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April 1, 2021

1.0 INTRODUCTION

Stantec Consulting Ltd. has been commissioned by 1702599 Ontario Inc. to prepare a servicing study in support of Site Plan Control submission of the proposed development located at 6102 Renaud Rd, Orléans within the City of Ottawa (City). The site is bounded to the north, east and south by Renaud Road, Saddleridge Drive and Rolling Meadow Crescent, respectively (see Location Plan below in **Figure 1**). Four site entrances are proposed: one off Saddleridge Drive that loops north and onto Renaud Road, and two additional accesses off Saddleridge Drive that are looped internally.

The 0.574ha area is currently zoned Development Reserve (DR). A zoning change is required to allow for the high-density residential units consistent with back-to-back stacked and row townhouses. The intent of this report is to provide a servicing scenario for the site that is free of conflicts, provides on-site servicing in accordance with City of Ottawa design guidelines, and utilizes the existing local infrastructure in accordance with the guidelines outlined per consultation with City of Ottawa staff.

Figure 1: Location Plan

2.0 BACKGROUND

Documents referenced in preparation of the design for the 6102 Renaud Rd, Orléans development include:

- Phase One Environmental Site Assessment, 6102 Renaud Road, Ottawa, Ontario. exp. Services Inc., September 18, 2017.
- Phase Two Environmental Site Assessment, 6102 Renaud Road, Ottawa, Ontario. exp. Services Inc., September 1, 2017.
- Storm and Sanitary Sewer Design Sheets and Drawings (EUC Phase 1), IBI Group, December 2008.
- City of Ottawa Sewer Design Guidelines, City of Ottawa, October 2012.
- City of Ottawa Design Guidelines – Water Distribution, City of Ottawa, July 2010.
- *Technical Bulletin ISDTB-2014-01,* City of Ottawa, February 2014
- *Technical Bulletin PIEDTB -2016-01,* City of Ottawa, September 6, 2016

3.0 WATER SUPPLY SERVICING

3.1 BACKGROUND

The proposed development will be composed of a combination of stacked townhomes and back-to-back row townhomes (2 to 3 bedrooms), complete with associated infrastructure and access areas. The site is located on the south of Renaud Rd. and East of Saddleridge Dr. within Orléans in the City of Ottawa. The site will be serviced via a proposed 200mm and 100mm diameter watermain, to be looped and connected to the existing watermains along Renaud Road (300mm diam.) and Saddleridge Drive (200mm diam.) The property is located within the City's Pressure Zone 2E. Average ground elevations of the site are approximately 76.2m. Under normal operating conditions, hydraulic grade-lines vary from approximately 130.8m to 110.7m, confirmed through boundary conditions provided by the City (see **Appendix A.3**).

3.2 WATER DEMAND

3.2.1 Domestic Water Demand

Water demands for the development were estimated using the Ministry of Environment's Design Guidelines for Drinking Water Systems (2008) and the Ottawa Design Guidelines – Water Distribution (2010). A consumption rate of 350 L/cap/day was used to estimate the domestic average daily rate. Population densities assumed 2.7 persons/ per townhome and 2.3 persons per /stacked back-to-back unit.

The average day demand (AVDY) for the entire site was determined to be 0.46 L/s. The maximum daily demand (MXDY) is 2.5 times the AVDY for residential areas and 1.5 times the AVDY for commercial areas, which sums to 1.14 L/s. The peak hour demand (PKHR) is 2.2 times the MXDY for residential areas and 1.8 times the MXDY for commercial areas, totaling 2.50 L/s.

3.2.2 Fire Flow Requirement

The water demand required to protect the buildings in case of a fire was determined using the Fire Underwriters Survey (FUS) method and in accordance with Section 7.2.11 of the Ontario Building Code. Wood frame construction was considered in the assessment. Per FUS Guidelines apartments and residential dwellings are considered as low hazard occupancies. The minimum required fire flow to protect the development is 283 L/s 17,000L/min.

3.3 PROPOSED WATER SERVICING

Per the City`s site boundary conditions and based on an approximate elevation of 77.1m, adequate domestic water flows are available with a pressure range of 71.0 to 76.4 psi; which complies with the City`s preferred pressure range of 50 to 80 psi. The determined maximum day demand plus fire flow of 17,000L/min gives a residual pressure of 47.8 psi; which complies with the City's (MXDY +FF) standard pressure range of 20 to 80 psi. As a result, the existing municipal watermains adjacent to the development are adequate to supply the development`s domestic and fire water needs.

3.4 SUMMARY

The proposed development is located in an area of the City's water distribution system that has sufficient capacity to provide both the required domestic and emergency fire flows. Based on boundary conditions as provided by City staff, the required fire flow is available for this development.

4.0 WASTEWATER SERVICING

4.1 BACKGROUND

The site will be serviced via an existing 200mm diameter sanitary sewer situated within the Saddleridge Drive ROW at the eastern boundary of the site (see **Drawing SP-1**). It is proposed to make one 200mm diameter sewer connection via monitoring manhole to the existing service stub drop-off for the proposed site.

4.2 DESIGN CRITERIA

As outlined in the City of Ottawa Sewer Design Guidelines and the MECP's Design Guidelines for Sewage Works, the following criteria were used to calculate estimated wastewater flow rates and to size the sanitary sewers:

- Minimum Velocity – 0.6 m/s (0.8 m/s for upstream sections)
- Maximum Velocity – 3.0 m/s
- Manning roughness coefficient for all smooth wall pipes – 0.013
- Minimum size – 200mm dia. for residential areas
- Average Wastewater Generation – 280L/cap/day
- Peak Factor – 4.0 (Harmon's)
- Extraneous Flow Allowance – 0.33 l/s/ha
- Manhole Spacing – 120 m
- Minimum Cover – 2.5m
- Population density for townhomes – 2.7 pers./townhome
- Population density for back-to-back stacked – 2.3 pers./unit

4.3 PROPOSED SERVICING

The proposed site will be serviced by gravity sewers which will direct the wastewater flows (approx. 1.3 L/s with allowance for infiltration) to the existing 200mm diameter sanitary sewer. Based on Sanitary Design Sheets as prepared by IBI Group, the downstream sewer has capacity to receive flows up to 1.53 L/s (see **Appendix B.2**). A Sanitary sewer design sheet for the proposed sewers are included in **Appendix B.1**. Full port backwater valves are to be installed on all sanitary services within the site to prevent any surcharge from the downstream sewer main from impacting the proposed property.

5.0 STORMWATER MANAGEMENT

5.1 OBJECTIVES

The objective of this stormwater management plan is to determine the measures necessary to control the quantity of stormwater released from the proposed development to criteria established during the pre-consultation for the region, and to provide sufficient detail for approval and construction.

5.2 SWM CRITERIA AND CONSTRAINTS

Criteria were established by combining current design practices outlined by the City of Ottawa Design Guidelines (2012), and through consultation with City of Ottawa staff. The following summarizes the criteria, with the source of each criterion indicated in brackets:

General

- Use of the dual drainage principle (City of Ottawa).
- Wherever feasible and practical, site-level measures should be used to reduce and control the volume and rate of runoff. (City of Ottawa).
- Assess impact of 100 year event outlined in the City of Ottawa Sewer Design Guidelines on major & minor drainage system (City of Ottawa).
- The proposed site is not subject to quality control criteria on-site, as it will be provided downstream in existing EUC Pond 3.

Storm Sewer & Inlet Controls

- Size on-site storm sewers to convey at minimum the 2 year storm event under free-flow conditions using City of Ottawa I-D-F parameters (City of Ottawa).
- Minor system inflow for areas including municipal ROW contributing areas to be limited to 5-year release rates specified in the background documents (IBI Spring Valley Design Sheets and Storm Drainage Area Plan)
- Proposed site to discharge the existing 600mm diameter storm sewer within the Rolling Meadow ROW at the boundary of the subject site (City of Ottawa).
- 100-year Storm HGL to be a minimum of 0.30 m below building foundation footing (City of Ottawa).

Surface Storage & Overland Flow

- Building openings to be a minimum of 0.30m above the 100-year water level (City of Ottawa)
- Maximum depth of flow under either static or dynamic conditions shall be less than 0.35m (City of Ottawa)
- Provide adequate emergency overflow conveyance off-site (City of Ottawa)

5.3 STORMWATER MANAGEMENT

The intent of the stormwater management plan presented herein is to mitigate any negative impact that the proposed development will have on the existing storm sewer infrastructure, while providing adequate capacity to service the proposed townhome and back-to back units. The proposed stormwater management plan is designed to detain runoff on the surface within three proposed dry ponds each with an additional 900mm diameter subsurface storage pipe running along the bottom of the pond, and subsurface storage under the parking area to ensure that peak flows after construction will not exceed the allowable site release rate detailed below.

5.3.1 Allowable Release Rate

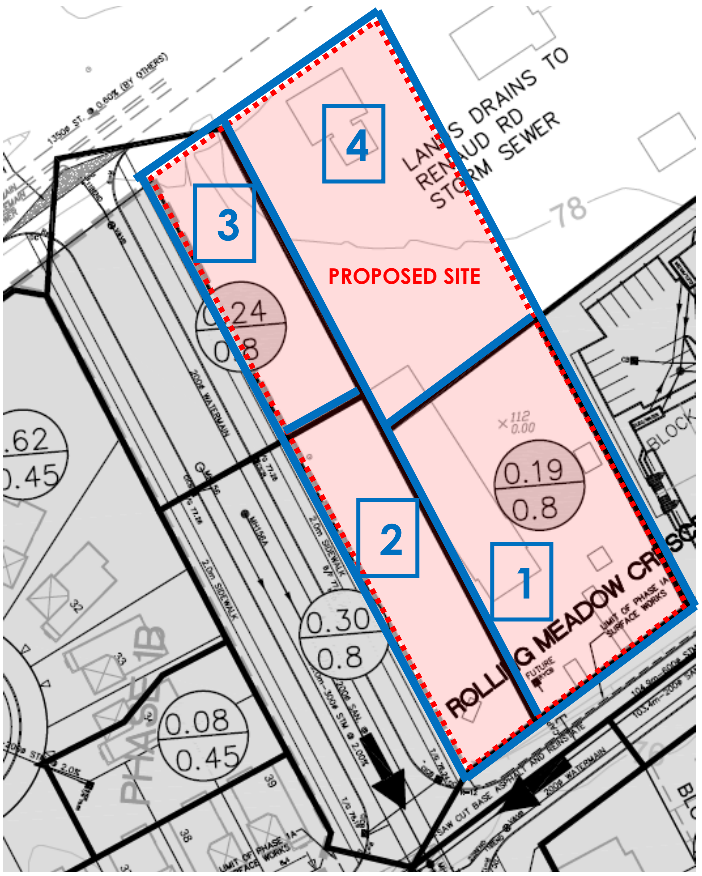
The proposed development at 6102 Renaud Road was included as part of the overall analysis provided by IBI Group. The Spring Valley Storm Sewer Design Sheets provided by IBI Group calculated the 5-year release rates from the site. The storm drainage area plan below (**Figure 2**) illustrates the allowable release rates for subcatchments 1- 3 for the proposed site. The remainder of the site not included in the overall background documents (subcatchment 4) is not tributary to the Spring Valley sewer and will be considered independently (see section 5.3.3 below).

The target 100-year release rates for tributary areas are summarized in **Table 1** below. A calculation sheet demonstrating determination of the figures below is provided in **Appendix C.3**.

Table 1: Target 100 Year Release Rates

Subcatchment Area	Area (ha)	Target Flow Rate (L/s)
Subcatchment 1	0.19	33.2
Subcatchment 2	0.10	23.2
Subcatchment 3	0.08	18.5
Total		**74.9**

Figure 2: Subcatchments 1-3 Based on IBI Storm Drainage Area Plan Phase 2B



5.3.2 Storage Requirements

The site requires quantity control measures to meet the restrictive stormwater release criteria. Inlet control devices in combination with surface grading to permit storage within three proposed dry ponds as well as a subsurface storage facility (storage pipe) will be provided to detain stormwater in excess of the allowable release rate. **Drawing SD-1** indicates the ICD size, location, storage volume, and design release rate of such controls.

5.3.3 Uncontrolled Catchments

Due to grading constraints, two subcatchments were designed without a storage component (UNC-1 and UNC-2). UNC-1 discharges overland to Rolling Meadow Crescent, and has been considered in the overall release rate to the Rolling Meadow sewer. UNC-2 flows uncontrolled toward Renaud Road.

Areas that discharge offsite tributary to the Rolling Meadow Crescent sewer without entering the proposed stormwater management system must be compensated for in areas with controls, as drainage will re-enter the storm sewer system downstream of the proposed site. **Table 2** summarizes the peak uncontrolled 100-year catchment release rates for catchment that is tributary to the controlled outlet sewer.

Table 2: Peak Uncontrolled (Non-Tributary) 100-Year Release Rate

Area ID	Area (ha)	C	Tc (min)	Intensity (mm/hr)	Qrelease (L/s)
UNC 1	0.05	0.78	10	104.20	25.2

Based on existing conditions, only a small portion of the site discharges overland to Renaud Road. **Appendix C.3** illustrates the pre-development area tributary to Renaud Road. Peak pre-development flows were calculated using the Rational Method as follows:

Q = 2.78 CiA
Where: Q = peak flow rate, L/s
A = drainage area, ha = 0.02
I = rainfall intensity, mm/hr (per Ottawa IDF curves) = 178.56 mm/hr
C = site runoff coefficient = 0.61 (increased by 25% for the 100-year storm event)

Q = 2.78(0.61)(178.56)(0.02)
Q = 6.0 L/s

The 100-year release rate during post development (UNC-2) from the PCSWMM model is **21.8L/s**. IBI's drainage area plan indicates that a substantial region is ultimately to be allotted to the Renaud Road sewer, however, the storm drainage area plan for the sewer on Renaud does not include this area, effectively leaving the region without a drainage outlet. Based on design sheets for the Renaud sewer, sufficient capacity exists (see sewer run MH104 – MH105 in excerpts provided in **Appendix C.5**) to permit the additional capture of approximately 15.8L/s. As such, it is assumed that the minimal increase in discharge can be adequately managed within Renaud Road.

5.3.4 PCSWMM Model

Key parameters for the subject area are summarized below; an example input file is provided for the 100-year, 3hr Chicago storm which indicates all other parameters. This analysis was performed using PCSWMM, which is a front-end GUI to the EPA-SWMM engine. Model files can be examined in any program which can read EPA-SWMM files version 5.1.012.

5.3.4.1 Hydrologic Parameters

Table 3 presents the general subcatchment parameters used:

Table 3: General Subcatchment Parameters

Subcatchment Parameter	Value
Infiltration Method	Horton
Max. Infil. Rate (mm/hr)	76.2
Min. Infil. Rate (mm/hr)	13.2
Decay Constant (1/hr)	4.14
N Imperv	0.013
N Perv	0.25
Dstore Imperv (mm)	1.57
Dstore Perv (mm)	4.67
Zero Imperv (%)	0

Table 4 presents the individual parameters that vary for each of the proposed subcatchments.

Table 4: Subcatchment Parameters

Area ID	Area (ha)	Width (m)	Slope (%)	% Impervious	Runoff Coefficient
L104A	0.22	73.2	3	71.4	0.70
L104B	0.10	30.4	3	80.0	0.76
L107A	0.13	84.0	3	80.0	0.76
L109A	0.04	37.5	3	92.9	0.85

Table 5 summarizes the storage node parameters used in the model. All catchbasins have been modeled as having an outlet invert as depicted on **Drawings SSP-1**.

Table 5: Storage Node Parameters

Storage Node	Invert Elevation (m)	Rim Elevation* (m)	Total Depth (m)
500-S	74.67	77.27	2.60
501-S	74.16	76.76	2.60
503-S	75.18	77.78	2.60
504-S	76.45	78.90	2.45

*The rim of the storage node represents the maximum allowable flow depth elevation above the storage node (equal to the top of the CB plus an additional 0.35 m or higher).

5.3.4.2 Hydraulic Parameters

As per the City of Ottawa Sewer Design Guidelines (2012), Manning's roughness values of 0.013 were used for sewer modeling and overland flow corridors representing roadways.

Storm sewers were modeled to confirm flow capacities, assess hydraulic grade lines (HGLs) and to determine minor system peak outflows to the outlet. The detailed storm sewer design sheet is included in **Appendix C**.

Table 6 below presents the parameters for the orifice, which represent ICDs. An appropriate discharge coefficient was applied for all modeled ICDs.

Table 6: Orifice and Outlet Parameters for Proposed Catchments

Orifice Name	Catchbasin ID	Tributary Area ID	ICD Type
500-IC	500-S	L104B	IPEX TEMPEST LMF 60
501-IC	501-S	L104A	IPEX TEMPEST LMF 105
503-IC	503-S	L107A	IPEX TEMPEST MHF (83mm ORIFICE)
504-IC	504-S	L109A	IPEX TEMPEST LMF 95

Calculations using the orifice equation based on catch basin manhole grate opening dimensions were conducted for CBMH 504 to ensure that 100-year flows directed to the catch basin are able to fully be captured by the grate at minimal head without spillage from the adjacent high point into subcatchment L107A. As demonstrated within calculations in **Appendix C.4**, sufficient depth of ponding is available to permit full capture of subcatchment flows before spilling overland to adjacent areas.

Channel conveyance capacity was assessed for the paved access roads directing overland flow to each of the three proposed dry ponds. Subcatchment runoff during the 100 year storm event and climate change scenario (100 year + 20% event) as determined via PCSWMM was compared the maximum open channel flow available to the street segment before impacting adjacent building garage openings. Calculation sheets are provided in **Appendix C.4** to demonstrate sufficient depth is available to convey overland flows without impact to adjacent buildings during all design storm events.

5.3.4.3 Model Results and Discussion

Table 7 provides a summary of the results from the PCSWMM model.

Table 7: Modeled Peak Controlled (Surface and Subsurface Storage) 100-Year Release Rates

Area Tributary to Proposed Surface Storage with Controlled Release Rate	Available 100 Year Surface and Subsurface Volume (m^3)	Required 100 Year Subsurface and Subsurface Volume (m^3)	100 Year Release Rate (L/s)
L107A	30.5	28.0	20.0
L104B	44.3	35.0	4.7
L104A	72.2	66.0	14.6
L109A	8.4	8.0	6.1

Table 9 summarizes the HGL results within the site for the 100-year, 3 hour Chicago storm event and the 'climate change' scenario storm required by the City of Ottawa Sewer Design Guidelines (2012), where intensities are increased by 20%.

The City of Ottawa requires that during major storm events, the maximum hydraulic grade line (HGL) be kept at least 0.30 m below the underside of footing (USF) of any adjacent buildings connected to the storm sewer during design storm events. HGL elevations during the climate change event are not to exceed adjacent USF elevations. USF elevations are detailed on **Drawing GP-1**.

Table 8: Modeled Hydraulic Grade Line (HGL) Results

STM MH	Adjacent USF (m)	100-year 3hr Chicago		100-year 3hr Chicago + 20%	
		HGL (m)	USF-HGL Clearance (m)	HGL (m)	USF-HGL Clearance (m)
STM100	74.32	72.77	1.55	72.77	1.55
STM101	74.32	72.88	1.44	72.89	1.43
STM103	74.32	73.36	0.96	73.36	0.96
STM104	74.32	73.53	0.79	73.53	0.79
STM105	74.78	73.66	1.12	73.67	1.11
STM106	74.78	73.81	0.97	73.81	0.97
STM107	74.78	73.96	0.82	73.96	0.82
STM108	75.73	74.49	1.24	74.51	1.22
STM109	75.73	74.57	1.16	74.59	1.14
STM110	75.73	74.42	1.31	74.42	1.31

As is demonstrated in the table above, the worst-case scenario results in HGL elevations remain well below the proposed USF elevations during the 100-year event and the 20% increased intensity 'climate change' scenario.

5.3.5 Results

Table 10 demonstrates the proposed stormwater management plan and demonstrates adherence to target peak outflow rates for the site.

Table 9: Summary of Total 100 Year Release Rates

	100-Year Peak Discharge (L/s)
Total for PCSWMM Model	67.7*
Target	**74.9**

*Determined through addition of hydrographs to outfalls 1000, 1001 (uncontrolled and controlled runoff to the Rolling Meadows sewer)

6.0 GRADING AND DRAINAGE

The proposed development site measures approximately 0.574ha in area. The topography across the site is slightly sloped, and currently drains from north to south with a difference in elevation over the length of the site of 3m, with overland flow generally being directed to the adjacent Saddleridge Drive and Rolling Meadow Crescent ROW. A detailed grading plan (see **Drawing GP-1**) has been provided to satisfy the stormwater management requirements, adhere to any geotechnical restrictions (see **Section 10.0**) for the site, and provide for minimum cover requirements for storm and sanitary sewers where possible. Site grading has been established to provide emergency overland flow routes required for stormwater management in accordance with City of Ottawa requirements.

The subject site maintains emergency overland flow routes for flows deriving from storm events in excess of the maximum design event to existing Saddleridge Drive and Rolling Meadow Crescent depicted in **Drawing GP-1.**

7.0 UTILITIES

As the subject site lies within a mature developed residential community, Hydro, Bell, Gas and Cable servicing for the proposed development should be readily available within the overhead or subsurface plant within the adjacent Saddleridge Drive, Renaud Road and Rolling Meadow Crescent ROWs. Exact size, location and routing of utilities, along with determination of any off-site works required for redevelopment, will be finalized after design circulation.

8.0 APPROVALS

Ontario Ministry of the Environment, Conservation and Parks (MECP) Environmental Compliance Approvals (ECA) are not expected to be required as the subject site is not industrial in nature, and is a single parcel under singular ownership where each proposed block of dwellings is to maintain a separate (private) drainage and storm sewer system discharging to a pre-existing sewer system.

Requirement for a MECP Permit to Take Water (PTTW) is unlikely for the site due to the limited size of excavations. The geotechnical consultant shall confirm at the time of application that a PTTW is not required.

9.0 EROSION CONTROL DURING CONSTRUCTION

Erosion and sediment controls must be in place during construction. The following recommendations to the contractor will be included in contract documents.

1. Implement best management practices to provide appropriate protection of the existing and proposed drainage system and the receiving water course(s).
2. Limit extent of exposed soils at any given time.
3. Re-vegetate exposed areas as soon as possible.
4. Minimize the area to be cleared and grubbed.
5. Protect exposed slopes with plastic or synthetic mulches.
6. Provide sediment traps and basins during dewatering.
7. Install sediment traps (such as SiltSack® by Terrafix) between catch basins and frames.
8. Plan construction at proper time to avoid flooding.

The contractor will, at every rainfall, complete inspections and guarantee proper performance. The inspection is to include:

9. Verification that water is not flowing under silt barriers.
10. Clean and change silt traps at catch basins.

Refer to **Drawing ECDS-1** for the proposed location of silt fences and other erosion control structures.

10.0 GEOTECHNICAL INVESTIGATION AND ENVIRONMENTAL ASSESSMENT

A geotechnical Investigation report was prepared by Exp. on May 18, 2018. The report summarizes the existing soil conditions within the subject area and construction recommendations. For details which are not summarized below, please see the original Exp. report.

Subsurface soil conditions within the subject area were determined from 5 boreholes distributed across the site. The investigation concluded that the site consisted of topsoil and pavement structure underlain by fill, silty sand and an extensive compressible marine clay deposit. Bedrock is anticipated to lie within 26.1m and 27.0m below surface elevation. Groundwater elevations are anticipated to occur between 0.4m and 1.4m below ground surface. The grade raise restriction of the site is 1.0m.

The required pavement structure of the proposed hard surfaced areas is outlined in **Table 11.**

Table 10: Pavement Structure – Car Only Parking Areas

Light Duty Traffic Thickness (mm)- Cars Only Parking Lots	Heavy Duty Thickness (mm)- Parking Lots and Access Roads	Material Description
65 mm HL3/ SP12.5 Cat. B	40 mm HL3/ SP12.5 Cat. B 50 mm HL8/SP 19 Cat. B	Asphaltic Concrete
150	150	OPSS Granular A Base Crushed Limestone
450	600	OPSS Granular B Type II Sub-base
-		The upper 300 mm of subgrade fill must be compacted to 98% SPMDD.

FUS Fire Flow Calculation Sheet

Stantec Project #: 160401422
Project Name: Richcraft Block 221 Riverside
Date: 6/4/2019
Fire Flow Calculation #: 1
Description: Back-to-back Stacked Block 1

Notes:

<table>
<tr><th>Step</th><th>Task</th><th colspan="6">Notes</th><th>Value Used</th><th>Req'd Fire Flow (L/min)</th></tr>
<tr><td>1</td><td>Determine Type of Construction</td><td colspan="6">Wood Frame</td><td>1.5</td><td>-</td></tr>
<tr><td rowspan="2">2</td><td>Determine Ground Floor Area of One Unit</td><td colspan="6">-</td><td>400</td><td>-</td></tr>
<tr><td>Determine Number of Adjoining Units</td><td colspan="6">Includes adjacent wood frame structures separated by 3m or less</td><td>1</td><td>-</td></tr>
<tr><td>3</td><td>Determine Height in Storeys</td><td colspan="6">Does not include floors >50% below grade or open attic space</td><td>3</td><td>-</td></tr>
<tr><td>4</td><td>Determine Required Fire Flow</td><td colspan="6">(F = 220 x C x A^1/2). Round to nearest 1000 L/min</td><td>-</td><td>11000</td></tr>
<tr><td>5</td><td>Determine Occupancy Charge</td><td colspan="6">Limited Combustible</td><td>-15%</td><td>9350</td></tr>
<tr><td rowspan="4">6</td><td rowspan="4">Determine Sprinkler Reduction</td><td colspan="6">None</td><td>0%</td><td rowspan="4">0</td></tr>
<tr><td colspan="6">Non-Standard Water Supply or N/A</td><td>0%</td></tr>
<tr><td colspan="6">Not Fully Supervised or N/A</td><td>0%</td></tr>
<tr><td colspan="6">% Coverage of Sprinkler System</td><td>0%</td></tr>
<tr><td rowspan="5">7</td><td rowspan="5">Determine Increase for Exposures (Max. 75%)</td><td>Direction</td><td>Exposure Distance (m)</td><td>Exposed Length (m)</td><td>Exposed Height (Stories)</td><td>Length-Height Factor (m x stories)</td><td>Construction of Adjacent Wall</td><td>-</td><td>-</td></tr>
<tr><td>North</td><td>30.1 to 45</td><td>26</td><td>2</td><td>31-60</td><td>Wood Frame or Non-Combustible</td><td>5%</td><td rowspan="4">2992</td></tr>
<tr><td>East</td><td>20.1 to 30</td><td>16</td><td>1</td><td>0-30</td><td>Wood Frame or Non-Combustible</td><td>8%</td></tr>
<tr><td>South</td><td>10.1 to 20</td><td>26</td><td>3</td><td>61-90</td><td>Wood Frame or Non-Combustible</td><td>14%</td></tr>
<tr><td>West</td><td>30.1 to 45</td><td>16</td><td>2</td><td>31-60</td><td>Wood Frame or Non-Combustible</td><td>5%</td></tr>
<tr><td rowspan="4">8</td><td rowspan="4">Determine Final Required Fire Flow</td><td colspan="7">Total Required Fire Flow in L/min, Rounded to Nearest 1000L/min</td><td>12000</td></tr>
<tr><td colspan="7">Total Required Fire Flow in L/s</td><td>200.0</td></tr>
<tr><td colspan="7">Required Duration of Fire Flow (hrs)</td><td>2.50</td></tr>
<tr><td colspan="7">Required Volume of Fire Flow (m^3)</td><td>1800</td></tr>
</table>

FUS Fire Flow Calculation Sheet

Stantec Project #: 160401422
Project Name: Richcraft Block 221 Riverside
Date: 6/4/2019
Fire Flow Calculation #: 1
Description: Back-to-back Townhomes Block 2

Notes:

Step	Task	Notes						Value Used	Req'd Fire Flow (L/min)
1	Determine Type of Construction	Wood Frame						1.5	-
2	Determine Ground Floor Area of One Unit	-						604	-
	Determine Number of Adjoining Units	Includes adjacent wood frame structures separated by 3m or less						1	-
3	Determine Height in Storeys	Does not include floors >50% below grade or open attic space						3	-
4	Determine Required Fire Flow	(F = 220 x C x $A^{1/2}$). Round to nearest 1000 L/min						-	14000
5	Determine Occupancy Charge	Limited Combustible						-15%	11900
6	Determine Sprinkler Reduction	None						0%	0
		Non-Standard Water Supply or N/A						0%	
		Not Fully Supervised or N/A						0%	
		% Coverage of Sprinkler System						0%	
7	Determine Increase for Exposures (Max. 75%)	Direction	Exposure Distance (m)	Exposed Length (m)	Exposed Height (Stories)	Length-Height Factor (m x stories)	Construction of Adjacent Wall	-	-
		North	10.1 to 20	32	3	91-120	Wood Frame or Non-Combustible	15%	5117
		East	20.1 to 30	15.1	3	31-60	Wood Frame or Non-Combustible	8%	
		South	10.1 to 20	32	3	91-120	Wood Frame or Non-Combustible	15%	
		West	30.1 to 45	15.1	2	31-60	Wood Frame or Non-Combustible	5%	
8	Determine Final Required Fire Flow	Total Required Fire Flow in L/min, Rounded to Nearest 1000L/min							17000
		Total Required Fire Flow in L/s							283.3
		Required Duration of Fire Flow (hrs)							3.50
		Required Volume of Fire Flow (m^3)							3570

FUS Fire Flow Calculation Sheet

Stantec Project #: 160401422
Project Name: Richcraft Block 221 Riverside
Date: 6/4/2019
Fire Flow Calculation #: 1
Description: Back-to-back Townhomes Block 3

Notes:

Step	Task	Notes						Value Used	Req'd Fire Flow (L/min)
1	Determine Type of Construction	Wood Frame						1.5	-
2	Determine Ground Floor Area of One Unit	-						483	-
	Determine Number of Adjoining Units	Includes adjacent wood frame structures separated by 3m or less						1	-
3	Determine Height in Storeys	Does not include floors >50% below grade or open attic space						3	-
4	Determine Required Fire Flow	(F = 220 x C x $A^{1/2}$). Round to nearest 1000 L/min						-	13000
5	Determine Occupancy Charge	Limited Combustible						-15%	11050
6	Determine Sprinkler Reduction	None						0%	0
		Non-Standard Water Supply or N/A						0%	
		Not Fully Supervised or N/A						0%	
		% Coverage of Sprinkler System						0%	
7	Determine Increase for Exposures (Max. 75%)	Direction	Exposure Distance (m)	Exposed Length (m)	Exposed Height (Stories)	Length-Height Factor (m x stories)	Construction of Adjacent Wall	-	-
		North	10.1 to 20	26	3	61-90	Wood Frame or Non-Combustible	14%	4531
		East	20.1 to 30	19	3	31-60	Wood Frame or Non-Combustible	8%	
		South	10.1 to 20	26	3	61-90	Wood Frame or Non-Combustible	14%	
		West	30.1 to 45	19	2	31-60	Wood Frame or Non-Combustible	5%	
8	Determine Final Required Fire Flow	Total Required Fire Flow in L/min, Rounded to Nearest 1000L/min							16000
		Total Required Fire Flow in L/s							266.7
		Required Duration of Fire Flow (hrs)							3.50
		Required Volume of Fire Flow (m^3)							3360

Stantec

FUS Fire Flow Calculation Sheet

Stantec Project #: 160401422
Project Name: Richcraft Block 221 Riverside
Date: 6/4/2019
Fire Flow Calculation #: 1
Description: Back-to-back Townhomes Block 4

Notes:

Step	Task	Notes						Value Used	Req'd Fire Flow (L/min)
1	Determine Type of Construction	Wood Frame						1.5	-
2	Determine Ground Floor Area of One Unit	-						604	-
	Determine Number of Adjoining Units	Includes adjacent wood frame structures separated by 3m or less						1	-
3	Determine Height in Storeys	Does not include floors >50% below grade or open attic space						3	-
4	Determine Required Fire Flow	($F = 220 \times C \times A^{1/2}$). Round to nearest 1000 L/min						-	14000
5	Determine Occupancy Charge	Limited Combustible						-15%	11900
6	Determine Sprinkler Reduction	None						0%	0
		Non-Standard Water Supply or N/A						0%	
		Not Fully Supervised or N/A						0%	
		% Coverage of Sprinkler System						0%	
7	Determine Increase for Exposures (Max. 75%)	Direction	Exposure Distance (m)	Exposed Length (m)	Exposed Height (Stories)	Length-Height Factor (m x stories)	Construction of Adjacent Wall	-	-
		North	10.1 to 20	32	3	91-120	Wood Frame or Non-Combustible	15%	4284
		East	20.1 to 30	19	3	31-60	Wood Frame or Non-Combustible	8%	
		South	30.1 to 45	32	2	61-90	Wood Frame or Non-Combustible	5%	
		West	20.1 to 30	19	2	31-60	Wood Frame or Non-Combustible	8%	
8	Determine Final Required Fire Flow	Total Required Fire Flow in L/min, Rounded to Nearest 1000L/min							16000
		Total Required Fire Flow in L/s							266.7
		Required Duration of Fire Flow (hrs)							3.50
		Required Volume of Fire Flow (m^3)							3360

A.3 BOUNDARY CONDITIONS

BOUNDARY CONDITIONS

Boundary Conditions For: 6201 Renaud Rd

Date of Boundary Conditions: 2019-Jun-13

Provided Information:

Scenario	Demand	
	L/min	L/s
Average Daily Demand	27.6	0.5
Maximum Daily Demand	68.4	1.1
Peak Hour	150	2.5
Fire Flow #1 Demand	12,000	200.0
Fire Flow #2 Demand	17,000	283.3

Number Of Connections: 2

Location:

BOUNDARY CONDITIONS

Results:

Connection #: 1

Demand Scenario	Head (m)	Pressure[1] (psi)
Maximum HGL	130.8	74.7
Peak Hour	127.0	69.3
Max Day Plus Fire (12,000) L/min	121.9	62.0
Max Day Plus Fire (17,000) L/min	116.7	54.7

[1]Elevation: **78.29 m**

Connection #: 2

Demand Scenario	Head (m)	Pressure[1] (psi)
Maximum HGL	130.8	77.7
Peak Hour	127.0	72.3
Max Day Plus Fire (12,000) L/min	118.7	60.5
Max Day Plus Fire (17,000) L/min	110.7	49.1

[1]Elevation: **76.17 m**

Notes:

1) As per the Ontario Building Code in areas that may be occupied, the static pressure at any fixture shall not exceed 552 kPa (80 psi.) Pressure control measures to be considered are as follows, in order of preference:

a) If possible, systems to be designed to residual pressures of 345 to 552 kPa (50 to 80 psi) in all occupied areas outside of the public right-of-way without special pressure control equipment.
b) Pressure reducing valves to be installed immediately downstream of the isolation valve in the home/ building, located downstream of the meter so it is owner maintained.

2) Insert an isolation valve in between the two connections so that the property can have an uninterrupted water service in the event of watermain closure on Renaud Rd or on Rolling Meadow Cres.

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.

BOUNDARY CONDITIONS

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. Fire Flow analysis is a reflection of available flow in the watermain; there may be additional restrictions that occur between the watermain and the hydrant that the model cannot take into account.

Appendix B WASTEWATER SERVICING

B.1 SANITARY SEWER DESIGN SHEET

	SUBDIVISION: 1702599 ONTARIO INC
DATE:	8/1/2019
REVISION:	1
DESIGNED BY:	MJS
CHECKED BY:	DT

SANITARY SEWER DESIGN SHEET
(City of Ottawa)

FILE NUMBER: 160401467

DESIGN PARAMETERS

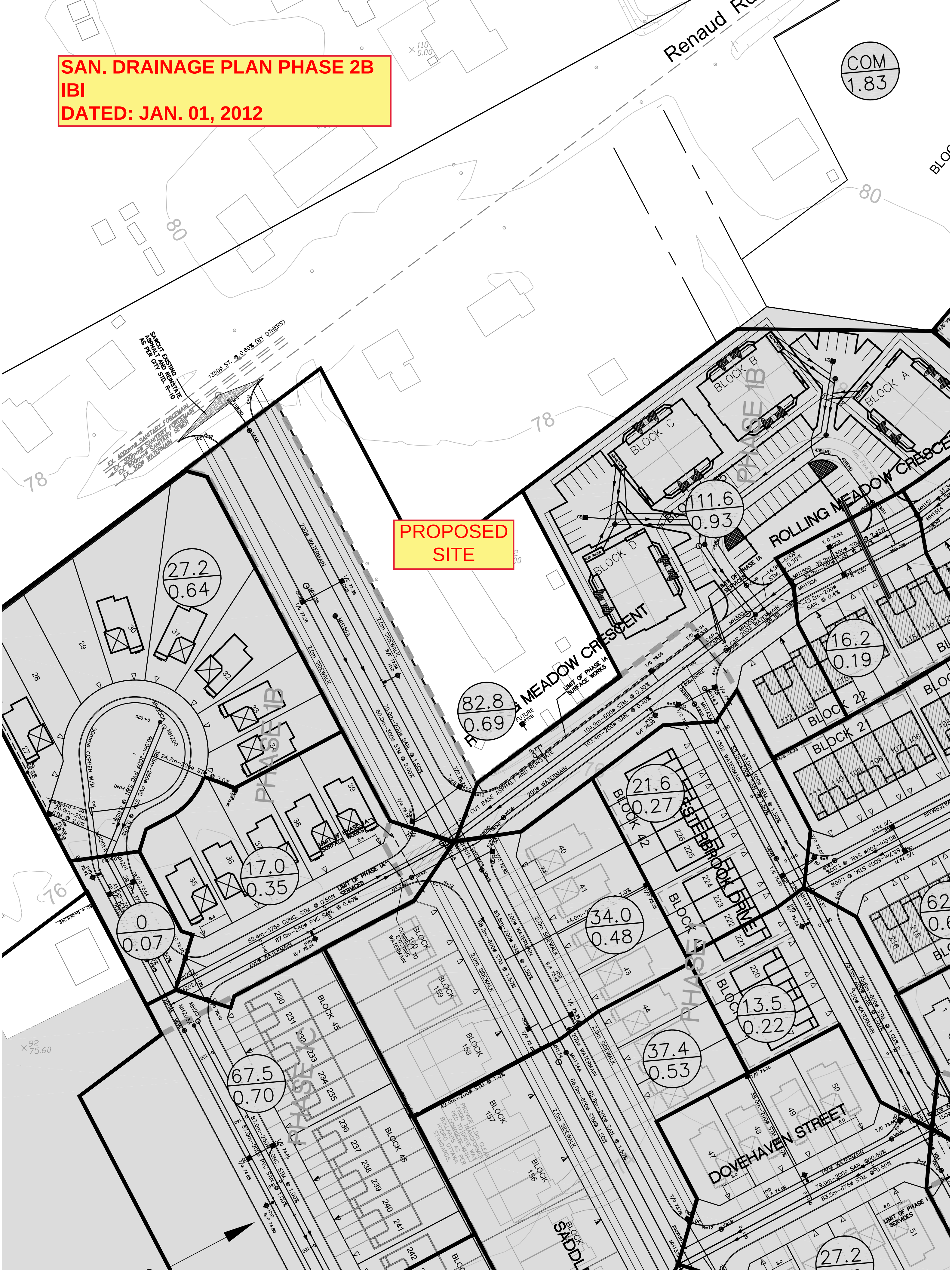
MAX PEAK FACTOR (RES.)=	4.0	AVG. DAILY FLOW / PERSON	280 l/p/day	MINIMUM VELOCITY	0.60 m/s
MIN PEAK FACTOR (RES.)=	2.0	COMMERCIAL	28,000 l/ha/day	MAXIMUM VELOCITY	3.00 m/s
PEAKING FACTOR (INDUSTRIAL):	2.4	INDUSTRIAL (HEAVY)	55,000 l/ha/day	MANNINGS n	0.013
PEAKING FACTOR (ICI >20%):	1.5	INDUSTRIAL (LIGHT)	35,000 l/ha/day	BEDDING CLASS	B
PERSONS / SINGLE	3.4	INSTITUTIONAL	28,000 l/ha/day	MINIMUM COVER	2.50 m
PERSONS / TOWNHOME	2.7	INFILTRATION	0.33 l/s/Ha	HARMON CORRECTION FACTOR	0.8
PERSONS / APARTMENT	2.3				

LOCATION			RESIDENTIAL AREA AND POPULATION									COMMERCIAL	
AREA ID NUMBER	FROM M.H.	TO M.H.	AREA (ha)	UNITS SINGLE	UNITS TOWN	UNITS BACK-TO-BACKS	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	AREA (ha)	ACCU. AREA (ha)
R6A	6	5	0.09	0	7	0	19	0.09	19	3.71	0.2	0.00	0.00
R5A	5	4	0.03	0	2	0	5	0.12	24	3.69	0.3	0.00	0.00
R9A	9	8	0.11	0	5	8	32	0.11	32	3.68	0.4	0.00	0.00
R11A	11	10	0.04	0	0	8	18	0.04	18	3.71	0.2	0.00	0.00
G10A	10	8	0.00	0	0	0	0	0.04	18	3.71	0.2	0.00	0.00
G8A	8	7	0.00	0	0	0	0	0.14	50	3.65	0.6	0.00	0.00
G7A	7	4	0.00	0	0	0	0	0.14	50	3.65	0.6	0.00	0.00
G4A	4	3	0.00	0	0	0	0	0.27	75	3.62	0.9	0.00	0.00
R3A	3	2	0.04	0	2	0	5	0.30	80	3.62	0.9	0.00	0.00
R2A	2	1	0.11	0	7	0	19	0.41	99	3.60	1.2	0.00	0.00
	1	EX.SAN	0.00	0	0	0	0	0.41	99	3.60	1.2	0.00	0.00

AREA ID NUMBER	INDUSTRIAL (L) AREA (ha)	INDUSTRIAL (L) ACCU. AREA (ha)	INDUSTRIAL (H) AREA (ha)	INDUSTRIAL (H) ACCU. AREA (ha)	INSTITUTIONAL AREA (ha)	INSTITUTIONAL ACCU. AREA (ha)	GREEN / UNUSED AREA (ha)	GREEN / UNUSED ACCU. AREA (ha)	C+I+I PEAK FLOW (l/s)	INFILTRATION TOTAL AREA (ha)	INFILTRATION ACCU. AREA (ha)	INFILT. FLOW (l/s)	TOTAL FLOW (l/s)	PIPE LENGTH (m)	DIA (mm)	MATERIAL	CLASS	SLOPE (%)	CAP. (FULL) (l/s)	CAP. V PEAK FLOW (%)	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
R6A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.09	0.09	0.0	0.3	22.2	200	PVC	SDR 35	0.65	27.0	**0.95%**	0.85	0.23
R5A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.03	0.12	0.0	0.3	13.3	200	PVC	SDR 35	0.65	27.0	**1.23%**	0.85	0.24
R9A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.11	0.11	0.0	0.4	35.0	200	PVC	SDR 35	0.40	21.1	**1.97%**	0.67	0.22
R11A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.04	0.04	0.0	0.2	21.4	200	PVC	SDR 35	0.65	27.0	**0.87%**	0.85	0.23
G10A	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.0	0.05	0.09	0.0	0.2	28.4	200	PVC	SDR 35	0.65	27.0	**0.92%**	0.85	0.23
G8A	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.06	0.0	0.01	0.20	0.1	0.7	4.8	200	PVC	SDR 35	0.40	21.1	**3.13%**	0.67	0.25
G7A	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.08	0.0	0.02	0.22	0.1	0.7	28.4	200	PVC	SDR 35	0.40	21.1	**3.16%**	0.67	0.25
G4A	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.10	0.0	0.02	0.37	0.1	1.0	26.2	200	PVC	SDR 35	0.40	21.1	**4.72%**	0.67	0.28
R3A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.0	0.04	0.41	0.1	1.1	11.3	200	PVC	SDR 35	0.40	21.1	**5.07%**	0.67	0.29
R2A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.0	0.11	0.52	0.2	1.3	32.6	200	PVC	SDR 35	0.40	21.1	**6.25%**	0.67	0.31
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.0	0.00	0.52	0.2	1.3	14.2	200	PVC	SDR 35	0.40	21.1	**6.25%**	0.67	0.31
															200							

B.2 BACKGROUND EXCERPTS (SANITARY DRAINAGE)

SAN. DRAINAGE PLAN PHASE 2B
IBI
DATED: JAN. 01, 2012



IBI GROUP

CCL/IBI
1770 WOODWARD DRIVE
OTTAWA, ONTARIO
K2C OP8

SANITARY SEWER DESIGN SHEET

PROJECT: CLARIDGE HOMES, NAVAN ROAD
LOCATION: CUMBERLAND
DEVELOPER: CLARIDGE HOMES

JOB: 3625-LD
DATE: Dec 2008
DESIGN: DY
FILE: 3625-LD Sewers.xls

LOCATION			INDIVIDUAL			CUMULATIVE			DESIGN FLOW						PROPOSED SEWER					
STREET	FROM MH	TO MH	com/Inst area Ha	Residential AREA (Ha)	Residential POP.	Com/Inst Area Ha	POP.	AREA (Ha)	Pop PEAK FACT.	POPLN FLOW (l/s)	Com/Inst Peak Fact	Com/Inst Peak Flow	INFILT FLOW (l/s)	PEAK FLOW (l/s)	CAPACITY l/s	VELOCITY (full) m/s	LGTH. (m)	PIPE (mm)	GRADE %	AVAIL. CAP. (%)
Phase 2 & External																				
Fountainhead Drive		162A				0.00	853.70	10.36	3.84	13.29	1.50	0.00	2.90	**16.19**						
Felicity Crescent	162A	195A		0.120	0.0	0.00	853.70	10.48	3.84	13.29	9.50	0.00	2.93	**16.22**	**32.23**	0.64	78	250	0.27	49.67%
Phase 2 & External																				
Joshua Avenue		195A				1.30	669.50	12.81	3.91	10.59	1.50	1.13	3.95	**15.67**						
Phase 2																				
Spring Valley		195A				2.83	667.60	9.43	3.91	10.56	1.50	2.46	3.43	**16.45**						
Joshua Avenue	195A	130B		0.540	34.0	4.13	2224.80	33.26	3.55	31.99	1.50	3.59	10.47	**46.05**	**68.41**	0.60	75	375	0.14	32.69%
Joshua Avenue	130B	130A		0.390	20.4	4.13	2245.20	33.65	3.55	32.25	1.50	3.59	10.58	**46.42**	**68.41**	0.60	75	375	0.14	32.15%
Felicity Crescent	162A	161A		0.480	30.6	0.00	30.60	0.48	4.00	0.50	1.50	0.00	0.13	**0.63**	**27.60**	0.85	66.1	200	0.65	97.72%
Felicity Crescent	161A	160B		0.170	6.8	0.00	37.40	0.65	4.00	0.61	1.50	0.00	0.18	**0.79**	**27.60**	0.85	12.6	200	0.65	97.14%
Felicity Crescent	160B	160A		0.430	27.2	0.00	64.60	1.08	4.00	1.05	1.50	0.00	0.30	**1.35**	**27.60**	0.85	65	200	0.65	95.11%
Felicity Crescent	160A	120B		0.490	27.2	0.00	91.80	1.57	4.00	1.49	1.50	0.00	0.44	**1.93**	**30.40**	0.60	68	250	0.24	93.65%
Saddleridge Drive	120B	201A		0.120	0.0	0.00	91.80	1.69	4.00	1.49	2.50	0.00	0.47	**1.96**	**30.40**	0.60	75.8	250	0.24	93.55%
Fountainhead Drive	203A	223A		0.540	34.0	0.00	34.00	0.54	4.00	0.55	3.50	0.00	0.15	**0.70**	**27.60**	0.85	63.9	200	0.65	97.46%
Fountainhead Drive	223A	201A		0.440	27.2	0.00	61.20	0.98	4.00	0.99	4.50	0.00	0.27	**1.26**	**19.36**	0.60	79.9	200	0.32	93.49%
Fountainhead Drive	162A	123A		0.400	27.2	0.00	27.20	0.40	4.00	0.44	4.50	0.00	0.11	**0.55**	**27.60**	0.85	73.4	200	0.65	98.01%
Fountainhead Drive	123A	201A		0.410	27.2	0.00	54.40	0.81	4.00	0.88	5.50	0.00	0.23	**1.11**	**27.60**	0.85	72.4	200	0.65	95.98%
Saddleridge Drive	201A	130A		0.460	27.2	0.00	234.60	3.94	4.00	3.80	7.50	0.00	1.10	**4.90**	**30.40**	0.60	78.1	250	0.24	83.88%
Rolling Meadow Crescent	142B	142A		0.120	8.1	0.00	8.10	0.12	4.00	0.13	1.50	0.00	0.03	**0.16**	**57.27**	1.77	9.7	200	2.80	99.72%
Rolling Meadow Crescent	142A	141A		0.630	62.1	0.00	70.20	0.75	4.00	1.14	1.50	0.00	0.21	**1.35**	**57.27**	1.77	83.2	200	2.80	97.64%
Rolling Meadow Crescent	141A	140A		0.210	18.9	0.00	89.10	0.96	4.00	1.44	1.50	0.00	0.27	**1.71**	**57.27**	1.77	34.9	200	2.80	97.01%
Rolling Meadow Crescent	140A	139A		0.590	54.0	0.00	143.10	1.55	4.00	2.32	1.50	0.00	0.43	**2.75**	**66.71**	2.06	100.1	200	3.80	95.88%
Rolling Meadow Crescent	139A	138A		0.290	29.7	0.00	172.80	1.84	4.00	2.80	1.50	0.00	0.52	**3.32**	**34.21**	1.06	35	200	1.00	90.30%
Rolling Meadow Crescent	138A	137A		0.610	62.1	0.00	234.90	2.45	4.00	3.81	1.50	0.00	0.69	**4.50**	**34.21**	1.06	90	200	1.00	86.85%
Esterbrook Drive	143A	137A		0.270	21.6	0.00	21.60	0.27	4.00	0.35	1.50	0.00	0.08	**0.43**	**41.90**	1.29	52.1	200	1.50	98.97%
Esterbrook Drive	137A	136A		0.220	13.5	0.00	270.00	2.94	4.00	4.38	1.50	0.00	0.82	**5.20**	**34.21**	1.06	75	200	1.00	84.80%
Dovehaven Street	136A	133A		0.460	27.2	0.00	297.20	3.40	4.00	4.82	1.50	0.00	0.95	**5.77**	**24.19**	0.75	79	200	0.50	76.15%
Rolling Meadow Crescent	155A	154A		0.510	45.9	0.00	45.90	0.51	4.00	0.74	1.50	0.00	0.14	**0.88**	**57.27**	1.77	55.8	200	2.80	98.46%
Rolling Meadow Crescent	154A	153A		0.220	21.6	0.00	67.50	0.73	4.00	1.09	1.50	0.00	0.20	**1.29**	**72.58**	2.24	31.5	200	4.50	98.22%
Rolling Meadow Crescent	153A	152A		0.560	54.0	0.00	121.50	1.29	4.00	1.97	1.50	0.00	0.36	**2.33**	**72.58**	2.24	79.9	200	4.50	96.79%
Rolling Meadow Crescent	152A	151A		0.190	16.2	0.00	137.70	1.48	4.00	2.23	1.50	0.00	0.41	**2.64**	**72.58**	2.24	31.5	200	4.50	96.36%
Rolling Meadow Crescent	151A	150A		0.190	16.2	0.00	153.90	1.67	4.00	2.49	1.50	0.00	0.47	**2.96**	**51.56**	1.59	39.2	200	2.27	94.26%
Rolling Meadow Crescent	150A	300A		0.000	0.0	0.00	153.90	1.67	4.00	2.49	1.50	0.00	0.47	**2.96**	**21.63**	0.67	13.4	200	0.40	86.32%
Rolling Meadow Crescent	300A	145A		0.930	111.6	0.00	265.50	2.60	4.00	4.30	1.50	0.00	0.73	**5.03**	**21.63**	0.67	103.4	200	0.40	76.75%
Saddleridge Drive	156A	145A		0.690	82.8	0.00	82.80	0.69	4.00	1.34	1.50	0.00	0.19	**1.53**	**41.90**	1.29	70	200	1.50	96.35%

Where Q = average daily per capita flow 350 l/cap/d
I = Unit of peak extraneous flow 0.28 l/sec/Ha

SPECIFY
Coeff. of friction (n) = 0.013

IBI GROUP

CCL/IBI
1770 WOODWARD DRIVE
OTTAWA, ONTARIO
K2C 0P8

SANITARY SEWER DESIGN SHEET

PROJECT: CLARIDGE HOMES, NAVAN ROAD
LOCATION: CUMBERLAND
DEVELOPER: CLARIDGE HOMES

JOB: 3625-LD
DATE: Dec 2008
DESIGN: DY
FILE: 3625-LD Sewers.xls

LOCATION			INDIVIDUAL			CUMULATIVE			DESIGN FLOW						PROPOSED SEWER					
STREET	FROM MH	TO MH	com/Inst area Ha	Residential AREA (Ha)	POP.	Com/Inst Area Ha	POP.	AREA (Ha)	Pop PEAK FACT.	POPLN FLOW (l/s)	Com/Inst Peak Fact	Com/Inst Peak Flow	INFILT FLOW (l/s)	PEAK FLOW (l/s)	CAPACITY l/s	VELOCITY (full) m/s	LGTH. (m)	PIPE (mm)	GRADE %	AVAIL. CAP. (%)
Gossamer St	200A	201A		0.640	27.2	0.00	27.20	0.64	4.00	0.44	1.50	0.00	0.18	**0.62**	**27.60**	0.85	40	200	0.65	97.75%
Gossamer St	201A	202A		0.070	0.0	0.00	27.20	0.71	4.00	0.44	1.50	0.00	0.20	**0.64**	**24.19**	0.75	41.5	200	0.50	97.35%
Prairie St	202A	145A		0.350	17.0	0.00	44.20	1.06	4.00	0.72	1.50	0.00	0.30	**1.02**	**39.22**	0.77	87	250	0.40	97.40%
Saddleridge Drive	145A	134A		0.480	34.0	0.00	426.50	4.83	4.00	6.91	1.50	0.00	1.35	**8.26**	**41.90**	1.29	65.8	200	1.50	80.29%
Saddleridge Drive	134A	133A		0.530	37.4	0.00	463.90	5.36	3.99	7.50	1.50	0.00	1.50	**9.00**	**41.90**	1.29	65.8	200	1.50	78.52%
Saddleridge Drive	133A	132A		0.620	44.2	0.00	805.30	9.38	3.86	12.59	1.50	0.00	2.63	**15.22**	**24.19**	0.75	93.7	200	0.50	37.09%
Saddleridge Drive	132A	130A		0.320	17.0	0.00	822.30	9.70	3.85	12.84	1.50	0.00	2.72	**15.56**	**24.19**	0.75	44	200	0.50	35.68%
Joshua Street	130A	127B		0.390	17.0	4.13	3319.10	47.68	3.40	45.78	1.50	3.59	14.51	**63.88**	**68.41**	0.60	95.05	375	0.14	6.62%
Phase 1B & External																				
Gossamer St	203A	204A		0.700	67.5	0.00	67.50	0.70	4.00	1.09	1.50	0.00	0.20	**1.29**	**34.21**	1.06	87	200	1.00	96.23%
Gossamer St	204A	205A		0.730	72.9	0.00	140.40	1.43	4.00	2.28	1.50	0.00	0.40	**2.68**	**34.21**	1.06	86.7	200	1.00	92.17%
Gossamer St	205A	127B		0.210	10.8	0.00	151.20	1.64	4.00	2.45	1.50	0.00	0.46	**2.91**	**24.19**	0.75	36.6	200	0.50	87.97%
Joshua Street	127B	116A		0.450	10.2	4.13	3480.50	49.77	3.39	47.75	1.50	3.59	15.09	**66.43**	**68.41**	0.60	65.5	375	0.14	2.90%
Joshua Street	116A	104D				4.13	3480.50	49.77	3.39	47.75	1.50	3.59	15.09	**66.43**	**68.41**	0.60	78	375	0.14	2.90%
Felicity Crescent	120A	111B		0.590	44.2	0.00	44.20	0.59	4.00	0.72	3.50	0.00	0.17	**0.89**	**27.60**	0.85	76	200	0.65	96.78%
Felicity Crescent	111B	101A		0.540	34.0	0.00	78.20	1.13	4.00	1.27	1.50	0.00	0.32	**1.59**	**30.40**	0.60	69.5	250	0.24	94.77%
Felicity Crescent	101A	101B		0.180	6.8	0.00	85.00	1.31	4.00	1.38	1.50	0.00	0.37	**1.75**	**30.40**	0.60	13	250	0.24	94.24%
Felicity Crescent	101B	102A		0.550	34.0	0.00	119.00	1.86	4.00	1.93	1.50	0.00	0.52	**2.45**	**313.75**	1.08	74	600	0.24	99.22%
Felicity Crescent	102A	103A		0.650	20.4	0.00	139.40	2.51	4.00	2.26	1.50	0.00	0.70	**2.96**	**313.75**	1.08	75	600	0.24	99.06%
Felicity Crescent	103A	104D		0.140	6.8	0.00	146.20	2.65	4.00	2.37	1.50	0.00	0.74	**3.11**	**311.13**	1.07	32.8	600	0.24	99.00%
External																				
Street 1	116C	116B		1.630	140.4	0.00	140.40	1.63	4.00	2.28	1.50	0.00	0.46	**2.74**	**30.40**	0.60	32	250	0.24	90.99%
Joshua Street	116B	104C		0.200	3.4	0.00	143.80	1.83	4.00	2.33	1.50	0.00	0.51	**2.84**	**30.40**	0.60	60.4	250	0.24	90.66%
Joshua Street	104A	104C		0.300	6.8	0.00	6.80	0.30	4.00	0.11	1.50	0.00	0.08	**0.19**	**27.60**	0.85	45	200	0.65	99.31%
Joshua Street	104C	104D				0.00	150.60	2.13	4.00	2.44	1.50	0.00	0.60	**3.04**	**62.02**	1.22	2.5	250	1.00	95.10%
Joshua Street	104D	EX				4.13	3777.30	54.55	3.36	51.34	1.50	3.59	16.43	**71.36**	**85.85**	0.75	49.6	375	0.22	16.88%

Where Q = average daily per capita flow 350 l/cap/d
I = Unit of peak extraneous flow 0.28 l/sec/Ha
M = Peaking Factor = 1+(14/(4+P)^0.5)), P=POP. IN 1000'S, Max of 4
Q(p) = Peak population flow (l/s)
Q(i) = peak extraneous flow (l/s)
Population = AVERAGE Per unit = 3.4 singles
2.7 Townhouses
General Population Densities Low Density = 120 pers / per gross hectare
Commercial and School - Average flow 50,000 l/ha/day with Peaking Factor = 1.5

SPECIFY
Coeff. of friction (n) = 0.013

REV. # : 9 15-Dec-08

Appendix C STORMWATER MANAGEMENT

C.1 STORM SEWER DESIGN SHEET

Stantec

1702599 ONTARIO INC	
DATE:	2021-04-01
REVISION:	3
DESIGNED BY:	MJS
CHECKED BY:	TR

STORM SEWER DESIGN SHEET
(City of Ottawa)

FILE NUMBER: **160401467**

DESIGN PARAMETERS

$I = a / (t+b)^c$ (As per City of Ottawa Guidelines, 2012)

	1:2 yr	1:5 yr	1:10 yr	1:100 yr			
a =	732.951	998.071	1174.184	1735.688	MANNING'S n =	0.013	
b =	6.199	6.053	6.014	6.014	MINIMUM COVER:	2.00	m
c =	0.810	0.814	0.816	0.820	TIME OF ENTRY	10	min

BEDDING CLASS = B

LOCATION			DRAINAGE AREA																									PIPE SELECTION											
AREA ID NUMBER	FROM M.H.	TO M.H.	AREA (2-YEAR) (ha)	AREA (5-YEAR) (ha)	AREA (10-YEAR) (ha)	AREA (100-YEAR) (ha)	AREA (ROOF) (ha)	C (2-YEAR) (-)	C (5-YEAR) (-)	C (10-YEAR) (-)	C (100-YEAR) (-)	A x C (2-YEAR) (ha)	ACCUM AxC (2YR) (ha)	A x C (5-YEAR) (ha)	ACCUM. AxC (5YR) (ha)	A x C (10-YEAR) (ha)	ACCUM. AxC (10YR) (ha)	A x C (100-YEAR) (ha)	ACCUM. AxC (100YR) (ha)	T of C (min)	$I_{2\text{-YEAR}}$ (mm/h)	$I_{5\text{-YEAR}}$ (mm/h)	$I_{10\text{-YEAR}}$ (mm/h)	$I_{100\text{-YEAR}}$ (mm/h)	$Q_{CONTROL}$ (L/s)	ACCUM. $Q_{CONTROL}$ (L/s)	Q_{ACT} (CIA/360) (L/s)	LENGTH (m)	PIPE WIDTH OR DIAMETE (mm)	PIPE HEIGHT (mm)	PIPE SHAPE (-)	MATERIAL (-)	CLASS (-)	SLOPE %	Q_{CAP} (FULL) (L/s)	% FULL (-)	VEL. (FULL) (m/s)	VEL. (ACT) (m/s)	TIME OF FLOW (min)
	110	109	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	0.0	35.0	300	300	CIRCULAR	PVC	-	0.50	68.0	**0.00%**	0.97	0.00	0.00
																				10.00																			
	504A	504	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	0.0	11.0	600	600	CIRCULAR	CONCRETE	-	0.10	202.6	**0.00%**	0.69	0.00	0.00
	504	109	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	0.0	11.1	200	200	CIRCULAR	PVC	-	1.00	33.3	**0.00%**	1.05	0.00	0.00
																				10.00																			
L109A	109	108	0.04	0.00	0.00	0.00	0.00	0.85	0.00	0.00	0.00	0.030	0.030	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	6.5	6.0	300	300	CIRCULAR	PVC	-	0.50	68.0	**9.55%**	0.97	0.50	0.20
	108	105	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.030	0.000	0.000	0.000	0.000	0.000	0.000	10.20	76.05	103.15	120.91	176.76	0.0	0.0	6.4	27.9	300	300	CIRCULAR	PVC	-	0.50	68.0	**9.46%**	0.97	0.50	0.92
																				11.12																			
	503A	503	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	0.0	35.0	900	900	CIRCULAR	CONCRETE	-	0.10	597.2	**0.00%**	0.91	0.00	0.00
	503	107	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	0.0	3.1	200	200	CIRCULAR	PVC	-	1.00	33.3	**0.00%**	1.05	0.00	0.00
L107A	107	106	0.13	0.00	0.00	0.00	0.00	0.76	0.00	0.00	0.00	0.096	0.096	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	20.4	28.4	300	300	CIRCULAR	PVC	-	0.50	68.0	**30.02%**	0.97	0.71	0.67
	106	105	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.096	0.000	0.000	0.000	0.000	0.000	0.000	10.67	74.32	100.78	118.12	172.66	0.0	0.0	19.8	13.9	300	300	CIRCULAR	PVC	-	0.50	68.0	**29.05%**	0.97	0.70	0.33
																				11.00																			
	105	101	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.126	0.000	0.000	0.000	0.000	0.000	0.000	11.12	72.75	98.61	115.57	168.90	0.0	0.0	25.5	30.8	375	375	CIRCULAR	PVC	-	0.50	116.5	**21.88%**	1.10	0.74	0.69
																				11.82																			
	505	500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	0.0	20.0	900	900	CIRCULAR	CONCRETE	-	0.10	593.5	**0.00%**	0.90	0.00	0.00
	500	104	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	0.0	7.8	200	200	CIRCULAR	PVC	-	1.00	33.3	**0.00%**	1.05	0.00	0.00
																				10.00																			
	502	501	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	0.0	22.4	900	900	CIRCULAR	CONCRETE	-	0.10	597.2	**0.00%**	0.91	0.00	0.00
	501	104	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	0.0	4.1	200	200	CIRCULAR	PVC	-	1.00	33.3	**0.00%**	1.05	0.00	0.00
																				10.00																			
L104B, L104A	104	103	0.31	0.00	0.00	0.00	0.00	0.72	0.00	0.00	0.00	0.226	0.226	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	48.2	29.3	300	300	CIRCULAR	PVC	-	0.50	68.0	**70.88%**	0.97	0.92	0.53
	103	101	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.226	0.000	0.000	0.000	0.000	0.000	0.000	10.53	74.82	101.46	118.92	173.83	0.0	0.0	46.9	12.2	300	300	CIRCULAR	PVC	-	0.50	68.0	**69.05%**	0.97	0.91	0.22
																				10.76																			
	101	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.352	0.000	0.000	0.000	0.000	0.000	0.000	11.82	70.47	95.48	111.88	163.49	0.0	0.0	68.9	35.5	375	375	CIRCULAR	PVC	-	1.00	164.8	**41.80%**	1.56	1.27	0.47
																				12.28									375	375									

C.2 PCSWMM MODEL

```
[TITLE]

[OPTIONS]
;;Options            Value
;;------------------ ------------
FLOW_UNITS           LPS
INFILTRATION         HORTON
FLOW_ROUTING         DYNWAVE
LINK_OFFSETS         ELEVATION
MIN_SLOPE            0
ALLOW_PONDING        YES
SKIP_STEADY_STATE    NO

START_DATE           05/09/2019
START_TIME           00:00:00
REPORT_START_DATE    05/09/2019
REPORT_START_TIME    00:00:00
END_DATE             05/10/2019
END_TIME             00:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          00:01:00
WET_STEP             00:01:00
DRY_STEP             00:01:00
ROUTING_STEP         1
RULE_STEP            00:00:00

INERTIAL_DAMPING     PARTIAL
NORMAL_FLOW_LIMITED  BOTH
FORCE_MAIN_EQUATION  H-W
VARIABLE_STEP        0
LENGTHENING_STEP     0
MIN_SURFAREA         0
MAX_TRIALS           8
HEAD_TOLERANCE       0.0015
SYS_FLOW_TOL         5
LAT_FLOW_TOL         5
MINIMUM_STEP         0.5
```

```
THREADS              6

[EVAPORATION]
;;Type          Parameters
;;------------- ----------
CONSTANT         0.0
DRY_ONLY         NO

[RAINGAGES]
;;               Rain      Time     Snow     Data
;;Name           Type      Intrvl   Catch    Source
;;-------------- --------- -------- -------- ----------
RG1              INTENSITY 0:10     1.0      TIMESERIES OTT_CHI_100YR_03HR

[SUBCATCHMENTS]
;;                                                   Total    Pcnt.             Pcnt.    Curb     Snow
;;Name           Raingage         Outlet           Area     Imperv   Width    Slope    Length   Pack
;;-------------- ---------------- ---------------- -------- -------- -------- -------- -------- --------
L104A            RG1              501-S            0.219057 71.429   73.2     3        0

L104B            RG1              500-S            0.09545  80       30.4     3        0

L107A            RG1              503-S            0.1256   80       84       3        0

L109A_1          RG1              504-S            0.0358   92.857   35.7     3        0

UNC-1            RG1              1001             0.051721 82.857   13.8     3        0

UNC-2            RG1              1002             0.0468   64.286   12.8     3        0


[SUBAREAS]
;;Subcatchment   N-Imperv   N-Perv     S-Imperv   S-Perv     PctZero    RouteTo    PctRouted
;;-------------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
L104A            0.013      0.25       1.57       4.67       0          OUTLET
L104B            0.013      0.25       1.57       4.67       0          OUTLET
L107A            0.013      0.25       1.57       4.67       0          OUTLET
L109A_1          0.013      0.25       1.57       4.67       0          OUTLET
UNC-1            0.013      0.25       1.57       4.67       0          PERVIOUS   100
```

```
UNC-2            0.013      0.25       1.57       4.67       0          PERVIOUS   100

[INFILTRATION]
;;Subcatchment   MaxRate    MinRate    Decay      DryTime    MaxInfil
;;-------------- ---------- ---------- ---------- ---------- ----------
L104A            76.2       13.2       4.14       7          0
L104B            76.2       13.2       4.14       7          0
L107A            76.2       13.2       4.14       7          0
L109A_1          76.2       13.2       4.14       7          0
UNC-1            76.2       13.2       4.14       7          0
UNC-2            76.2       13.2       4.14       7          0

[OUTFALLS]
;;               Invert     Outfall    Stage/Table      Tide
;;Name           Elev.      Type       Time Series      Gate     Route To
;;-------------- ---------- ---------- ---------------- -------- ----------------
1000             72.095     FIXED      72.77            NO
1001             0          FREE                        NO
1002             0          FREE                        NO
OF1              0          FREE                        NO

[STORAGE]
;;               Invert   Max.       Init.      Storage    Curve                                Evap.
;;Name           Elev.    Depth      Depth      Curve      Params                               Frac.
Infiltration parameters
;;-------------- -------- ---------- ---------- ---------- --------- --------- -------- -------- --------
----------------------
101              72.45    4.493      0          FUNCTIONAL 0         0         1.13     0        0
103              73.198   3.67       0          FUNCTIONAL 0         0         1.13     0        0
104              73.416   3.263      0          FUNCTIONAL 0         0         1.13     0        0
105              73.24    4          0          FUNCTIONAL 0         0         1.13     0        0
106              73.378   4.11       0          FUNCTIONAL 0         0         1.13     0        0
107              73.55    3.77       0          FUNCTIONAL 0         0         1.13     0        0
108              74.133   4.48       0          FUNCTIONAL 0         0         1.13     0        0
109              74.21    4.3        0          FUNCTIONAL 0         0         1.13     0        0
110              74.416   3.568      0          FUNCTIONAL 0         0         1.13     0        0
500-S            74.67    2.6        0          TABULAR    500                         0        0
501-S            74.16    2.6        0          TABULAR    501                         0        0
503-S            75.18    2.6        0          TABULAR    503                         0        0
```

```
;LMF95
504-S            76.45    2.45       0          TABULAR    504                         0        0

[CONDUITS]
;;               Inlet            Outlet                      Manning    Inlet      Outlet     Init.
Max.
;;Name           Node             Node             Length     N          Offset     Offset     Flow
Flow
;;-------------- ---------------- ---------------- ---------- ---------- ---------- ---------- ----------
----------
C1               504-S            503-S            45.12      0.013      78.58      77.71      0          0

C4               501-S            OF1              5          0.013      76.41      76.23      0          0

Pipe_11          105              101              30.78      0.013      73.54      73.39      0          0

Pipe_13          108              105              27.261     0.013      74.43      74.3       0          0

Pipe_14          106              105              15.59      0.013      73.68      73.6       0          0

Pipe_15          101              1000             35.484     0.013      72.75      72.4       0          0

Pipe_16          104              103              29.3       0.013      73.42      73.27      0          0

Pipe_17          103              101              12.192     0.013      73.23      73.2       0          0

Pipe_19          107              106              28.4       0.013      73.85      73.71      0          0

Pipe_23          109              108              7.457      0.013      74.51      74.47      0          0

Pipe_24          110              109              35         0.013      74.72      74.54      0          0


[ORIFICES]
;;               Inlet            Outlet           Orifice      Crest      Disch.     Flap Open/Close
;;Name           Node             Node             Type         Height     Coeff.     Gate Time
;;-------------- ---------------- ---------------- ------------ ---------- ---------- ---- ----------
503-IC           503-S            107              SIDE         75.18      0.572      NO   0
```

```
[WEIRS]
;;              Inlet            Outlet           Weir         Crest      Disch.     Flap     End      End

;;Name          Node             Node             Type         Height     Coeff.     Gate     Con.
Coeff.     Surcharge  RoadWidth  RoadSurf   Coeff. Curve
;;-------------- ---------------- ---------------- ------------ ---------- ---------- -------- --------
---------- ---------- ---------- ---------- ----------------
W1              503-S            500-S            TRANSVERSE   77.43      1.38       NO       0        0
       YES
W2              500-S            501-S            TRANSVERSE   76.92      1.38       NO       0        0
       YES

[OUTLETS]
;;              Inlet            Outlet           Outflow    Outlet           Qcoeff/
Flap
;;Name          Node             Node             Height     Type             QTable           Qexpon
Gate
;;-------------- ---------------- ---------------- ---------- ---------------- ---------------- ----------
----
;LMF 60
500-IC          500-S            104              74.67      FUNCTIONAL/HEAD  3.244            0.495
NO
;LMF105
501-IC          501-S            104              74.16      FUNCTIONAL/HEAD  9.797            0.5
NO
;LMF95
504-IC          504-S            109              76.45      FUNCTIONAL/HEAD  7.996            0.499
NO

[XSECTIONS]
;;Link          Shape        Geom1            Geom2      Geom3      Geom4      Barrels
;;-------------- ------------ ---------------- ---------- ---------- ---------- ----------
C1              TRAPEZOIDAL  0.1              6          1          1          1
C4              TRAPEZOIDAL  0.1              6          1          1          1
Pipe_11         CIRCULAR     0.375            0          0          0          1
Pipe_13         CIRCULAR     0.3              0          0          0          1
Pipe_14         CIRCULAR     0.3              0          0          0          1
Pipe_15         CIRCULAR     0.375            0          0          0          1
Pipe_16         CIRCULAR     0.3              0          0          0          1
```

```
Pipe_17         CIRCULAR     0.3              0          0          0          1
Pipe_19         CIRCULAR     0.3              0          0          0          1
Pipe_23         CIRCULAR     0.3              0          0          0          1
Pipe_24         CIRCULAR     0.3              0          0          0          1
503-IC          CIRCULAR     0.083            0          0          0
W1              RECT_OPEN    0.15             1          0          0
W2              RECT_OPEN    0.15             1          0          0

[TRANSECTS]
;;Transect Data in HEC-2 format
;
NC 0.02     0.02     0.013
X1 PrivateRd         2        0        6        0.0      0.0      0.0      0.0      0.0
GR 0.21     0        0        6

[LOSSES]
;;Link          Inlet      Outlet     Average    Flap Gate  SeepageRate
;;-------------- ---------- ---------- ---------- ---------- ----------
Pipe_11         0          0.06       0          NO         0
Pipe_13         0          0.06       0          NO         0
Pipe_14         0          1.32       0          NO         0
Pipe_16         0          0.21       0          NO         0
Pipe_17         0          0.21       0          NO         0
Pipe_19         0          0.06       0          NO         0
Pipe_23         0          0.64       0          NO         0
Pipe_24         0          0.39       0          NO         0

[CURVES]
;;Name          Type       X-Value    Y-Value
;;-------------- ---------- ---------- ----------
500-O           Rating     0          0
500-O                      2.5        4
500-O                      2.85       4

501-O           Rating     0          0
501-O                      2.5        30
501-O                      2.85       30

503-O           Rating     0          0
```

```
503-O                       1.5         20
503-O                       1.85        20

504-O           Rating      0           0
504-O                       2.1         10
504-O                       2.45        10

500             Storage     0           0
500                         0.9         35.57
500                         0.901       0
500                         1.83        0
500                         1.8301      44
500                         2.25        105.3
500                         2.2501      0
500                         2.6         0

501             Storage     0           0
501                         0.9         37.8
501                         0.901       0
501                         1.9         0
501                         1.901       145
501                         2.25        153
501                         2.2501      0
501                         2.6         0

503             Storage     0           0
503                         0.9         47
503                         0.901       0
503                         1.7         0
503                         1.701       4.07
503                         2.25        30.51
503                         2.2501      0
503                         2.6         0

504             Storage     0           0
504                         0.6         28
504                         0.601       0
504                         2.1         0
504                         2.13        34.3
```

```
504                         2.131       0
504                         2.45        0

[TIMESERIES]
;;Name           Date       Time       Value
;;-------------- ---------- ---------- ----------
OTT_CHI_100YR_03HR            0:00       0
OTT_CHI_100YR_03HR            0:10       6.05
OTT_CHI_100YR_03HR            0:20       7.54
OTT_CHI_100YR_03HR            0:30       10.16
OTT_CHI_100YR_03HR            0:40       15.97
OTT_CHI_100YR_03HR            0:50       40.65
OTT_CHI_100YR_03HR            1:00       178.56
OTT_CHI_100YR_03HR            1:10       54.05
OTT_CHI_100YR_03HR            1:20       27.32
OTT_CHI_100YR_03HR            1:30       18.24
OTT_CHI_100YR_03HR            1:40       13.74
OTT_CHI_100YR_03HR            1:50       11.06
OTT_CHI_100YR_03HR            2:00       9.29
OTT_CHI_100YR_03HR            2:10       8.02
OTT_CHI_100YR_03HR            2:20       7.08
OTT_CHI_100YR_03HR            2:30       6.35
OTT_CHI_100YR_03HR            2:40       5.76
OTT_CHI_100YR_03HR            2:50       5.28
OTT_CHI_100YR_03HR            3:00       4.88

[REPORT]
;;Reporting Options
INPUT      YES
CONTROLS   NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]
Node       101              MN
Node       103              MN
Node       104              MN
Node       105              MN
```

```
Node       106              MN
Node       107              MN
Node       108              MN
Node       109              MN
Node       110              MN
Link       C1               MJ
Link       C4               MJ

[MAP]
DIMENSIONS       381593.3199      5032470.5814     381690.5181      5032621.4706
UNITS            Meters

[COORDINATES]
;;Node           X-Coord          Y-Coord
;;-------------- ---------------- ----------------
1000             381686.1         5032497
1001             381665.913       5032486.153
1002             381615.954       5032603.429
OF1              381649.01        5032477.44
101              381672.3         5032530
103              381663.1         5032522
104              381634.9         5032507
105              381660.4         5032558
106              381646           5032552
107              381621.3         5032539
108              381649.8         5032583
109              381642.7         5032585
110              381609.2         5032568
500-S            381632.4         5032513
501-S            381637           5032505
503-S            381620           5032541
504-S            381635           5032594

[VERTICES]
;;Link           X-Coord          Y-Coord
;;-------------- ---------------- ----------------
C1               381641.209       5032577.877
C1               381636.55        5032572.243
C1               381616.181       5032562.601
C1               381613.255       5032558.483
W2               381634.179       5032505.488

[POLYGONS]
;;Subcatchment   X-Coord          Y-Coord
;;-------------- ---------------- ----------------
L104A            381651.362       5032484.689
L104A            381643.686       5032479.342
L104A            381643.686       5032479.342
L104A            381630.506       5032510.694
L104A            381630.506       5032510.694
L104A            381639.654       5032515.555
L104A            381639.654       5032515.555
L104A            381638.363       5032517.984
L104A            381638.363       5032517.984
L104A            381634.005       5032526.196
L104A            381634.005       5032526.196
L104A            381653.072       5032536.316
L104A            381653.072       5032536.316
L104A            381638.729       5032563.322
L104A            381638.729       5032563.322
L104A            381646.745       5032567.577
L104A            381646.745       5032567.577
L104A            381642.971       5032574.688
L104A            381642.971       5032574.688
L104A            381654.184       5032579.4
L104A            381654.184       5032579.4
L104A            381680.918       5032515.789
L104A            381680.918       5032515.789
L104A            381674.573       5032513.123
L104A            381674.573       5032513.123
L104A            381668.785       5032510.05
L104A            381668.785       5032510.05
L104A            381646.035       5032497.976
L104A            381646.035       5032497.976
L104A            381650.394       5032489.764
L104A            381650.394       5032489.764
L104A            381651.362       5032484.689
L104B            381618.603       5032539.008
```

L104B	381623.852	5032541.796
L104B	381623.852	5032541.796
L104B	381622.565	5032544.218
L104B	381622.565	5032544.218
L104B	381618.207	5032552.43
L104B	381618.207	5032552.43
L104B	381638.729	5032563.322
L104B	381638.729	5032563.322
L104B	381653.072	5032536.316
L104B	381653.072	5032536.316
L104B	381634.005	5032526.196
L104B	381634.005	5032526.196
L104B	381638.363	5032517.984
L104B	381638.363	5032517.984
L104B	381639.654	5032515.555
L104B	381639.654	5032515.555
L104B	381630.506	5032510.694
L104B	381630.506	5032510.694
L104B	381618.603	5032539.008
L107A	381605.189	5032570.919
L107A	381609.264	5032572.722
L107A	381605.596	5032579.631
L107A	381628.204	5032591.633
L107A	381630.396	5032588.057
L107A	381635.265	5032590.105
L107A	381644.342	5032588.177
L107A	381649.572	5032590.377
L107A	381654.184	5032579.4
L107A	381642.971	5032574.688
L107A	381646.745	5032567.577
L107A	381638.729	5032563.322
L107A	381618.207	5032552.43
L107A	381622.565	5032544.218
L107A	381623.852	5032541.796
L107A	381618.603	5032539.008
L107A	381605.189	5032570.919
L109A_1	381630.396	5032588.057
L109A_1	381628.204	5032591.633
L109A_1	381628.21	5032591.637
L109A_1	381624.542	5032598.546
L109A_1	381624.987	5032600.92
L109A_1	381630.41	5032603.201
L109A_1	381634.406	5032609.175
L109A_1	381640.579	5032611.771
L109A_1	381649.572	5032590.377
L109A_1	381644.342	5032588.177
L109A_1	381635.265	5032590.105
L109A_1	381630.396	5032588.057
UNC-1	381643.686	5032479.342
UNC-1	381651.362	5032484.689
UNC-1	381651.362	5032484.689
UNC-1	381650.394	5032489.764
UNC-1	381650.394	5032489.764
UNC-1	381646.035	5032497.976
UNC-1	381646.035	5032497.976
UNC-1	381668.785	5032510.05
UNC-1	381668.785	5032510.05
UNC-1	381674.573	5032513.123
UNC-1	381674.573	5032513.123
UNC-1	381680.918	5032515.789
UNC-1	381680.918	5032515.789
UNC-1	381685.324	5032505.306
UNC-1	381685.324	5032505.306
UNC-1	381643.686	5032479.342
UNC-2	381640.579	5032611.771
UNC-2	381634.406	5032609.175
UNC-2	381630.41	5032603.201
UNC-2	381624.987	5032600.92
UNC-2	381624.542	5032598.546
UNC-2	381628.21	5032591.637
UNC-2	381605.596	5032579.631
UNC-2	381609.264	5032572.722
UNC-2	381605.189	5032570.919
UNC-2	381597.738	5032588.642
UNC-2	381639.385	5032614.612
UNC-2	381640.579	5032611.771

[SYMBOLS]

```
;;Gage           X-Coord          Y-Coord
;;-------------- ---------------- ----------------
```

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)

****
Element Count
****

Number of rain gages 1
Number of subcatchments ... 6
Number of nodes 17
Number of links 17
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
RG1	OTT_CHI_100YR_03HR	INTENSITY	10 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
L104A	0.22	73.20	71.43	3.0000	RG1	501-S
L104B	0.10	30.40	80.00	3.0000	RG1	500-S
L107A	0.13	84.00	80.00	3.0000	RG1	503-S
L109A_1	0.04	35.70	92.86	3.0000	RG1	504-S
UNC-1	0.05	13.80	82.86	3.0000	RG1	1001
UNC-2	0.05	12.80	64.29	3.0000	RG1	1002

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
1000	OUTFALL	72.09	0.68	0.0	
1001	OUTFALL	0.00	0.00	0.0	
1002	OUTFALL	0.00	0.00	0.0	
OF1	OUTFALL	0.00	76.33	0.0	
101	STORAGE	72.45	4.49	0.0	
103	STORAGE	73.20	3.67	0.0	
104	STORAGE	73.42	3.26	0.0	
105	STORAGE	73.24	4.00	0.0	
106	STORAGE	73.38	4.11	0.0	
107	STORAGE	73.55	3.77	0.0	
108	STORAGE	74.13	4.48	0.0	
109	STORAGE	74.21	4.30	0.0	
110	STORAGE	74.42	3.57	0.0	
500-S	STORAGE	74.67	2.60	0.0	
501-S	STORAGE	74.16	2.60	0.0	
503-S	STORAGE	75.18	2.60	0.0	
504-S	STORAGE	76.45	2.45	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
C1	504-S	503-S	CONDUIT	45.1	1.9286	0.0130
C4	501-S	OF1	CONDUIT	5.0	3.6023	0.0130
Pipe_11	105	101	CONDUIT	30.8	0.4873	0.0130
Pipe_13	108	105	CONDUIT	27.3	0.4769	0.0130
Pipe_14	106	105	CONDUIT	15.6	0.5132	0.0130
Pipe_15	101	1000	CONDUIT	35.5	0.9864	0.0130
Pipe_16	104	103	CONDUIT	29.3	0.5120	0.0130
Pipe_17	103	101	CONDUIT	12.2	0.2461	0.0130
Pipe_19	107	106	CONDUIT	28.4	0.4930	0.0130

Pipe_23	109	108	CONDUIT	7.5	0.5364	0.0130
Pipe_24	110	109	CONDUIT	35.0	0.5143	0.0130
503-IC	503-S	107	ORIFICE			
W1	503-S	500-S	WEIR			
W2	500-S	501-S	WEIR			
500-IC	500-S	104	OUTLET			
501-IC	501-S	104	OUTLET			
504-IC	504-S	109	OUTLET			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
C1	TRAPEZOIDAL	0.10	0.61	0.10	6.20	1	1376.61
C4	TRAPEZOIDAL	0.10	0.61	0.10	6.20	1	1881.43
Pipe_11	CIRCULAR	0.38	0.11	0.09	0.38	1	122.40
Pipe_13	CIRCULAR	0.30	0.07	0.07	0.30	1	66.78
Pipe_14	CIRCULAR	0.30	0.07	0.07	0.30	1	69.28
Pipe_15	CIRCULAR	0.38	0.11	0.09	0.38	1	174.15
Pipe_16	CIRCULAR	0.30	0.07	0.07	0.30	1	69.19
Pipe_17	CIRCULAR	0.30	0.07	0.07	0.30	1	47.97
Pipe_19	CIRCULAR	0.30	0.07	0.07	0.30	1	67.90
Pipe_23	CIRCULAR	0.30	0.07	0.07	0.30	1	70.83
Pipe_24	CIRCULAR	0.30	0.07	0.07	0.30	1	69.35

****
Transect Summary
****

Transect PrivateRd

Area:

	0.0004	0.0016	0.0036	0.0064	0.0100
	0.0144	0.0196	0.0256	0.0324	0.0400
	0.0484	0.0576	0.0676	0.0784	0.0900
	0.1024	0.1156	0.1296	0.1444	0.1600
	0.1764	0.1936	0.2116	0.2304	0.2500
	0.2704	0.2916	0.3136	0.3364	0.3600
	0.3844	0.4096	0.4356	0.4624	0.4900
	0.5184	0.5476	0.5776	0.6084	0.6400
	0.6724	0.7056	0.7396	0.7744	0.8100
	0.8464	0.8836	0.9216	0.9604	1.0000
Hrad:					
	0.0200	0.0400	0.0600	0.0800	0.1000
	0.1200	0.1400	0.1600	0.1800	0.2000
	0.2200	0.2400	0.2600	0.2800	0.3000
	0.3200	0.3400	0.3600	0.3800	0.4000
	0.4200	0.4400	0.4600	0.4800	0.5000
	0.5200	0.5400	0.5600	0.5800	0.6000
	0.6200	0.6400	0.6600	0.6800	0.7000
	0.7200	0.7400	0.7600	0.7800	0.8000
	0.8200	0.8400	0.8600	0.8800	0.9000
	0.9200	0.9400	0.9600	0.9800	1.0000
Width:					
	0.0200	0.0400	0.0600	0.0800	0.1000
	0.1200	0.1400	0.1600	0.1800	0.2000
	0.2200	0.2400	0.2600	0.2800	0.3000
	0.3200	0.3400	0.3600	0.3800	0.4000
	0.4200	0.4400	0.4600	0.4800	0.5000
	0.5200	0.5400	0.5600	0.5800	0.6000
	0.6200	0.6400	0.6600	0.6800	0.7000
	0.7200	0.7400	0.7600	0.7800	0.8000
	0.8200	0.8400	0.8600	0.8800	0.9000
	0.9200	0.9400	0.9600	0.9800	1.0000

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options

```
****************
Flow Units ............... LPS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ YES
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... EXTRAN
Starting Date ............ 05/09/2019 00:00:00
Ending Date .............. 05/10/2019 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:01:00
Wet Time Step ............ 00:01:00
Dry Time Step ............ 00:01:00
Routing Time Step ........ 1.00 sec
Variable Time Step ....... NO
Maximum Trials ........... 8
Number of Threads ........ 1
Head Tolerance ........... 0.001500 m


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         0.041        71.667
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.006        10.956
Surface Runoff ...........         0.034        59.613
Final Storage ............         0.001         1.201
Continuity Error (%) .....        -0.144


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.034         0.342
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.002
External Outflow .........         0.034         0.342
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.002
Final Stored Volume ......         0.000         0.004
Continuity Error (%) .....        -0.086


********************************
Highest Flow Instability Indexes
********************************
All links are stable.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :      1.00 sec
Average Time Step           :      1.00 sec
Maximum Time Step           :      1.00 sec
Percent in Steady State     :      0.00
Average Iterations per Step :      2.00
Percent Not Converging      :      0.00


***************************
Subcatchment Runoff Summary
***************************

-----------------------------------------------------------------------------------------------------------
-------------------
```

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
L104A	71.67	0.00	0.00	12.68	50.14	7.82	57.96	0.13	101.36	0.809
L104B	71.67	0.00	0.00	8.84	56.15	5.51	61.66	0.06	45.52	0.860
L107A	71.67	0.00	0.00	8.78	56.17	5.57	61.74	0.08	60.45	0.862
L109A_1	71.67	0.00	0.00	3.12	65.20	2.01	67.21	0.02	17.58	0.938
UNC-1	71.67	0.00	0.00	10.10	58.15	60.38	60.38	0.03	25.22	0.843
UNC-2	71.67	0.00	0.00	19.97	45.13	50.80	50.80	0.02	21.82	0.709

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days	Time of Max Occurrence hr:min	Reported Max Depth Meters
1000	OUTFALL	0.67	0.68	72.77	0	00:00	0.68
1001	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
1002	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
OF1	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
101	STORAGE	0.33	0.43	72.88	0	01:16	0.43
103	STORAGE	0.05	0.16	73.36	0	01:31	0.16
104	STORAGE	0.02	0.11	73.53	0	01:30	0.11
105	STORAGE	0.30	0.42	73.66	0	01:13	0.42
106	STORAGE	0.30	0.43	73.81	0	01:13	0.43
107	STORAGE	0.30	0.41	73.96	0	01:12	0.41
108	STORAGE	0.29	0.36	74.49	0	01:13	0.36
109	STORAGE	0.30	0.36	74.57	0	01:12	0.36
110	STORAGE	0.00	0.00	74.42	0	00:00	0.00
500-S	STORAGE	0.25	2.12	76.79	0	01:33	2.12
501-S	STORAGE	0.19	2.23	76.39	0	01:29	2.23
503-S	STORAGE	0.06	2.17	77.35	0	01:12	2.17
504-S	STORAGE	0.02	0.58	77.03	0	01:11	0.58

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow LPS	Maximum Total Inflow LPS	Time of Max Occurrence days	Time of Max Occurrence hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
1000	OUTFALL	0.00	45.18	0	01:16	0	0.289	0.000
1001	OUTFALL	25.22	25.22	0	01:10	0.0312	0.0312	0.000
1002	OUTFALL	21.82	21.82	0	01:10	0.0238	0.0238	0.000
OF1	OUTFALL	0.00	0.00	0	00:00	0	0	0.000 ltr
101	STORAGE	0.00	45.18	0	01:16	0	0.288	0.003
103	STORAGE	0.00	19.32	0	01:30	0	0.186	0.000
104	STORAGE	0.00	19.32	0	01:30	0	0.186	0.006
105	STORAGE	0.00	26.10	0	01:13	0	0.1	0.008
106	STORAGE	0.00	20.01	0	01:13	0	0.0772	0.013
107	STORAGE	0.00	20.01	0	01:12	0	0.0775	0.012
108	STORAGE	0.00	6.09	0	01:12	0	0.0237	0.043
109	STORAGE	0.00	6.10	0	01:11	0	0.0241	0.057
110	STORAGE	0.00	0.00	0	00:00	0	0	0.000 ltr
500-S	STORAGE	45.52	45.52	0	01:10	0.0589	0.0589	-0.434
501-S	STORAGE	101.36	101.36	0	01:10	0.127	0.127	-0.037
503-S	STORAGE	60.45	60.45	0	01:10	0.0776	0.0776	0.008
504-S	STORAGE	17.58	17.58	0	01:10	0.0241	0.0241	-0.011

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow LPS
101	0.000	7	0	0	0.000	10	0 01:16	45.18
103	0.000	1	0	0	0.000	4	0 01:31	19.32
104	0.000	1	0	0	0.000	3	0 01:30	19.32
105	0.000	8	0	0	0.000	10	0 01:13	26.10
106	0.000	7	0	0	0.000	10	0 01:13	20.01
107	0.000	8	0	0	0.000	11	0 01:12	20.01
108	0.000	7	0	0	0.000	8	0 01:13	6.09
109	0.000	7	0	0	0.000	8	0 01:12	6.09
110	0.000	0	0	0	0.000	0	0 00:00	0.00
500-S	0.003	7	0	0	0.035	74	0 01:33	4.70
501-S	0.004	6	0	0	0.066	95	0 01:29	14.62
503-S	0.001	3	0	0	0.028	93	0 01:12	20.01
504-S	0.000	2	0	0	0.008	88	0 01:11	6.10

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow LPS	Max Flow LPS	Total Volume 10^6 ltr
1000	69.81	4.79	45.18	0.289
1001	10.72	3.37	25.22	0.031
1002	9.70	2.84	21.82	0.024
OF1	0.00	0.00	0.00	0.000
System	22.56	11.00	0.00	0.344

****
Link Flow Summary
****

Link	Type	Maximum |Flow| LPS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	CONDUIT	0.00	0 00:00	0.00	0.00	0.00
C4	CONDUIT	0.00	0 00:00	0.00	0.00	0.00
Pipe_11	CONDUIT	26.10	0 01:13	0.89	0.21	0.31
Pipe_13	CONDUIT	6.09	0 01:13	0.61	0.09	0.20
Pipe_14	CONDUIT	20.01	0 01:13	0.77	0.29	0.39
Pipe_15	CONDUIT	45.18	0 01:16	0.58	0.26	0.67
Pipe_16	CONDUIT	19.32	0 01:30	0.85	0.28	0.36
Pipe_17	CONDUIT	19.32	0 01:31	0.76	0.40	0.39
Pipe_19	CONDUIT	20.01	0 01:13	0.85	0.29	0.37
Pipe_23	CONDUIT	6.09	0 01:12	0.59	0.09	0.20
Pipe_24	CONDUIT	0.00	0 00:00	0.00	0.00	0.06
503-IC	ORIFICE	20.01	0 01:12			1.00

W1	WEIR	0.00	0	00:00	0.00
W2	WEIR	0.00	0	00:00	0.00
500-IC	DUMMY	4.70	0	01:33	
501-IC	DUMMY	14.62	0	01:29	
504-IC	DUMMY	6.10	0	01:11	

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
		---------- Fraction of Time in Flow Class ----------								
C1	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C4	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pipe_11	1.00	0.03	0.00	0.00	0.00	0.00	0.00	0.97	0.00	0.00
Pipe_13	1.00	0.03	0.00	0.00	0.00	0.00	0.00	0.97	0.00	0.00
Pipe_14	1.00	0.02	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00
Pipe_15	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.20	0.00
Pipe_16	1.00	0.02	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00
Pipe_17	1.00	0.02	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00
Pipe_19	1.00	0.02	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00
Pipe_23	1.00	0.02	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00
Pipe_24	1.00	0.94	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Thu Mar 25 13:43:24 2021
Analysis ended on: Thu Mar 25 13:43:25 2021
Total elapsed time: 00:00:01

IDs:	Outfall 1000 and 1001	
Date/Time	Total inflow	
M/d/yyyy	L/s	
5/9/2019 0:01		0.950777
5/9/2019 0:02		0.9508119
5/9/2019 0:03		0.9508119
5/9/2019 0:04		0.9508119
5/9/2019 0:05		0.9508119
5/9/2019 0:06		0.9508119
5/9/2019 0:07		0.3264973
5/9/2019 0:08		0.33944
5/9/2019 0:09		0.2648712
5/9/2019 0:10		0.2822265
5/9/2019 0:11		0.2953283
5/9/2019 0:12		0.3116265
5/9/2019 0:13		0.3234664
5/9/2019 0:14		0.3387304
5/9/2019 0:15		0.3493959
5/9/2019 0:16		0.3636466
5/9/2019 0:17		0.3732169
5/9/2019 0:18		0.3864739
5/9/2019 0:19		0.3950209
5/9/2019 0:20		0.4073032
5/9/2019 0:21		0.4148925
5/9/2019 0:22		0.4262184
5/9/2019 0:23		0.4329098
5/9/2019 0:24		0.4432972
5/9/2019 0:25		0.4491455
5/9/2019 0:26		0.4586117
5/9/2019 0:27		0.463667
5/9/2019 0:28		0.4750631
5/9/2019 0:29		0.2580751
5/9/2019 0:30		1.518476
5/9/2019 0:31		2.107027
5/9/2019 0:32		2.707811
5/9/2019 0:33		3.206957
5/9/2019 0:34		3.62249
5/9/2019 0:35		3.972112
5/9/2019 0:36		4.250993
5/9/2019 0:37		4.478855
5/9/2019 0:38		4.668828
5/9/2019 0:39		5.60664
5/9/2019 0:40		6.91423
5/9/2019 0:41		7.613604
5/9/2019 0:42		7.973953
5/9/2019 0:43		8.475277
5/9/2019 0:44		9.308743

5/9/2019 0:45	10.18405
5/9/2019 0:46	10.87457
5/9/2019 0:47	11.49625
5/9/2019 0:48	12.06051
5/9/2019 0:49	12.56813
5/9/2019 0:50	13.01639
5/9/2019 0:51	13.56098
5/9/2019 0:52	14.54694
5/9/2019 0:53	16.16498
5/9/2019 0:54	18.10834
5/9/2019 0:55	19.93575
5/9/2019 0:56	21.43737
5/9/2019 0:57	22.62928
5/9/2019 0:58	23.57232
5/9/2019 0:59	24.33351
5/9/2019 1:00	24.96476
5/9/2019 1:01	26.96746
5/9/2019 1:02	33.41048
5/9/2019 1:03	41.06437
5/9/2019 1:04	48.0123
5/9/2019 1:05	54.48807
5/9/2019 1:06	57.01112
5/9/2019 1:07	59.11285
5/9/2019 1:08	60.89581
5/9/2019 1:09	63.74362
5/9/2019 1:10	67.69788
5/9/2019 1:11	67.37609
5/9/2019 1:12	61.87542
5/9/2019 1:13	58.06367
5/9/2019 1:14	55.77443
5/9/2019 1:15	54.43546
5/9/2019 1:16	53.65287
5/9/2019 1:17	53.19409
5/9/2019 1:18	52.92463
5/9/2019 1:19	52.76604
5/9/2019 1:20	52.67223
5/9/2019 1:21	52.3191
5/9/2019 1:22	51.41916
5/9/2019 1:23	50.53656
5/9/2019 1:24	49.79869
5/9/2019 1:25	49.2067
5/9/2019 1:26	48.72713
5/9/2019 1:27	48.32443
5/9/2019 1:28	47.97006
5/9/2019 1:29	47.63961
5/9/2019 1:30	47.31047
5/9/2019 1:31	46.87427

5/9/2019 1:32	46.11203
5/9/2019 1:33	44.09
5/9/2019 1:34	41.53326
5/9/2019 1:35	40.30791
5/9/2019 1:36	39.91575
5/9/2019 1:37	39.67752
5/9/2019 1:38	39.46999
5/9/2019 1:39	39.27885
5/9/2019 1:40	39.09929
5/9/2019 1:41	38.89265
5/9/2019 1:42	38.63886
5/9/2019 1:43	38.3699
5/9/2019 1:44	38.1013
5/9/2019 1:45	37.84056
5/9/2019 1:46	37.58942
5/9/2019 1:47	37.34734
5/9/2019 1:48	37.1123
5/9/2019 1:49	36.88164
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5/9/2019 1:51	36.409
5/9/2019 1:52	36.13544
5/9/2019 1:53	35.84594
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5/9/2019 1:56	34.93807
5/9/2019 1:57	34.62627
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5/9/2019 1:59	33.97873
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5/9/2019 2:01	33.27046
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5/9/2019 2:04	31.85556
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5/9/2019 2:06	30.78326
5/9/2019 2:07	30.42697
5/9/2019 2:08	30.1585
5/9/2019 2:09	29.9351
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5/9/2019 2:16	28.29846
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5/9/2019 2:24	26.00822
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5/9/2019 2:40	21.3504
5/9/2019 2:41	21.31271
5/9/2019 2:42	21.27294
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5/9/2019 2:48	20.91764
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5/9/2019 3:37	8.265776
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5/9/2019 3:49	2.969332
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5/9/2019 3:52	2.92619

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5/9/2019 3:56	2.874473
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5/9/2019 4:14	2.658896
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5/9/2019 4:16	2.633937
5/9/2019 4:17	2.621367
5/9/2019 4:18	2.608678
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5/9/2019 4:20	2.582983
5/9/2019 4:21	2.569968
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5/9/2019 4:23	2.543546
5/9/2019 4:24	2.530136
5/9/2019 4:25	2.516616
5/9/2019 4:26	2.502941
5/9/2019 4:27	2.489107
5/9/2019 4:28	2.475135
5/9/2019 4:29	2.461018
5/9/2019 4:30	2.446748
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5/9/2019 4:32	2.417733
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5/9/2019 4:34	2.388014
5/9/2019 4:35	2.372731
5/9/2019 4:36	2.357185
5/9/2019 4:37	2.341515
5/9/2019 4:38	2.32571
5/9/2019 4:39	2.309734

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5/9/2019 4:41	2.277161
5/9/2019 4:42	2.260866
5/9/2019 4:43	2.244429
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5/9/2019 4:46	2.192698
5/9/2019 4:47	2.174821
5/9/2019 4:48	2.156607
5/9/2019 4:49	2.138072
5/9/2019 4:50	2.119208
5/9/2019 4:51	2.100007
5/9/2019 4:52	2.080454
5/9/2019 4:53	2.060541
5/9/2019 4:54	2.040354
5/9/2019 4:55	2.019759
5/9/2019 4:56	1.998674
5/9/2019 4:57	1.977098
5/9/2019 4:58	1.955024
5/9/2019 4:59	1.932432
5/9/2019 5:00	1.909299
5/9/2019 5:01	1.885589
5/9/2019 5:02	1.861287
5/9/2019 5:03	1.836397
5/9/2019 5:04	1.810778
5/9/2019 5:05	1.784437
5/9/2019 5:06	1.757233
5/9/2019 5:07	1.729151
5/9/2019 5:08	1.700199
5/9/2019 5:09	1.6702
5/9/2019 5:10	1.639049
5/9/2019 5:11	1.60666
5/9/2019 5:12	1.572924
5/9/2019 5:13	1.537888
5/9/2019 5:14	1.50121
5/9/2019 5:15	1.462536
5/9/2019 5:16	1.421658
5/9/2019 5:17	1.378501
5/9/2019 5:18	1.332479
5/9/2019 5:19	1.28302
5/9/2019 5:20	1.229499
5/9/2019 5:21	1.173921
5/9/2019 5:22	1.108944
5/9/2019 5:23	1.031158
5/9/2019 5:24	0.9243046
5/9/2019 5:25	0.6164418
5/9/2019 5:26	0.5906948

5/9/2019 5:27	0.2625262
5/9/2019 5:28	0.3220116
5/9/2019 5:29	0.06247342
5/9/2019 5:30	0.2187267
5/9/2019 5:31	0.01644515
5/9/2019 5:32	0.1544077
5/9/2019 5:33	0.01284394
5/9/2019 5:34	0.1350162
5/9/2019 5:35	0.038254
5/9/2019 5:36	0.1100924
5/9/2019 5:37	0.06694423
5/9/2019 5:38	0.1040504
5/9/2019 5:39	0.06838132
5/9/2019 5:40	0.1017192
5/9/2019 5:41	0.07001437
5/9/2019 5:42	0.09916511
5/9/2019 5:43	0.07126869
5/9/2019 5:44	0.09672046
5/9/2019 5:45	0.07197578
5/9/2019 5:46	0.09441677
5/9/2019 5:47	0.07221854
5/9/2019 5:48	0.09218431
5/9/2019 5:49	0.07203592
5/9/2019 5:50	0.08996691
5/9/2019 5:51	0.07154558
5/9/2019 5:52	0.08772023
5/9/2019 5:53	0.07075803
5/9/2019 5:54	0.08544727
5/9/2019 5:55	0.06970081
5/9/2019 5:56	0.08314553
5/9/2019 5:57	0.06840262
5/9/2019 5:58	0.08067794
5/9/2019 5:59	0.0668868
5/9/2019 6:00	0.07814796
5/9/2019 6:01	0.06517203
5/9/2019 6:02	0.07550008
5/9/2019 6:03	0.06326532
5/9/2019 6:04	0.0727567
5/9/2019 6:05	0.06117211
5/9/2019 6:06	0.06993597
5/9/2019 6:07	0.05894865
5/9/2019 6:08	0.06697528
5/9/2019 6:09	0.05656606
5/9/2019 6:10	0.0639262
5/9/2019 6:11	0.05403445
5/9/2019 6:12	0.06081692
5/9/2019 6:13	0.05136012

5/9/2019 6:14	0.05759676
5/9/2019 6:15	0.0485633
5/9/2019 6:16	0.05429791
5/9/2019 6:17	0.04564812
5/9/2019 6:18	0.05092518
5/9/2019 6:19	0.0426044
5/9/2019 6:20	0.04684473
5/9/2019 6:21	0.03944909
5/9/2019 6:22	0.04336593
5/9/2019 6:23	0.03621325
5/9/2019 6:24	0.03983656
5/9/2019 6:25	0.03290319
5/9/2019 6:26	0.03625513
5/9/2019 6:27	0.02892818
5/9/2019 6:28	0.03201371
5/9/2019 6:29	0.02547263
5/9/2019 6:30	0.02832813
5/9/2019 6:31	0.02197166
5/9/2019 6:32	0.0246154
5/9/2019 6:33	0.01842822
5/9/2019 6:34	0.02087952
5/9/2019 6:35	0.01471583
5/9/2019 6:36	0.01732684
5/9/2019 6:37	0.01147616
5/9/2019 6:38	0.01359848
5/9/2019 6:39	0.007893185
5/9/2019 6:40	0.009865462
5/9/2019 6:41	0.004304739
5/9/2019 6:42	0.006139037
5/9/2019 6:43	0.000717268
5/9/2019 6:44	0.00242536
5/9/2019 6:45	0.00327996
5/9/2019 6:46	0.001590353
5/9/2019 6:47	0.006735435
5/9/2019 6:48	0.00522662
5/9/2019 6:49	0.01024177
5/9/2019 6:50	0.008827401
5/9/2019 6:51	0.01371853
5/9/2019 6:52	0.01238562
5/9/2019 6:53	0.01715109
5/9/2019 6:54	0.01588981
5/9/2019 6:55	0.0205329
5/9/2019 6:56	0.01892414
5/9/2019 6:57	0.02352389
5/9/2019 6:58	0.02239928
5/9/2019 6:59	0.02681956
5/9/2019 7:00	0.02574442

5/9/2019 7:01	0.03004817
5/9/2019 7:02	0.02901628
5/9/2019 7:03	0.0332025
5/9/2019 7:04	0.03220383
5/9/2019 7:05	0.03627332
5/9/2019 7:06	0.03530153
5/9/2019 7:07	0.03925189
5/9/2019 7:08	0.03829957
5/9/2019 7:09	0.04270585
5/9/2019 7:10	0.04178288
5/9/2019 7:11	0.04550962
5/9/2019 7:12	0.0445951
5/9/2019 7:13	0.04820511
5/9/2019 7:14	0.04729566
5/9/2019 7:15	0.05078789
5/9/2019 7:16	0.04987831
5/9/2019 7:17	0.05325532
5/9/2019 7:18	0.05233848
5/9/2019 7:19	0.05559951
5/9/2019 7:20	0.05467697
5/9/2019 7:21	0.05782031
5/9/2019 7:22	0.0568813
5/9/2019 7:23	0.06058551
5/9/2019 7:24	0.05961975
5/9/2019 7:25	0.06251653
5/9/2019 7:26	0.06153282
5/9/2019 7:27	0.06431176
5/9/2019 7:28	0.06330087
5/9/2019 7:29	0.06596427
5/9/2019 7:30	0.06492928
5/9/2019 7:31	0.06747331
5/9/2019 7:32	0.06640032
5/9/2019 7:33	0.06882619
5/9/2019 7:34	0.067725
5/9/2019 7:35	0.07003173
5/9/2019 7:36	0.06889441
5/9/2019 7:37	0.07108432
5/9/2019 7:38	0.06990709
5/9/2019 7:39	0.07199375
5/9/2019 7:40	0.07025472
5/9/2019 7:41	0.07220498
5/9/2019 7:42	0.07094089
5/9/2019 7:43	0.07277015
5/9/2019 7:44	0.07146333
5/9/2019 7:45	0.07318364
5/9/2019 7:46	0.0718304
5/9/2019 7:47	0.07343841

C.3 PRE-DEVELPMENT AND TARGET RELEASE RATE CALCULATIONS

100 Year Target Flow Rates

Parameters from IBI Groups Storm Sewer Design Sheet for Spring Valley completed on July 2006.

Subcatchment Area	Area Without ROW (ha)	I (mm/hr)	C	Target Flow Rate (L/s)
Subcatchment 1	0.19	78.60	0.80	33.2
Subcatchment 2	0.10	104.19	0.80	23.2
Subcatchment 3	0.08	104.19	0.80	18.5
Total				**74.9**

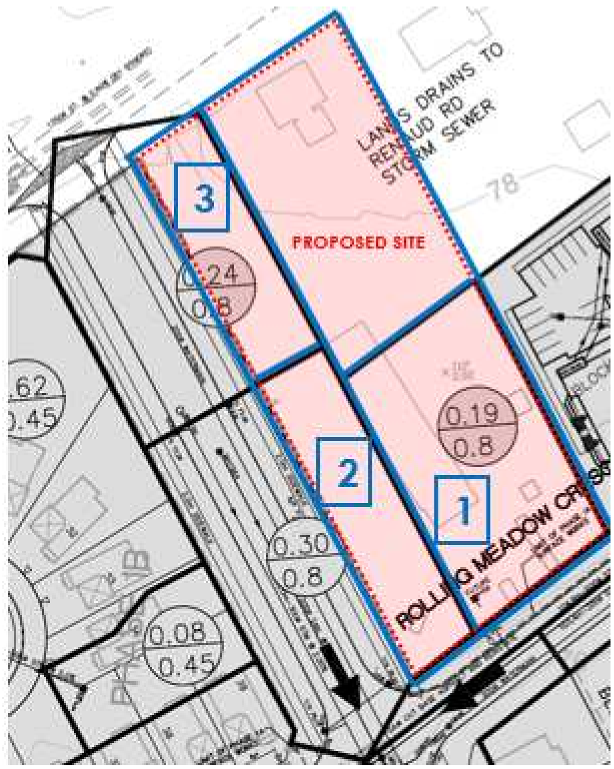
$Q = 2.78 CIA$
Where:

- Q = peak flow rate, L/s
- A = drainage area,
- I = rainfall intensity, mm/hr
- C = site runoff coefficient

Subcatchment 1
$Q = 2.78(0.8)(78.60)(0.19)$
Q = 33.21 L/s

Subcatchment 2
$Q = 2.78(0.8)(104.19)(0.10)$
Q = 23.17 L/s

Subcatchment 3
$Q = 2.78(0.8)(104.19)(0.08)$
Q = 18.54 L/s



Area = 0.02ha
C = 0.61
I = 178.6mm/hr
100 year Q = 6.1L/s
RENAUD ROAD
SADDLERIDGE DRIVE
ROLLING MEADOW CRESCENT
JOB BENCHMARK No. 2
TOS ON FIRE HYDRANT
ELEV=77.76
JOB BENCHMARK No. 1
TOS ON FIRE HYDRANT
ELEV=77.83
ASPHALT DRIVEWAY
GRAVEL SURFACE
GRAVEL DRIVEWAY
REMAINS OF ASPHALT SURFACE
EX. CONCRETE SIDEWALK
EX. CONCRETE CURB
C/L EX. DITCH
EX.200mm Ø PVC DR18 WATERMAIN
APPROXIMATE CROWN OF ROAD
EX. 70.08m - 200mmØ SANITARY SEWER @ 1.49%±
EX. 79.15m - 300mmØ PVC STORM SEWER @ 2.00%±
EX. 120m - 1350mmØ CONC
CL100-D STORM SEWER @ 0.75%±

C.4 CHANNEL CONVEYANCE AND ORIFICE CAPACITY CALCULATIONS

Job # 160401467 - 6102 Renaud Road

Date: 31-Mar-21

Channel Conveyance Design

Flows Directed to Dry Pond 3 - CBMH-503

Expected Flow Depth

n=	0.013	
Depth =	0.086	m
A=	0.133	m2
P=	4.590	
R=	0.029	
S=	0.015	
Q=	0.119	m3/s
V=	0.890	m/s

$$R = \frac{A}{P}$$

$$V = \frac{Q}{A}$$

$$Q = \frac{A}{n} R^{2/3} \sqrt{S}$$

$$Fr = \sqrt{\frac{Q^2 T}{g A^3}}$$

100 Year Flow Generated in Subcatchment L107A(value from PCSWMM) =	60.5	L/s
100 Year + 20% Flow Generated in Subcatchment L107A(value from PCSWMM) =	73.1	L/s
Full Flow Channel Capacity =	118.8	L/s

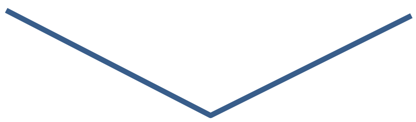
Channel OK

Job # 160401467 - 6102 Renaud Road

Date: 1-Apr-21

Channel Conveyance Design

Depressed Curb Directed to Dry Pond 3



$$R = \frac{A}{P}$$

$$V = \frac{Q}{A}$$

$$Q = \frac{A}{n} R^{2/3} \sqrt{S}$$

$$Fr = \sqrt{\frac{Q^2 T}{g A^3}}$$

Expected Flow Depth

n=	0.013	
Depth =	0.06	m
A=	0.105	m2
P=	3.502	
R=	0.030	
S=	0.015	
Q=	0.095	m3/s
V=	0.909	m/s

100 Year Flow Generated in Subcatchment L107A(value from PCSWMM) =	60.5	L/s
100 Year + 20% Flow Generated in Subcatchment L107A(value from PCSWMM) =	73.1	L/s
Full Flow Channel Capacity =	95.5	L/s

Channel OK

Job # 160401467 - 6102 Renaud Road

Date: 31-Mar-21

Channel Conveyance Design

Flows Directed to Dry Pond 2- CBMH-500

Expected Flow Depth

n=	0.013	
Depth =	0.084	m
A=	0.127	m2
P=	4.080	
R=	0.031	
S=	0.007	
Q=	0.081	m3/s
V=	0.636	m/s

$$R = \frac{A}{P}$$

$$V = \frac{Q}{A}$$

$$Q = \frac{A}{n} R^{2/3} \sqrt{S}$$

$$Fr = \sqrt{\frac{Q^2 T}{g A^3}}$$

100 Year Flow Generated in Subcatchment L104B(value from PCSWMM) =	45.5	L/s
100 Year + 20% Flow Generated in Subcatchment L107A(value from PCSWMM) =	55.3	L/s
Full Flow Channel Capacity =	80.6	L/s

Channel OK

Job # 160401467 - 6102 Renaud Road

Date: 31-Mar-21

Channel Conveyance Design

Flows Directed to Dry Pond 1 - CBMH-501

<u>Expected Flow Depth</u>

n=	0.013	
Depth =	0.0925	m
A=	0.155	m2
P=	4.080	
R=	0.038	
S=	0.007	
Q=	0.113	m3/s
V=	1.218	m/s

$$R = \frac{A}{P}$$

$$V = \frac{Q}{A}$$

$$Q = \frac{A}{n} R^{2/3} \sqrt{S}$$

$$Fr = \sqrt{\frac{Q^2 T}{g A^3}}$$

100 Year Flow Generated in Subcatchment L104A(value from PCSWMM) =	101.4	L/s
100 Year + 20% Flow Generated in Subcatchment L107A(value from PCSWMM) =	124.4	L/s
Full Flow Channel Capacity =	112.7	L/s

Channel OK

Job # 160401467 - 6102 Renaud Road

Date: 31-Mar-21

Orifice Equation for CBMH 504

$$Q = Cd * A\sqrt{2gh}$$

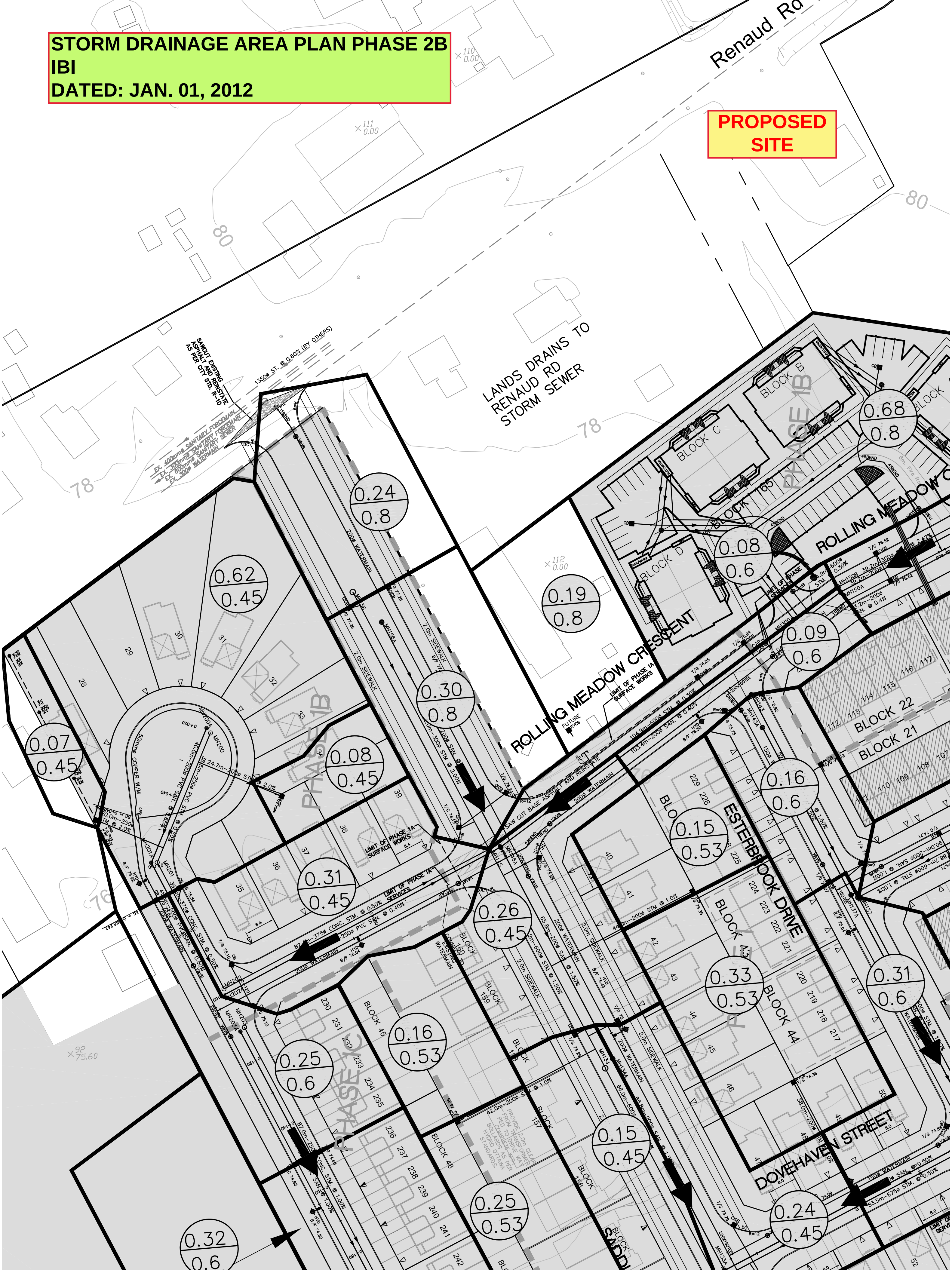
Cd=	0.61
A=	0.59
g=	9.81
h=	0.02

100 Year Peak Runoff Generated in Subcatchment L109A(value from PCSWMM) =	17.58	L/s
100 Year + 20% Peak Runoff Generated in Subcatchment L109A(value from PCSWMM) =	21.14	L/s
Full Flow Orifice Capacity =	224.97	L/s

Orifice Capacity OK

C.5 BACKGROUND EXCERPTS (STORM DRAINAGE)

STORM DRAINAGE AREA PLAN PHASE 2B
IBI
DATED: JAN. 01, 2012



IBI GROUP	CCL/IBI 1770 WOODWARD DRIVE OTTAWA, ONTARIO K2C OP8	STORM SEWER DESIGN SHEET		PAGE:	1 OF 2
		PROJECT:	SPRING VALLEY	JOB #:	3625-LD
		LOCATION:	CITY OF OTTAWA	DATE:	JULY 2006
		DEVELOPER:	CLARIDGE HOMES	DESIGN:	DY

LOCATION			AREA (Ha.)							DESIGN FLOW					SEWER DATA						
STREET	FROM MH	TO MH	C= 0.25	C= 0.45	C= 0.53	C= 0.6	C= 0.8	INDIV. 2.78AC	ACCUM. 2.78AC	INLET (min.)	TIME IN PIPE	TOTAL	I (mm/Hr)	PEAK FLOW (l/s)	CAP. (l/s)	LENGTH (M)	PIPE (mm)	SLOPE (%)	n	VEL. (M/s)	AVAIL. CAP. (%)
Street 1	Stub	116				1.40		2.34	2.34	15.00	0.29	15.29	83.60	**195.62**	**317.31**	25.0	525	0.5	0.013	1.42	38.35%
Joshua Avenue	116	108		0.39				0.49	2.83	15.00	0.59	15.59	83.60	**236.59**	**274.17**	58.8	450	0.85	0.013	1.67	13.71%
Joshua Avenue	108	104						0.00	2.83	15.59	0.05	15.63	81.70	**231.21**	**473.15**	7.9	450	2.53	0.013	2.882	51.13%
Joshua Avenue	104B	104		0.16				0.20	0.20	10.00	0.36	10.36	104.20	**20.84**	**87.71**	37.0	250	2	0.013	1.731	76.24%
Felicity Crescent	104	103						0.00	3.03	15.63	0.20	15.83	81.60	**247.25**	**515.18**	37.0	450	3	0.013	3.138	52.01%
Felicity Crescent	103	102	0.430	0.45				0.86	3.89	15.83	0.59	16.42	81.00	**315.09**	**511.50**	81.0	525	1.3	0.013	2.289	38.40%
Felicity Crescent	102	101		0.88				1.10	4.99	16.42	0.53	16.95	79.20	**395.21**	**527.14**	75.5	525	1.38	0.013	2.359	25.03%
Rolling Meadow Crescent	155	154				0.09		0.15	0.15	15.00	0.46	15.46	83.60	**12.54**	**103.82**	56.9	250	2.8	0.013	2.049	87.92%
Rolling Meadow Crescent	154	153				0.20		0.33	0.48	15.46	0.20	15.66	82.10	**39.41**	**131.59**	31.2	250	4.5	0.013	2.597	70.05%
Rolling Meadow Crescent	153	152				0.55		0.92	1.40	15.66	0.51	16.17	81.50	**114.10**	**131.59**	79.6	250	4.5	0.013	2.597	13.29%
Rolling Meadow Crescent	152	151				0.00		0.00	1.40	16.17	0.18	16.35	79.90	**111.86**	**214.01**	31.3	300	4.5	0.013	2.933	47.73%
Rolling Meadow Crescent	151	150B				0.18		0.30	1.70	16.35	0.30	16.66	79.40	**134.98**	**156.95**	39.2	300	2.42	0.013	2.151	14.00%
Rolling Meadow Crescent	150B	300				0.08	0.87	2.07	3.77	16.66	0.21	16.86	78.60	**296.32**	**350.82**	14.9	600	0.3	0.013	1.202	15.53%
Rolling Meadow Crescent	300	145						0.00	3.77	16.86	1.46	18.32	78.00	**294.06**	**350.82**	104.9	600	0.3	0.013	1.202	16.18%
Saddleridge Drive	156	145					0.54	1.20	1.20	10.00	0.68	10.68	104.20	**125.04**	**142.65**	80.0	300	2	0.013	1.955	12.34%
Gossamer	200	201		0.15				0.19	0.19	15.00	0.74	15.74	83.60	**15.88**	**43.88**	38.5	250	0.5	0.013	0.866	63.80%
Gossamer	201	202		0.62				0.78	0.97	15.74	0.58	16.32	81.20	**78.76**	**129.29**	39.3	375	0.5	0.013	1.134	39.08%
Prairie	202	145		0.31				0.39	1.36	16.32	1.21	17.53	79.50	**108.12**	**129.29**	82.4	375	0.5	0.013	1.134	16.37%
Saddleridge Drive	145	134		0.26	0.310			0.78	7.11	18.32	0.42	18.74	74.20	**527.56**	**784.53**	68.2	600	1.5	0.013	2.688	32.75%
Saddleridge Drive	134	133						0.00	7.11	18.74	0.41	19.15	73.10	**519.74**	**784.53**	66.0	600	1.5	0.013	2.688	33.75%
External		143B	4.200					2.92	2.92	20.00	0.11	20.11	70.30	**205.28**	**205.33**	12.0	375	1.26	0.013	1.801	0.03%
Rolling Meadow Crescent	143B	142				0.12		0.20	3.12	20.11	0.05	20.17	70.00	**218.40**	**306.11**	8.7	375	2.8	0.013	2.685	28.65%
Rolling Meadow Crescent	142	141				0.40		0.67	3.79	20.17	0.53	20.69	69.90	**264.92**	**306.11**	84.7	375	2.8	0.013	2.685	13.46%
Rolling Meadow Crescent	141	140						0.00	3.79	20.69	0.24	20.93	68.80	**260.75**	**306.11**	38.2	375	2.8	0.013	2.685	14.82%
Rolling Meadow Crescent	140	139				0.82		1.37	5.16	20.93	0.46	21.39	68.30	**352.43**	**579.86**	97.3	450	3.8	0.013	3.532	39.22%
Rolling Meadow Crescent	139	138				0.38		0.63	5.79	21.39	0.29	21.68	67.30	**389.67**	**448.70**	35.3	525	1	0.013	2.008	13.16%
Rolling Meadow Crescent	138	137				0.40		0.67	6.46	21.68	0.67	22.35	66.80	**431.53**	**640.64**	88.7	600	1	0.013	2.195	32.64%

Q = Peak Flow in Litres per Second (l/s)
A = Area in Hectares (ha.)
I = Rainfall Intensity in Millimeters per Hour (mm/hr) `
C = Runoff Coefficient

I=998.07/(6.053 +TC)^0.814

REV. # : July 22, 2008

Stantec

RENAUD RD. DESIGN

ULTIMATE CONDITIONS

DATE: 1/31/2020 8:48

REVISION:

DESIGNED BY: NPC

CHECKED BY:

FILE NUMBER: 1604-00704

STORM SEWER DESIGN SHEET

(City of Ottawa)

DESIGN PARAMETERS

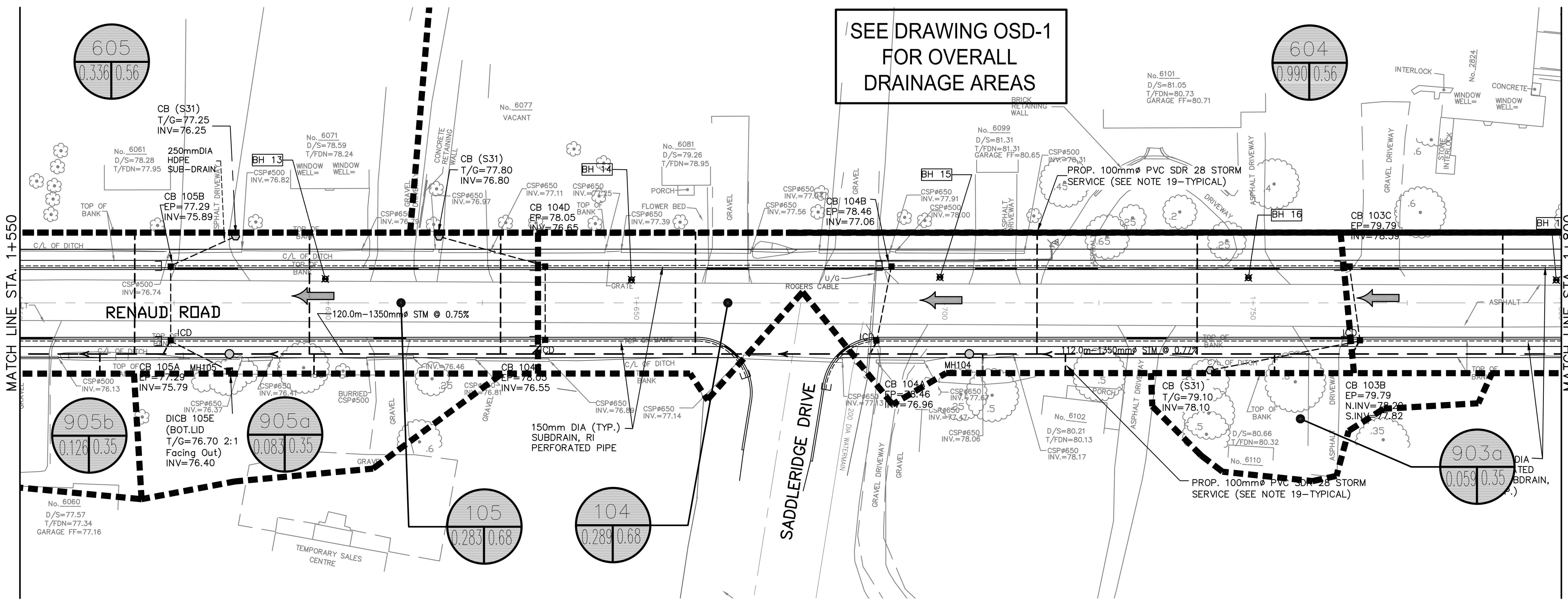
$I = a / (t+b)^c$ (As per City of Ottawa Guidelines, 2004)

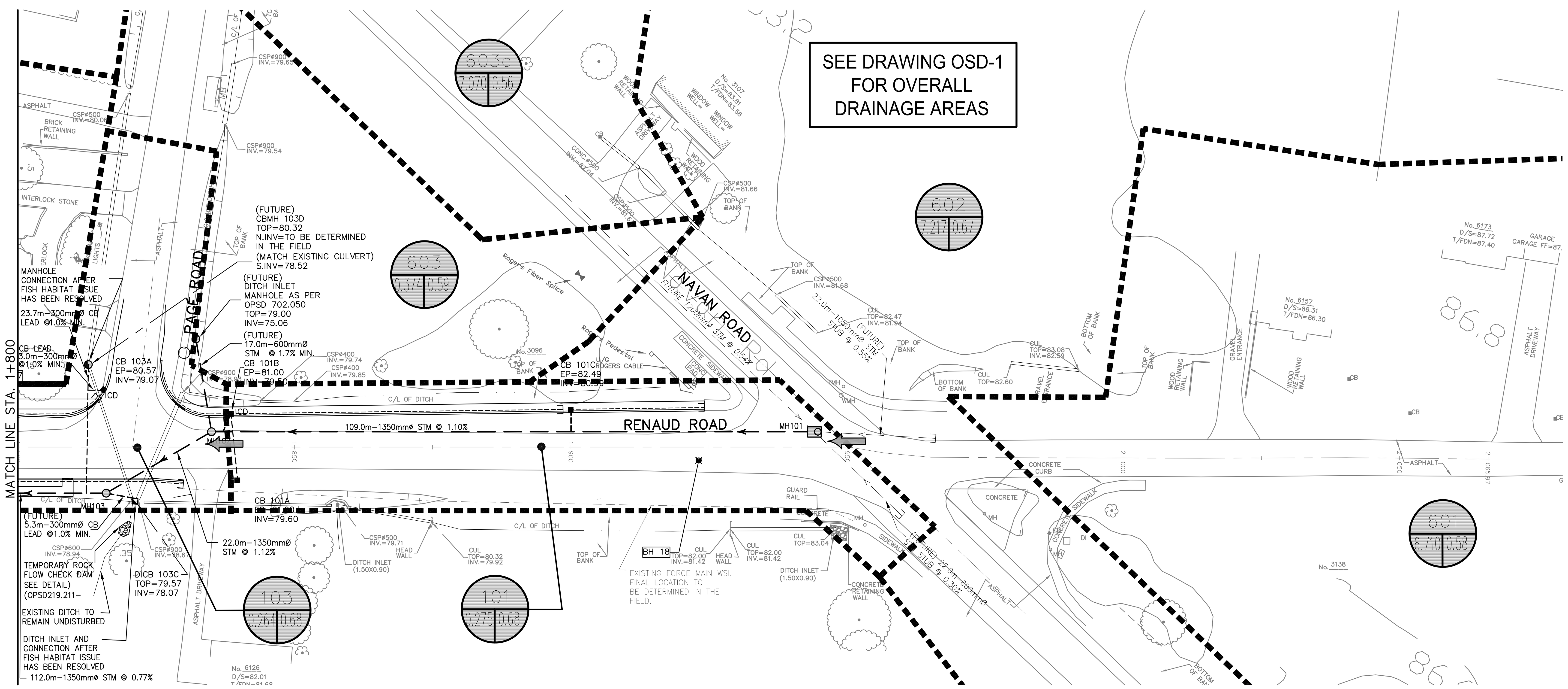
	1:5 yr	1:10 yr			
a =	998.07	1174.184	MANNING'S n =	0.013	
b =	6.053	6.014	MINIMUM COVER:	2.00	m
c =	0.814	0.816	TIME OF ENTRY	15	min

LOCATION			DRAINAGE AREA															PIPE SELECTION							
Contributing Area	FROM M.H.	TO M.H.	AREA (ha)	C (-)	EUC A (ha)	EUC C (-)	ACCUM. AREA (ha)	A x C (ha)	ACCUM. AxC (ha)	EUC ACCUM AxC	T of C (min)	I (mm/h)	Indiv. Arterial Area (ha)	Accum. Arterial 2.78AxC (ha)	Arterial Intensity 10 yr	Arterial Flow (L/s)	Total FLOW (L/s)	LENGTH (m)	PIPE SIZE (mm)	SLOPE %	Q_{CAP} (FULL) (L/s)	Q_{ACT}/Q_{CAP} (-)	VEL. (FULL) (m/s)	VEL. (ACT) (m/s)	TIME OF FLOW (min)
603b (Sewer by others)	603b	603a	0.00	0.00	9.12	0.56	9.12	5.08	5.08	5.08	22.00	66.15	1.80	4.10	77.39	317.5	1250.2	150.0	1050	0.30	1560.4	0.80	1.75	1.82	1.38
603a (Sewer by others)	603a	603	0.00	0.00	6.69	0.55	15.81	3.65	8.72	8.72	23.38	63.62	0.38	4.97	74.42	369.8	1911.4	110.0	1200	0.45	2728.5	0.70	2.34	2.41	0.76
											24.14														
601a (Sewer by others)	601a	601	0.00	0.00	5.95	0.57	5.95	3.41	3.41	3.41	21.00	68.13	0.00	0.00	79.72	0.0	645.3	90.0	750	0.35	687.1	0.94	1.51	1.73	0.87
601 (Sewer by others)	601	602	0.00	0.00	6.71	0.58	12.66	3.88	7.29	7.29	21.87	66.41	0.00	0.00	77.69	0.0	1344.1	220.0	900	0.55	1400.7	0.96	2.13	2.46	1.49
602 (Sewer by others)	602	603	0.00	0.00	6.16	0.67	18.82	4.13	11.42	11.42	23.35	63.66	1.75	3.99	74.46	297.1	2316.0	62.0	1200	0.55	3012.1	0.77	2.58	2.77	0.37
											23.73														
603 (sewer by others)	*603*	*MH101-A*	*0.00*	*0.00*	*0.93*	*0.73*	*35.56*	*0.68*	*20.82*	*20.82*	*24.14*	*62.31*	*0.00*	*8.96*	*72.88*	*653.0*	*4256.5*	*40.0*	*1350*	*1.00*	*5568.4*	*0.76*	*3.77*	*4.03*	*0.17*
101 (sewer by others)	*MH101-A*	*MH102*	*0.28*	*0.00*	*0.00*	*0.00*	*35.84*	*0.00*	*20.82*	*20.82*	*24.30*	*62.03*	*0.00*	*8.96*	*72.56*	*650.1*	*4237.6*	*40.0*	*1350*	*1.00*	*5568.4*	*0.76*	*3.77*	*4.03*	*0.17*
	MH102	MH103	0.00	0.68	0.00	0.00	35.84	0.00	20.82	20.82	24.47	61.76	0.00	8.96	72.23	647.2	4218.9	18.9	1350	1.11	5869.6	0.72	3.97	4.17	0.08
103, 604	MH103	MH104	0.26	0.68	1.29	0.67	37.39	1.04	21.86	21.68	24.54	61.63	0.00	8.96	72.09	645.9	4388.4	116.0	1350	0.77	4877.5	0.90	3.30	3.66	0.53
104	MH104	MH105	0.29	0.68	0.00	0.00	37.68	0.20	22.06	21.68	25.07	60.78	0.00	8.96	71.09	637.0	4360.9	120.0	1350	0.75	4822.3	0.90	3.26	3.62	0.55
105, 605	MH105	MH106	0.28	0.68	0.71	0.56	38.67	0.59	22.65	22.08	25.62	59.92	0.00	8.96	70.07	627.9	4397.1	100.0	1350	0.80	4980.5	0.88	3.37	3.72	0.45
106, 606	MH106	MH107	0.13	0.68	1.04	0.55	39.84	0.66	23.31	22.65	26.07	59.24	0.00	8.96	69.28	620.7	4455.8	88.0	1350	0.80	4966.3	0.90	3.36	3.73	0.39
107	MH107	MH108	0.25	0.68	0.00	0.00	40.09	0.17	23.48	22.65	26.47	58.65	0.00	8.96	68.59	614.6	4439.9	90.0	1350	0.80	4980.5	0.89	3.37	3.74	0.40
	MH108	MH109	0.00	0.68	0.00	0.00	40.09	0.00	23.48	22.65	26.87	58.07	0.00	8.96	67.91	608.5	4395.8	16.2	1350	0.80	4988.2	0.88	3.38	3.73	0.07
109	MH109	216	0.39	0.68	0.00	0.00	40.49	0.27	23.75	22.65	26.94	57.97	0.00	8.96	67.79	607.4	4431.0	120.0	1350	0.80	4980.5	0.89	3.37	3.74	0.53
											27.47														
110	MH110	MH111	0.16	0.68	0.00	0.00	0.16	0.11	0.11	0.00	15.00	83.56	0.0	0.0	97.85	0.0	25.7	57.0	375	0.30	100.2	0.26	0.88	0.70	1.35
											16.35														
608e (Sewer by others)	608e	MH111	0.00	0.00	5.78	0.56	5.78	3.24	3.24	3.24	15.00	83.56	0.0	0.0	97.85	0.0	751.3	170.0	900	0.22	892.9	0.84	1.36	1.54	1.84
											16.84														
111 (*Sewer by others*)	MH111	216	0.26	0.68	0.00	0.00	6.21	0.18	3.53	3.24	16.84	78.04	0.0	0.0	91.36	0.0	764.4	94.4	975	0.11	758.7	1.01	0.98	1.15	1.37
											18.22														
608c (Sewer by others)	608C	608B	0.00	0.00	8.19	0.59	8.19	4.83	4.83	4.83	19.00	72.53	0.0	0.0	84.88	0.0	973.5	60.0	825	0.50	1058.9	0.92	1.92	2.20	0.46
608b (Sewer by others)	608B	608A	0.00	0.00	4.07	0.57	12.26	2.32	7.15	7.15	19.46	71.47	0.0	0.0	83.64	0.0	1420.0	120.0	975	0.50	1653.2	0.86	2.15	2.42	0.83
608a (Sewer by others)	608A	216	0.00	0.00	4.76	0.52	17.03	2.48	9.63	9.63	20.28	69.64	0.0	0.0	81.49	0.0	1862.9	70.0	1050	0.50	2014.5	0.92	2.25	2.59	0.45
											20.73														
	To 216		0.00	0.00	0.00	0.00	63.72	0.00	36.90	35.5	27.47	57.21	0.0	8.96	66.90	599.4	6464.3								
	Area Summaries		**2.32**	**ha**	**61.40**								**3.9**												

Check		
63.72	36.903	36.903

Total site area = 67.65





Stantec Consulting Ltd.
1505 Laperriere Avenue
Ottawa ON Canada
K1Z 7T1
Tel. 613.722.4420
Fax. 613.722.2799
www.stantec.com

Legend

- A3 — DRAINAGE AREA NO.
- 0.56 — RUNOFF COEFFICIENT
- 4.61 — STORM DRAINAGE AREA (ha)
- DRAINAGE DIVIDE
- PROPOSED STORM SEWER
- PROPOSED CATCH BASIN
- EXISTING STORM SEWER
- EXISTING CATCH BASIN
- DIRECTION OF OVERLAND FLOW

Notes

1. ALL STREET 'CB's WILL BE INTERCONNECTED c/w ICD (SEE SCHEDULE)

OVERALL ICD SCHEDULE

AREA ID	ICD TYPE	MAX. INFLOW (L/s)	ICD TO BE LOCATED IN STRUCTURE
101	IPEX 'A'	21.2	CB101C
101	IPEX 'A'	21.2	CB101B
103	IPEX 'A'	21.2	CB103A
903a 103	IPEX 'A'	21.2	CB103B
104	IPEX 'A'	21.2	CB104A
604 104	IPEX 'D'	60	CB104C
905a 605 105	IPEX 'C'	39.9	CB105A
905b 105	IPEX 'A'	21.2	CB105C
606a 106 906a	IPEX 'D'	60	CB106A
606b	IPEX 'C'	39.9	DICB106C
907a 107	IPEX 'B'	30.8	CB107A
109	IPEX 'A'	21.2	CB109B
109	IPEX 'A'	21.2	CB109D
110	IPEX 'A'	21.2	CB111B

Revision		By	Appd.	YY.MM.DD
5	ISSUED FOR CONSTRUCTION	NI	TJW	10.04.01
4	ISSUED FOR TENDER	NI	TJW	09.04.17
3	ADD FRONT YARD GRADING	NI	TJW	09.02.25
2	REVISED AS PER CITY COMMENTS/ ADD BOREHOLES INFORMATION	NI	TJW	08.12.01
1	REVISED STORM SEWER ALIGNMENT AS PER CITY COMMENTS	NI	TJW	08.10.17
0	1ST SUBMISSION	NPC	MAF	08.08.12

File Name: 160400704C–SD.dwg	Dwn.	Chkd.	Dsgn.	YY.MM.DD
	NPC	MAF	TJW	08.07.16

Permit-Seal

Client/Project

CLARIDGE HOMES (CARSON) INC.

RENAUD ROAD IMPROVEMENTS

Ottawa ON Canada

Title

STORM DRAINAGE PLAN
STA 1+550 TO 2+050

Project No. 160400704

Scale 1:500 (0 5 15 25m)

Drawing No. SD-2

Sheet 11 of 12

Revision 5

V:\01-604\active\160400704_renaudroad\design\drawing\160400704C- SP & PROFILES-CE.dwg
2010-05-06 01:28PM By: mehorp

ORIGINAL SHEET – ISO A1

Appendix D PRE-CONSULTATION NOTES

6102 Renaud Rd. – Pre-consultation Notes

August 30, 2018, 1:00-2:30 PM – Room 4103E, City Hall

Proposal Summary

The applicant is proposing to change the zoning for the subject property in order to allow for the development of four blocks of back-to-back towns, containing a total of 52 units. Three primary accesses are provided into the site off of Saddleridge Drive, which all dead end at the rear property line.

An application for Site Plan Control (Manager Approval, Public Consultation) would be required for the above-described development concept. In addition, it was acknowledged that the site is currently zoned "Development Reserve" (DR) in the City's Zoning By-law 2008-250 and that a zoning by-law amendment would be required to rezone the site to the appropriate Third Residential Density Zone.

Staff Comments

Planning:

1. This is a pre-application consultation meeting for a Major Zoning By-law Amendment and Site Plan Control (New, Manager Approval with Public Consultation) applications. Application form, timeline and fees can be found here.
2. Please contact the Ward Councilor following the swearing in of the new Council on December 1, 2018.
3. The subject property is currently zoned "Development Reserve" (DR), which does not permit residential uses. A zoning change will be required inn order to permit the proposed blocks of back-to-back townhomes.
4. Consider solid waste management for the site. Please consult the Solid Waste Collection Design Guidelines for Multi-unit Residential Development.
5. The subject site falls within the East Urban Community – CDP for the Phase 1 Area. This plan suggests target densities for different portions of the plan area (Figure 14 – Demonstration Plan). The current proposal does not align with the CDP, as the site is currently designated as medium density, and the proposal is considered high density. Please provide an updated demonstration plan displaying the change in designation to the subject site.
6. Consider alternative building configurations, as well reducing density, in order to improve circulation throughout the site and increase amenity space.
7. Ensure that property owners are in good standing with the East Urban Community Landowners Group. The City requires evidence of payment pursuant to the cost sharing agreement as a condition of approval for site plan control agreements.
8. More information is required regarding the placement/design of sidewalks on the north side of Rolling Meadow Crescent.

Site Design:

1. A more substantial building should be located at the intersection of Saddleridge Drive and Renaud Road. Consider Low-Rise staked towns or Rear Lane Towns.
2. Driveways and garages should be discouraged fronting on Renaud Road. Alternative building typology should be considered in this location. An alternative consideration would be locating the private amenity area at this intersection, increased in size and include tree retention if possible.
3. Pairing of Driveways should be a goal for the entire site. This would allow for better tree and landscaping opportunities.
4. Please enlarge the amount of private amenity area provided. The amount required for planned unit developments is dependent on the dwelling type. Please refer to Section 137 of the City's Zoning By-law for more information.
5. A landscaped feature at the intersection of Saddleridge Drive and Renaud Road is identified on the Pathways and Gateways Map, as shown in Figure 15 of the CDP.

Parkland Dedication:

1. Cash-in-lieu of parkland will be applicable. The rate will be 1 ha per 300 units (not 1 ha per 500 units, as this area has an approved park plan in place). In the site plan conditions, we will need to make note that both the 60% and the 40% portions of the cash-in-lieu are to be flagged for the future district park in this area.

Engineering:

1. The Servicing Study Guidelines for Development Applications are available at the following address: https://documents.ottawa.ca/sites/default/files/servicing_report_template_en.pdf

2. The following Engineering plans and reports are requested for submission:

    a. Site Servicing Plan

    b. Site Servicing Report

    c. Grade Control and Drainage Plan

    d. Geotechnical Study

    e. Erosion and Sediment Control Plan

    f. Stormwater Management Report

3. Plans are to be submitted on standard **A1 size** (594mm x 841mm) sheets, utilizing an appropriate Metric scale (1:200, 1:250, 1:300, 1:400, or 1:500). With all submitted plans and reports, please provide an individual PDF format of the files.

4. Servicing and site works shall be in accordance with the following documents:

   - ⇨ Ottawa Sewer Design Guidelines (October 2012)
   - ⇨ Ottawa Design Guidelines – Water Distribution (2010)
   - ⇨ Geotechnical Investigation and Reporting Guidelines for Development Applications in the City of Ottawa (2007)
   - ⇨ City of Ottawa Slope Stability Guidelines for Development Applications (revised 2012)
   - ⇨ City of Ottawa Environmental Noise Control Guidelines (January, 2016)
   - ⇨ City of Ottawa Park and Pathway Development Manual (2012)
   - ⇨ City of Ottawa Accessibility Design Standards (2012)
   - ⇨ Ottawa Standard Tender Documents (latest version)
   - ⇨ Ontario Provincial Standards for Roads & Public Works (2013)

5. Record drawings and utility plans are also available for purchase from the City (Contact the City's Information Centre by email at InformationCentre@ottawa.ca or by phone at (613) 580-2424 ext.44455).

6. The Stormwater Management Criteria, for the subject site, is to be based on the following:

   i. The 5-yr storm event using the IDF information derived from the Meteorological Services of Canada rainfall data, taken from the MacDonald Cartier Airport, collected 1966 to 1997.

   ii. For separated sewer system built pre-1970 the design of the storm sewers are based on a 2 year storm.

   iii. The pre-development runoff coefficient or a maximum equivalent 'C' of 0.5, whichever is less (§ 8.3.7.3).

   iv. A calculated time of concentration (Cannot be less than 10 minutes).

   v. Flows to the storm sewer in excess of the 5-year storm release rate, up to and including the 100-year storm event, must be detained on site.

vi. For a combined sewer system the maximum C= 0.4 or the pre-development C value, whichever is less. In the absence of other information the allowable release rate shall be based on a 2 year storm event.

Note: There may be area specific SWM Criteria that may apply. Check for any related SWM &/or Sub-watershed studies that may have been completed.

7. Deep Services (Storm, Sanitary & Water Supply)

i. *Provide existing servicing information and the recommended location for the proposed connections. Services should ideally be grouped in a common trench to minimize the number of road cuts.*

ii. *Connections to trunk sewers and easement sewers are typically not permitted.*

iii. *Provide information on the monitoring manhole requirements – should be located in an accessible location on private property near the property line (i.e. not in a parking area).*

iv. *Review provision of a high-level sewer.*

v. *Provide information on the type of connection permitted*

Sewer connections to be made above the springline of the sewermain as per:

a. Std Dwg S11.1 for flexible main sewers – *connections made using approved tee or wye fittings.*

b. Std Dwg S11 (For rigid main sewers) – *lateral must be less than 50% the diameter of the sewermain,*

c. Std Dwg S11.2 (for rigid main sewers using bell end insert method) – *for larger diameter laterals where manufactured inserts are not available; lateral must be less that 50% the diameter of the sewermain,*

d. Connections to manholes permitted when the connection is to rigid main sewers where the lateral exceeds 50% the diameter of the sewermain. – Connect obvert to obvert with the outlet pipe unless pipes are a similar size.

e. *No submerged outlet connections.*

8. Water Boundary condition requests must include the location of the service and the expected loads required by the proposed development. Please provide the following information:

   i. Location of service

   ii. Type of development and the amount of fire flow required (as per FUS, 1999).

   iii. Average daily demand: ___ l/s.

   iv. Maximum daily demand: ___l/s.

   v. Maximum hourly daily demand: ___ l/s.

9. MOECC ECA Requirements – The applicant shall consult with the local office of the MOECC to determine which ECA, if any, are required. **NOTE: Site Plan Approval, or Draft Approval, is required before any Ministry of the Environment and Climate Change application is sent to the MOECC.**

   For residential applications: Charlie Primeau

   (613) 521-3450, ext. 251

   Charlie.Primeau@ontario.ca

   For I/C/I applications: Emily Diamond

   (613) 521-3450, ext. 238

   Emily.Diamond@ontario.ca

10. Phase 1 ESAs and Phase 2 ESAs must conform to clause 4.8.4 of the Official Plan that requires that development applications conform to Ontario Regulation 153/04.

Environmental:

1. The subject property is designated General Urban Area under Schedule A of the Official Plan

2. The subject property is designated General Urban Area under Schedule A of the Official Plan

3. There are no natural heritage system overlay features identified on Schedule L of the Official Plan.

4. There are no environmental constraints identified on Schedule K of the Official Plan

5. There are no surface water features or natural heritage features on or adjacent to the subject property

6. Recommend using locally appropriate native species for landscaping

7. Refer to Section 4 subsection 4.9 Energy Conservation through Design:

   - Provide for energy conservation through appropriate location and choice of species to provide shade and cooling during the summer and wind protection in winter;
   - Utilize native species and species with low watering requirements wherever possible; and
   - Utilize permeable, light-coloured or landscaped surfaces wherever practical to reduce heat retention and encourage natural infiltration of stormwater.

8. There is no trigger for an Environmental Impact Statement but a Tree Conservation Report is required for all plans of subdivision, site plan control applications, common elements condominium applications and vacant land condominium applications where there is a tree of 10 cm in diameter or greater on the site.

Transportation:

1. Please fill out the Transportation Impact Assessment (TIA) Screening Tool to determine if a Transportation Impact Assessment is required. Please consult Asad Yousfani (asad.yousfani@ottawa.ca) for any required clarification.
2. Please complete a noise study for the proposed development.

Regards,

Colette Gorni
Planning Student | Ètudiante en Urbanisme
Development Review | Examen des projets d'aménagement
Planning, Infrastructure and Economic Development Department | Services de la planification, de l'infrastructure et du développement économique
City of Ottawa | Ville d'Ottawa
613-580-2424 ext./poste 14743, fax/téléc: 613-560-6006
Colette.Gorni@ottawa.ca

Appendix E GEOTECHNICAL INVESTIGATION

2597237 Ontario Ltd.

Geotechnical Investigation

Type of Document
Draft

Project Name
Proposed Residential Development
6102 Renaud Road
Ottawa, Ontario

Project Number
OTT-00246046-A0

Prepared By: Susan M. Potyondy, P.Eng.

Reviewed By: Ismail M. Taki, M.Eng., P.Eng.

EXP Services Inc.
100-2650 Queensview Drive
Ottawa, ON   K2B 8H6
Canada

Date Submitted
May 18, 2018

2597237 Ontario Ltd.

Geotechnical Investigation

Type of Document:
Draft

Project Name:
Proposed Residential Development
6102 Renaud Road
Ottawa, Ontario

Project Number:
OTT-00246046-A0

Prepared By:
EXP
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Susan M. Potyondy, P.Eng.
Senior Project Manager, Geotechnical Services
Earth and Environment

Ismail M. Taki, M.Eng., P.Eng.
Manager, Geotechnical Services
Earth and Environment

Date Submitted:
May 18, 2018

Legal Notification

This report was prepared by EXP Services Inc. for the account of **2597237 Ontario Ltd.**

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. EXP Services Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this project.

Executive Summary

EXP Services Inc. (EXP) is pleased to present the results of the geotechnical investigation recently completed for the proposed new residential development to be located at 6102 Renaud Road in the City of Ottawa, ON. The site location is shown on Figure 1. This work was authorized by Mr. Sael Nemorin of 2597237 Ontario Ltd.

The subject site is approximately 0.6 hectare (1.4 acres) in size and is currently occupied by buildings that will be demolished as part of the proposed development. It is our understanding that the proposed preliminary development plans consist of four-storey apartment buildings with one underground parking level.

The fieldwork for the geotechnical investigation was undertaken from April 16 to 18, 2018 and consisted of five (5) boreholes (Borehole Nos. 1 to 5) at the locations shown on the Borehole Location Plan, Figure 2. The boreholes were advanced to termination depths from 8.1 m to 11.6 m and dynamic cone refusal depths of 26.1 m and 27.0 m below existing grade. The fieldwork was supervised on a full-time basis by a representative from EXP.

The geotechnical investigation revealed the subsurface soil conditions at the site to comprise of a surficial topsoil layer and pavement structure underlain by fill, silty sand and an extensive compressible marine clay deposit. Groundwater level measurements ranged from 0.4 m to 1.4 m depths (Elevation 76.4 m to 75.4 m).

The subsurface soils are not considered to be liquefiable.

The site is classified as **Class D** for seismic site response in accordance with Table 4.1.8.4.A of the 2012 Ontario Building Code.

The site is underlain by a compressible marine clay prone to consolidation settlement if overstressed by loads imposed on it by site grade raise, foundations and groundwater lowering resulting in settlement of foundations. Based on a review of the engineering properties of the clay, it is considered that the maximum site grade raise may be up to 1.0 m when combined with a one to two storey building with or without a basement, supported by footings founded at a 1.0 m depth below existing grade and designed for a bearing pressure at serviceability limit state (SLS) of 96 kPa and factored geotechnical resistance at ultimate limit state (ULS) of 120 kPa. Settlements of the footings designed for the SLS value above and properly constructed are expected to be within the normally tolerated limits of 25 mm total and 19 mm differential movements.

For the proposed four-storey apartment building with one level underground parking and for other types of residential building configurations requiring higher bearing pressure values than indicated above in combination with a maximum 1.0 m grade raise, the buildings may be supported by footings, raft or pile foundations in combination with soil fill and light weight fill.

Since the bearing values of foundations supported by the marine clay depend on the magnitude of the site grade raise, it is recommended that once the grade raise of the site is known and the grading plan is available, EXP be contacted to provide more detailed foundation recommendations.

For the pile foundation option, an additional geotechnical investigation will be required to determine the depth to bedrock.

The lowest floor slabs of the one- to two-storey buildings with or without basement may be designed on slabs on grade. Perimeter drains for buildings without a basement will not be required provided the floor slab is set at least 150 mm above the final grade. Perimeter drains will be required for buildings with a basement. The need for underfloor drains will have to be assessed during detailed design.

Subsurface basement walls should be designed to resist static lateral earth pressure and dynamic lateral earth pressure during a seismic event.

The excavations at the site may be undertaken as open cut provided they meet the requirements of the Ontario Occupational Health and Safety Act (OHSA). Seepage of water is expected in the excavations and maybe handled by conventional sump-pump techniques. High capacity pumps may be required in zones of persistent seepage.

Based on the geotechnical investigation, the majority of material required for backfilling against subsurface walls, footings and service trenches would have to be imported and should conform to the OPSS requirements of Granular B Type II and Select Subgrade Material (SSM). On-site soils may be used as backfill in landscaped areas.

The pavement structure for light duty traffic areas may consist of 65 mm of asphaltic concrete underlain by 150 mm of OPSS 1010 Granular A base and 450 mm of OPSS 1010 Granular B Type II sub-base. The pavement structure for heavy duty traffic areas may consist of 90 mm of asphaltic concrete underlain by 150 mm of OPSS 1010 Granular A base and 600 mm of OPSS 1010 Granular B Type II sub-base.

Normal Portland cement may be used in the sub-surface concrete at this site. The subsurface soils are considered to be moderately to mildly corrosive to buried steel members/structures. Appropriate measures should be undertaken to protect buried steel elements from corrosion.

Tree planting restrictions and setbacks will require consultation with a landscape architect and should be in accordance with City of Ottawa guidelines and policy.

The above and other related considerations are discussed in greater detail in the main body of this report.

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1 Introduction

EXP Services Inc. (EXP) is pleased to present the results of the geotechnical investigation recently completed for the proposed new residential development to be located at 6102 Renaud Road in the City of Ottawa, Ontario. The site location is shown on Figure 1. This work was authorized by Mr. Sael Nemorin of 2597237 Ontario Ltd. on April 4, 2018.

The subject site is approximately 0.6 hectare (1.4 acres) in size and is currently occupied by buildings that will be demolished as part of the proposed development. It is our understanding that the proposed preliminary development plans consist of four-storey apartment buildings with one underground parking level.

EXP completed a Phase I Environmental Site Assessment (ESA) of the site and the results are presented in our report dated September 18, 2017. EXP completed a Phase II ESA of the site and the results are presented in our report dated October 30, 2017.

The geotechnical investigation was undertaken to:

a) Establish the subsurface soil and groundwater conditions at the five (5) boreholes located on site and a review of the subsurface soil and groundwater conditions of boreholes from the Phase II ESA;

b) Assess the potential for liquefaction of the subsurface soils during a seismic event and classify the site for seismic site response in accordance with the requirements of the 2012 Ontario Building Code (OBC);

c) Comment on grade-raise restrictions ;

d) Make recommendations regarding the most suitable type of foundations, founding depth and bearing pressure at serviceability limit state (SLS) and factored geotechnical resistance at ultimate limit state (ULS) of the founding strata and comment on the anticipated total and differential settlements of the recommended foundation type;

e) Discuss slab-on-grade construction and permanent drainage system requirements;

f) Provide lateral earth pressure parameters for subsurface basement wall design;

g) Comment on excavation conditions and de-watering requirements during construction;

h) Provide comments regarding pipe bedding requirements;

i) Discuss backfilling requirements and suitability of on-site soils for backfilling purposes;

j) Comment on subsurface concrete requirements for buried concrete structures/members and corrosion potential of subsurface soils to buried metal structures/members;

k) Recommend pavement structures for the parking lots and access roads; and

l) Provide recommendations for the planting of trees.

The comments and recommendations given in this report assume that the above-described design concept will proceed into construction. If changes are made either in the design phase or during construction, this office must be retained to review these modifications. The result of this review may be a modification of our recommendations or it may require additional field or laboratory work to check whether the changes are acceptable from a geotechnical viewpoint.

2 Phase II ESA Information

A Phase II Environmental Site Assessment (ESA) of the site was undertaken by EXP and the results are presented in the report titled, "Phase II Environmental Site Assessment, 6102 Renaud Road, Ottawa, Ontario" dated October 30, 2017 (EXP Project No. OTT-00246046-A0).

The Phase II ESA consisted of four (4) boreholes located inside and outside the existing buildings on site. The borehole information indicates that below interior concrete slabs, the subsurface soil conditions consist of fill to a 1.8 m depth underlain by native silty clay. The boreholes terminated within the silty clay at 3.7 m to 4.8 m depths. The groundwater levels measured in the monitoring wells installed in the four (4) boreholes ranges from 1.5 m to 1.7 m depths (Elevation 76.9 m to 75.5 m).

3 Site Description

The site is located on the south side of Renaud Road and east of Saddleridge Drive in Ottawa, Ontario. The site is approximately 0.6 hectare (1.4 acres) in size and is occupied by a residential building in the north part and a commercial building in the south part of the site. The surrounding properties consist of residential development. The site location is shown in Figure 1.

Based on the approximate ground surface elevations of the boreholes ranging from Elevation 79.1 m near the front of the property along Renaud Road to Elevation 76.7 m at the rear of the property, the topography of the site is relatively flat.

4 Procedure

The fieldwork for the geotechnical investigation was undertaken from April 16 to 18, 2018 and consisted of five boreholes (Borehole Nos. 1 to 5) at the locations shown on the Borehole Location Plan, Figure 2. The boreholes were advanced to termination depths from 8.1 m to 11.6 m and dynamic cone refusal depths of 26.1 m and 27.0 m below existing grade. The fieldwork was supervised on a full-time basis by a representative from EXP.

The borehole locations and geodetic elevations were estimated from the spot elevations provided on the survey plan titled, "Part of Lot 6, Concession 4 (Ottawa Front) Geographic Township of Gloucester, City of Ottawa", dated September 22, 2017 and prepared by Annis, O'Sullivan, Vollebekk Ltd. (AOV). Therefore, the ground surface elevations indicated on the borehole logs should be considered approximate. The borehole locations were cleared of private and public underground services, prior to the start of drilling operations.

The boreholes were drilled with a CME-55 truck-mounted drill rig equipped with continuous flight hollow-stem auger equipment. Standard penetration tests (ASTM 1586) were performed in all the boreholes at 0.75 m to 3.0 m depth intervals and soil samples retrieved by the split-barrel sampler. Relatively undisturbed thin-walled tube samples (Shelby tube samples) were retrieved at selected depth intervals within the clay. The undrained shear strength of the clay was measured by conducting penetrometer and in-situ vane tests at selected depth intervals. Borehole Nos. 1 and 4 were advanced unsampled from 10.1 m to cone refusal depth of 27.0 m in Borehole No. 1 and from 19.2 m to cone refusal depth of 26.1 m in Borehole No. 4.

Groundwater levels were measured in the open boreholes upon completion of drilling. In addition, 19 mm diameter slotted standpipe piezometers were installed in three boreholes for long-term monitoring of the groundwater levels. The standpipe piezometers were installed in accordance with EXP standard practice and their installation configuration is documented on the respective borehole log.

On completion of the fieldwork, all the soil samples were transported to the EXP laboratory located in the City of Ottawa. All the borehole samples were visually examined in the laboratory by a senior geotechnical engineer for textural classification. The engineer also assigned the laboratory testing, which consisted of performing the following tests in accordance with the American Society for Testing and Materials (ASTM).

Natural Moisture Content .... 48 tests

Natural Unit Weight .... 10 tests

Grain-Size Analyses.. 2 tests

Atterberg Limits .... 4 tests

pH, Sulphate Chlorides and Resistivity Analyses .... 2 tests

Consolidation Tests.. 2 tests

5 Subsurface Soil and Groundwater Conditions

A detailed description of the subsurface soil and groundwater conditions determined from the boreholes are given on the attached borehole logs, Figure Nos. 3 to 7.

The borehole logs and related information depict subsurface conditions only at the specific locations and times indicated. Subsurface conditions and water levels at other locations may differ from conditions at the locations where sampling was conducted. The passage of time also may result in changes in the conditions interpreted to exist at the locations where sampling was conducted. Boreholes were drilled to provide representation of subsurface conditions as part of a geotechnical exploration program and are not intended to provide evidence of potential environmental conditions.

It should be noted that the soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change. The "Notes on Sample Descriptions" preceding the borehole logs form an integral part of this report and should be read in conjunction with this report.

A review of the borehole logs indicates the following soil stratigraphy with depth and groundwater level measurements.

5.1 Topsoil

A 50 mm thick surficial topsoil layer was contacted in Borehole Nos. 3 and 4.

5.2 Pavement Structure

Borehole No. 1 is located within the existing paved driveway. The pavement structure consists of 50 mm thick asphaltic concrete underlain by 150 mm thick crushed limestone gravel layer.

5.3 Fill

Fill was surficially encountered in Borehole Nos. 2 and 5 and below the topsoil in Borehole Nos. 3 and 4. The fill extends to depths of 0.7 m and 0.9 m (Elevation 76.8 m to 76.0 m). The fill consists of a mixture of gravel, silty sand with topsoil, roots, rootlets and wood debris (Borehole No. 5). Based on the N-values of 4 to 21 from the Standard Penetration Test (SPT), the fill is in a loose to compact state. The natural moisture content of the fill is 15 percent to 27 percent.

5.4 Silty Sand

The fill in Borehole No. 1 is underlain by silty sand to a 2.2 m depth (Elevation 76.9 m). Based on N-values of 8 and 13 from the SPT, the silty sand is in a loose to compact state. The natural moisture content of the silty sand ranges from 18 percent to 27 percent.

The results of the grain-size analysis of one sample of the silty sand is summarized in Table I. The grain-size distribution curve is shown in Figure 8.

Table I: Summary of Results from Grain-size Analysis – Silty Sand Sample				
Borehole - Sample No.	Depth (Elevation) (m)	Grain Size Analysis (%)		
		Gravel	Sand	Fines (Silt and Clay)
BH 1 - SS3	1.5 – 2.1 (77.6 – 77.0)	0	80	20

Based on a review of the results from the grain-size analysis, the soil may be described as a silty sand (SM) in accordance with the Unified Soil Classification System (USCS).

5.5 Clay

Sensitive marine clay was contacted beneath the fill and silty sand at 0.7 m to 0.9 m depths (Elevation 76.8 m to 76.0 m) in the five (5) boreholes. The clay consists of an upper desiccated brown crust underlain by grey clay.

5.5.1 *Brown Clay (Desiccated Crust)*

The brown clay crust was contacted in Borehole Nos. 2 to 5 and was not present in Borehole No. 1. The upper crust extends to depths ranging from 2.1 to 3.0 m depths (Elevation 75.3 m to 74.2 m). The clay crust is approximately 1.4 m to 2.1 m thick. The undrained shear strength of the crust is 82 kPa to 192 kPa indicating a stiff to very stiff consistency. The sensitivity values of the clay are 4.9 and 7.2, indicating the sensitivity of the clay may be described as sensitive. The natural moisture content and unit weight of the crust are 23 percent to 60 percent and 16.9 kN/m^3 to 19.0 kN/m^3 respectively. Grain-size analysis and Atterberg limit determination of two (2) samples of the brown clay crust are summarized in Tables II and III. The grain-size distribution curve is shown in Figure 9.

Table II: Summary of Results from Grain-size Analysis – Brown Clay Sample				
Borehole No. - Sample No.	Depth (Elevation) (m)	Grain Size Analysis (%)		
		Gravel	Sand	Fines (Silt and Clay)
BH2 – SS2	0.8 – 1.4 (76.7 – 76.1)	0	2	98

Table III: Summary of Atterberg Limit Results – Brown Clay Sample					
Borehole No. - Sample No.	**Depth (Elevation) (m)**	**Atterberg Limit Results (%)**			
		w_n	**LL**	**PL**	**PI**
BH4 – SS2	0.8 – 1.4 (75.9 – 75.3)	45	72	29	43
W_n: Natural Moisture Content; **LL**: Liquid Limit; **PL:** Plastic Limit; **PI**: Plasticity Index (1): Refer to Casagrande Plasticity Chart (1932).					

Based on a review of the results from the grain-size analysis and the Atterberg limits, the soil may be classified as a high plastic clay (CH), in accordance with the Unified Soil Classification System (USCS).

5.5.2 *Grey Clay*

The silty sand in Borehole No. 1 and the brown clay crust in Borehole Nos. 2 to 5 are underlain by the grey clay contacted at 2.1 m to 3.0 m depths (Elevation 76.9 m to 74.2 m). The undrained shear strength of the clay ranges from 29 to 86 kPa with one measurement of 115 kPa at 14.6 m (Elevation 62.1 m) in Borehole No. 4. The grey clay has a weaker zone in the upper 1.0 m in Borehole Nos. 2 and 3, as indicated by the lowest measured undrained shear strength values of 29 kPa and 34 kPa. Based on the undrained shear strength measurements the clay has a firm to stiff consistency with a very stiff zone at 14.6 m depth (Elevation 62.1 m) in Borehole No. 4. The sensitivity values of 4.6 to 18 indicate the clay has a sensitivity that may be described a sensitive to quick. The silty clay has a moisture content of 35 percent to 88 percent and a natural unit weight measured from one sample of 17.9 kN/m^3.

Atterberg limit values of the clay are summarized in Table IV.

Table IV: Summary of Atterberg Limit Results – Grey Clay Samples					
Borehole No. - Sample No.	**Depth (Elevation) (m)**	**Atterberg Limit Results (%)**			
		w_n	**LL**	**PL**	**PI**
BH3 – SS6	3.8 – 4.4 (73.6 – 72.4)	82	59	27	32
BH4 – SS8	6.1 – 6.7 (70.6 – 70.0)	78	59	25	34
BH4 – SS11	10.7 – 11.3 (66.0 – 65.4)	76	60	30	30
W_n: Natural Moisture Content; **LL**: Liquid Limit; **PL:** Plastic Limit; **PI**: Plasticity Index (1): Refer to Casagrande Plasticity Chart (1932).					

Based on a review of the results from the grain-size analysis and the Atterberg limits, the soil may be classified as a high plastic clay (CH), in accordance with the USCS.

One-dimensional oedometer (consolidation) test was conducted on two (2) thin walled tube samples of the grey clay and the results are summarized in Table V. The stress versus void ratio curves are shown in Figures 10 and 11.

Table V: One-Dimensional Oedometer (Consolidation) Test Results on Grey Clay Samples										
Borehole - Sample No.	**Depth (Elevation) (m)**	**σ'_{v0} (kPa)**	**w_c (%)**	**γ (kN/m^3)**	**σ'_p (kPa)**	**e_o**	**c_r**	**c_c**	**OCR**	**OC**
BH 1-ST8	6.1-6.7 (73.0 – 72.4)	68	84	14.9	150	2.322	0.037	2.80	2.2	82
BH 5-ST6	3.8-4.4 (73.4 – 72.8)	47	81	15.1	110	2.229	0.034	2.66	2.3	63

σ'_{v0} = estimated effective overburden pressure (kPa); w_c: natural moisture content (%), γ: estimated natural unit weight (kN/m^3) σ'_p = pre-consolidation pressure (kPa), e_o = initial void ratio; c_r = re-compression index; c_c = compression index; OCR = Over consolidation ratio; OC= over-consolidation pressure (kPa);
(1)- estimated σ'_{v0} based on May 7, 2018 groundwater level measurements.

Based on a review of the consolidation test results, the over consolidation ratio is 2.2 and 2.3 indicating the clay is over consolidated.

5.6 Inferred Boulders and Bedrock

Boulders within glacial till and bedrock are inferred at cone refusal depths of 26.1 m and 27.0 m (Elevation 52.1 m and 50.6 m) in Borehole Nos. 1 and 4. Review of published geology maps indicate the bedrock is limestone of the Ottawa Formation.

5.7 Groundwater

The groundwater level measurements taken several days following the completion of drilling in the standpipe piezometers installed in selected boreholes are summarized in Table VI.

Table VI: Summary of Groundwater Levels in Boreholes					
Borehole No.	**Ground Surface Elevation (m)**	**Drill Date**	**Date of Groundwater Level Measurement (Number of Days After Drilling)**	**Depth of Groundwater Level Below Ground Surface (m)**	**Elevation of Groundwater Level (m)**
3	76.81	April 17, 2018	May 7, 2018 (20 days)	0.4	76.4
4	76.67	April 17, 2018	May 7, 2018 (20 days)	1.3	75.4
5	77.18	April 18, 2018	May 7, 2018 (19 days)	1.4	75.8

A review of Table VI indicates that the groundwater level ranges from 0.4 m to 1.4 m depth (Elevation 76.4 m to 75.4 m).

Water levels were determined in the boreholes at the times and under the conditions stated in the scope of services. Note that fluctuations in the level of groundwater may occur due to a seasonal variation such as precipitation, snowmelt, rainfall activities, and other factors not evident at the time of measurement and therefore may be at a higher level during wet weather periods.

6 Liquefaction Potential and Seismic Site Classification

6.1 Liquefaction Potential

Based on the findings from this geotechnical investigation, it is recommended the proposed buildings be supported by footings founded on the compact zone of the silty sand and on the stiff to very stiff clay.

The compact zone of the silty sand is not considered liquefiable.

As indicated in Section 5.5 of this report, the liquid limit of the brown and grey silty clay from four (4) tested samples ranges from 59 percent to 72 percent and the plasticity index from 30 to 43 percent. Based on the results of the Atterberg limits and natural moisture contents, the brown and grey clay are not susceptible to liquefaction during a seismic event as per Bray et. al. (2004) criteria for fine-grained soils shown in Figure 12.

6.2 Seismic Site Classification

The subsoil information at this site has been examined in relation to Section 4.1.8.4 of the 2012 Ontario Building Code (OBC). The average shear-wave velocity value of the clay, inferred glacial till and bedrock to a 30-m depth was estimated.

The shear-wave velocity value of the clay deposit was correlated to the undrained shear strength values (Su) using the Dickenson, S.E. (1994)[1] formula:

$$Vs(m/s) = 23.Su^{0.475}$$

The shear-wave velocity value of the inferred glacial till was correlated to the standard penetration test values using Imai and Tonouchi2 (1982) formula:

$$Vs(m/s) = 91.7\ N^{0.26}$$

The shear-wave velocity of the inferred bedrock was assumed as 360 m/s.

The average shear-wave velocity to 30 m depth was estimated at 221 m/s. On this basis, the site may be classified as Class D for seismic site response in accordance with Table 4.1.8.4 A of the 2012 OBC.

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[1] Dickenson, S.E. (1994), "Dynamic Response of Soft and Deep Cohesive Soils during the Loma Prieta Earthquake".
2 Imai, T, and K Tonouchi (1982). Correlation of N value with S-wave velocity and shear modulus, Proc., 2nd European Symp. on Penetration Testing, Amsterdam, pp. 67–72.

7 Grade Raise Restrictions

The site is underlain by a sensitive marine clay deposit consisting of a brown clay crust of limited thickness underlain by a grey clay which weakens with depth to a minimum value and thereafter increases with depth. The marine clay deposit is prone to consolidation settlement if overstressed by loads imposed on it by site grade raise, foundations, and by groundwater level lowering following construction. Overstressing of the clay stratum may result in its consolidation and subsequent settlement of foundations, which may exceed the tolerable limits of the structure resulting in cracking of the structure.

Based on a review of the engineering properties of the clay, it is considered that the site grade raise may be 1.0 m in conjunction with the footings designed as per Section 9 of this report. An allowance for groundwater lowering was not required as part of the review, since the proposed footings will be at or above the measured groundwater level in the clay and measures are employed in new service trenches to minimize the permanent lowering of the groundwater level at the site (use of clay seals), as recommended in Sections 12 and 14.

8 Site Grading Operations

As part of the site preparation, the site grading within the footprint of the proposed building and paved areas should consist of the excavation and removal of all topsoil, paved surfaces, fill and any organic stained soils from the site. Any soft/loose areas identified in the interior of the building footprint should be excavated and replaced with Ontario Provincial Standard Specification (OPSS 1010 as amended by SSP110S13) Granular B Type II compacted to 98 percent standard Proctor maximum dry density (SPMDD).

It may be possible to leave some of the existing fill and silty sand in-place in the parking lot/access road areas, pending further evaluation in the field during construction and acceptability from an environmental perspective. For budgeting purposes, the contractor should assume that all the existing fill material will be required to be removed and replaced with imported granular material from the area of the proposed building and parking lot/access road areas.

Following approval of the exposed subgrade, the grades beneath the floor slabs may be raised to the underside of the 300 mm thick clear stone layer by the placement of engineered fill consisting of OPSS 1010 Granular B Type II placed in 300 mm thick lifts and each lift compacted to 98 percent of the SPMDD.

For the proposed parking and access road areas, the site grades may be raised to the design subgrade level by the placement of OPSS 1010 select subgrade material (SSM) compacted to 95 percent of the SPMDD.

In-place density tests should be performed on each lift of placed material to ensure that it has been compacted to the project specifications.

9 Foundation Considerations

The investigation has revealed that for the maximum permissible grade raise of 1.0 m, the geotechnical conditions at the site are suitable for the construction of residential one- to two-storey wood-frame type structures with or without a basement supported by conventional strip and spread footings designed for the limit state bearing pressure values indicated below.

For the proposed four-storey apartment building with one level underground parking and other types of residential building configurations requiring higher bearing pressure values than indicated below in combination with a maximum 1.0 m grade raise, the buildings may be supported by footings, raft or pile foundations in combination with soil fill and light weight fill.

Since the bearing values of foundations supported by the marine clay depend on the magnitude of the site grade raise, it is recommended that once the grade raise of the site is known and the grading plan is available, EXP be contacted to provide more detailed foundation recommendations.

For the pile foundation option, an additional geotechnical investigation will be required to determine the depth to bedrock.

9.1 Footings

The one- to two-storey wood-frame type buildings with a basement and 1.0 m grade raise may be supported by maximum 1.0 m wide strip and 3 m by 3 m square pad footings founded on the compact zone of the silty sand and stiff to very stiff clay at a maximum depth of 1.0 m below existing grade and designed for a bearing pressure at serviceability limit state (SLS) of 96 kPa and a factored geotechnical resistance at ultimate limit state (ULS) of 120 kPa. The factored ULS value includes a resistance factor of 0.5 in accordance with the 2006 Canadian Foundation Engineering Manual (CFEM). The above SLS value is considered valid, provided the site grade raise of 1.0 m is respected.

Settlements of the footings designed for the SLS value above and properly constructed are expected to be within the normally tolerated limits of 25 mm total and 19 mm differential movements.

In areas where the founding soil is the silty sand (Borehole No. 1), the footing excavation will need to extend to the compact zone of the silty sand contacted at approximately 1.8 m depth (Elevation 77.3 m). The sub-excavated area may be backfilled with lean concrete or engineered fill compacted to 100 percent SPMDD.

The footings should be kept at the maximum 1.0 m depth below existing grade, to minimize overstressing the weaker zone of the underlying grey clay and excavations below the measured groundwater level.

All the footing beds should be examined by a geotechnical engineer to ensure that the founding surfaces are capable of supporting the design bearing pressure at SLS and that the footing beds have been properly prepared.

A minimum of 1.5 m of earth cover should be provided to the exterior foundations of heated structures to protect them from damage due to frost penetration. The frost cover should be increased to 2.1 m for unheated structures if snow will not be removed from their vicinity and to 2.4 m if snow will be removed from the vicinity of the structure. When earth cover is less than the minimum required, an equivalent combination of earth cover and rigid insulation (such as Styrofoam HI-40) or rigid insulation alone should be provided. EXP can provide additional comments in this regard, if required.

The footings should be reinforced, and nominal reinforcing steel should be provided in the basement walls to minimize cracking. For guidance, the reinforcement in the basement walls may consist of a minimum of two upper and two lower 15M-size reinforcing bar sizes. The required reinforcing detail for the footings and basement walls will need to be determined by the structural engineer.

It should be noted that the surface of the clay is susceptible to disturbance due to movement of workers and construction equipment especially if the excavations are undertaken during wet weather periods. It is therefore considered that depending on the weather conditions prevailing at the time of construction, footing beds may have to be covered with a mud slab to prevent disturbance to the clay subgrade.

The depth to the native silty sand and clay may vary from that indicated on the borehole logs due to presence of the existing buildings on site. For example, the fill thickness and depth to native silty sand and clay may be deeper than shown on the borehole logs at locations close to and/or within the footprint of existing buildings and underground service trenches. The boreholes from the Phase II ESA indicate the fill extends to 1.8 m depth below existing grade. Therefore, it is recommended that once the existing buildings have been demolished and foundations, foundation walls and floor slabs have been removed, additional boreholes be undertaken within the footprints of the existing buildings to determine the subsurface conditions, suitable founding soil conditions and depths for footings, the groundwater level, bearing pressure at SLS and factored geotechnical resistance at ULS, excavation and dewatering requirements.

9.2 General Comment

The recommended bearing pressure at SLS and factored geotechnical resistances at ULS have been calculated by EXP from the borehole information for the design stage only. The investigation and comments are necessarily on-going as new information of underground conditions becomes available. For example, more specific information is available with respect to conditions between boreholes when foundation construction is underway. The interpretation between boreholes and the recommendations of this report must therefore be checked through field monitoring provided by an experienced geotechnical engineer to validate the information for use during the construction stage.

10 Floor Slab and Drainage Requirements

The floor slabs of the buildings may be constructed as slabs-on-grade provided they are set on a bed of well-packed 19 mm clear stone at least 300 mm thick placed on native soil or on well compacted engineered fill prepared as indicated in Section 8 of the report. The clear stone would prevent the capillary rise of moisture from the sub-soil to the floor slab. Adequate saw cuts should be provided in the floor slabs to control cracking.

Perimeter drains are not required for buildings with no basement, provided the floor slab is set at least 150 mm higher than the surrounding finished grade. For buildings with a basement, perimeter drains will be required as discussed in Section 11.

The need for underfloor drains for buildings with and without basements will have to be assessed once the slab elevation is available and compared with the elevation of the prevailing groundwater level.

The finished exterior grade should be sloped away from the buildings at an inclination of at least two percent to prevent surface ponding close to the exterior walls.

11 Subsurface Walls

The subsurface basement walls should be backfilled with free draining material, such as OPSS 1010 Granular B Type II and equipped with a perimeter drainage system to prevent the buildup of hydrostatic pressure behind the walls. The walls will be subjected to lateral static and dynamic (seismic) earth forces. The expressions below assume free draining backfill material, a perimeter drainage system, level backfill surface behind the wall and vertical face on the back side of the wall.

For design purposes, the lateral static earth thrust against the subsurface walls may be computed from the following equation:

$$P = K_0 h (\tfrac{1}{2} \gamma h + q)$$

where

- P = lateral earth thrust acting on the subsurface wall; kN/m
- K_0 = lateral earth pressure coefficient for 'at rest' condition for Granular B Type II backfill material = 0.50
- γ = unit weight of free draining granular backfill; Granular B Type II = 22 kN/m^3
- h = depth of point of interest below top of backfill, m
- q = surcharge load, kPa

The lateral seismic thrust may be computed from the equation given below:

$$\Delta_{Pe} = \gamma H^2 \frac{a_h}{g} F_b$$

where

- Δ_{Pe} = dynamic thrust in kN/m of wall
- H = height of wall, m
- γ = unit weight of backfill material = 22 kN/m^3
- $\frac{a_h}{g}$ = seismic coefficient = 0.309 (refer to 2015 National Building Code Seismic Hazard Calculation shown in Appendix A)
- F_b = thrust factor = 1.0

The dynamic thrust does not take into account the surcharge load. The resultant force acts approximately at 0.63H above the base of the wall.

All subsurface basement walls should be properly damp-proofed.

12 Pipe Bedding Requirements

It is recommended that the bedding for the underground services including material specifications, thickness of cover material and compaction requirements conform to City of Ottawa requirements and/or Ontario Provincial Standard Specification and Drawings (OPSS and OPSD).

Due to the presence of the sand and clay and high groundwater level, it is recommended the pipe bedding consist of 300 mm thick OPSS 1010 Granular B Type II sub-bedding material overlain by 150 mm thick OPSS 1010 Granular A bedding material. The bedding materials should be compacted to at least 95 percent SPMDD.

The bedding thickness may be further increased in areas where the sand and clay subgrade become disturbed. Trench base stabilization techniques, such as removal of loose/soft material, placement of crushed stone sub-bedding (Granular B Type II), completely wrapped in a non-woven geotextile, may also be used if trench base disturbance becomes a problem in wet or soft areas.

If the backfill for the service trenches will consist of granular fill, clay seals should be installed in the service trenches at select intervals as per City of Ottawa Drawing No. S8. The seals should be 1 m wide, extend over the entire trench width and from the bottom of the trench to the underside of the pavement structure. The clay should be compacted to 95 percent SPMDD. The purpose of the clay seals is to prevent the permanent lowering of the groundwater level.

13 Excavations and De-Watering Requirements

13.1 Excavations

Excavations for the construction of the proposed structures and installation of the underground services assuming a site grade raise of 1.0 m are anticipated to extend to a 2.0 m depth below existing grade. The excavations are expected to extend through the silty sand and into the clay. The excavations are anticipated to be up to 1.6 m below the groundwater level.

Upon completion of the demolition and removal of the existing buildings and their floor slabs, foundation walls and footings, the soils at the site may be excavated with conventional mechanical equipment capable of removing possible debris within the existing fill.

The excavations at the site may be undertaken as open cut provided they meet the requirements of the Ontario Occupational Health and Safety Act (OHSA). The overall soils are classified as Type 3 and must be cut back at 1H:1V from the bottom of the excavation. For excavations that extend below the groundwater level, the side slopes should be cut back at 2H:1V to H:1V from the bottom of the excavation. If space restrictions prevent open cut excavations, such as for underground service trenches, the excavations may be undertaken within the confines of a prefabricated support system (trench box) or engineered support system designed and installed in accordance with the above noted regulation.

Excavations up to a 2.0 m depth below existing grade are not expected to experience base-heave type failure.

The silty sand and clay stratum at the site are susceptible to disturbance due to the movement of construction equipment, and personnel on its surface. It is therefore recommended that the excavation at the site should be undertaken by equipment that does not travel on the excavated surface, such as a gradall or mechanical shovel. It is anticipated that temporary granular roads may be required to gain access to the site.

Many geologic materials deteriorate rapidly upon exposure to meteorological elements. Unless otherwise specifically indicated in this report, walls and floors of excavations must be protected from moisture, desiccation, and frost action throughout the course of construction.

13.2 De-Watering Requirements

Seepage of the surface and subsurface water into the excavations is anticipated. However, it should be possible to collect water entering the excavations at low points and to remove it by conventional pumping techniques. In areas of high infiltration or in areas where more permeable soil layers may exist (such as the silty sand) a higher seepage rate should be anticipated. Therefore, the need for high capacity pumps to keep the excavation dry should not be ignored.

It has been assumed that the maximum excavation depth at the site will be approximately 2.0 m and would necessitate groundwater removal from the site. It is noteworthy to mention that new legislation came into force in Ontario on March 29, 2016 to regulate groundwater takings for construction dewatering purposes. Prior to March 29, 2016, a Category 2 Permit to Take Water (PTTW) was required from the Ontario Ministry of the Environment and Climate Change (MOECC) for groundwater takings related to construction dewatering, where taking volumes in excess of 50 m^3/day, but less than 400 m^3/day, and the taking duration was no more than 30 consecutive days. The new legislation replaces the Category 2 PTTW for construction dewatering with a new process under the Environmental Activity and Sector Registry (EASR). The EASR is an on-line registry, which allows persons engaged in prescribed activities, such as water takings, to register with the MOECC instead of applying for a PTTW.

To be eligible for the new EASR process, the construction dewatering taking must be less than 400 m^3/day under normal conditions. The water taking can be groundwater, storm water, or a combination of both. It should be noted that the 30-consecutive day limit on the water taking under the old Category 2 PTTW process has been removed in the new EASR process. Also, it should be noted that the EASR process requires two technical studies be prepared by a Qualified Person, prior to any water taking. These studies include a Water Taking Report, which provides assurance that the taking will not cause any unacceptable impacts, and a Discharge Plan, which provides assurance that the discharge will not result in any adverse impacts to the environment. A significant advantage of the new EASR process over the former Category 2 PTTW process, is that the groundwater taking may begin immediately after completing the on-line registration of the taking and paying the applicable fee, assuming the accompanying technical studies have been completed. The former PTTW process typically took more than 90 days, which had the potential to impact construction schedules. EXP can provide assistance during the EASR/PTTW process, if required.

Although this investigation has estimated the groundwater levels at the time of the fieldwork, and commented on dewatering and general construction problems, conditions may be present which are difficult to establish from standard boring and excavating techniques and which may affect the type and nature of dewatering procedures used by the contractor in practice. These conditions include local and seasonal fluctuations in the groundwater table, erratic changes in the soil profile, thin layers of soil with large or small permeabilities compared with the soil mass, etc. Only carefully controlled tests using pumped wells and observation wells will yield the quantitative data on groundwater volumes and pressures that are necessary to adequately engineer construction dewatering systems.

14 Backfilling Requirements and Suitability of On-Site Soils for Backfilling Purposes

The on-site soils to be excavated are anticipated to consist of a granular fill, silty sand, brown clay (desiccated crust) and grey clay. Select portions of the granular fill, silty sand and brown clay (desiccated crust) from above the groundwater level may be used in service trenches outside the building area, subject to further examination and testing during the early stages of construction. These soils are moisture sensitive and should be protected from the effects of weather if stockpiled on site. The brown and grey clay below the groundwater level are considered too wet to achieve the required degree of compaction. Therefore, these soils may be used for general grading purposes in landscaped areas, provided the moisture content of these soils is lowered by air-drying in the sun.

It is anticipated that the majority of the material required for backfilling purposes or as subgrade fill for the project would have to be imported and should preferably conform to the following specification:

- Engineered fill under slabs-on-grade - OPSS 1010 Granular B Type II placed in 300 mm thick lifts and each lift compacted to 98 percent of the SPMDD.
- Backfill in services trenches inside buildings – OPSS 1010 Granular B Type II placed in 300 mm thick lifts and each lift compacted to 98 percent of the SPMDD.
- Trench backfill and subgrade fill in parking area and access roadways – OPSS 1010 Select Subgrade Material (SSM) placed in 300 mm thick lifts and each lift compacted to 95 percent of the SPMDD. To minimize settlement of the pavement structure over services trenches, the trench backfill material within the frost zone should match the existing material along the trench walls to minimize differential frost heaving of the subgrade soil, provided this material is compactible. Other wise, frost tapers may be required.

As previously indicated, if the backfill for the service trenches will consist of granular fill, clay seals should be installed in the service trenches at select intervals as per City of Ottawa Drawing No. S8. The seals should be 1 m wide, extend over the entire trench width and from the bottom of the trench to the underside of the pavement structure. The clay should be compacted to 95 percent SPMDD. The purpose of the clay seals is to minimize the permanent lowering of the groundwater level.

15 Pavement Structures

Pavement structures for the surface parking areas and access roads are given on Table VII below for the anticipated engineered fill subgrade used to raise the site grades and for the native silty sand and clay subgrades. The pavement structures are based upon the assumption that the subgrade will be properly prepared and assumes a functional design life of 15 to 18 years. The proposed functional design life represents the number of years to the first rehabilitation, assuming regular maintenance is carried out.

Table VII: Recommended Pavement Structure Thicknesses

Pavement Layer	Compaction Requirements	Computed Pavement Structure	
		Light Duty Traffic (Parking Lots - Cars Only)	Heavy Duty (Parking Lots and Access Roads)
Asphaltic Concrete (PG 58-34)	92-97% MRD	65 mm HL3/SP12.5 mm/ Cat.B	40 mm HL3/SP12.5 Cat. B 50 mm HL8/SP 19 Cat. B
OPSS 1010 Granular A Base (crushed limestone)	100% SPMDD	150 mm	150 mm
OPSS 1010 Granular B Type II Sub-base	100% SPMDD	450 mm	600 mm

Notes:

1. SPMDD denotes standard Proctor maximum dry density, ASTM, D-698-12e2.
2. MRD denotes Maximum Relative Density, ASTM D2041.

The upper 300 mm of the subgrade fill must be compacted to 98% SPMDD.

Additional comments on the construction of the parking lot and access roads are as follows:

1. As part of the subgrade preparation, the proposed parking areas and access roads should be stripped of topsoil and other obviously unsuitable material. Fill required to raise the grades to design elevations should conform to requirement as per Section 8 and should be placed and compacted to 95 percent of the SPMDD. The subgrade should be properly shaped, crowned, then proofrolled with a heavy vibratory roller in the full-time presence of a representative of this office. Any soft or spongy subgrade areas detected should be sub excavated and properly replaced with suitable approved backfill compacted to 95 percent SPMDD (ASTM D698-12e2).
2. The long-term performance of the pavement structure is highly dependent upon the subgrade support conditions. Stringent construction control procedures should be maintained to ensure that uniform subgrade moisture and density conditions are achieved. The need for adequate drainage cannot be over-emphasized. Subdrains should be installed on both sides of the access road(s). Subdrains must be installed in the proposed parking area at low points and should be continuous between catchbasins to intercept excess surface and subsurface moisture and to prevent subgrade softening. This will ensure no water collects in the granular course, which could result in pavement failure during the spring thaw. The location and extent of subdrainage required within the paved areas should be reviewed by this office in conjunction with the proposed site grading.

3. To minimize the problems of differential movement between the pavement and catchbasins/manhole due to frost action, the backfill around the structures should consist of free-draining granular preferably conforming to OPSS Granular B Type II material. Weep holes should be provided in the catchbasins/manholes to facilitate drainage of any water that may accumulate in the granular fill.
4. The most severe loading conditions on light-duty pavement areas and the subgrade may occur during construction. Consequently, special provisions such as restricted lanes, half-loads during paving, temporary construction roadways, etc., may be required, especially if construction is carried out during unfavorable weather.
5. The finished pavement surface should be free of depressions and should be sloped (preferably at a minimum cross fall of 2 percent) to provide effective surface drainage towards catch basins. Surface water should not be allowed to pond adjacent to the outside edges of paved areas.
6. Relatively weaker subgrade may develop over service trenches at subgrade level. These areas may require the use of thicker/coarser sub-base material and the use of a geotextile at the subgrade level. If this is the case, it is recommended that additional 150 mm of granular sub-base, OPSS Granular B Type II, should be provided in these areas, in addition to the use of a geotextile at the subgrade level.
7. The granular materials used for pavement construction should conform to Ontario Provincial Standard Specifications (OPSS 1010) for Granular A and Granular B Type II and should be compacted to 100 percent of the SPMDD.

The asphaltic concrete used and its placement should meet OPSS 1150 or 1151 requirements. It should be compacted from 92 to 97 percent of the MRD (ASTM D2041). Asphalt placement should be in accordance with OPSS 310 and OPSS 313.

It is recommended that EXP be retained to review the final pavement structure design and drainage plans prior to construction to ensure they are consistent with the recommendations of this report.

16 Corrosion Potential of Subsurface Soils

Chemical tests limited to pH, sulphate, chloride and resistivity tests were performed on two (2) selected soil samples. The results are shown on Table No. VIII. The Certificate of Analysis is included in Appendix B.

Table VIII: Results of pH, Sulphate, Chloride and Resistivity Tests on Soil Samples

Borehole No. - Sample No.	Depth (Elevation) (m)	Soil	pH	Sulphate (%)	Chloride Content (%)	Resistivity (ohm.cm)
			<5	>0.1 %	>0.04 %	
BH 1 – SS4	2.3 – 2.9 (76.8 – 76.2)	Grey Clay	7.54	0.0025	0.0051	6,170
BH 4 – SS3	1.5 – 2.1 (75.2 – 74.6)	Brown Clay	7.05	0.0122	0.0054	4,270

The results indicate a soil with a sulphate content of less than 0.1 percent. This concentration of sulphate in the soil would have a negligible potential of sulphate attack on subsurface concrete. The concrete should be designed in accordance with CSA A.23.1-14. However, the concrete should be dense, well compacted and cured.

The results of the resistivity tests indicate that the soil is moderately to mildly corrosive to buried steel elements. Appropriate measures should be undertaken to protect buried steel elements from corrosion.

17 Tree Planting Restrictions

The brown clay crust extends to depths ranging from 2.1 m to 3.0 m (Elevation 75.3 m to 74.2 m) and the footings are proposed to be set at 0.1 m to 0.3 m below the surface of the brown clay crust at a 1.0 m depth below existing grade in Borehole Nos. 2 to 5.

Based on the City of Ottawa document titled, “Tree Planting in Sensitive Marine Clay Soils – 2017 Guidelines,” the modified plasticity index of the brown clay was estimated at 43 percent indicating the brown clay crust has a high potential for soil volume change.

The grey clay was contacted beneath the silty sand in Borehole No. 1 and the brown clay crust in the remaining boreholes at 2.1 m to 3.0 m depth (Elevation 76.9 m to 74.2 m). The modified plasticity index of the grey clay is estimated at 32 percent indicating the grey clay has a medium potential for soil volume change.

In accordance with the above referenced 2017 guidelines, for high potential volume change soil types, the tree planting restrictions and setbacks from structures should follow the 2005 clay soil policy.

For medium potential volume change soil types, the tree planting restrictions and setbacks from structures should follow the above noted 2017 guidelines.

A landscape architect should be consulted to ensure the applicable tree planting restrictions and setbacks for the development of this site are in accordance with the applicable City of Ottawa guideline and policy.

18 Additional Comment

The depth to the native silty sand and clay may vary from that indicated on the borehole logs due to presence of the existing buildings on site. For example, the fill thickness and depth to native silty sand and clay may be deeper than shown on the borehole logs at locations close to and/or within the footprint of existing buildings and underground service trenches. The boreholes from the Phase II ESA indicate the fill extends to 1.8 m depth below existing grade. Therefore, it is recommended that once the existing buildings have been demolished and foundations, foundation walls and floor slabs have been removed, additional boreholes be undertaken within the footprints of the existing buildings to determine the subsurface conditions, suitable founding soil conditions and depths for footings, the groundwater level, bearing pressure at SLS and factored geotechnical resistance at ULS, excavation and dewatering requirements.

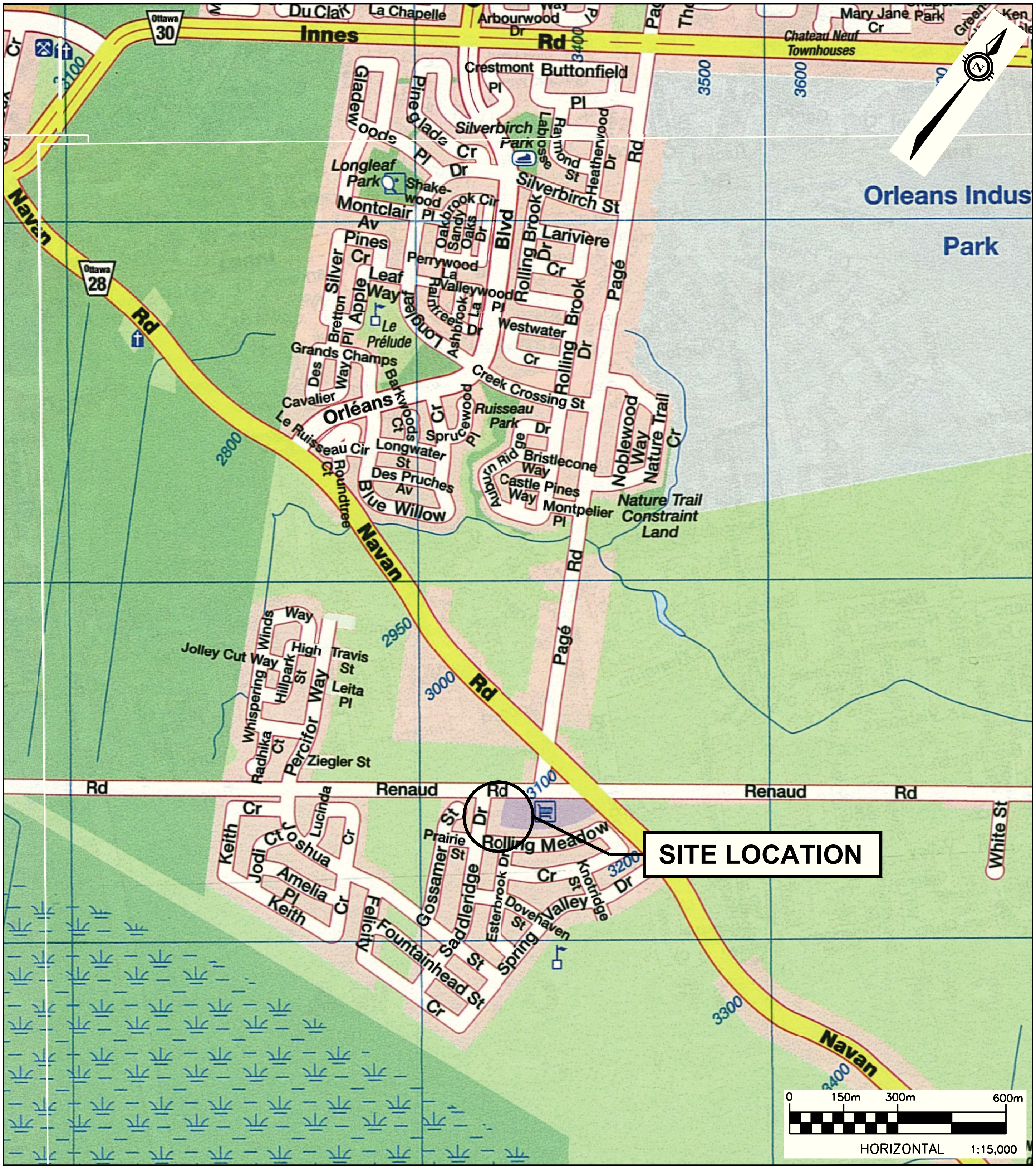
19 General Comments

The comments given in this report are intended only for the guidance of design engineers. The number of boreholes required to determine the localized underground conditions between boreholes affecting construction costs, techniques, sequencing, equipment, scheduling, etc., would be much greater than has been carried out for the design purposes. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

The information contained in this report is not intended to reflect on environmental aspects of the soils. Should specific information be required, including for example, the presence of pollutants, contaminants or other hazards in the soil, additional testing may be required.

We trust that the information contained in this report will be satisfactory for your purposes. Should you have any questions, please do not hesitate to contact this office.

Figures



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scale 1:15 000	PROJECT: 2597237 ONTARIO LTD. 6102 RENAUD ROAD, OTTAWA, ON	project no. OTT-00246046-A0	
date MAY 2018		design S.P.	checked I.T.
drawn by J.R.	TITLE: SITE LOCATION PLAN	FIG 1	

Filename: r:\240000\246046-a0 6102 renaud rd\246046-ge.dwg Pen Table:: trow standard, july 01, 2004.ctb
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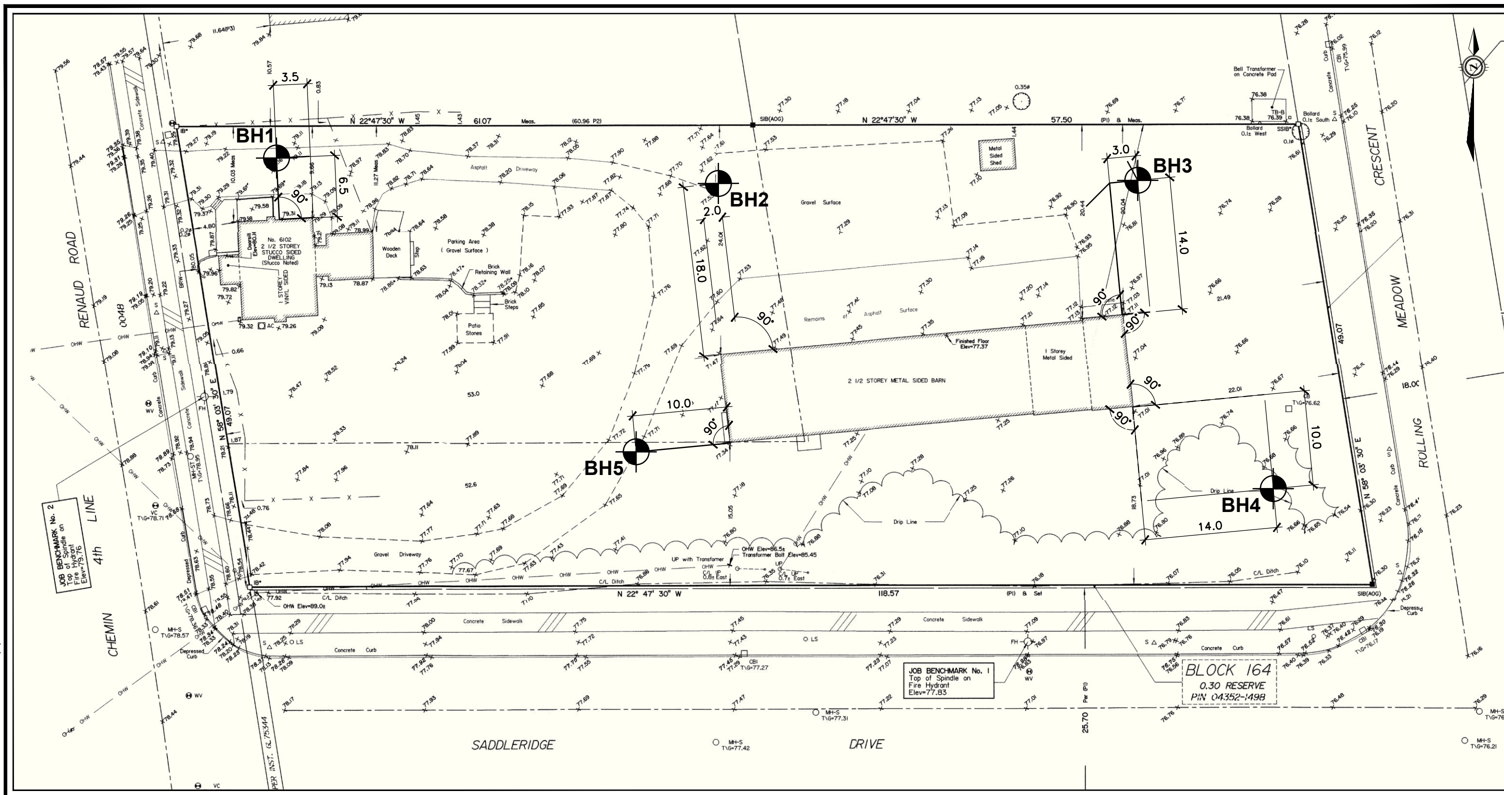
Last Plotted: 5/8/2018 9:42:16 AM Plotted by: RevellJ



NOTES :

1. THE BOUNDARIES AND SOIL TYPES HAVE BEEN ESTABLISHED ONLY AT BOREHOLE LOCATIONS. BETWEEN BOREHOLES THEY ARE ASSUMED AND MAY BE SUBJECT TO CONSIDERABLE ERROR.
2. SOIL SAMPLES WILL BE RETAINED IN STORAGE FOR THREE MONTHS AND THEN DESTROYED UNLESS THE CLIENT ADVISES THAT AN EXTENDED TIME PERIOD IS REQUIRED.
3. TOPSOIL QUANTITIES SHOULD NOT BE ESTABLISHED FROM THE INFORMATION PROVIDED AT THE BOREHOLE LOCATIONS.
4. BOREHOLE ELEVATIONS SHOULD NOT BE USED TO DESIGN BUILDING(S) OR FLOOR SLABS OR PARKING LOT(S) GRADES.
5. THIS DRAWING FORMS PART OF THE REPORT PROJECT NUMBER AS REFERENCED AND SHOULD BE USED ONLY IN CONJUNCTION WITH THIS REPORT.
6. SURVEY PLAN PREPARED BY ANNIS, O'SULLIVAN, VOLLEBEKK LTD. JOB N°.18260-17 UTOPIA, DATED SEPTEMBER 1ST, 2017.

LEGEND :

BH1 — PROPOSED BOREHOLE NUMBER & LOCATION

NOTE : ALL UNITS IN METRIC

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scale 1:400	PROJECT: 259727 ONTARIO LTD. PROPOSED RESIDENTIAL PROPERTY 6102 RENAUD ROAD, OTTAWA, ON		project no. OTT-00246046-A0
date MAY 2018			
drawn by J.R.	TITLE: BOREHOLE LOCATION PLAN		FIG 2

Filename: r:\240000\246000\246046-a0 6102 renaud rd\246046-ge.dwg
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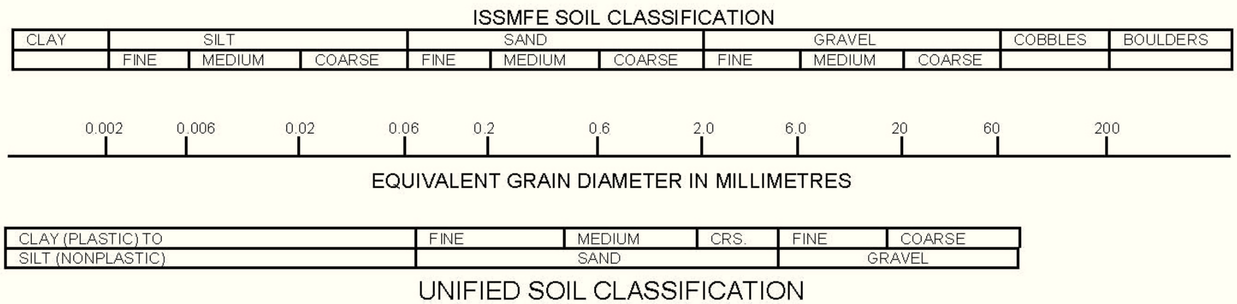
Last Plotted: 5/15/2018 12:37:58 PM Plotted by: RevellJ Pen Table:: trow standard, july 01, 2004.ctb

Notes On Sample Descriptions

1. All sample descriptions included in this report follow the Canadian Foundations Engineering Manual soil classification system. This system follows the standard proposed by the International Societv for Soil Mechanics and Foundation Engineering. Laboratory grain size analyses provided by **exp** Services Inc. also follow the same system. Different classification systems may be used by others; one such system is the Unified Soil Classification. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.



2. Fill: Where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc., none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional geotechnical site investigation.

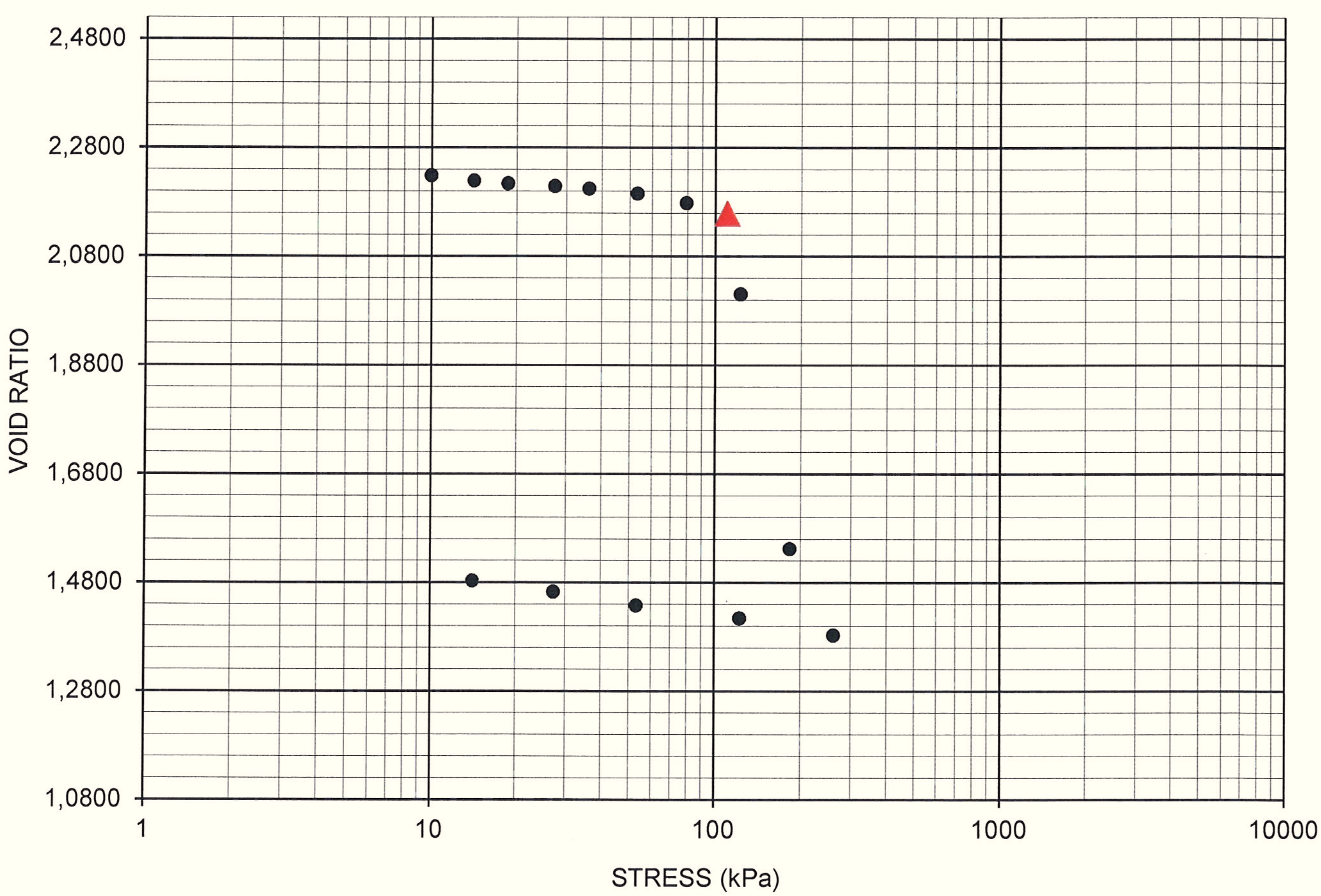
3. Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

Englobe

One-Dimensional Consolidation Properties of Soils Using Incremental Loading

ASTM D 2435 - Taylor Method

Client: Y/Project: OTT-00246046-A0 **Date :** 2018-04-26
Project : EXP Ontario **Our file No. :** P-0011703-6-01
Boring No. : BH-5, ST-6 **Sample No. :** 13 **Depth (m) :** 4,2 à 4,3m
Hydrostatic stress at the test (date) : Provided by ☐ the client ☐ Englobe



Geotechnical Characteristics of Soils :

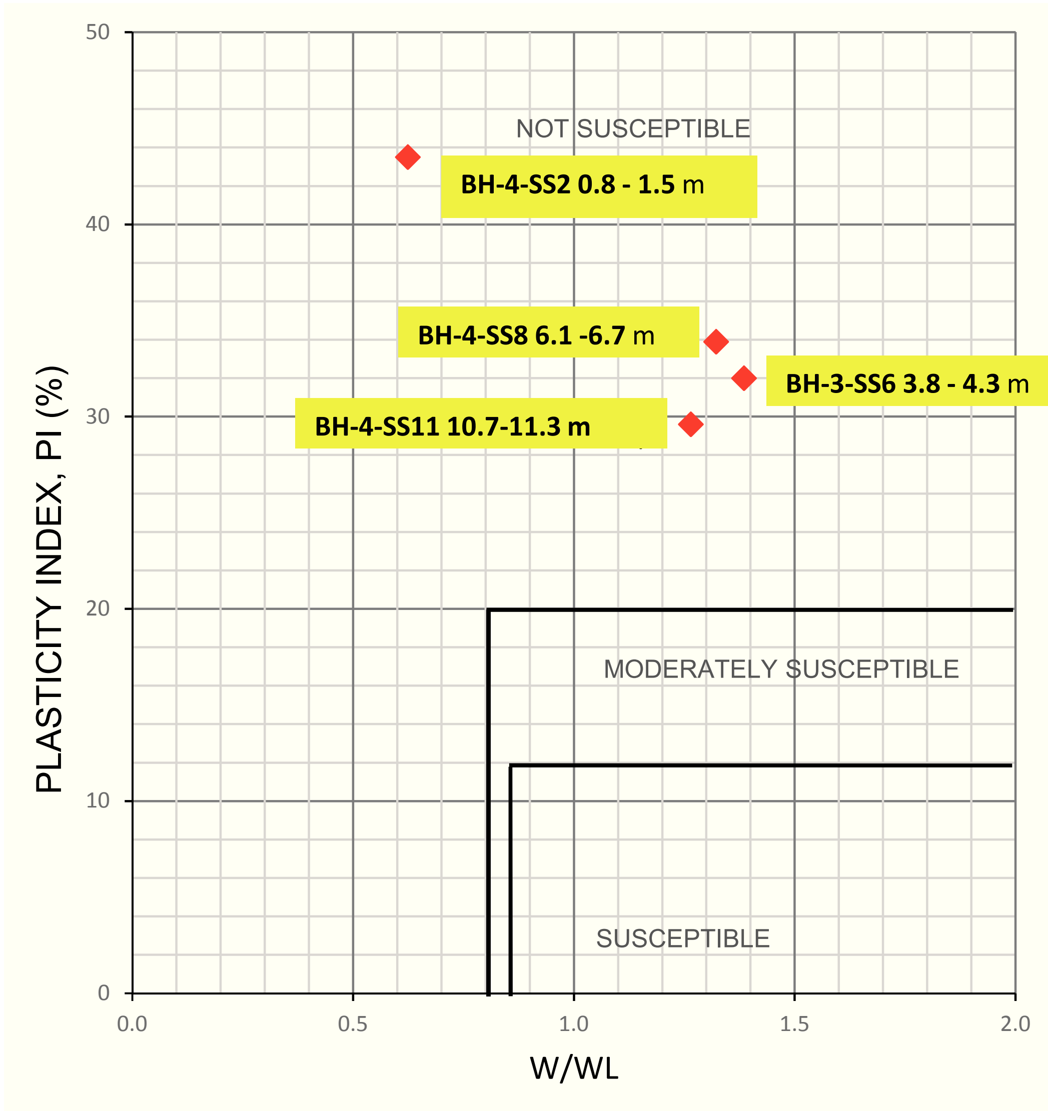
Initial void ratio (e_o) :	2,229	Recompression index (C_r) :	0,034
Initial water content (w) :	81,0%	Virgin compression index (C_c) :	2,66
Initial humid unit weight (γ_h) :	15,1 kN/m³	Initial effective stress (σ'_v) :	47 kPa
Initial saturation degree (S_r) :	99,9%	Preconsolidation pressure (σ'_p):	110 kPa
		Overconsolidation deviation ($\Delta\sigma$) :	63 kPa

Coefficient of consolidation Cv 2,19E-01 m2/j at 53 kPa
Coefficient of consolidation Cv 9,52E-02 m2/j at 122 kPa

Remarks : The sampling and transportation of the sample were carried out by a client's representative.
The initial effective stress has been provided by the client.

Prepared by : Adlane Bouadma, jr Eng

Verified by : Famakhan Fainke, Eng



BRAY ET AL. (2004) CRITERIA FOR LIQUEFACTION ASSESSMENT OF FINE GRAINED SOILS

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scale: N.T.S.	CLIENT: 2597237 Ontario Ltd.		project no. OTT-0024606-A0
date: May 2018	TITLE: Proposed Residential Subdivision - 6102 Renaud Road, Ottawa, ON.		FIG 12
drawn by: M.L.			

Appendix A: 2015 National Building Code Seismic Hazard Calculation

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

April 26, 2018

Site: 45.4292 N, 75.518 W   User File Reference: 6102 Renaud Road, Ottawa, ON.

Requested by: , EXP Services Inc.

National Building Code ground motions: 2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.05)	Sa(0.1)	**Sa(0.2)**	Sa(0.3)	**Sa(0.5)**	**Sa(1.0)**	**Sa(2.0)**	**Sa(5.0)**	**Sa(10.0)**	**PGA (g)**	**PGV (m/s)**
0.501	0.581	**0.482**	0.363	**0.255**	**0.125**	**0.059**	**0.015**	**0.0055**	**0.309**	**0.211**

Notes. Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC 2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are specified in **bold** font. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. ***These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.***

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.05)	0.047	0.164	0.276
Sa(0.1)	0.065	0.204	0.331
Sa(0.2)	0.058	0.174	0.278
Sa(0.3)	0.046	0.133	0.211
Sa(0.5)	0.032	0.093	0.148
Sa(1.0)	0.016	0.046	0.073
Sa(2.0)	0.0062	0.021	0.034
Sa(5.0)	0.0013	0.0048	0.0084
Sa(10.0)	0.0006	0.0019	0.0032
PGA	0.035	0.110	0.179
PGV	0.022	0.072	0.118

References

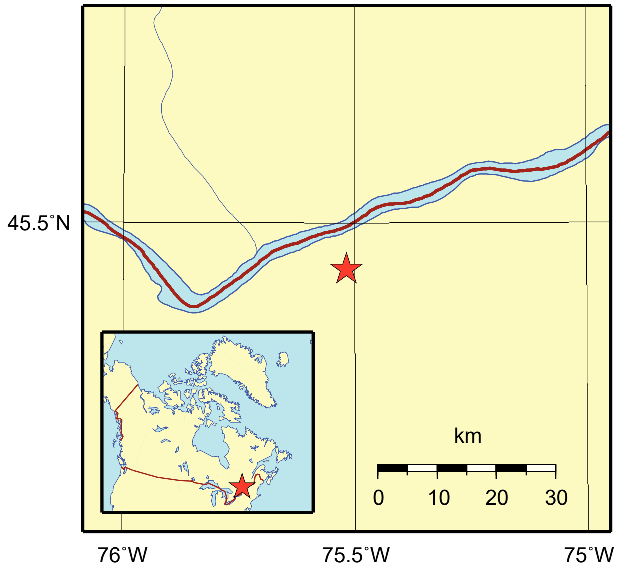
National Building Code of Canada 2015 NRCC no. 56190;
Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

User's Guide - NBC 2015, Structural Commentaries NRCC no. xxxxxx (in preparation)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites *www.EarthquakesCanada.ca* and *www.nationalcodes.ca* for more information

Aussi disponible en français



Appendix B: AGAT Certificate of Analysis

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
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FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: **EXP SERVICES INC**
2650 QUEENSVIEW DRIVE, UNIT 100
OTTAWA, ON K2B8H6
(613) 688-1899

ATTENTION TO: **Susan Potyondy**

PROJECT: **OTT-246046**

AGAT WORK ORDER: **18Z331542**

SOIL ANALYSIS REVIEWED BY: **Amanjot Bhela, Inorganic Coordinator**

DATE REPORTED: **Apr 27, 2018**

PAGES (INCLUDING COVER): **5**

VERSION*: **1**

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

Certificate of Analysis

AGAT Laboratories

AGAT WORK ORDER: 18Z331542
PROJECT: OTT-246046

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MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: EXP SERVICES INC
SAMPLING SITE:6102 Renaud Road
ATTENTION TO: Susan Potyondy
SAMPLED BY:exp

Inorganic Chemistry (Soil)

DATE RECEIVED: 2018-04-23 **DATE REPORTED: 2018-04-26**

Parameter	Unit	G / S	RDL	BH1 SS4 7. 5'-9.5'	BH4 SS3 5'-7'
			SAMPLE TYPE:	Soil	Soil
			DATE SAMPLED:	2018-04-18	2018-04-18
				9195398	9195399
pH, 2:1 CaCl2 Extraction	pH Units			7.54	7.05
Chloride (2:1)	µg/g		2	51	54
Sulphate (2:1)	µg/g		2	25	122
Resistivity (2:1)	ohm.cm		1	6170	4270

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

9195398-9195399 EC/Resistivity, Chloride and Sulphate were determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the 0.01M CaCl2 extract prepared at 2:1 ratio.

Certified By: Amanjot Bhela

Results relate only to the items tested and to all the items tested