA	Identification of municipal drains and related approvals requirements.	
Y	Descriptions of how the conveyance and storage capacity will be achieved for the development.	Section 4.5
Y	100 years flood levels and major flow routing to protect proposed development from flooding for establishing minimum building elevations (MBE) and overall grading.	Drawing C101
NA	Inclusion of hydraulic analysis including hydraulic grade line elevations.	
Y	Description of approach to erosion and sediment control during construction for the protection of receiving watercourse or drainage corridors.	Section 5.0

Development Servicing Study Checklist		
NA	Identification of floodplains - proponent to obtain relevant floodplain information from the appropriate Conservation Authority. The proponent may be required to delineate floodplain elevations to the satisfaction of the Conservation Authority if such information is not available or if information does not match current conditions.	
NA	Identification of fill constraints related to floodplain and geotechnical investigation.	
5 Approval and Permit Requirements: Checklist		**Comments**
NA	Conservation Authority as the designated approval agency for modification of floodplain, potential impact on fish habitat, proposed works in or adjacent to a watercourse, cut/fill permits and Approvals under Lakes and Rivers Improvements Act. The Conservation Authority is not the approval authority for the Lakes and Rivers Improvements Act. Where there are Conservation Authority regulations in place, approval under the Lakes and Rivers Improvements Act is not required, except in cases of dams as defined in the Act.	
NA	Application for Certificate of Approvals (CofA) under the Ontario Water Resources Act.	
NA	Change to Municipal Drains	
NA	Other permits (National Capital Commission, Parks Canada, Public Works and Government Services Canada, Ministry of Transportation etc.)	
6 Conclusion Checklist		**Comments**
Y	Clearly stated conclusion and recommendations.	Section 6.0
Y	Comments received from review agencies including the City of Ottawa and information on how the comments were addressed. Final sign-off from the responsible reviewing agency.	Appendix A
Y	All draft and final reports shall be signed and stamped by a professional Engineer registered in Ontario.	Report

APPENDIX C | DRAWINGS



LEGEND:

- EXISTING PROPERTY LINE
- EXISTING CONCRETE CURB
- PROPOSED CONCRETE CURB
- PROPOSED DEPRESSED CURB
- PROPOSED BUILDING OR STRUCTURE
- EXISTING WATERMAIN
- EXISTING V&VB
- EXISTING CURBSTOP
- EXISTING FIRE HYDRANT
- PROPOSED WATERMAIN
- PROPOSED V&VB
- PROPOSED FIRE HYDRANT
- EXISTING SANITARY SEWER AND MANHOLE
- PROPOSED SANITARY SEWER AND MANHOLE
- EXISTING STORM SEWER AND MANHOLE
- PROPOSED STORM SEWER AND MANHOLE
- PROPOSED CATCH BASIN AND LANDSCAPE DRAIN
- PROPOSED SUBDRAIN
- PROPOSED PIPE INSULATION
- PROPOSED BACKWATER VALVE
- PROPOSED REMOTE METER
- PROPOSED WATER METER
- PROPOSED DITCH
- EXISTING GRADE
- PROPOSED GRADE
- PROPOSED BOTTOM OF WALL GRADE
- PROPOSED TOP OF WALL GRADE
- PROPOSED TOP OF CURB GRADE
- PROPOSED TERRANCING (MAX 3:1 SLOPE)
- PROPOSED RETAINING WALL
- PROPOSED TWSI AS PER SC7.3
- PROPOSED SILT FENCE AS PER OPSD 219.110
- SILT SACKS IN CATCH BASIN GRATE PER DETAIL D1

SCALE: 1:200

ICD DATA						
ICD ID	LOCATION	OUTLET DIAMETER	FLOW (L/s)	HEAD	MODEL	STORAGE VOLUME PROVIDED
1	STMH-02	250mm	7.3 L/s	0.64m	HYDROVEX MODEL No. 100 VHV-1	9.2m³

STORM MAINTENANCE HOLE DATA					
STRUCTURE	COVER	SIZE	STANDARD	ELEVATION T/G	ELEVATION INVERT
STLD-05	S31	300mm	S31	67.10	NE 66.44 (250mm)
STLD-06	S30	300mm	S30	67.24	SW 66.35 (250mm) NE 66.35 (250mm)
STLD-07	S30	300mm	S30	67.21	SW 66.20 (250mm) SE 66.20 (250mm)
STCB-04	S19	600x600mm	OPSD 705.010	67.04	SE 66.21 (250mm)
STCB-03	S19	600x600mm	OPSD 705.010	67.24	SE 66.22 (250mm)
STMH-01	S24.1	1200mm	OPSD 701.010	67.98	NE 65.88 (600mm)
STMH-02	S24.1	1200mm	OPSD 701.010	67.15	SW 65.83 (600mm) NE 65.80 (250mm)

CROSSING TABLE			
CROSSING No.	SEWER ELEV. AT CROSSING	SEWER ELEV. AT CROSSING	CLEARANCE
CR-01	STM. INV. 66.48	SAN. TOP. ±64.39	2.09m
CR-02	STM. INV. 66.50	WM. TOP. ±66.00	0.50m
CR-03	SAN. INV. 66.52	WM. TOP. ±66.02	0.50m
CR-04	STM. INV. 65.76	SAN. TOP. ±64.71	1.05m
CR-05	STM. INV. 65.75	WM. TOP. ±65.25	0.50m

STORM SEWER DATA							
LOCATION FROM	LOCATION TO	DIAMETER	MATERIAL	CLASS	LENGTH	INVERT ELEVATIONS UPSTREAM	INVERT ELEVATIONS DOWNSTREAM
CAP 1.0m FROM BLDG	CHURCHILL AVE CONNECTION*	200mm	PVC	SDR-35	9.0m	66.62	66.44*
STLD-05	STLD-06	250mm	HDPE	-	18.2m	66.44	66.35
STLD-06	STLD-07	250mm	HDPE	-	29.8m	66.35	66.20
STLD-07	CONNECTION**	250mm	PVC	SDR-35	4.5m	66.20	66.16**
STCB-04	CONNECTION**	250mm	PVC	SDR-35	3.0m	66.21	66.18**
STCB-03	CONNECTION**	250mm	PVC	SDR-35	2.5m	66.22	66.20**
STMH-01	STMH-02	600mm	PVC	SDR-35	32.5m	65.88	65.83
STMH-02	WINONA AVE CONNECTION*	250mm	PVC	SDR-35	14.8m	65.80	65.73*

* INVERT AT TOP BEND. CONNECT TO EXISTING PIPE AS PER CITY OF OTTAWA STD. S11 AND S11.1.
** INVERT AT TOP BEND. CONNECT TO PIPE AS PER CITY OF OTTAWA STD. S11.1.

SANITARY SEWER DATA						
LOCATION FROM	LOCATION TO	DIAMETER	MATERIAL	CLASS	LENGTH	INVERT ELEVATIONS UPSTREAM	INVERT ELEVATIONS DOWNSTREAM
CAP 1.0m FROM BLDG	SA MONITORING MH	150mm	PVC	SDR-35	0.5m	66.68	66.67
SA MONITORING MH	CHURCHILL AVE CONNECTION*	150mm	PVC	SDR-35	6.8m	66.64	66.50*

*INVERT AT TOP BEND. CONNECT TO EXISTING PIPE AS PER CITY OF OTTAWA STD. S11.1.

SANITARY MAINTENANCE HOLE DATA					
STRUCTURE	COVER	SIZE	STANDARD	ELEVATION T/G	ELEVATION INVERT
SA MONITORING MH	S24	1200mm	OPSD 701.010	68.42	NE 66.67 (150mm) SW 66.64 (150mm)

EROSION AND SEDIMENT CONTROL MEASURES:

- CONTRACTOR IS RESPONSIBLE FOR ALL INSTALLATION, MONITORING, REPAIR AND REMOVAL OF ALL EROSION AND SEDIMENT CONTROL FEATURES. THE CONTRACTOR SHALL IMPLEMENT BEST MANAGEMENT PRACTICES, TO PROVIDE FOR PROTECTION OF THE AREA DRAINAGE SYSTEM AND THE RECEIVING WATERCOURSE, DURING CONSTRUCTION ACTIVITIES. THE CONTRACTOR ACKNOWLEDGES THAT FAILURE TO IMPLEMENT APPROPRIATE EROSION AND SEDIMENT CONTROL MEASURE MAY BE SUBJECT TO PENALTIES IMPOSED BY ANY APPLICABLE REGULATORY AGENCY.
- SEDIMENT AND EROSION CONTROL PLAN OBJECTIVES:
- PREVENT SOIL EROSION. THIS CAN RESULT FROM STREAMING RAIN WATER OR WIND EROSION DURING CONSTRUCTION,
- PREVENT SEDIMENT DEPOSITS IN THE SEWER PIPES AND NEARBY COLLECTING STREAMS (AS APPLICABLE),
- PREVENT AIR POLLUTION FROM PARTICULATE MATTER AND DUST.

1. PRIOR TO START OF CONSTRUCTION:

PRIOR TO THE REMOVAL OF ANY VEGETATIVE COVER, MOVING OF SOIL AND CONSTRUCTION:

- INSTALL FILTER CLOTH ON DOWNSTREAM MANHOLE COVERS.
- INSTALL SILTSACK FILTERS IN ALL CONCRETE CATCH BASINS STRUCTURES.
- INSPECT MEASURES IMMEDIATELY AFTER INSTALLATION.
- THE CONTRACTOR MUST SET UP THE MEASURES INDICATED ON THE PLAN. INSPECT THEM FREQUENTLY AND CLEAN AND REPAIR OR REPLACE THE DETERIORATED STRUCTURES. AT THE END OF THE CONSTRUCTION PERIOD, THE CONTRACTOR IS RESPONSIBLE FOR REMOVAL OF THE TEMPORARY STRUCTURES AND RECONDITIONING THE AFFECTED AREAS

2. DURING CONSTRUCTION:

- SEDIMENT AND EROSION CONTROL MEASURES TO BE CONSTRUCTED AS PER OPSS 805.
- WHEN SEDIMENT AND EROSION CONTROL MEASURES MUST BE REMOVED TO COMPLETE A PORTION OF THE WORK, THE SAME MEASURES MUST BE REINSTATED UPON THE WORK'S COMPLETION.
- WORK TO BE DONE IN THE VICINITY OF MAJOR WATERWAYS TO BE CARRIED OUT FROM JULY AND SEPTEMBER ONLY.
- MINIMIZE THE EXTENT OF DISTURBED AREAS AND THE DURATION OF EXPOSURE.
- PROTECT DISTURBED AREAS FROM RUNOFF.
- PROVIDE TEMPORARY COVER SUCH AS SEEDING OR MULCHING IF DISTURBED AREA WILL NOT BE REHABILITATED SHORTLY.
- INSPECT STRAW BALE FLOW CHECK DAMS, SILT FENCES, SILT SACKS, AND CATCH BASIN SUMPS REGULARLY AND AFTER EVERY MAJOR STORM EVENT. CLEAN AND REPAIR WHEN NECESSARY.
- PLAN TO BE REVIEWED AND REVISED AS REQUIRED DURING CONSTRUCTION.
- EROSION CONTROL FENCING TO BE ALSO INSTALLED AROUND THE BASE OF ALL STOCKPILES.
- DO NOT LOCATE TOPSOIL PILES AND EXCAVATION MATERIAL CLOSER THAN 2.5m FROM ANY PAVED SURFACE, OR ONE WHICH IS TO BE PAVED BEFORE THE PILE IS REMOVED. ALL TOPSOIL PILES ARE TO BE SEEDED IF THEY ARE TO REMAIN ON SITE LONG ENOUGH FOR SEEDS TO GROW (LONGER THAN 30 DAYS). WHEN STORING SOIL ON SITE IN PILES THE CONTRACTOR MUST COVER EACH PILE WITH TARPS, STRAW OR A GEOTEXTILE FABRIC TO AVOID FINE PARTICLE TRANSPORT BY WIND AND/OR STREAMING RAIN WATER,
- CONTROL WIND-BLOWN DUST OFF SITE TO ACCEPTABLE LEVELS BY SEEDING TOPSOIL PILES AND OTHER AREAS TEMPORARILY (PROVIDE WATERING AS REQUIRED). FOR DUST CONTROL, CONTRACTOR TO APPLY CALCIUM CHLORIDE (TYPE I – OPSS 2501 AND CAN/CGSB-15-1) AND WATER WITH EQUIPMENT APPROVED BY THE OWNER'S REPRESENTATIVE AT RATE IN ACCORDANCE TO OPSS 506 WHEN DIRECTED BY OWNER'S REPRESENTATIVE.
- ALL EROSION CONTROL STRUCTURE TO REMAIN IN PLACE UNTIL ALL DISTURBED GROUND SURFACES HAVE BEEN DESTABILIZED EITHER BY PAVING OR RESTORATION OF VEGETATIVE GROUND COVER. SEDIMENT CAPTURE SILT SACKS MUST BE MAINTAINED AND CANNOT BE REMOVED UNTIL ALL LANDSCAPING AREAS ARE COMPLETED.
- NO ALTERNATE METHODS OF EROSION PROTECTION SHALL BE PERMITTED UNLESS APPROVED BY THIS CONSULTING ENGINEER AND THE TOWN DEPARTMENT OF PUBLIC WORKS.
- CONTRACTOR RESPONSIBLE FOR MUNICIPAL ROADWAY AND SIDEWALK TO BE CLEANED OF ALL SEDIMENT FROM VEHICULAR TRACKING ETC. AT THE END OF EACH WORK DAY.
- DURING WET CONDITIONS, TIRES OF ALL VEHICLES/EQUIPMENT LEAVING THE SITE ARE TO BE SCRAPED.
- ANY MUD/MATERIAL TRACKED ONTO THE ROAD SHALL BE REMOVED IMMEDIATELY BY HAND OR RUBBER TIRE LOADER.
- TAKE ALL NECESSARY STEPS TO PREVENT BUILDING MATERIAL, CONSTRUCTION DEBRIS OR WASTE BEING SPILLED OR TRACKED ONTO ABUTTING PROPERTIES OR PUBLIC STREETS DURING CONSTRUCTION AND PROCEED IMMEDIATELY TO CLEAN UP ANY AREAS SO AFFECTED.
- PROVIDE GRAVEL ENTRANCE WHEREVER EQUIPMENT LEAVES THE SITE TO PROVIDE MUD TRACKING ONTO PAVED SURFACES. GRAVEL BED SHALL BE A MINIMUM OF 10m LONG, 4m WIDE, AND 0.15m DEEP AND SHALL CONSIST OF COARSE MATERIAL. MAINTAIN GRAVEL ENTRANCE IN CLEAN CONDITION.

3. AFTER CONSTRUCTION:

- PROVIDE PERMANENT COVER CONSISTING OF TOPSOIL AND SEED TO DISTURBED AREAS.
- ALL SEDIMENT AND EROSION CONTROL MEASURES TO BE REMOVED BY THE CONTRACTOR FOLLOWING THE COMPLETION OF WORK AND AFTER DISTURBED AREAS HAVE BEEN REHABILITATED AND STABILIZED. THIS INCLUDES REMOVE STRAW BALE FLOW CHECK DAMS, SILT FENCES AND FILTER CLOTHS ON CATCH BASINS AND MANHOLE COVERS.
- INSPECT AND CLEAN CATCH BASIN SUMPS AND STORM SEWERS.

KEY PLAN

NOTES: GENERAL

1. CONTRACTOR IS RESPONSIBLE FOR ALL LAYOUT FOR CONSTRUCTION PURPOSES.
2. ALL ELEVATIONS ARE GEODETIC AND UTILIZE METRIC UNITS.
3. JOB BENCH MARK - REFER TO SURVEY BY AOV LTD. CONFIRM WITH CONTRACT ADMINISTRATOR PRIOR TO UTILIZATION OF BENCH MARK.
4. ALL GROUND SURFACES SHALL BE EVENLY GRADED WITHOUT PONDING AREAS AND WITHOUT LOW POINTS EXCEPT WHERE APPROVED SWALE OR CATCH BASIN OUTLETS ARE PROVIDED.
5. STRIP AND REMOVE ALL TOPSOIL FROM IMPROVED AREAS.
6. COORDINATE AND SCHEDULE ALL WORK WITH OTHER TRADES AND CONTRACTORS.
7. ALL EDGES OF DISTURBED PAVEMENT SHALL BE SAW CUT TO FORM A NEAT AND STRAIGHT LINE PRIOR TO PLACING NEW PAVEMENT, PAVEMENT REINSTATEMENT SHALL BE PER CITY OF OTTAWA STD. R10.
8. CURBS TO BE CONCRETE BARRIER, CONSTRUCTED AS PER CITY OF OTTAWA DETAIL SC1.1. ELEVATIONS AT CURB INDICATE THE GRADE AT THE FINISHED ROAD SURFACE UNLESS NOTED OTHERWISE.
9. RESTORE PAVEMENT STRUCTURE AND SURFACES ON EXISTING ROADS TO A CONDITION AT LEAST EQUAL TO ORIGINAL AND TO THE SATISFACTION OF THE MUNICIPAL AUTHORITIES.
10. ALL MATERIAL SUPPLIED AND PLACED FOR PARKING LOT AND ACCESS ROAD CONSTRUCTION SHALL BE TO OPSS STANDARDS AND SPECIFICATIONS UNLESS OTHERWISE NOTED. CONSTRUCTION TO OPSS 206, 310 & 314. MATERIALS TO OPSS 1001, 1003 & 1010.
11. ABUTTING PROPERTY GRADE TO BE MATCHED.
12. OBTAIN AND PAY FOR ALL NECESSARY PERMITS AND APPROVALS FROM THE MUNICIPAL AUTHORITIES PRIOR TO COMMENCING CONSTRUCTION.
13. MINIMIZE DISTURBANCE TO EXISTING VEGETATION DURING THE EXECUTION OF ALL WORKS.
14. FILTER FABRIC TO BE INSTALLED AND MAINTAINED BETWEEN THE FRAME AND COVER OF ALL CATCHBASINS AND CATCHBASIN MANHOLES DURING THE CONSTRUCTION PERIOD TO MINIMIZE SEDIMENTS ENTERING THE STORM SEWER SYSTEM. ALL GRASSED AREAS MUST BE COMPLETED PRIOR TO THE REMOVAL OF THE FILTER FABRIC IN THE CATCH BASINS.
15. REMOVE FROM SITE ALL EXCESS EXCAVATED MATERIAL UNLESS OTHERWISE DIRECTED FROM THE ENGINEER. EXCAVATE AND REMOVE ALL ORGANIC MATERIAL AND DEBRIS LOCATED WITHIN THE PROPOSED BUILDING, PARKING AND ROADWAY LOCATIONS. ANY CONTAMINATED MATERIAL SHALL BE DISPOSED OF AT A LICENSED LANDFILL FACILITY.
16. THE APPROVAL OF THIS PLAN DOES NOT EXEMPT THE CONTRACTOR FROM THE REQUIREMENTS TO OBTAIN THE VARIOUS PERMITS/APPROVALS REQUIRED TO COMPLETE A CONSTRUCTION PROJECT, SUCH AS BUT NOT LIMITED TO; ROAD CUT PERMITS, SEWER PERMITS, WATER PERMIT, ETC.
17. AT PROPOSED UTILITY CONNECTION POINTS AND CROSSINGS (I.E. STORM SEWER, SANITARY SEWER, WATER, ETC.) THE CONTRACTOR SHALL DETERMINE THE PRECISE LOCATION AND DEPTH AND SIZE OF EXISTING UTILITIES AND REPORT ANY DISCREPANCIES OR CONFLICTS TO THE ENGINEER BEFORE COMMENCING WORK, PROTECT AND ASSUME RESPONSIBILITY FOR ALL EXISTING UTILITIES.
18. REFER TO ARCHITECT AND LANDSCAPE ARCHITECTS DRAWINGS FOR BUILDING, LANDSCAPE, AND HARD SURFACE AREAS AND DIMENSIONS.
19. CONTRACTOR IS RESPONSIBLE TO KEEP THE ROADS FREE AND CLEAN FROM MUD OR DEBRIS,

NOTES: SEWER

20. SUPPLY AND INSTALL ALL SEWERS AND APPURTENANCES IN ACCORDANCE WITH MOST CURRENT CITY OF OTTAWA STANDARDS AND SPECIFICATIONS.
21. SEWER BEDDING AS PER CITY OF OTTAWA STANDARD S6 FOR SINGLE TRENCH AND CITY OF OTTAWA STANDARD S7 FOR COMBINED TRENCH.
22. ALL WORK SHALL BE PERFORMED, AS APPLICABLE IN ACCORDANCE WITH OPSS 407, AND 410.
23. CONTRACTOR TO CONFIRM ELEVATION OF EXISTING STORM AND SANITARY SEWERS AT PROPOSED CONNECTION POINTS AND REPORT ANY DISCREPANCIES TO THE ENGINEER BEFORE COMMENCING ANY WORK.
24. ALL SEWERS WITH LESS THAN 1.5m OF COVER ARE SUBJECT TO INSULATION DETAIL.
25. STORM AND SANITARY LATERALS SHALL BE EQUIPPED WITH BACKWATER VALVES IN ACCORDANCE WITH CITY OF OTTAWA STANDARDS.
26. CONTRACTOR TO CCTV ALL NEW SEWERS, 250mmØ OR GREATER, TO ENSURE THEY ARE CLEAN AND OPERATIONAL UPON COMPLETION OF CONTRACT. THE CONTRACTOR IS RESPONSIBLE TO FLUSH AND CLEAN ALL SEWERS.
27. PROVIDE SANITARY BACKWATER VALVES IN ACCORDANCE WITH CITY OF OTTAWA STANDARD S14.1 AND FOUNDATION DRAIN BACKWATER VALVE IN ACCORDANCE WITH CITY OF OTTAWA STANDARD S14,
28. SEWER CONNECTIONS TO BE MADE ABOVE THE SPRINGLINE OF THE SEWER AS PER CITY OF OTTAWA STANDARD S11, S11.1, AND S11.2.

NOTES: WATERMAIN

29. SUPPLY AND INSTALL ALL WATERMAIN AND APPURTENANCES IN ACCORDANCE WITH MOST CURRENT CITY OF OTTAWA STANDARDS AND SPECIFICATIONS,
30. ALL WATER MAIN TO BE INSTALLED AT MINIMUM COVER OF 2.4m BELOW FINISHED GRADE. WHERE REQUIRED, PROVIDE INSULATION IN ACCORDANCE WITH CITY OF OTTAWA STANDARDS W22 AND W23.
31. WATER MAIN BEDDING AS PER CITY OF OTTAWA STANDARD W17,
32. CONCRETE THRUST BLOCKS AND RESTRAINING AS PER DETAILS ON DRAWING C103.
33. CATHODIC PROTECTION REQUIRED FOR ALL IRON FITTINGS,
34. IF WATER MAIN MUST BE DEFLECTED TO MEET ALIGNMENT, ENSURE THAT THE AMOUNT OF DEFLECTION USED IS LESS THAN HALF THAT RECOMMENDED BY THE MANUFACTURER,
35. EXCAVATION, INSTALLATION, AND BACKFILL BY CONTRACTOR, CONNECTIONS AND SHUT-OFFS AT THE MAIN BY CITY.

NOTES: UNDERGROUND STORMWATER STORAGE

36. OVERSIZED PIPE STMH-01 TO STMH-02.
37. UNDERGROUND STORMWATER STORAGE REQUIRED: 8.3m³ UNDERGROUND STORMWATER PROVIDED: 9.2m³

Owner
Richmond Churchill Limited Partnership
485 Bank Street, Suite 200
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K2P 1Z2

HOBIN
Hobin Architecture Incorporated
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CSW
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No.	Revision	Date
02	RE-ISSUED FOR SPA	DEC 18, 2020
01	ISSUED FOR SPA	JUNE 11, 2020

Stamp:
REGISTERED PROFESSIONAL ENGINEER
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100104372
DEC 18, 2020
PROVINCE OF ONTARIO

Stamp:
REGISTERED PROFESSIONAL ENGINEER
S. L. STERLING
100232952
DEC 18, 2020
PROVINCE OF ONTARIO

PARSONS
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Project:
327 RICHMOND ROAD
OTTAWA, ONTARIO

Drawing: SITE SERVICING, GRADING, AND EROSION AND SEDIMENT CONTROL PLAN

Scale: 1:200	Date: MAY 2020
Design By: MM	Drawn By: SS
Project Number: 477093	Sheet Number: C101

D07-12-20-0081

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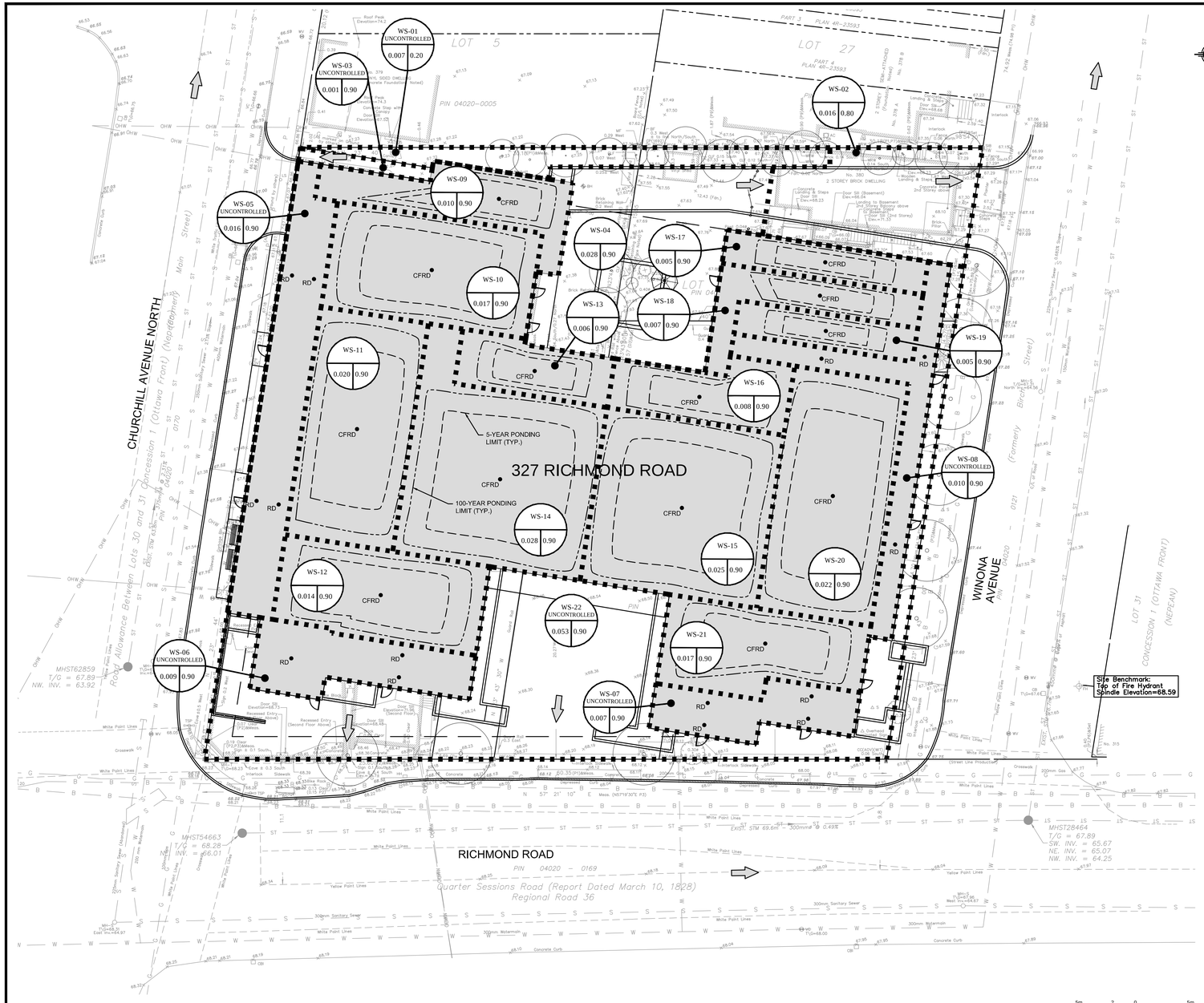
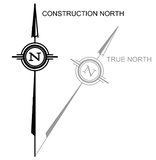
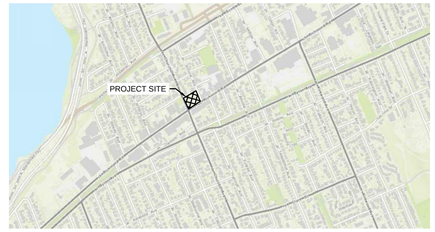






KEY PLAN

NOTES: GENERAL

1. CONTRACTOR IS RESPONSIBLE FOR ALL LAYOUT FOR CONSTRUCTION PURPOSES.
2. ALL ELEVATIONS ARE GEODETIC AND UTILIZE METRIC UNITS.
3. JOB BENCH MARK - REFER TO SURVEY BY AOV LTD. CONFIRM WITH CONTRACT ADMINISTRATOR PRIOR TO UTILIZATION OF BENCH MARK.
4. ALL GROUND SURFACES SHALL BE EVENLY GRADED WITHOUT PONDING AREAS AND WITHOUT LOW POINTS EXCEPT WHERE APPROVED SWALE OR CATCH BASIN OUTLETS ARE PROVIDED.
5. STRIP AND REMOVE ALL TOPSOIL FROM IMPROVED AREAS.
6. COORDINATE AND SCHEDULE ALL WORK WITH OTHER TRADES AND CONTRACTORS.
7. ALL EDGES OF DISTURBED PAVEMENT SHALL BE SAW CUT TO FORM A NEAT AND STRAIGHT LINE PRIOR TO PLACING NEW PAVEMENT. PAVEMENT REINSTATEMENT SHALL BE PER CITY OF OTTAWA STD. R10.
8. CURBS TO BE CONCRETE BARRIER, CONSTRUCTED AS PER CITY OF OTTAWA DETAIL SC1.1. ELEVATIONS AT CURB INDICATE THE GRADE AT THE FINISHED ROAD SURFACE UNLESS NOTED OTHERWISE.
9. RESTORE PAVEMENT STRUCTURE AND SURFACES ON EXISTING ROADS TO A CONDITION AT LEAST EQUAL TO ORIGINAL AND TO THE SATISFACTION OF THE MUNICIPAL AUTHORITIES.
10. ALL MATERIAL SUPPLIED AND PLACED FOR PARKING LOT AND ACCESS ROAD CONSTRUCTION SHALL BE TO OPSS STANDARDS AND SPECIFICATIONS UNLESS OTHERWISE NOTED. CONSTRUCTION TO OPSS 206, 310 & 314. MATERIALS TO OPSS 1001, 1003 & 1010.
11. ABUTTING PROPERTY GRADE TO BE MATCHED.
12. OBTAIN AND PAY FOR ALL NECESSARY PERMITS AND APPROVALS FROM THE MUNICIPAL AUTHORITIES PRIOR TO COMMENCING CONSTRUCTION.
13. MINIMIZE DISTURBANCE TO EXISTING VEGETATION DURING THE EXECUTION OF ALL WORKS.
14. FILTER FABRIC TO BE INSTALLED AND MAINTAINED BETWEEN THE FRAME AND COVER OF ALL CATCHBASINS AND CATCHBASIN MANHOLES DURING THE CONSTRUCTION PERIOD TO MINIMIZE SEDIMENTS ENTERING THE STORM SEWER SYSTEM. ALL GRASSED AREAS MUST BE COMPLETED PRIOR TO THE REMOVAL OF THE FILTER FABRIC IN THE CATCH BASINS.
15. REMOVE FROM SITE ALL EXCESS EXCAVATED MATERIAL UNLESS OTHERWISE DIRECTED FROM THE ENGINEER. EXCAVATE AND REMOVE ALL ORGANIC MATERIAL AND DEBRIS LOCATED WITHIN THE PROPOSED BUILDING, PARKING AND ROADWAY LOCATIONS. ANY CONTAMINATED MATERIAL SHALL BE DISPOSED OF AT A LICENSED LANDFILL FACILITY.
16. THE APPROVAL OF THIS PLAN DOES NOT EXEMPT THE CONTRACTOR FROM THE REQUIREMENTS TO OBTAIN THE VARIOUS PERMITS/APPROVALS REQUIRED TO COMPLETE A CONSTRUCTION PROJECT, SUCH AS BUT NOT LIMITED TO; ROAD CUT PERMITS, SEWER PERMITS, WATER PERMIT, ETC.
17. AT PROPOSED UTILITY CONNECTION POINTS AND CROSSINGS (I.E. STORM SEWER, SANITARY SEWER, WATER, ETC.) THE CONTRACTOR SHALL DETERMINE THE PRECISE LOCATION AND DEPTH AND SIZE OF EXISTING UTILITIES AND REPORT ANY DISCREPANCIES OR CONFLICTS TO THE ENGINEER BEFORE COMMENCING WORK. PROTECT AND ASSUME RESPONSIBILITY FOR ALL EXISTING UTILITIES.
18. REFER TO ARCHITECT AND LANDSCAPE ARCHITECTS DRAWINGS FOR BUILDING, LANDSCAPE, AND HARD SURFACE AREAS AND DIMENSIONS.
19. CONTRACTOR IS RESPONSIBLE TO KEEP THE ROADS FREE AND CLEAN FROM MUD OR DEBRIS.

LEGEND:

- EXISTING PROPERTY LINE
- EXISTING CONCRETE CURB
- PROPOSED CONCRETE CURB
- PROPOSED DEPRESSED CURB
- PROPOSED BUILDING OR STRUCTURE
- EXISTING WATERMAIN
- EXISTING V&VB
- EXISTING CURBSTOP
- EXISTING FIRE HYDRANT
- PROPOSED WATERMAIN
- PROPOSED V&VB
- PROPOSED FIRE HYDRANT
- EXISTING SANITARY SEWER AND MANHOLE
- PROPOSED SANITARY SEWER AND MANHOLE
- EXISTING STORM SEWER AND MANHOLE
- PROPOSED STORM SEWER AND MANHOLE
- PROPOSED CATCH BASIN AND LANDSCAPE DRAIN
- PROPOSED SUBDRAIN
- PROPOSED CONTROLLED ROOF DRAIN
- PROPOSED ROOF DRAIN
- PROPOSED DITCH
- EXISTING GRADE
- PROPOSED TERRANCING (MAX 3:1 SLOPE)
- PROPOSED RETAINING WALL
- PROPOSED TWSI AS PER SC7.3
- PROPOSED STORM DRAINAGE AREA
- OVERLAND FLOW ROUTE
- STORM DRAINAGE AREA ID
- RUNOFF COEFFICIENT
- DRAINAGE AREA (Ha)

CONTROLED ROOF DRAIN DATA

LOCATION	DRAINAGE AREA (sqm)	MODEL	No. OF DRAINS	CONTROLLED FLOW (L/s)		MAX PONDING DEPTH (mm)		STORAGE VOLUME (cu.m)	
				5 YEAR	100 YEAR	5 YEAR	100 YEAR	5 YEAR	100 YEAR
WS-9	96.52	WATTS ADJUSTABLE ACCUTROL WEIR	1	1.054	1.425	85.0	114.9	0.9	2.2
WS-10	173.28	WATTS ADJUSTABLE ACCUTROL WEIR	1	1.184	1.565	95.5	126.2	2.2	5.2
WS-11	196.03	WATTS ADJUSTABLE ACCUTROL WEIR	1	1.208	1.592	97.4	128.4	2.7	6.1
WS-12	144.23	WATTS ADJUSTABLE ACCUTROL WEIR	1	1.145	1.523	92.4	122.8	1.7	4.0
WS-13	63.86	WATTS ADJUSTABLE ACCUTROL WEIR	1	0.952	1.310	76.8	105.7	0.4	1.1
WS-14	275.42	WATTS ADJUSTABLE ACCUTROL WEIR	1	1.272	1.662	102.5	134.0	4.4	9.8
WS-15	245.06	WATTS ADJUSTABLE ACCUTROL WEIR	1	1.251	1.639	100.9	132.1	3.7	8.4
WS-16	80.21	WATTS ADJUSTABLE ACCUTROL WEIR	1	1.013	1.013	81.7	118.8	0.6	2.0
WS-17	53.99	WATTS ADJUSTABLE ACCUTROL WEIR	1	0.899	1.265	72.5	102.0	0.3	0.8
WS-18	67.61	WATTS ADJUSTABLE ACCUTROL WEIR	1	0.968	1.326	78.1	106.9	0.5	1.2
WS-19	48.02	WATTS ADJUSTABLE ACCUTROL WEIR	1	0.872	1.229	70.3	99.1	0.2	0.7
WS-20	222.02	WATTS ADJUSTABLE ACCUTROL WEIR	1	1.232	1.618	99.4	130.5	3.2	7.3
WS-21	126.67	WATTS ADJUSTABLE ACCUTROL WEIR	1	1.118	1.493	90.2	120.4	1.4	3.3
TOTAL FLOW				14.168	18.660				

Owner
Richmond Churchill Limited Partnership
485 Bank Street, Suite 200
Ottawa, Ontario
K2P 1Z2

HOBIN
Hobin Architecture Incorporated
63 Pamilla Street
Ottawa, Ontario
K1S 3K7

CSW
Landscape Architecture
Urban Design
Site Planning
Recreation and Park Planning
Project Management
319 McRae Avenue, Suite 502, Ottawa, Ontario, K1Z 0B9
Tel: (613) 729-4536

No.	Revision	Date
02	RE-ISSUED FOR SPA	DEC 18, 2020
01	ISSUED FOR SPA	JUNE 11, 2020

Stamp:
REGISTERED PROFESSIONAL ENGINEER
M.E. MACSWEEN
100104372
DEC 18, 2020
PROVINCE OF ONTARIO

Stamp:
REGISTERED PROFESSIONAL ENGINEER
S. L. STERLING
100232952
DEC 18, 2020
PROVINCE OF ONTARIO

PARSONS
1223 MICHAEL STREET, SUITE 100, OTTAWA, ONTARIO K1J 7T2
Tel: 613-738-4160 Fax: 613-739-7105

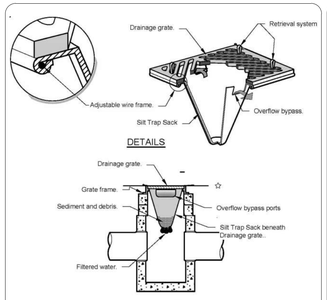
Project:
327 RICHMOND ROAD
OTTAWA, ONTARIO

Drawing:
DRAINAGE AREAS AND ROOF DRAIN PLAN

Scale:	Date:
1:200	MAY 2020
Design By:	Drawn By:
MM	SS
Project Number:	Sheet Number:
477093	C102

D07-12-20-0081

#18218



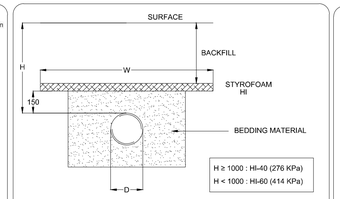
NOTES

1. Size and shape of the silt trap sack to fit the storm structure it will service. (rectangular or round).
2. The silt trap sack shall have a built-in high-flow relief system (overflow bypass).
3. The silt trap sack assembly must allow removal without spilling the collected material.
4. Empty silt trap sack and dispose of sediment and debris before the sack is half-full.
5. Ensure the silt trap sack assembly does not spill or fall into the storm structure. If sediment is spilled into the storm structure, remove the spilled material by suction hose or other approved method.
6. Provide protection for catch basin hoods (Wattles, 2x4 lumber, and so forth)

SILT SACK DETAIL

PARSONS

D1



INSULATION MINIMUM WIDTH (W)

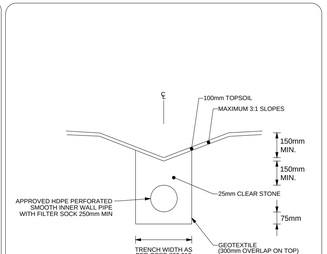
H \ D	≤150	200	250	300	400	500	600	INSULATION THICKNESS
750	2250	2300	2350	2400	2500	2600	2700	100
1000	1750	1800	1850	1900	2000	2100	2200	90
1250	1250	1300	1350	1400	1500	1600	1700	80
1500	750	800	850	900	1000	1100	1200	70
1750	600	600	600	600	600	600	700	60

ALL DIMENSIONS IN MILLIMETERS

THERMAL INSULATION FOR SEWER IN SHALLOW TRENCHES

PARSONS

D2



NOTES:

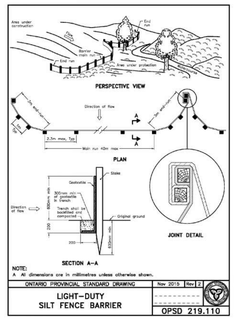
1. SIDE SLOPE OF SWALE - MIN. 1.5%, MAX 3:1.
2. UNDER PAVEMENT STRUCTURE NON PERFORATED PIPE TO BE USED WITH 75mm BEDDING AND BACKFILLED WITH APPROVED NATIVE MATERIAL.
3. GEOTEXTILE SHALL BE APPROVED NON-WOVEN CLASS 1 OR AS SPECIFIED.

PERFORATED PIPE INSTALLATION UNDERNEATH SWALE

N.T.S.

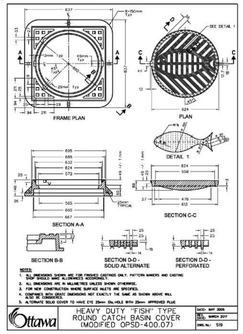
PARSONS

D3



NOTE:
A. All dimensions are in millimetres unless otherwise shown.

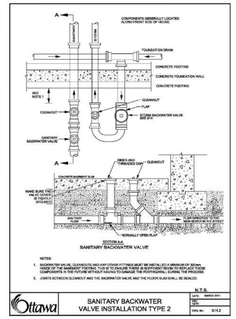
LIGHT-DUTY SILT FENCE BARRIER — OPSD 219.110



NOTES:

1. SECTION 'A' AND 'B' ARE FOR STANDARD CASTING ONLY. PATTERN MAKERS AND CASTING HOUSES MAY ELIMINATE SECTIONS NOT REQUIRED.
2. THE NEW CONCRETE MIX SHALL HAVE A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 30 MPa.
3. CONCRETE SHALL CONTAIN 5% ± 1% AIR ENTRAINMENT.
4. REINFORCING STEEL SHALL BE 400 MPa DEFORMED BAR ANCHORS.
5. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN.

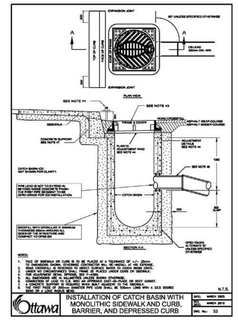
HEAVY DUTY "FISH" TYPE ROUND CATCH BASIN COVER (MODIFIED OPSD-400.07)



NOTES:

1. BACKWATER VALVE, CLEANOUTS AND ANY OTHER FITTINGS MUST BE INSTALLED A MINIMUM OF 600mm FROM THE BUILDING OR FOUNDATION WALL, OR AS OTHERWISE DIRECTED BY THE ENGINEER.
2. ALL COMPONENTS IN THE FUTURE WITHOUT HAVING TO EXCAVATE THE FOUNDATION OR THE STRUCTURAL DURING THE PROCESS.
3. UPPER EXTENSION IS CLEANOUT AND THE SNORKEL FOR VENTING. ALL PIPES SHALL BE SEALED.

SANITARY BACKWATER VALVE INSTALLATION TYPE 2



APPENDIX D | BOUNDARY CONDITIONS

[EXTERNAL] RE: 319 Richmond Road Development - Boundary Conditions

Wu, John <John.Wu@ottawa.ca>

Mon 2020-05-11 10:12 AM

To: MacSween, Meghan <Meghan.Macsween@parsons.com>

Here is the result:

The following are boundary conditions, HGL, for hydraulic analysis at 319 Richmond (zone 1W) assumed to be connected to the 406mm on Richmond (see attached PDF for location).

Minimum HGL = 108.5m

Maximum HGL = 114.7m

MaxDay + FireFlow (367 L/s) = 106.0m

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.

Please refer to tech bulletin regarding demands greater than 0.5L/s

Thanks.

John

From: MacSween, Meghan <Meghan.Macsween@parsons.com>
Sent: May 5, 2020 10:59 AM
To: Wu, John <John.Wu@ottawa.ca>
Subject: Re: 319 Richmond Road Development - Boundary Conditions

CAUTION: This email originated from an External Sender. Please do not click links or open attachments unless you recognize the source.

ATTENTION : Ce courriel provient d'un expéditeur externe. Ne cliquez sur aucun lien et n'ouvrez pas de pièce jointe, excepté si vous connaissez l'expéditeur.

Please see FUS calculation sheet attached. The gross floor area is pretty large given it's 9 storeys and the exposure factor is also pretty high at 60%.

Meghan

Meghan MacSween, M.Eng., P.Eng.
Municipal Engineer

1223 Michael St. North, Suite 100, Ottawa, ON K1J 7T2
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PARSONS

From: Wu, John <John.Wu@ottawa.ca>
Sent: May 5, 2020 10:50 AM
To: MacSween, Meghan <Meghan.Macsween@parsons.com>
Subject: [EXTERNAL] RE: 319 Richmond Road Development - Boundary Conditions

Please submit the FUS calculation sheet, why that high?

From: MacSween, Meghan <Meghan.Macsween@parsons.com>
Sent: May 5, 2020 10:47 AM
To: Wu, John <John.Wu@ottawa.ca>
Subject: 319 Richmond Road Development - Boundary Conditions

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ATTENTION : Ce courriel provient d'un expéditeur externe. Ne cliquez sur aucun lien et n'ouvrez pas de pièce jointe, excepté si vous connaissez l'expéditeur.

Hi John,

We are working on the SPA application for the proposed development at the corner of Richmond and Churchill, we had a pre-application consultation meeting with you for this project last summer.

We would like to request the boundary conditions for the existing 406mm diameter watermain on Churchill Avenue, just north of the intersection with Richmond Road. Please refer to the site map below showing the proposed connection location. Please see the following for a summary of the estimated demands:

ADD = 3.0 L/s
MDD = 7.4 L/s
PHD = 11.9 L/s
Fire Demand (FUS) = 367 L/s

Thanks,

Meghan

Meghan MacSween, M.Eng., P.Eng.
Municipal Engineer

1223 Michael St. North, Suite 100, Ottawa, ON K1J 7T2
meghan.macsween@parsons.com

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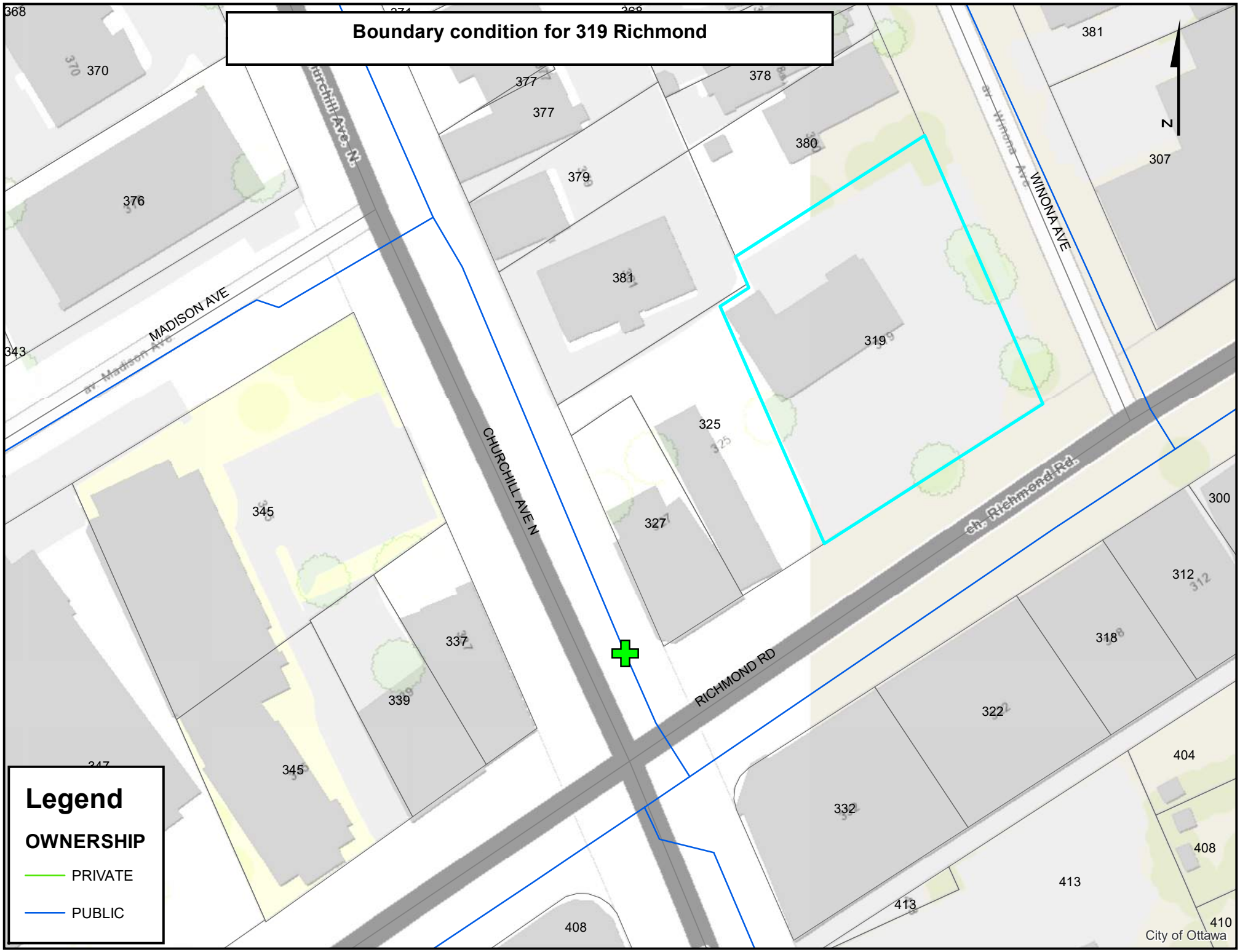
Boundary condition for 319 Richmond
N
Legend
OWNERSHIP
PRIVATE
PUBLIC
MADISON AVE
CHURCHILL AVE N
RICHMOND RD
WINONA AVE
368
370
376
343
345
337
339
347
377
378
379
380
381
307
319
325
327
300
312
318
322
404
332
408
413
410
City of Ottawa

APPENDIX E | WATER DEMAND

Table1 : Water Demand for Proposed Building

Building	Units	Population	Gross Floor Area (m2)	Average Daily Demand (ADD)	Maximum Daily Demand (MDD)**	Peak Hourly Demand (PHD)**	Fire Flow (FF)	MDD + FF
				L/s	3.6*ADD (residential) 1.5*ADD (non-residential) L/s	5.4*ADD (residential) 1.8*MDD (non-residential) L/s	L/s	L/s
327 Richmond Road				**3.9**	**8.6**	**14.0**	**367.0**	**375.6**
Residential	184	332		1.3	4.8	7.3		
Commercial*			1736	2.5	3.8	6.8		

* There are three separate retail spaces proposed on the ground floor that will be rented. The future tenants are unknown at this time but restaurant and café uses are likely. To be conservative, worst case scenario of all three of these retail spaces being used for restaurants/cafes was assumed.

Average Daily Demands

Based on Ottawa Design Guidelines - Water Distribution, 2010 and MOE Design Guidelines for Drinking-Water Systems, 2008

Average Residential Daily Flow : 350 L/p/d
Retail Stores = 5 L/d/m2
Restaurant (Ordinary not 24h) = 125 L/seat/d
** Residential Peaking factors as per MOE Guidelines for Drinking-Water Systems Table 3-3 for 0 to 500 persons

Population Densities

Appartment average	1.8	p./unit
Bachelor	1.4	p./unit
1 Bedroom	1.4	p./unit
2 Bedrooms	2.1	p./unit
3 Bedrooms	3.1	p./unit
Restaurant	1	seat/m2

Unit Summary		bach	1bed	1bed +	2 bed	2 bed +	TOTAL	GRAND TOTAL
LEVEL 2	x1	4	5	7	8	2	26	26
LEVEL 3	x1	4	5	7	8	2	26	26
LEVEL 4	x1	5	6	6	7	2	26	26
LEVEL 5	x1	4	9	2	9	1	25	25
LEVEL 6	x1	4	8	2	9	1	24	24
LEVEL 7	x1	4	7	2	9	1	23	23
LEVEL 8	x1	1	6	1	7	2	17	17
LEVEL 9	x1	2	5	1	6	3	17	17
Total Units		**28**	**51**	**28**	**63**	**14**	**184**	**184**
Unit Mix		15%	28%	15%	34%	8%	100%	
Persons per unit		1.4	1.4	2.1	2.1	2.1		
Population		**39**	**71**	**59**	**132**	**29**		**332**

Table 2: Hazen-Williams Head Loss Calculations: $hl = c*V^{1.85}L/(C^{1.85}D^{1.165})$

327 Richmond Road	Boundary Condition		Description								Demand Results		
	Head (m)	Elevation at Boundary Condition (m)	Pipe Segment Length (m)	Diameter (mm)	Demand (L/s)	Hazen Williams Coefficient, C	Area (m^2)	Velocity (m/s)	Unit Conversion, K	Elevation at Building Connection (m)	Head loss (m)	Pressure (kPa)	Pressure (psi)
Peak Hour Demand	108.5	68.0	7.0	200	14.0	110	0.0314	0.45	6.79	68.30	0.0116	393	**57**
Average Daily Demand	108.5	68.0	7.0	200	3.9	110	0.0314	0.12	6.79	68.30	0.0011	394	**57**
Max Day + Fire Flow Demand	106.0	68.0	7.0	200	375.6	110	0.0314	11.96	6.79	68.30	5.0668	319	**46**

Table 3: Fire Flow Calculations

Building	Type of Construction C	Total Floor Area m^2 A	Fire Flow (min. 2,000) L/min F	Adjusted (nearest 1,000) L/min	Occupancy Factor O	Reduction / Increase due to Occupancy	Fire Flow with Occupancy (min. 2,000) L/min	Sprinklers Factor S	Reduction due to Sprinklers L/min	Exposure Factor % E	Increase due to Exposure L/min	Fire Flow L/min	Roof Contribution L/min R	Required Fire Flow: Adjusted to the nearest 1000 (min. 2,000, max. L/min F	Required Fire Flow: minimum 33 L/s
Building	0.8	16,540	22,635	23,000	-15%	-3,450	19,550	50%	9,775	60%	11,730	22,000	0	22,000	367

Outline of Procedure P. 20

Reference:

References

Water Supply for Public Fire Protection , 1999 by Fire Underwriters Survey (FUS) and Ottawa Design Guidelines - Water Distribution, July 2010 and subsequent Technical Bulletins

C Type of Construction

Wood Frame	1.5
Ordinary Construction (joist masonry)	1
Non-Combustible Construction (unprotected metal structure, masonry non-combustible)	0.8
Fire resistive construction (= or > 3 hours)	0.7

A Total Floor Area (m^2)

First Floor

Basement excluded if at least 50% below grade

Fire-resistive Building Floor Area

Less than 1 hour rating

two largest adjoining floors

Additional floors (up to 8) at 50%

Fully protected, equal or more than 3 hours rating (reinforced concrete, protected steel)

largest floor

Additional two adjoining floors at 25%

F

Fire Flow (L/Min)

220*C*(A^0.5)

2,000<F<45,000

FS Fire Wall Separation

Per Wall 1,000 L/min

O

O Occupancy

Non-Combustible	-25%
Limited Combustible	-15%
Combustible	0%
Free Burning	15%
Rapid Burning	25%
Commercial	0%

S Sprinklers

	Complete coverage	Partial coverage
Automatic Sprinklers NFPA Standards	30%	30% * x%
Standard Water Supply	10%	10% * x%
Full Supervision	10%	10% * x%
Residential Sprinklers	30%	30% * x%

(x%: percentage of total protected floor area)

E Exposure

Cumulative , maximum 75%

Distance (m)	*	N	S	E	W
0-3	25%	x			
3.1-10	20%				
10.1-20	15%			x	
20.1-30	10%		x		x
30.1-45	5%				

R Roof

Shake	2,000 to 4,000 L/min
Wood	2,000 to 4,000 L/min

APPENDIX F | SANITARY FLOWS, SEWER DESIGN SHEET AND DRAINAGE AREAS

SANITARY SEWER DESIGN SHEET

Proposed Development at 327 Richmond Road
Flow and Capacity Analysis of Existing Sanitary Sewers from Subject Site to Collector Sewer in Scott Street

Population density
Restaurant 1 seat/m2

App 1.8 people/unit
House 3.4 people/unit

Restaurant (Ordinary not 24h): 125 L/seat/d
Retail stores - washrooms only: 50000 L/ha/d
Mannings Rougness Coefficient: 0.013

Residential Unit average daily flow (q): 280 L/cap.d
daily commercial flow (c): 28000 L/ha/d
infiltration allowance for Q(e) 0.33 L/s/gross ha

Review Date: 12/16/2020
Reviewer: S. Sterling
Prepared by: B. Villeneuve

q = average daily per capita flow (L/cap.d)
Q(p) = peak population flow (L/s)
Q(c) = peak commercial flow (L/s)
Q(e) = peak extraneous flow (L/s)
Q(d) = peak design flow (L/s)

Peaking Factor:
M = 1+14/(4+(P/1000)^0.5)*0.8 (max 4.0)
Q(p) = (P/1000)qM/86.4 (L/s)

Q(d) = Q(p) + Q(c) + Q(e) (L/s)

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

Location				Extraneous Peak flow	Restaurant			Commercial			Residential									Peak Flow			Pipe				
												Apartment		Housing		Cumulative			Peak	Resid. Flow	Comm. Flow	Cumulative Design	Dia.	Slope	Length	Capacity	Velocity	
Street Name	From	To	Total	Q(e)	Gross Floor	Avg. Flow	Peak	Gross Floor	Avg. Flow	Peak	Area	Units	P	Units	P	Area	P	Avg. Flow	Factor	Q(p)	Q(c)	Q(d)	D	S	L	Qcap	V	Q(d)/Qcap
	MH	MH	Area (ha)	(L/s)	Area (ha)	(L/s)	Factor	Area (ha)	(L/s)	Factor	(ha)		(person)		(person)	(ha)	(person)	(L/s)	M	(L/s)	(L/s)	(L/s)	(mm)	(%)	(m)	(L/s)	(m/s)	
327 Richmond Road (Subject Site)			0.33	0.11	0.17	2.51	1.5				0.33	184	332			0.33	332	1.08	3.45	3.71	3.77	7.58	150	2.00	6.8	21.51	1.22	0.35
Madison	MHSA27561	MHSA61673	0.85	0.28				0.02	0.01	1.5	0.83			17	58	0.83	58	0.19	3.64	0.68	0.01	0.98	225	0.68	194.6	36.98	0.93	0.03
Whitby	MHSA27559	MHSA61674	1.45	0.48				0.01	0.00	1.0	1.44	48	87	29	99	1.44	186	0.60	3.53	2.13	0.00	2.61	225	0.82	207.0	40.61	1.02	0.06
Winston/Wilmont	MHSA27554	MHSA61675	2.62	0.86							2.62			80	272	2.62	272	0.88	3.48	3.06		3.93	225	0.50	461.9	31.71	0.80	0.12
Churchill	MHSA61672	MHSA61673	0.22	0.07							0.22			1	4	0.55	336	0.01	3.45	0.04		7.70	250	2.32	60.3	90.46	1.85	0.09
	MHSA61673	MHSA61674	0.65	0.21				0.29	0.09	1.5	0.36	6	11	4	14	1.74	419	0.08	3.41	0.28	0.14	9.31	250	0.39	78.8	37.09	0.76	0.25
	MHSA61674	MHSA61675	0.42	0.14				0.08	0.03	1.0	0.34			7	24	3.52	629	0.08	3.34	0.26	0.03	12.34	300	0.34	77.2	56.32	0.80	0.22
	MHSA61675	MHSA61676	0.50	0.17	0.04	0.54	1.5	0.20	0.06	1.5	0.27			1	4	6.41	905	0.01	3.26	0.04	0.91	17.39	300	0.52	81.2	69.65	0.99	0.25
Picton	MHSA27573	MHSA27574	0.26	0.09							0.26			10	34	0.26	34	0.11	3.68	0.41		0.49	225	0.51	63.3	32.02	0.81	0.02
Elmgrove	MHSA27575	MHSA27576	1.24	0.41				0.20	0.07	1.0	1.04			23	79	1.04	79	0.26	3.62	0.93	0.07	1.40	375	0.31	81.2	97.51	0.88	0.01
Ashton	MHSA27577	MHSA27578	0.70	0.23							0.70	6	11	12	41	0.70	52	0.17	3.65	0.61		0.85	225	0.47	79.5	30.74	0.77	0.03
Winona	MHSA27572	MHSA27574	0.30	0.10							0.30			5	17	0.30	17	0.06	3.71	0.20		0.30	225	0.77	44.3	39.35	0.99	0.01
	MHSA27574	MHSA27576	0.38	0.13							0.38			6	21	0.95	72	0.07	3.62	0.25		1.17	225	2.83	75.9	75.44	1.90	0.02
	MHSA27576	MHSA27578	0.45	0.15							0.45	6	11	11	38	2.44	200	0.16	3.52	0.56		3.28	225	0.58	77.7	34.15	0.86	0.10
2070 Scott Proposed Development*	MHSA27578	MHSA61680	0.20																			5.78						
			0.28	0.09							0.28			5	17	3.42	269	0.06	3.48	0.19		10.19	225	1.60	80.4	56.72	1.43	0.18
Scott	MHSA27558	MHSA61676	0.50	0.17							0.50	112	202			0.50	202	0.65	3.52	2.30		2.47	225	1.02	85.4	45.29	1.14	0.05
	MHSA61676	MHSA61684	0.04	0.01												6.91	1107		3.22			19.87	300	0.72	11.1	81.95	1.16	0.24
	MHSA61684	MHSA61680	0.17	0.06												6.91	1107		3.22			19.92	300	1.51	64.8	118.68	1.68	0.17
	MHSA61680	MHSA61681	0.28	0.09				0.02	0.01	1.0	0.26	42	76			10.59	1452	0.25	3.15	0.78	0.01	30.99	375	0.25	59.4	87.56	0.79	0.35
	MHSA61681	MHSA61682	0.72	0.24				0.16	0.05	1.5	0.56					11.15	1452		3.15		0.08	31.31	375	0.26	57.2	89.30	0.81	0.35
	MHSA61682	MHSA61683														11.15	1452		3.15			31.31	375	0.34	5.9	102.12	0.93	0.31
	MHSA61683	MHSA01710														11.15	1452		3.15			31.31	300	0.50	10.3	68.29	0.97	0.46

* The flows from the proposed development at 2070 Scott Street were taken from "Site Servicing and Stormwater Management Brief - 2070 Scott Street, Ottawa, ON" by Stantec, dated October 2, 2019

LEGEND

WINONA
3.71 | 3.16

SANITARY DRAINAGE AREA ID

FLOW (L/s)

DRAINAGE AREA (Ha)

SANITARY DRAINAGE AREA

CONSTRUCTION NORTH

TRUE NORTH

Workman Ave

Scott St

Wilmont Ave

Whitby Ave

Madison Ave

Richmond Rd

Churchill Ave N

Winona Ave

Ashton Ave

Elmgrove Ave

Picton Ave

Athlone Ave

Winston Ave

Ex. SAN 1500mm

Ex. SAN 225mm

Ex. SAN 300mm

Ex. SAN 375mm

Ex. SAN 250mm

MHSA61684
0.04 | 0.01

MHSA61680
0.17 | 0.06

MHSA27558
0.50 | 2.47

MHSA61676
0.50 | 1.12

2070 SCOTT
0.20 | 5.75

MHSA61681
0.28 | 0.88

MHSA61682
0.72 | 0.32

MHSA27578
0.28 | 0.28

WILMONT
2.62 | 3.93

ASHTON
0.70 | 0.85

WHITBY
1.45 | 2.61

MHSA61675
0.42 | 0.42

MHSA27576
0.45 | 0.71

MADISON
0.85 | 0.98

MHSA61674
0.65 | 0.63

MHSA27574
0.38 | 0.37

ELMGROVE
1.24 | 1.40

MHSA61673
0.22 | 0.12

327
0.33 | 7.59

PICTON
0.26 | 0.49

MHSA27572
0.30 | 0.30

30m 15 0 30 60m

SCALE: 1:1750

PARSONS

327 RICHMOND ROAD
OTTAWA, ON

SANITARY DRAINAGE AREAS

December, 2020
477093
FIGURE A

H:\(SD\ 477093\ 1000\ DWGS\ 477093_ RICHMOND_ CHURCHILL_ v8.dwg Dec 16, 2020 - 8:32am

APPENDIX G | STORMWATER MANAGEMENT CALCULATIONS, SEWER DESIGN SHEET AND PRE-DRAINAGE AREAS

LEGEND

EWS-01 — STORM DRAINAGE AREA ID

0.33 | 0.79 — RUNOFF COEFFICIENT / DRAINAGE AREA (Ha)

EXISTING STORM DRAINAGE AREA

OVERLAND FLOW ROUTE

CONSTRUCTION NORTH

TRUE NORTH

CHURCHILL AVENUE NORTH

WINONA AVENUE

RICHMOND ROAD

EWS-01
0.33 | 0.79

No. 381
3 STOREY BRICK APARTMENT BUILDING
(Brick Noted)

No. 380
2 STOREY BRICK DWELLING

No. 319
Richmond Road
1 Storey Brick Garage
(Brick Noted)

No. 325
2 Storey
Brick & Concrete Block
Building

No. 327 – 331
Richmond Road
2 Storey
Brick Building
(Brick Noted)

LOT 4
PIN 04020–0004

LOT 28
PIN 04020–0035

LOT 1
LOT 2
LOT 3
REGISTERED PLAN 04020

PIN 04020–0005

PIN 04020–0033
PART 5
PLAN 4R–23593

PIN 04020–0001

PIN 04020 – 0002

PIN 04020 – 0003

PIN 04020 – 0121

PIN 04020 – 0169

Site Benchmark:
Top of Fire Hydrant
Spindle Elevation=68.59

MHST62859
T/G = 67.89
NW. INV. = 63.92

MHST54663
T/G = 68.28
NE. INV. = 66.01

MHST28464
T/G = 67.89
SW. INV. = 65.67
NE. INV. = 65.07
NW. INV. = 64.25

EXIST. STM 63.8m – 375mmØ @ 2.31%

EXIST. STM 69.6m – 300mmØ @ 0.49%

Lots 30 and 31 Concession 1 (Ottawa Front) (Nepean)

Road Allowance Between Lots 30 and 31 Concession 1 (Ottawa Front) (Nepean)

CONCESSION 1 (OTTAWA FRONT) (NEPEAN)

5m 2 0 5 10m

SCALE: 1:300

PARSONS

327 RICHMOND ROAD
OTTAWA, ON

PRE DRAINAGE PLAN

December, 2020
477093
FIGURE B

H:\SO\477093\1000\DWGS\477093_RICHMOND_CHURCHILL_v9.dwg Dec 17, 2020 – 9:14am

TABLE I - ALLOWABLE RUNOFF CALCULATIONS BASED ON PRE-EXISTING CONDITIONS

Area Description	Area (ha)	Time of Conc, Tc (min)	Minor Storm				Storm = 100 yr		
				I_5 (mm/hr)	C_{AVG}*	Q_{ALLOW} (L/s)	I_{100} (mm/hr)	C_{AVG}	Q_{ALLOW} (L/sec)
EXISTING SITE	0.327	10	Storm = 5 yr	104.19	0.79	**74.8**	178.56	0.99	**160.3**

5-year Storm $C_{ASPHALT/ROOF}$ = 0.90 C_{GRASS} = 0.20
100-year Storm $C_{ASPHALT/ROOF}$ = 1.00 C_{GRASS} = 0.25

TABLE II- POST-DEVELOPMENT AVERAGE RUNOFF COEFFICIENTS

Watershed Area No.	Impervious Areas (m^2)	A * $C_{ASPH/ROOF}$	Pervious Grass Areas (m^2)	A * C_{GRASS}	Sum AC	Total Area (m^2)	$C_{AVG\ (5yr)}$	$C_{AVG(100yr)}$
WS-01 (UC)	0.00	0	74.83	15	15	75	0.20	0.25
WS-03 (UC)	13.86	12	0.00	0	12	14	0.90	1.00
WS-02/WS-04 ('C)	415.85	374	22.82	5	379	439	0.86	1.00
WS-05 (UC)	155.85	140	0.00	0	140	156	0.90	1.00
WS-06 (UC)	91.51	82	0.00	0	82	92	0.90	1.00
WS-07 (UC)	70.94	64	0.00	0	64	71	0.90	1.00
WS-08 (UC)	99.11	89	0.00	0	89	99	0.90	1.00
WS-09 ('C)	96.52	87	0.00	0	87	97	0.90	1.00
WS-10 ('C)	173.28	156	0.00	0	156	173	0.90	1.00
WS-11 ('C)	196.03	176	0.00	0	176	196	0.90	1.00
WS-12 ('C)	144.23	130	0.00	0	130	144	0.90	1.00
WS-13 ('C)	63.86	57	0.00	0	57	64	0.90	1.00
WS-14 ('C)	275.42	248	0.00	0	248	275	0.90	1.00
WS-15 ('C)	245.06	221	0.00	0	221	245	0.90	1.00
WS-16 ('C)	80.21	72	0.00	0	72	80	0.90	1.00
WS-17 ('C)	53.99	49	0.00	0	49	54	0.90	1.00
WS-18 ('C)	67.61	61	0.00	0	61	68	0.90	1.00
WS-19 ('C)	48.02	43	0.00	0	43	48	0.90	1.00
WS-20 ('C)	222.02	200	0.00	0	200	222	0.90	1.00
WS-21 ('C)	126.67	114	0.00	0	114	127	0.90	1.00
WS-22 (UC)	533.85	480	0.00	0	480	534	0.90	1.00
Total	3174		98		2876	3272		
Total Controlled	2209		23		1992	2232		

UC indicates the area is uncontrolled
C indicates the area is controlled

TABLE III- TOTAL RUNOFF COEFFICIENT FOR CONTROLLED AREAS

$C_{AVG(5yr)}$ = Sum AC / Total Area = **1,992 / 2,232** = **0.89**

$C_{AVG(100yr)}$ = **1.00**

TABLE IV- SUMMARY OF POST-DEVELOPMENT RUNOFF

Area No	Area (ha)	Storm = 5 yr				Storm = 100 yr			
		I_5 (mm/hr)	$C_{AVG(5yr)}$	Q_{GEN} (L/s)	Q_{CONT} (L/s)	I_{100} (mm/hr)	$C_{AVG(100yr)}$	Q_{GEN} (L/s)	Q_{CONT} (L/s)
WS-01 (UC)	0.007	104.19	0.20	0.4	**0.4**	178.56	0.25	0.9	**0.9**
WS-03 (UC)	0.001	104.19	0.90	0.4	**0.4**	178.56	1.00	0.7	**0.7**
WS-02/WS-04 ('C)	0.044	104.19	0.86	11.0	**4.0**	178.56	1.00	21.8	**7.3**
WS-05 (UC)	0.016	104.19	0.90	4.1	**4.1**	178.56	1.00	7.7	**7.7**
WS-06 (UC)	0.009	104.19	0.90	2.4	**2.4**	178.56	1.00	4.5	**4.5**
WS-07 (UC)	0.007	104.19	0.90	1.8	**1.8**	178.56	1.00	3.5	**3.5**
WS-08 (UC)	0.010	104.19	0.90	2.6	**2.6**	178.56	1.00	4.9	**4.9**
WS-09 ('C)	0.010	104.19	0.90	2.5	**1.1**	178.56	1.00	4.8	**1.4**
WS-10 ('C)	0.017	104.19	0.90	4.5	**1.2**	178.56	1.00	8.6	**1.6**
WS-11 ('C)	0.020	104.19	0.90	5.1	**1.2**	178.56	1.00	9.7	**1.6**
WS-12 ('C)	0.014	104.19	0.90	3.8	**1.1**	178.56	1.00	7.2	**1.5**
WS-13 ('C)	0.006	104.19	0.90	1.7	**1.0**	178.56	1.00	3.2	**1.3**
WS-14 ('C)	0.028	104.19	0.90	7.2	**1.3**	178.56	1.00	13.7	**1.7**
WS-15 ('C)	0.025	104.19	0.90	6.4	**1.3**	178.56	1.00	12.2	**1.6**
WS-16 ('C)	0.008	104.19	0.90	2.1	**1.0**	178.56	1.00	4.0	**1.0**
WS-17 ('C)	0.005	104.19	0.90	1.4	**0.9**	178.56	1.00	2.7	**1.3**
WS-18 ('C)	0.007	104.19	0.90	1.8	**1.0**	178.56	1.00	3.4	**1.3**
WS-19 ('C)	0.005	104.19	0.90	1.3	**0.9**	178.56	1.00	2.4	**1.2**
WS-20 ('C)	0.022	104.19	0.90	5.8	**1.2**	178.56	1.00	11.0	**1.6**
WS-21 ('C)	0.013	104.19	0.90	3.3	**1.1**	178.56	1.00	6.3	**1.5**
WS-22 (UC)	0.053	104.19	0.90	13.9	**13.9**	178.56	1.00	26.5	**26.5**
Total	0.327			83.3	**43.8**			159.6	**74.8**

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

Allowable outlet flow = 74.8 L/s

Table V - Storage Volumes (5-Year and 100-Year Storm Events)

Storage Requirement for WS-9

C_{AVG} = 0.90 (5-year)
C_{AVG} = 1.00 (100-year)
Time Interval = 5 (mins)
Drainage Area = 0.010 (hectares)

Watts Adjustable Accutrol Weir Roof Drain
Number of Drains 1

	Release Rate = **1.05** (L/sec) Return Period = 5 (years) IDF Parameters, A = 998.071 , B = 0.814 $I = A/(T_c+C)B$, C = 6.053					Release Rate = **1.42** (L/sec) Return Period = 100 (years) IDF Parameters, A = 1735.688 , B = 0.820 $I = A/(Tc+C)B$, C = 6.014				
Duration (min)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)
0	-	-	-	-	-	-	-	-	-	-
5	141.2	3.4	1.1	2.4	0.7	242.7	6.5	1.4	5.1	1.5
10	104.2	2.5	1.1	1.5	0.9	178.6	4.8	1.4	3.4	2.0
15	83.6	2.0	1.1	1.0	0.9	142.9	3.8	1.4	2.4	2.2
20	70.3	1.7	1.1	0.6	0.8	120.0	3.2	1.4	1.8	2.2
25	60.9	1.5	1.1	0.4	0.6	103.8	2.8	1.4	1.4	2.0
30	53.9	1.3	1.1	0.2	0.4	91.9	2.5	1.4	1.0	1.9
35	48.5	1.2	1.1	0.1	0.2	82.6	2.2	1.4	0.8	1.7
40	44.2	1.1	1.1	0.0	0.0	75.1	2.0	1.4	0.6	1.4
45	40.6	1.0	1.1	-0.1	-0.2	69.1	1.9	1.4	0.4	1.2
50	37.7	0.9	1.1	-0.1	-0.4	64.0	1.7	1.4	0.3	0.9
55	35.1	0.8	1.1	-0.2	-0.7	59.6	1.6	1.4	0.2	0.6
60	32.9	0.8	1.1	-0.3	-0.9	55.9	1.5	1.4	0.1	0.3
65	31.0	0.7	1.1	-0.3	-1.2	52.6	1.4	1.4	0.0	0.0
70	29.4	0.7	1.1	-0.3	-1.4	49.8	1.3	1.4	-0.1	-0.4
75	27.9	0.7	1.1	-0.4	-1.7	47.3	1.3	1.4	-0.2	-0.7
80	26.6	0.6	1.1	-0.4	-2.0	45.0	1.2	1.4	-0.2	-1.0
85	25.4	0.6	1.1	-0.4	-2.3	43.0	1.2	1.4	-0.3	-1.4
90	24.3	0.6	1.1	-0.5	-2.5	41.1	1.1	1.4	-0.3	-1.7
95	23.3	0.6	1.1	-0.5	-2.8	39.4	1.1	1.4	-0.4	-2.1
100	22.4	0.5	1.1	-0.5	-3.1	37.9	1.0	1.4	-0.4	-2.4
105	21.6	0.5	1.1	-0.5	-3.4	36.5	1.0	1.4	-0.4	-2.8
110	20.8	0.5	1.1	-0.6	-3.6	35.2	0.9	1.4	-0.5	-3.2
115	20.1	0.5	1.1	-0.6	-3.9	34.0	0.9	1.4	-0.5	-3.5
120	19.5	0.5	1.1	-0.6	-4.2	32.9	0.9	1.4	-0.5	-3.9
Max Storage Volume =					**0.877**					**2.168**
Average Ponding Depth (mm)					**9.1**					**22.5**
Maximum Ponding Depth (mm)					**85.0**					**114.9**

Notes

1) Peak flow is equal to the product of 2.78 x C x I x A
2) Rainfall Intensity, $I = A/(Tc/60)^B$
3) Release Rate = LESSER of Min (Release Rate, Peak Flow) - Minus 100 Year Flow Of Uncontroled Areas OR Pipe Outlet Capacity
4) Storage Rate = Peak Flow - Release Rate
5) Storage = Duration x Storage Rate
6) Maximium Storage = Max Storage Over Duration

Table VI - Storage Volumes (5-Year and 100-Year Storm Events)

Storage Requirement for WS-10

C_{AVG} = 0.90 (5-year)
C_{AVG} = 1.00 (100-year)
Time Interval = 5 (mins)
Drainage Area = 0.017 (hectares)

Watts Adjustable Accutrol Weir Roof Drain
Number of Drains 1

	Release Rate = **1.18** (L/sec) Return Period = 5 (years) IDF Parameters, A = 998.071 , B = 0.814 $I = A/(T_c+C)B$, C = 6.053					Release Rate = **1.56** (L/sec) Return Period = 100 (years) IDF Parameters, A = 1735.688 , B = 0.820 $I = A/(Tc+C)B$, C = 6.014				
Duration (min)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)
0	-	-	-	-	-	-	-	-	-	-
5	141.2	6.1	1.2	4.9	1.5	242.7	11.7	1.6	10.1	3.0
10	104.2	4.5	1.2	3.3	2.0	178.6	8.6	1.6	7.0	4.2
15	83.6	3.6	1.2	2.4	2.2	142.9	6.9	1.6	5.3	4.8
20	70.3	3.0	1.2	1.9	2.2	120.0	5.8	1.6	4.2	5.1
25	60.9	2.6	1.2	1.5	2.2	103.8	5.0	1.6	3.4	5.2
30	53.9	2.3	1.2	1.2	2.1	91.9	4.4	1.6	2.9	5.1
35	48.5	2.1	1.2	0.9	1.9	82.6	4.0	1.6	2.4	5.1
40	44.2	1.9	1.2	0.7	1.8	75.1	3.6	1.6	2.1	4.9
45	40.6	1.8	1.2	0.6	1.6	69.1	3.3	1.6	1.8	4.8
50	37.7	1.6	1.2	0.4	1.3	64.0	3.1	1.6	1.5	4.5
55	35.1	1.5	1.2	0.3	1.1	59.6	2.9	1.6	1.3	4.3
60	32.9	1.4	1.2	0.2	0.9	55.9	2.7	1.6	1.1	4.1
65	31.0	1.3	1.2	0.2	0.6	52.6	2.5	1.6	1.0	3.8
70	29.4	1.3	1.2	0.1	0.4	49.8	2.4	1.6	0.8	3.5
75	27.9	1.2	1.2	0.0	0.1	47.3	2.3	1.6	0.7	3.2
80	26.6	1.2	1.2	0.0	-0.2	45.0	2.2	1.6	0.6	2.9
85	25.4	1.1	1.2	-0.1	-0.4	43.0	2.1	1.6	0.5	2.6
90	24.3	1.1	1.2	-0.1	-0.7	41.1	2.0	1.6	0.4	2.2
95	23.3	1.0	1.2	-0.2	-1.0	39.4	1.9	1.6	0.3	1.9
100	22.4	1.0	1.2	-0.2	-1.3	37.9	1.8	1.6	0.3	1.6
105	21.6	0.9	1.2	-0.2	-1.6	36.5	1.8	1.6	0.2	1.2
110	20.8	0.9	1.2	-0.3	-1.9	35.2	1.7	1.6	0.1	0.9
115	20.1	0.9	1.2	-0.3	-2.2	34.0	1.6	1.6	0.1	0.5
120	19.5	0.8	1.2	-0.3	-2.4	32.9	1.6	1.6	0.0	0.1
Max Storage Volume =					**2.234**					**5.157**
Average Ponding Depth (mm)					**12.9**					**29.8**
Ponding Depth (mm)					**95.5**					**126.2**

Notes

1) Peak flow is equal to the product of 2.78 x C x I x A
2) Rainfall Intensity, $I = A/(Tc/60)^B$
3) Release Rate = LESSER of Min (Release Rate, Peak Flow) - Minus 100 Year Flow Of Uncontroled Areas OR Pipe Outlet Capacity
4) Storage Rate = Peak Flow - Release Rate
5) Storage = Duration x Storage Rate
6) Maximium Storage = Max Storage Over Duration

Table VII - Storage Volumes (5-Year and 100-Year Storm Events)

Storage Requirement for WS-11

C_{AVG} = 0.90 (5-year)
C_{AVG} = 1.00 (100-year)
Time Interval = 5 (mins)
Drainage Area = 0.020 (hectares)

Watts Adjustable Accutrol Weir Roof Drain
Number of Drains 1

	Release Rate = **1.21** (L/sec) Return Period = 5 (years) IDF Parameters, A = 998.071 , B = 0.814 $I = A/(T_c+C)B$, C = 6.053					Release Rate = **1.59** (L/sec) Return Period = 100 (years) IDF Parameters, A = 1735.688 , B = 0.820 $I = A/(Tc+C)B$, C = 6.014				
Duration (min)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)
0	-	-	-	-	-	-	-	-	-	-
5	141.2	6.9	1.2	5.7	1.7	242.7	13.2	1.6	11.6	3.5
10	104.2	5.1	1.2	3.9	2.3	178.6	9.7	1.6	8.1	4.9
15	83.6	4.1	1.2	2.9	2.6	142.9	7.8	1.6	6.2	5.6
20	70.3	3.4	1.2	2.2	2.7	120.0	6.5	1.6	4.9	5.9
25	60.9	3.0	1.2	1.8	2.7	103.8	5.7	1.6	4.1	6.1
30	53.9	2.6	1.2	1.4	2.6	91.9	5.0	1.6	3.4	6.1
35	48.5	2.4	1.2	1.2	2.5	82.6	4.5	1.6	2.9	6.1
40	44.2	2.2	1.2	1.0	2.3	75.1	4.1	1.6	2.5	6.0
45	40.6	2.0	1.2	0.8	2.1	69.1	3.8	1.6	2.2	5.9
50	37.7	1.8	1.2	0.6	1.9	64.0	3.5	1.6	1.9	5.7
55	35.1	1.7	1.2	0.5	1.7	59.6	3.2	1.6	1.7	5.5
60	32.9	1.6	1.2	0.4	1.5	55.9	3.0	1.6	1.5	5.2
65	31.0	1.5	1.2	0.3	1.2	52.6	2.9	1.6	1.3	5.0
70	29.4	1.4	1.2	0.2	1.0	49.8	2.7	1.6	1.1	4.7
75	27.9	1.4	1.2	0.2	0.7	47.3	2.6	1.6	1.0	4.4
80	26.6	1.3	1.2	0.1	0.5	45.0	2.5	1.6	0.9	4.1
85	25.4	1.2	1.2	0.0	0.2	43.0	2.3	1.6	0.7	3.8
90	24.3	1.2	1.2	0.0	-0.1	41.1	2.2	1.6	0.6	3.5
95	23.3	1.1	1.2	-0.1	-0.4	39.4	2.1	1.6	0.6	3.2
100	22.4	1.1	1.2	-0.1	-0.7	37.9	2.1	1.6	0.5	2.8
105	21.6	1.1	1.2	-0.1	-0.9	36.5	2.0	1.6	0.4	2.5
110	20.8	1.0	1.2	-0.2	-1.2	35.2	1.9	1.6	0.3	2.2
115	20.1	1.0	1.2	-0.2	-1.5	34.0	1.9	1.6	0.3	1.8
120	19.5	1.0	1.2	-0.3	-1.8	32.9	1.8	1.6	0.2	1.4
Max Storage Volume =					**2.685**					**6.146**
Average Ponding Depth (mm)					**13.7**					**31.4**
Ponding Depth (mm)					**97.4**					**128.4**

Notes

1) Peak flow is equal to the product of 2.78 x C x I x A
2) Rainfall Intensity, $I = A/(Tc/60)^B$
3) Release Rate = LESSER of Min (Release Rate, Peak Flow) - Minus 100 Year Flow Of Uncontroled Areas OR Pipe Outlet Capacity
4) Storage Rate = Peak Flow - Release Rate
5) Storage = Duration x Storage Rate
6) Maximium Storage = Max Storage Over Duration

Table VIII - Storage Volumes (5-Year and 100-Year Storm Events)

Storage Requirement for WS-12

C_{AVG} = 0.90 (5-year)
C_{AVG} = 1.00 (100-year)
Time Interval = 5 (mins)
Drainage Area = 0.014 (hectares)

Watts Adjustable Accutrol Weir Roof Drain
Number of Drains 1

	Release Rate = **1.15** (L/sec) Return Period = 5 (years) IDF Parameters, A = 998.071 , B = 0.814 $I = A/(T_c+C)B$, C = 6.053					Release Rate = **1.52** (L/sec) Return Period = 100 (years) IDF Parameters, A = 1735.688 , B = 0.820 $I = A/(Tc+C)B$, C = 6.014				
Duration (min)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)
0	-	-	-	-	-	-	-	-	-	-
5	141.2	5.1	1.1	3.9	1.2	242.7	9.7	1.5	8.2	2.5
10	104.2	3.8	1.1	2.6	1.6	178.6	7.2	1.5	5.6	3.4
15	83.6	3.0	1.1	1.9	1.7	142.9	5.7	1.5	4.2	3.8
20	70.3	2.5	1.1	1.4	1.7	120.0	4.8	1.5	3.3	3.9
25	60.9	2.2	1.1	1.1	1.6	103.8	4.2	1.5	2.6	4.0
30	53.9	1.9	1.1	0.8	1.4	91.9	3.7	1.5	2.2	3.9
35	48.5	1.8	1.1	0.6	1.3	82.6	3.3	1.5	1.8	3.8
40	44.2	1.6	1.1	0.4	1.1	75.1	3.0	1.5	1.5	3.6
45	40.6	1.5	1.1	0.3	0.9	69.1	2.8	1.5	1.2	3.4
50	37.7	1.4	1.1	0.2	0.6	64.0	2.6	1.5	1.0	3.1
55	35.1	1.3	1.1	0.1	0.4	59.6	2.4	1.5	0.9	2.9
60	32.9	1.2	1.1	0.0	0.2	55.9	2.2	1.5	0.7	2.6
65	31.0	1.1	1.1	0.0	-0.1	52.6	2.1	1.5	0.6	2.3
70	29.4	1.1	1.1	-0.1	-0.4	49.8	2.0	1.5	0.5	2.0
75	27.9	1.0	1.1	-0.1	-0.6	47.3	1.9	1.5	0.4	1.7
80	26.6	1.0	1.1	-0.2	-0.9	45.0	1.8	1.5	0.3	1.3
85	25.4	0.9	1.1	-0.2	-1.2	43.0	1.7	1.5	0.2	1.0
90	24.3	0.9	1.1	-0.3	-1.5	41.1	1.6	1.5	0.1	0.7
95	23.3	0.8	1.1	-0.3	-1.7	39.4	1.6	1.5	0.1	0.3
100	22.4	0.8	1.1	-0.3	-2.0	37.9	1.5	1.5	0.0	0.0
105	21.6	0.8	1.1	-0.4	-2.3	36.5	1.5	1.5	-0.1	-0.4
110	20.8	0.8	1.1	-0.4	-2.6	35.2	1.4	1.5	-0.1	-0.7
115	20.1	0.7	1.1	-0.4	-2.9	34.0	1.4	1.5	-0.2	-1.1
120	19.5	0.7	1.1	-0.4	-3.2	32.9	1.3	1.5	-0.2	-1.5
Max Storage Volume =					**1.683**					**3.961**
Average Ponding Depth (mm)					**11.7**					**27.5**
Ponding Depth (mm)					**92.4**					**122.8**

Notes

1) Peak flow is equal to the product of 2.78 x C x I x A
2) Rainfall Intensity, $I = A/(Tc/60)^B$
3) Release Rate = LESSER of Min (Release Rate, Peak Flow) - Minus 100 Year Flow Of Uncontroled Areas OR Pipe Outlet Capacity
4) Storage Rate = Peak Flow - Release Rate
5) Storage = Duration x Storage Rate
6) Maximium Storage = Max Storage Over Duration

Table IX - Storage Volumes (5-Year and 100-Year Storm Events)

Storage Requirement for WS-13

C_{AVG} = 0.90 (5-year)
C_{AVG} = 1.00 (100-year)
Time Interval = 5 (mins)
Drainage Area = 0.006 (hectares)

Watts Adjustable Accutrol Weir Roof Drain
Number of Drains 1

	Release Rate = **0.95** (L/sec) Return Period = 5 (years) IDF Parameters, A = 998.071 , B = 0.814 $I = A/(T_c+C)B$, C = 6.053					Release Rate = **1.31** (L/sec) Return Period = 100 (years) IDF Parameters, A = 1735.688 , B = 0.820 $I = A/(Tc+C)B$, C = 6.014				
Duration (min)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)
0	-	-	-	-	-	-	-	-	-	-
5	141.2	2.3	1.0	1.3	0.4	242.7	4.3	1.3	3.0	0.9
10	104.2	1.7	1.0	0.7	0.4	178.6	3.2	1.3	1.9	1.1
15	83.6	1.3	1.0	0.4	0.3	142.9	2.5	1.3	1.2	1.1
20	70.3	1.1	1.0	0.2	0.2	120.0	2.1	1.3	0.8	1.0
25	60.9	1.0	1.0	0.0	0.0	103.8	1.8	1.3	0.5	0.8
30	53.9	0.9	1.0	-0.1	-0.2	91.9	1.6	1.3	0.3	0.6
35	48.5	0.8	1.0	-0.2	-0.4	82.6	1.5	1.3	0.2	0.3
40	44.2	0.7	1.0	-0.2	-0.6	75.1	1.3	1.3	0.0	0.1
45	40.6	0.6	1.0	-0.3	-0.8	69.1	1.2	1.3	-0.1	-0.2
50	37.7	0.6	1.0	-0.4	-1.1	64.0	1.1	1.3	-0.2	-0.5
55	35.1	0.6	1.0	-0.4	-1.3	59.6	1.1	1.3	-0.3	-0.8
60	32.9	0.5	1.0	-0.4	-1.5	55.9	1.0	1.3	-0.3	-1.1
65	31.0	0.5	1.0	-0.5	-1.8	52.6	0.9	1.3	-0.4	-1.5
70	29.4	0.5	1.0	-0.5	-2.0	49.8	0.9	1.3	-0.4	-1.8
75	27.9	0.4	1.0	-0.5	-2.3	47.3	0.8	1.3	-0.5	-2.1
80	26.6	0.4	1.0	-0.5	-2.5	45.0	0.8	1.3	-0.5	-2.5
85	25.4	0.4	1.0	-0.5	-2.8	43.0	0.8	1.3	-0.5	-2.8
90	24.3	0.4	1.0	-0.6	-3.0	41.1	0.7	1.3	-0.6	-3.1
95	23.3	0.4	1.0	-0.6	-3.3	39.4	0.7	1.3	-0.6	-3.5
100	22.4	0.4	1.0	-0.6	-3.6	37.9	0.7	1.3	-0.6	-3.8
105	21.6	0.3	1.0	-0.6	-3.8	36.5	0.6	1.3	-0.7	-4.2
110	20.8	0.3	1.0	-0.6	-4.1	35.2	0.6	1.3	-0.7	-4.5
115	20.1	0.3	1.0	-0.6	-4.3	34.0	0.6	1.3	-0.7	-4.9
120	19.5	0.3	1.0	-0.6	-4.6	32.9	0.6	1.3	-0.7	-5.2
Max Storage Volume =					**0.428**					**1.116**
Average Ponding Depth (mm)					**6.7**					**17.5**
Ponding Depth (mm)					**76.8**					**105.7**

Notes

1) Peak flow is equal to the product of 2.78 x C x I x A
2) Rainfall Intensity, $I = A/(Tc/60)^B$
3) Release Rate = LESSER of Min (Release Rate, Peak Flow) - Minus 100 Year Flow Of Uncontroled Areas OR Pipe Outlet Capacity
4) Storage Rate = Peak Flow - Release Rate
5) Storage = Duration x Storage Rate
6) Maximium Storage = Max Storage Over Duration

Table X - Storage Volumes (5-Year and 100-Year Storm Events)

Storage Requirement for WS-14

C_{AVG} = 0.90 (5-year)
C_{AVG} = 1.00 (100-year)
Time Interval = 5 (mins)
Drainage Area = 0.028 (hectares)

Watts Adjustable Accutrol Weir Roof Drain
Number of Drains 1

	Release Rate = **1.27** (L/sec) Return Period = 5 (years) IDF Parameters, A = 998.071 , B = 0.814 $I = A/(T_c+C)B$, C = 6.053					Release Rate = **1.66** (L/sec) Return Period = 100 (years) IDF Parameters, A = 1735.688 , B = 0.820 $I = A/(Tc+C)B$, C = 6.014				
Duration (min)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)
0	-	-	-	-	-	-	-	-	-	-
5	141.2	9.7	1.3	8.5	2.5	242.7	18.6	1.7	16.9	5.1
10	104.2	7.2	1.3	5.9	3.5	178.6	13.7	1.7	12.0	7.2
15	83.6	5.8	1.3	4.5	4.0	142.9	10.9	1.7	9.3	8.4
20	70.3	4.8	1.3	3.6	4.3	120.0	9.2	1.7	7.5	9.0
25	60.9	4.2	1.3	2.9	4.4	103.8	8.0	1.7	6.3	9.4
30	53.9	3.7	1.3	2.4	4.4	91.9	7.0	1.7	5.4	9.7
35	48.5	3.3	1.3	2.1	4.4	82.6	6.3	1.7	4.7	9.8
40	44.2	3.0	1.3	1.8	4.3	75.1	5.8	1.7	4.1	9.8
45	40.6	2.8	1.3	1.5	4.1	69.1	5.3	1.7	3.6	9.8
50	37.7	2.6	1.3	1.3	4.0	64.0	4.9	1.7	3.2	9.7
55	35.1	2.4	1.3	1.1	3.8	59.6	4.6	1.7	2.9	9.6
60	32.9	2.3	1.3	1.0	3.6	55.9	4.3	1.7	2.6	9.4
65	31.0	2.1	1.3	0.9	3.4	52.6	4.0	1.7	2.4	9.2
70	29.4	2.0	1.3	0.8	3.2	49.8	3.8	1.7	2.2	9.0
75	27.9	1.9	1.3	0.7	2.9	47.3	3.6	1.7	2.0	8.8
80	26.6	1.8	1.3	0.6	2.7	45.0	3.4	1.7	1.8	8.6
85	25.4	1.7	1.3	0.5	2.4	43.0	3.3	1.7	1.6	8.3
90	24.3	1.7	1.3	0.4	2.2	41.1	3.1	1.7	1.5	8.0
95	23.3	1.6	1.3	0.3	1.9	39.4	3.0	1.7	1.4	7.7
100	22.4	1.5	1.3	0.3	1.6	37.9	2.9	1.7	1.2	7.4
105	21.6	1.5	1.3	0.2	1.4	36.5	2.8	1.7	1.1	7.1
110	20.8	1.4	1.3	0.2	1.1	35.2	2.7	1.7	1.0	6.8
115	20.1	1.4	1.3	0.1	0.8	34.0	2.6	1.7	0.9	6.5
120	19.5	1.3	1.3	0.1	0.5	32.9	2.5	1.7	0.9	6.2
Max Storage Volume =					**4.400**					**9.820**
Average Ponding Depth (mm)					**16.0**					**35.7**
Ponding Depth (mm)					**102.5**					**134.0**

Notes

1) Peak flow is equal to the product of 2.78 x C x I x A
2) Rainfall Intensity, $I = A/(Tc/60)^B$
3) Release Rate = LESSER of Min (Release Rate, Peak Flow) - Minus 100 Year Flow Of Uncontroled Areas OR Pipe Outlet Capacity
4) Storage Rate = Peak Flow - Release Rate
5) Storage = Duration x Storage Rate
6) Maximium Storage = Max Storage Over Duration

Table XI - Storage Volumes (5-Year and 100-Year Storm Events)

Storage Requirement for WS-15

C_{AVG} = 0.90 (5-year)
C_{AVG} = 1.00 (100-year)
Time Interval = 5 (mins)
Drainage Area = 0.025 (hectares)

Watts Adjustable Accutrol Weir Roof Drain
Number of Drains 1

	Release Rate = **1.25** (L/sec) Return Period = 5 (years) IDF Parameters, A = 998.071 , B = 0.814 $I = A/(T_c+C)B$, C = 6.053					Release Rate = **1.64** (L/sec) Return Period = 100 (years) IDF Parameters, A = 1735.688 , B = 0.820 $I = A/(Tc+C)B$, C = 6.014				
Duration (min)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)
0	-	-	-	-	-	-	-	-	-	-
5	141.2	8.7	1.3	7.4	2.2	242.7	16.5	1.6	14.9	4.5
10	104.2	6.4	1.3	5.1	3.1	178.6	12.2	1.6	10.5	6.3
15	83.6	5.1	1.3	3.9	3.5	142.9	9.7	1.6	8.1	7.3
20	70.3	4.3	1.3	3.1	3.7	120.0	8.2	1.6	6.5	7.8
25	60.9	3.7	1.3	2.5	3.7	103.8	7.1	1.6	5.4	8.2
30	53.9	3.3	1.3	2.1	3.7	91.9	6.3	1.6	4.6	8.3
35	48.5	3.0	1.3	1.7	3.6	82.6	5.6	1.6	4.0	8.4
40	44.2	2.7	1.3	1.5	3.5	75.1	5.1	1.6	3.5	8.4
45	40.6	2.5	1.3	1.2	3.3	69.1	4.7	1.6	3.1	8.3
50	37.7	2.3	1.3	1.1	3.2	64.0	4.4	1.6	2.7	8.2
55	35.1	2.2	1.3	0.9	3.0	59.6	4.1	1.6	2.4	8.0
60	32.9	2.0	1.3	0.8	2.8	55.9	3.8	1.6	2.2	7.8
65	31.0	1.9	1.3	0.7	2.5	52.6	3.6	1.6	1.9	7.6
70	29.4	1.8	1.3	0.6	2.3	49.8	3.4	1.6	1.8	7.4
75	27.9	1.7	1.3	0.5	2.1	47.3	3.2	1.6	1.6	7.1
80	26.6	1.6	1.3	0.4	1.8	45.0	3.1	1.6	1.4	6.8
85	25.4	1.6	1.3	0.3	1.6	43.0	2.9	1.6	1.3	6.6
90	24.3	1.5	1.3	0.2	1.3	41.1	2.8	1.6	1.2	6.3
95	23.3	1.4	1.3	0.2	1.0	39.4	2.7	1.6	1.0	6.0
100	22.4	1.4	1.3	0.1	0.7	37.9	2.6	1.6	0.9	5.7
105	21.6	1.3	1.3	0.1	0.5	36.5	2.5	1.6	0.8	5.3
110	20.8	1.3	1.3	0.0	0.2	35.2	2.4	1.6	0.8	5.0
115	20.1	1.2	1.3	0.0	-0.1	34.0	2.3	1.6	0.7	4.7
120	19.5	1.2	1.3	-0.1	-0.4	32.9	2.2	1.6	0.6	4.3
Max Storage Volume =					**3.725**					**8.373**
Average Ponding Depth (mm)					**15.2**					**34.2**
Ponding Depth (mm)					**100.9**					**132.1**

Notes

1) Peak flow is equal to the product of 2.78 x C x I x A
2) Rainfall Intensity, $I = A/(Tc/60)^B$
3) Release Rate = LESSER of Min (Release Rate, Peak Flow) - Minus 100 Year Flow Of Uncontroled Areas OR Pipe Outlet Capacity
4) Storage Rate = Peak Flow - Release Rate
5) Storage = Duration x Storage Rate
6) Maximium Storage = Max Storage Over Duration

Table XII - Storage Volumes (5-Year and 100-Year Storm Events)

Storage Requirement for WS-16

C_{AVG} = 0.90 (5-year)
C_{AVG} = 1.00 (100-year)
Time Interval = 5 (mins)
Drainage Area = 0.008 (hectares)

Watts Adjustable Accutrol Weir Roof Drain
Number of Drains 1

	Release Rate = **1.01** (L/sec) Return Period = 5 (years) IDF Parameters, A = 998.071 , B = 0.814 $I = A/(T_c+C)B$, C = 6.053					Release Rate = **1.01** (L/sec) Return Period = 100 (years) IDF Parameters, A = 1735.688 , B = 0.820 $I = A/(Tc+C)B$, C = 6.014				
Duration (min)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)
0	-	-	-	-	-	-	-	-	-	-
5	141.2	2.8	1.0	1.8	0.5	242.7	5.4	1.0	4.4	1.3
10	104.2	2.1	1.0	1.1	0.6	178.6	4.0	1.0	3.0	1.8
15	83.6	1.7	1.0	0.7	0.6	142.9	3.2	1.0	2.2	2.0
20	70.3	1.4	1.0	0.4	0.5	120.0	2.7	1.0	1.7	2.0
25	60.9	1.2	1.0	0.2	0.3	103.8	2.3	1.0	1.3	2.0
30	53.9	1.1	1.0	0.1	0.1	91.9	2.0	1.0	1.0	1.9
35	48.5	1.0	1.0	0.0	-0.1	82.6	1.8	1.0	0.8	1.7
40	44.2	0.9	1.0	-0.1	-0.3	75.1	1.7	1.0	0.7	1.6
45	40.6	0.8	1.0	-0.2	-0.5	69.1	1.5	1.0	0.5	1.4
50	37.7	0.8	1.0	-0.3	-0.8	64.0	1.4	1.0	0.4	1.2
55	35.1	0.7	1.0	-0.3	-1.0	59.6	1.3	1.0	0.3	1.0
60	32.9	0.7	1.0	-0.4	-1.3	55.9	1.2	1.0	0.2	0.8
65	31.0	0.6	1.0	-0.4	-1.5	52.6	1.2	1.0	0.2	0.6
70	29.4	0.6	1.0	-0.4	-1.8	49.8	1.1	1.0	0.1	0.4
75	27.9	0.6	1.0	-0.5	-2.0	47.3	1.1	1.0	0.0	0.2
80	26.6	0.5	1.0	-0.5	-2.3	45.0	1.0	1.0	0.0	0.0
85	25.4	0.5	1.0	-0.5	-2.6	43.0	1.0	1.0	-0.1	-0.3
90	24.3	0.5	1.0	-0.5	-2.8	41.1	0.9	1.0	-0.1	-0.5
95	23.3	0.5	1.0	-0.5	-3.1	39.4	0.9	1.0	-0.1	-0.8
100	22.4	0.4	1.0	-0.6	-3.4	37.9	0.8	1.0	-0.2	-1.0
105	21.6	0.4	1.0	-0.6	-3.7	36.5	0.8	1.0	-0.2	-1.3
110	20.8	0.4	1.0	-0.6	-3.9	35.2	0.8	1.0	-0.2	-1.5
115	20.1	0.4	1.0	-0.6	-4.2	34.0	0.8	1.0	-0.3	-1.8
120	19.5	0.4	1.0	-0.6	-4.5	32.9	0.7	1.0	-0.3	-2.0
Max Storage Volume =					**0.647**					**1.994**
Average Ponding Depth (mm)					**8.1**					**24.9**
Ponding Depth (mm)					**81.7**					**118.8**

Notes

1) Peak flow is equal to the product of 2.78 x C x I x A
2) Rainfall Intensity, $I = A/(Tc/60)^B$
3) Release Rate = LESSER of Min (Release Rate, Peak Flow) - Minus 100 Year Flow Of Uncontroled Areas OR Pipe Outlet Capacity
4) Storage Rate = Peak Flow - Release Rate
5) Storage = Duration x Storage Rate
6) Maximium Storage = Max Storage Over Duration

Table XIII - Storage Volumes (5-Year and 100-Year Storm Events)

Storage Requirement for WS-17

C_{AVG} = 0.90 (5-year)
C_{AVG} = 1.00 (100-year)
Time Interval = 5 (mins)
Drainage Area = 0.005 (hectares)

Watts Adjustable Accutrol Weir Roof Drain
Number of Drains 1

	Release Rate = **0.90** (L/sec) Return Period = 5 (years) IDF Parameters, A = 998.071 , B = 0.814 $I = A/(T_c+C)B$, C = 6.053					Release Rate = **1.27** (L/sec) Return Period = 100 (years) IDF Parameters, A = 1735.688 , B = 0.820 $I = A/(Tc+C)B$, C = 6.014				
Duration (min)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)
0	-	-	-	-	-	-	-	-	-	-
5	141.2	1.9	0.9	1.0	0.3	242.7	3.6	1.3	2.4	0.7
10	104.2	1.4	0.9	0.5	0.3	178.6	2.7	1.3	1.4	0.8
15	83.6	1.1	0.9	0.2	0.2	142.9	2.1	1.3	0.9	0.8
20	70.3	0.9	0.9	0.0	0.1	120.0	1.8	1.3	0.5	0.6
25	60.9	0.8	0.9	-0.1	-0.1	103.8	1.6	1.3	0.3	0.4
30	53.9	0.7	0.9	-0.2	-0.3	91.9	1.4	1.3	0.1	0.2
35	48.5	0.7	0.9	-0.2	-0.5	82.6	1.2	1.3	0.0	-0.1
40	44.2	0.6	0.9	-0.3	-0.7	75.1	1.1	1.3	-0.1	-0.3
45	40.6	0.5	0.9	-0.4	-0.9	69.1	1.0	1.3	-0.2	-0.6
50	37.7	0.5	0.9	-0.4	-1.2	64.0	1.0	1.3	-0.3	-0.9
55	35.1	0.5	0.9	-0.4	-1.4	59.6	0.9	1.3	-0.4	-1.2
60	32.9	0.4	0.9	-0.5	-1.6	55.9	0.8	1.3	-0.4	-1.5
65	31.0	0.4	0.9	-0.5	-1.9	52.6	0.8	1.3	-0.5	-1.9
70	29.4	0.4	0.9	-0.5	-2.1	49.8	0.7	1.3	-0.5	-2.2
75	27.9	0.4	0.9	-0.5	-2.4	47.3	0.7	1.3	-0.6	-2.5
80	26.6	0.4	0.9	-0.5	-2.6	45.0	0.7	1.3	-0.6	-2.8
85	25.4	0.3	0.9	-0.6	-2.8	43.0	0.6	1.3	-0.6	-3.2
90	24.3	0.3	0.9	-0.6	-3.1	41.1	0.6	1.3	-0.6	-3.5
95	23.3	0.3	0.9	-0.6	-3.3	39.4	0.6	1.3	-0.7	-3.8
100	22.4	0.3	0.9	-0.6	-3.6	37.9	0.6	1.3	-0.7	-4.2
105	21.6	0.3	0.9	-0.6	-3.8	36.5	0.5	1.3	-0.7	-4.5
110	20.8	0.3	0.9	-0.6	-4.1	35.2	0.5	1.3	-0.7	-4.9
115	20.1	0.3	0.9	-0.6	-4.3	34.0	0.5	1.3	-0.8	-5.2
120	19.5	0.3	0.9	-0.6	-4.6	32.9	0.5	1.3	-0.8	-5.6
Max Storage Volume =					**0.305**					**0.849**
Average Ponding Depth (mm)					**5.6**					**15.7**
Ponding Depth (mm)					**72.5**					**102.0**

Notes

1) Peak flow is equal to the product of 2.78 x C x I x A
2) Rainfall Intensity, $I = A/(Tc/60)^B$
3) Release Rate = LESSER of Min (Release Rate, Peak Flow) - Minus 100 Year Flow Of Uncontroled Areas OR Pipe Outlet Capacity
4) Storage Rate = Peak Flow - Release Rate
5) Storage = Duration x Storage Rate
6) Maximium Storage = Max Storage Over Duration

Table XIV - Storage Volumes (5-Year and 100-Year Storm Events)

Storage Requirement for WS-18

C_{AVG} = 0.90 (5-year)
C_{AVG} = 1.00 (100-year)
Time Interval = 5 (mins)
Drainage Area = 0.007 (hectares)

Watts Adjustable Accutrol Weir Roof Drain
Number of Drains 1

	Release Rate = **0.97** (L/sec) Return Period = 5 (years) IDF Parameters, A = 998.071 , B = 0.814 $I = A/(T_c+C)B$, C = 6.053					Release Rate = **1.33** (L/sec) Return Period = 100 (years) IDF Parameters, A = 1735.688 , B = 0.820 $I = A/(Tc+C)B$, C = 6.014				
Duration (min)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)
0	-	-	-	-	-	-	-	-	-	-
5	141.2	2.4	1.0	1.4	0.4	242.7	4.6	1.3	3.2	1.0
10	104.2	1.8	1.0	0.8	0.5	178.6	3.4	1.3	2.0	1.2
15	83.6	1.4	1.0	0.4	0.4	142.9	2.7	1.3	1.4	1.2
20	70.3	1.2	1.0	0.2	0.3	120.0	2.3	1.3	0.9	1.1
25	60.9	1.0	1.0	0.1	0.1	103.8	2.0	1.3	0.6	0.9
30	53.9	0.9	1.0	-0.1	-0.1	91.9	1.7	1.3	0.4	0.7
35	48.5	0.8	1.0	-0.1	-0.3	82.6	1.6	1.3	0.2	0.5
40	44.2	0.7	1.0	-0.2	-0.5	75.1	1.4	1.3	0.1	0.2
45	40.6	0.7	1.0	-0.3	-0.8	69.1	1.3	1.3	0.0	-0.1
50	37.7	0.6	1.0	-0.3	-1.0	64.0	1.2	1.3	-0.1	-0.4
55	35.1	0.6	1.0	-0.4	-1.2	59.6	1.1	1.3	-0.2	-0.7
60	32.9	0.6	1.0	-0.4	-1.5	55.9	1.1	1.3	-0.3	-1.0
65	31.0	0.5	1.0	-0.4	-1.7	52.6	1.0	1.3	-0.3	-1.3
70	29.4	0.5	1.0	-0.5	-2.0	49.8	0.9	1.3	-0.4	-1.6
75	27.9	0.5	1.0	-0.5	-2.2	47.3	0.9	1.3	-0.4	-2.0
80	26.6	0.4	1.0	-0.5	-2.5	45.0	0.8	1.3	-0.5	-2.3
85	25.4	0.4	1.0	-0.5	-2.7	43.0	0.8	1.3	-0.5	-2.6
90	24.3	0.4	1.0	-0.6	-3.0	41.1	0.8	1.3	-0.6	-3.0
95	23.3	0.4	1.0	-0.6	-3.3	39.4	0.7	1.3	-0.6	-3.3
100	22.4	0.4	1.0	-0.6	-3.5	37.9	0.7	1.3	-0.6	-3.7
105	21.6	0.4	1.0	-0.6	-3.8	36.5	0.7	1.3	-0.6	-4.0
110	20.8	0.4	1.0	-0.6	-4.1	35.2	0.7	1.3	-0.7	-4.4
115	20.1	0.3	1.0	-0.6	-4.3	34.0	0.6	1.3	-0.7	-4.7
120	19.5	0.3	1.0	-0.6	-4.6	32.9	0.6	1.3	-0.7	-5.1
Max Storage Volume =					**0.477**					**1.224**
Average Ponding Depth (mm)					**7.0**					**18.1**
Ponding Depth (mm)					**78.1**					**106.9**

Notes

1) Peak flow is equal to the product of 2.78 x C x I x A
2) Rainfall Intensity, $I = A/(Tc/60)^B$
3) Release Rate = LESSER of Min (Release Rate, Peak Flow) - Minus 100 Year Flow Of Uncontroled Areas OR Pipe Outlet Capacity
4) Storage Rate = Peak Flow - Release Rate
5) Storage = Duration x Storage Rate
6) Maximium Storage = Max Storage Over Duration

Table XV - Storage Volumes (5-Year and 100-Year Storm Events)

Storage Requirement for WS-19

C_{AVG} = 0.90 (5-year)
C_{AVG} = 1.00 (100-year)
Time Interval = 5 (mins)
Drainage Area = 0.005 (hectares)

Watts Adjustable Accutrol Weir Roof Drain
Number of Drains 1

	Release Rate = **0.87** (L/sec) Return Period = 5 (years) IDF Parameters, A = 998.071 , B = 0.814 $I = A/(T_c+C)B$, C = 6.053					Release Rate = **1.23** (L/sec) Return Period = 100 (years) IDF Parameters, A = 1735.688 , B = 0.820 $I = A/(Tc+C)B$, C = 6.014				
Duration (min)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)
0	-	-	-	-	-	-	-	-	-	-
5	141.2	1.7	0.9	0.8	0.2	242.7	3.2	1.2	2.0	0.6
10	104.2	1.3	0.9	0.4	0.2	178.6	2.4	1.2	1.2	0.7
15	83.6	1.0	0.9	0.1	0.1	142.9	1.9	1.2	0.7	0.6
20	70.3	0.8	0.9	0.0	0.0	120.0	1.6	1.2	0.4	0.4
25	60.9	0.7	0.9	-0.1	-0.2	103.8	1.4	1.2	0.2	0.2
30	53.9	0.6	0.9	-0.2	-0.4	91.9	1.2	1.2	0.0	0.0
35	48.5	0.6	0.9	-0.3	-0.6	82.6	1.1	1.2	-0.1	-0.3
40	44.2	0.5	0.9	-0.3	-0.8	75.1	1.0	1.2	-0.2	-0.5
45	40.6	0.5	0.9	-0.4	-1.0	69.1	0.9	1.2	-0.3	-0.8
50	37.7	0.5	0.9	-0.4	-1.3	64.0	0.9	1.2	-0.4	-1.1
55	35.1	0.4	0.9	-0.4	-1.5	59.6	0.8	1.2	-0.4	-1.4
60	32.9	0.4	0.9	-0.5	-1.7	55.9	0.7	1.2	-0.5	-1.7
65	31.0	0.4	0.9	-0.5	-1.9	52.6	0.7	1.2	-0.5	-2.1
70	29.4	0.4	0.9	-0.5	-2.2	49.8	0.7	1.2	-0.6	-2.4
75	27.9	0.3	0.9	-0.5	-2.4	47.3	0.6	1.2	-0.6	-2.7
80	26.6	0.3	0.9	-0.6	-2.7	45.0	0.6	1.2	-0.6	-3.0
85	25.4	0.3	0.9	-0.6	-2.9	43.0	0.6	1.2	-0.7	-3.3
90	24.3	0.3	0.9	-0.6	-3.1	41.1	0.5	1.2	-0.7	-3.7
95	23.3	0.3	0.9	-0.6	-3.4	39.4	0.5	1.2	-0.7	-4.0
100	22.4	0.3	0.9	-0.6	-3.6	37.9	0.5	1.2	-0.7	-4.3
105	21.6	0.3	0.9	-0.6	-3.9	36.5	0.5	1.2	-0.7	-4.7
110	20.8	0.3	0.9	-0.6	-4.1	35.2	0.5	1.2	-0.8	-5.0
115	20.1	0.2	0.9	-0.6	-4.3	34.0	0.5	1.2	-0.8	-5.3
120	19.5	0.2	0.9	-0.6	-4.6	32.9	0.4	1.2	-0.8	-5.7
Max Storage Volume =					**0.247**					**0.693**
Average Ponding Depth (mm)					**5.1**					**14.4**
Ponding Depth (mm)					**70.3**					**99.1**

Notes

1) Peak flow is equal to the product of 2.78 x C x I x A
2) Rainfall Intensity, $I = A/(Tc/60)^B$
3) Release Rate = LESSER of Min (Release Rate, Peak Flow) - Minus 100 Year Flow Of Uncontroled Areas OR Pipe Outlet Capacity
4) Storage Rate = Peak Flow - Release Rate
5) Storage = Duration x Storage Rate
6) Maximium Storage = Max Storage Over Duration

Table XVI - Storage Volumes (5-Year and 100-Year Storm Events)

Storage Requirement for WS-20

C_{AVG} = 0.90 (5-year)
C_{AVG} = 1.00 (100-year)
Time Interval = 5 (mins)
Drainage Area = 0.022 (hectares)

Watts Adjustable Accutrol Weir Roof Drain
Number of Drains 1

	Release Rate = **1.23** (L/sec) Return Period = 5 (years) IDF Parameters, A = 998.071 , B = 0.814 $I = A/(T_c+C)B$, C = 6.053					Release Rate = **1.62** (L/sec) Return Period = 100 (years) IDF Parameters, A = 1735.688 , B = 0.820 $I = A/(Tc+C)B$, C = 6.014				
Duration (min)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)
0	-	-	-	-	-	-	-	-	-	-
5	141.2	7.8	1.2	6.6	2.0	242.7	15.0	1.6	13.4	4.0
10	104.2	5.8	1.2	4.6	2.7	178.6	11.0	1.6	9.4	5.6
15	83.6	4.6	1.2	3.4	3.1	142.9	8.8	1.6	7.2	6.5
20	70.3	3.9	1.2	2.7	3.2	120.0	7.4	1.6	5.8	6.9
25	60.9	3.4	1.2	2.2	3.2	103.8	6.4	1.6	4.8	7.2
30	53.9	3.0	1.2	1.8	3.2	91.9	5.7	1.6	4.1	7.3
35	48.5	2.7	1.2	1.5	3.1	82.6	5.1	1.6	3.5	7.3
40	44.2	2.5	1.2	1.2	2.9	75.1	4.6	1.6	3.0	7.2
45	40.6	2.3	1.2	1.0	2.8	69.1	4.3	1.6	2.6	7.1
50	37.7	2.1	1.2	0.9	2.6	64.0	3.9	1.6	2.3	7.0
55	35.1	2.0	1.2	0.7	2.4	59.6	3.7	1.6	2.1	6.8
60	32.9	1.8	1.2	0.6	2.2	55.9	3.4	1.6	1.8	6.6
65	31.0	1.7	1.2	0.5	1.9	52.6	3.2	1.6	1.6	6.4
70	29.4	1.6	1.2	0.4	1.7	49.8	3.1	1.6	1.5	6.1
75	27.9	1.5	1.2	0.3	1.4	47.3	2.9	1.6	1.3	5.8
80	26.6	1.5	1.2	0.2	1.2	45.0	2.8	1.6	1.2	5.6
85	25.4	1.4	1.2	0.2	0.9	43.0	2.7	1.6	1.0	5.3
90	24.3	1.3	1.2	0.1	0.6	41.1	2.5	1.6	0.9	5.0
95	23.3	1.3	1.2	0.1	0.4	39.4	2.4	1.6	0.8	4.7
100	22.4	1.2	1.2	0.0	0.1	37.9	2.3	1.6	0.7	4.3
105	21.6	1.2	1.2	0.0	-0.2	36.5	2.3	1.6	0.6	4.0
110	20.8	1.2	1.2	-0.1	-0.5	35.2	2.2	1.6	0.6	3.7
115	20.1	1.1	1.2	-0.1	-0.8	34.0	2.1	1.6	0.5	3.3
120	19.5	1.1	1.2	-0.2	-1.1	32.9	2.0	1.6	0.4	3.0
Max Storage Volume =					**3.226**					**7.305**
Average Ponding Depth (mm)					**14.5**					**32.9**
Ponding Depth (mm)					**99.4**					**130.5**

Notes

1) Peak flow is equal to the product of 2.78 x C x I x A
2) Rainfall Intensity, $I = A/(Tc/60)^B$
3) Release Rate = LESSER of Min (Release Rate, Peak Flow) - Minus 100 Year Flow Of Uncontroled Areas OR Pipe Outlet Capacity
4) Storage Rate = Peak Flow - Release Rate
5) Storage = Duration x Storage Rate
6) Maximium Storage = Max Storage Over Duration

Table XVII - Storage Volumes (5-Year and 100-Year Storm Events)

Storage Requirement for WS-21

C_{AVG} = 0.90 (5-year)
C_{AVG} = 1.00 (100-year)
Time Interval = 5 (mins)
Drainage Area = 0.013 (hectares)

Watts Adjustable Accutrol Weir Roof Drain
Number of Drains 1

	Release Rate = **1.12** (L/sec) Return Period = 5 (years) IDF Parameters, A = 998.071 , B = 0.814 $I = A/(T_c+C)B$, C = 6.053					Release Rate = **1.49** (L/sec) Return Period = 100 (years) IDF Parameters, A = 1735.688 , B = 0.820 $I = A/(Tc+C)B$, C = 6.014				
Duration (min)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)
0	-	-	-	-	-	-	-	-	-	-
5	141.2	4.5	1.1	3.4	1.0	242.7	8.5	1.5	7.1	2.1
10	104.2	3.3	1.1	2.2	1.3	178.6	6.3	1.5	4.8	2.9
15	83.6	2.6	1.1	1.5	1.4	142.9	5.0	1.5	3.5	3.2
20	70.3	2.2	1.1	1.1	1.3	120.0	4.2	1.5	2.7	3.3
25	60.9	1.9	1.1	0.8	1.2	103.8	3.7	1.5	2.2	3.2
30	53.9	1.7	1.1	0.6	1.1	91.9	3.2	1.5	1.7	3.1
35	48.5	1.5	1.1	0.4	0.9	82.6	2.9	1.5	1.4	3.0
40	44.2	1.4	1.1	0.3	0.7	75.1	2.6	1.5	1.2	2.8
45	40.6	1.3	1.1	0.2	0.5	69.1	2.4	1.5	0.9	2.5
50	37.7	1.2	1.1	0.1	0.2	64.0	2.3	1.5	0.8	2.3
55	35.1	1.1	1.1	0.0	0.0	59.6	2.1	1.5	0.6	2.0
60	32.9	1.0	1.1	-0.1	-0.3	55.9	2.0	1.5	0.5	1.7
65	31.0	1.0	1.1	-0.1	-0.5	52.6	1.9	1.5	0.4	1.4
70	29.4	0.9	1.1	-0.2	-0.8	49.8	1.8	1.5	0.3	1.1
75	27.9	0.9	1.1	-0.2	-1.1	47.3	1.7	1.5	0.2	0.8
80	26.6	0.8	1.1	-0.3	-1.3	45.0	1.6	1.5	0.1	0.4
85	25.4	0.8	1.1	-0.3	-1.6	43.0	1.5	1.5	0.0	0.1
90	24.3	0.8	1.1	-0.3	-1.9	41.1	1.4	1.5	0.0	-0.2
95	23.3	0.7	1.1	-0.4	-2.2	39.4	1.4	1.5	-0.1	-0.6
100	22.4	0.7	1.1	-0.4	-2.5	37.9	1.3	1.5	-0.2	-1.0
105	21.6	0.7	1.1	-0.4	-2.7	36.5	1.3	1.5	-0.2	-1.3
110	20.8	0.7	1.1	-0.5	-3.0	35.2	1.2	1.5	-0.3	-1.7
115	20.1	0.6	1.1	-0.5	-3.3	34.0	1.2	1.5	-0.3	-2.0
120	19.5	0.6	1.1	-0.5	-3.6	32.9	1.2	1.5	-0.3	-2.4
Max Storage Volume =					**1.377**					**3.277**
Average Ponding Depth (mm)					**10.9**					**25.9**
Ponding Depth (mm)					**90.2**					**120.4**

Notes

1) Peak flow is equal to the product of 2.78 x C x I x A
2) Rainfall Intensity, $I = A/(Tc/60)^B$
3) Release Rate = LESSER of Min (Release Rate, Peak Flow) - Minus 100 Year Flow Of Uncontroled Areas OR Pipe Outlet Capacity
4) Storage Rate = Peak Flow - Release Rate
5) Storage = Duration x Storage Rate
6) Maximium Storage = Max Storage Over Duration

Table XVIII - Storage Volumes (5-Year and 100-Year Storm Events)

Storage Requirement for Oversized Pipe

C_{AVG} = 0.90 (5-year)
C_{AVG} = 1.00 (100-year)
Time Interval = 5 (mins)
Drainage Area = 0.042 (hectares)

	Release Rate = **4.0** (L/sec)					Release Rate = **7.3** (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				
	$I = A/(T_c+C)B$, C = 6.053					$I = A/(Tc+C)B$, C = 6.014				
Duration (min)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)	Rainfall Intensity, I (mm/hr)	Peak Flow (L/sec)	Release Rate (L/sec)	Storage Rate (L/sec)	Storage (m^3)
0	-	-	-	-	-	-	-	-	-	-
5	141.2	14.7	4.0	10.7	3.2	242.7	28.1	7.3	20.8	6.2
10	104.2	10.8	4.0	6.8	4.1	178.6	20.6	7.3	13.3	8.0
15	83.6	8.7	4.0	4.7	4.2	142.9	16.5	7.3	9.2	8.3
20	70.3	7.3	4.0	3.3	4.0	120.0	13.9	7.3	6.6	7.9
25	60.9	6.3	4.0	2.3	3.5	103.8	12.0	7.3	4.7	7.1
30	53.9	5.6	4.0	1.6	2.9	91.9	10.6	7.3	3.3	6.0
35	48.5	5.0	4.0	1.0	2.2	82.6	9.5	7.3	2.2	4.7
40	44.2	4.6	4.0	0.6	1.4	75.1	8.7	7.3	1.4	3.3
45	40.6	4.2	4.0	0.2	0.6	69.1	8.0	7.3	0.7	1.8
50	37.7	3.9	4.0	-0.1	-0.2	64.0	7.4	7.3	0.1	0.3
55	35.1	3.7	4.0	-0.3	-1.1	59.6	6.9	7.3	-0.4	-1.3
60	32.9	3.4	4.0	-0.6	-2.1	55.9	6.5	7.3	-0.8	-3.0
65	31.0	3.2	4.0	-0.8	-3.0	52.6	6.1	7.3	-1.2	-4.7
70	29.4	3.1	4.0	-0.9	-4.0	49.8	5.8	7.3	-1.5	-6.5
75	27.9	2.9	4.0	-1.1	-4.9	47.3	5.5	7.3	-1.8	-8.3
80	26.6	2.8	4.0	-1.2	-5.9	45.0	5.2	7.3	-2.1	-10.1
85	25.4	2.6	4.0	-1.4	-6.9	43.0	5.0	7.3	-2.3	-11.9
90	24.3	2.5	4.0	-1.5	-8.0	41.1	4.8	7.3	-2.5	-13.8
95	23.3	2.4	4.0	-1.6	-9.0	39.4	4.6	7.3	-2.7	-15.6
100	22.4	2.3	4.0	-1.7	-10.0	37.9	4.4	7.3	-2.9	-17.5
105	21.6	2.2	4.0	-1.8	-11.1	36.5	4.2	7.3	-3.1	-19.4
110	20.8	2.2	4.0	-1.8	-12.1	35.2	4.1	7.3	-3.2	-21.3
115	20.1	2.1	4.0	-1.9	-13.2	34.0	3.9	7.3	-3.4	-23.2
120	19.5	2.0	4.0	-2.0	-14.2	32.9	3.8	7.3	-3.5	-25.2
125	18.9	2.0	4.0	-2.0	-15.3	31.9	3.7	7.3	-3.6	-27.1
130	18.3	1.9	4.0	-2.1	-16.4	30.9	3.6	7.3	-3.7	-29.1
135	17.8	1.8	4.0	-2.2	-17.4	30.0	3.5	7.3	-3.8	-31.0
140	17.3	1.8	4.0	-2.2	-18.5	29.2	3.4	7.3	-3.9	-33.0
145	16.8	1.7	4.0	-2.3	-19.6	28.4	3.3	7.3	-4.0	-35.0
150	16.4	1.7	4.0	-2.3	-20.7	27.6	3.2	7.3	-4.1	-37.0
155	15.9	1.7	4.0	-2.3	-21.8	26.9	3.1	7.3	-4.2	-39.0
160	15.6	1.6	4.0	-2.4	-22.9	26.2	3.0	7.3	-4.3	-41.0
165	15.2	1.6	4.0	-2.4	-24.0	25.6	3.0	7.3	-4.3	-43.0
170	14.8	1.5	4.0	-2.5	-25.1	25.0	2.9	7.3	-4.4	-45.0
175	14.5	1.5	4.0	-2.5	-26.2	24.4	2.8	7.3	-4.5	-47.0
180	14.2	1.5	4.0	-2.5	-27.3	23.9	2.8	7.3	-4.5	-49.0
185	13.9	1.4	4.0	-2.6	-28.4	23.4	2.7	7.3	-4.6	-51.0
190	13.6	1.4	4.0	-2.6	-29.5	22.9	2.6	7.3	-4.7	-53.0
195	13.3	1.4	4.0	-2.6	-30.6	22.4	2.6	7.3	-4.7	-55.1
200	13.0	1.4	4.0	-2.6	-31.7	22.0	2.5	7.3	-4.8	-57.1
205	12.8	1.3	4.0	-2.7	-32.8	21.6	2.5	7.3	-4.8	-59.1
210	12.6	1.3	4.0	-2.7	-33.9	21.1	2.4	7.3	-4.9	-61.2
215	12.3	1.3	4.0	-2.7	-35.1	20.8	2.4	7.3	-4.9	-63.2
220	12.1	1.3	4.0	-2.7	-36.2	20.4	2.4	7.3	-4.9	-65.3
Max Storage Volume =					**4.2**					**8.3**

Notes

1) Peak flow is equal to the product of 2.78 x C x I x A
2) Rainfall Intensity, $I = A/(Tc/60)^b$
3) Release Rate = Existing 5 year Peak Flow Rate
4) Storage Rate = Peak Flow - Release Rate

STORM SEWER COMPUTATION FORM

Rational Method

Q = 2.78*A*I*R

Q = Flow (L/sec)
A = Area (ha)
I = Rainfall Intensity (mm/h)
R = Ave. Runoff Coefficient

Ottawa IDF Curve - 5-y (MacDonald Cartier Airport)

$I_5 = 998.071 / (Tc + 6.053)^{0.814}$

Minimum Time of Conc. Tc = **10 min**

Manning's n = **0.013**

Ottawa IDF Curve - 100-y (MacDonald Cartier Airport)

$I_{100} = 1735.688 / (Tc + 6.014)^{0..820}$

Minimum Time of Conc. Tc = **10 min**

Drainage Area	From	To	Area (ha)	Runoff Parameters: Runoff Coeff. R	Indiv. 2.78AR	Accum. 2.78AR	Time of Conc. (min)	Rainfall Intensity (mm/hr)	Roof Flow* Q (L/sec)	Peak Flow Q (L/sec)	Pipe Dia. nom. (mm)	Pipe Dia. actual (mm)	Slope (%)	Length (m)	Capacity full (L/sec)	Velocity full (m/sec)	Velocity actual (m/sec)	Time of Flow (min)	Q(d) / Q(f)	Volume (m3)
Total Roof (Controlled and Uncontrolled)	Bldg	Stm Sewer in Churchill Avenue (375mm diameter)	0.179							18.66	200	201.16	2.00	9.0	46.38	1.48	1.18	0.10	0.40	
Back Courtyard Oversized Pipe (WS-02 and WS-04) - 5 year storm	STMH-01	STMH-02	0.044	0.86	0.11	0.11	10.00	104.19		10.97	600	594.00	0.15	32.5	237.81	0.84	0.42	0.64	0.05	9.19
Back Courtyard Oversized Pipe (WS-02 and WS-04) - 100 year storm	STMH-01	STMH-02	0.044	1.00	0.12	0.12	10.00	178.56		21.78	600	594.00	0.15	32.5	237.81	0.84	0.47	0.64	0.09	
	STMH-02	Stm Sewer in Winona Avenue (450mm diameter)								7.34	250	251.46	0.50	14.8	42.05	0.86	0.56	0.29	0.17	

* This pipe is oversized to provide storage to maintain the maximum allowable release rate of 7.3 L/s using an ICD in STMH-02
A minimum of 8.3 m3 is required, a total of 9.2 m3 is provided in the oversized pipe.

Design: S.Sterling
Check: M. MacSween
Date: ########

Project: 327 Richmond Road, Ottawa, ON

Client: Richmond Churchill Limited Partnership