APPENDICES

Appendix A : HYDRAULIC ANALYSIS

A.1 DOMESTIC WATER DEMANDS

114 Richmond Road - Domestic Water Demand Estimates

Total Site :	**1375**					**334.25**	**5.57**	**835.63**	**13.93**	**1838.38**	**30.64**

A.2 POTABLE WATER HYDRAULIC ANALYSIS

114 Richmond Road - Potable Water Servicing Analysis

Prepared by:

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Project No. 160400864

April 10, 2013

Executive Summary

The following report identifies and evaluates the proposed water distribution system for a mixed-use development located in the central/western area of the City of Ottawa's water distribution system. The proposed 114 Richmond Road development is located between Richmond Road and Byron Avenue in Zone 1W of the City of Ottawa water distribution system. The current development consists of two phases. Phase 1 features 3 nine-storey mixed-use residential and commercial buildings. Phase 2 includes 2 nine-storey residential buildings and 4 four-storey residential buildings. Phases 1 and 2 will house approximately 1278 people upon completion.

The modeling results show that the proposed water distribution network is capable of servicing the proposed mixed-use development with suitable flows and pressures under typical demands (average day, peak hour) and under emergency fire flow demands (maximum day + fire flow).

Questions or comments regarding the analysis presented may be directed to the undersigned.

STANTEC CONSULTING LTD.

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Table of Contents

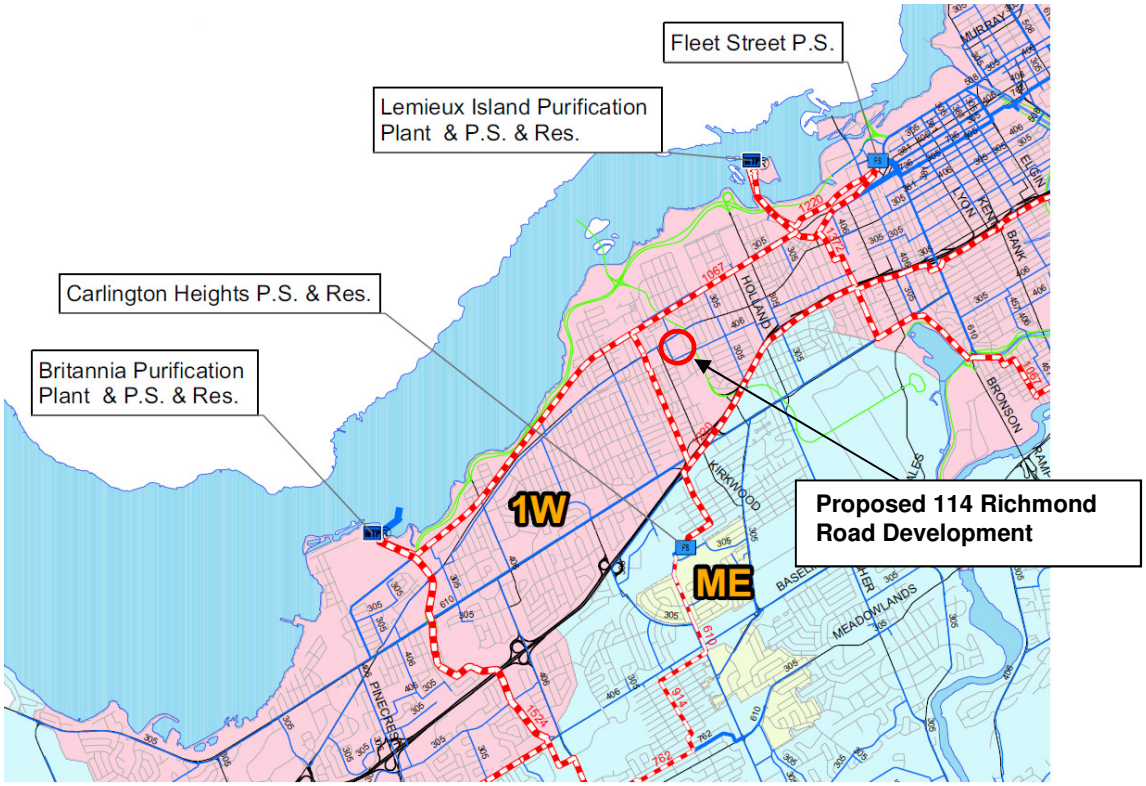
1.0 Potable Water Analysis

1.1 BACKGROUND

Stantec Consulting Ltd. (Stantec) has undertaken a hydraulic analysis of the potable water servicing for the proposed 114 Richmond Road development. This predominantly residential development will include multiple mixed-use high-rise buildings as well as a senior condominium development and a senior living facility. An existing heritage building on the site will also be preserved and renovated for residential and commercial use.

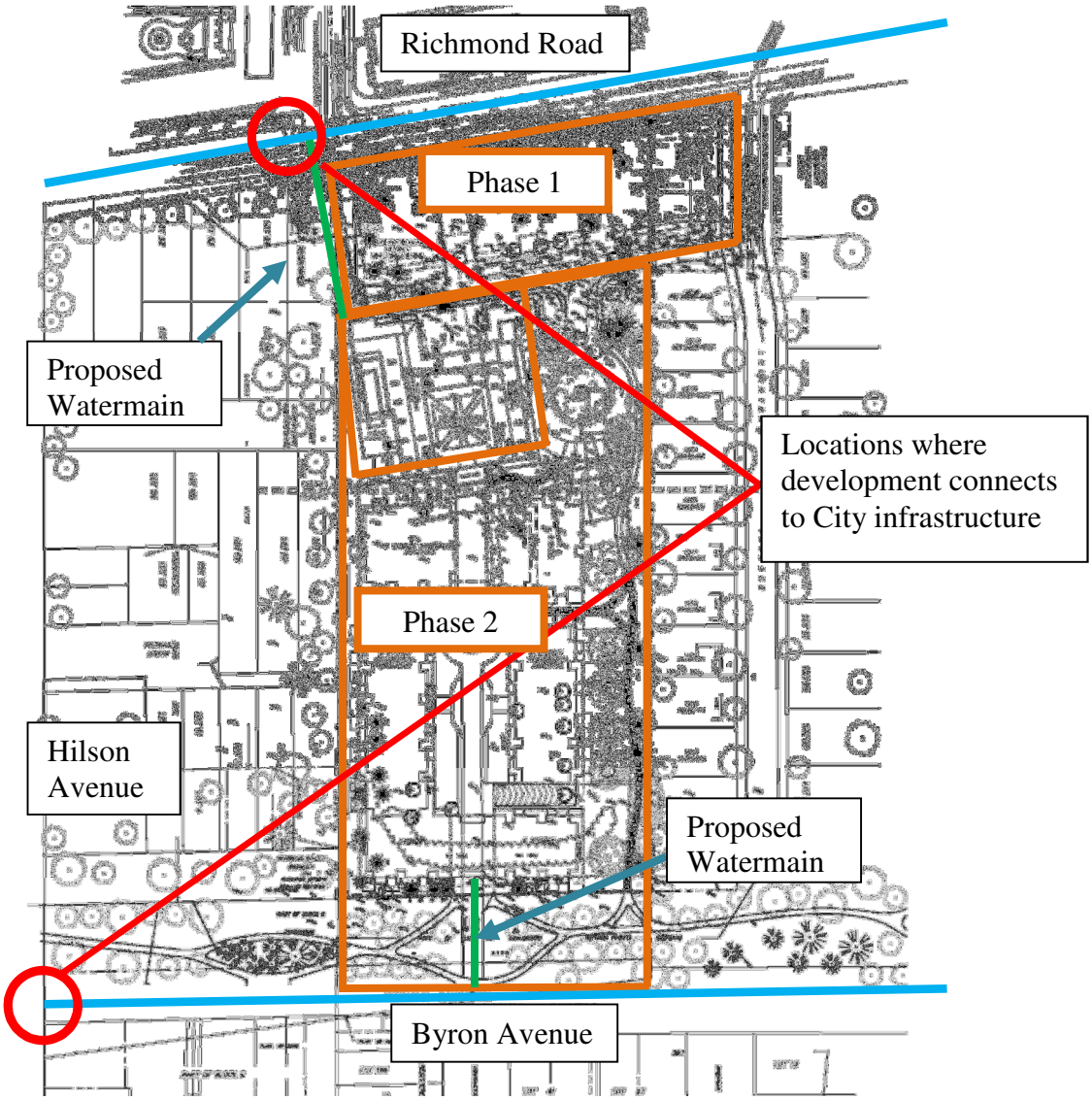
The proposed site is located between Richmond Road and Byron Avenue as shown on **Figure 1-1**. It is part of Zone 1W of the City of Ottawa water distribution system. This zone is fed by the Britannia, Lemieux Island and Fleet Street Pumping Stations. Also located in this zone, the Carlington Heights Reservoir provides balancing storage for peak flows and demands.

Figure 1-1: Proposed Development at 114 Richmond Road



The proposed servicing plan (shown on **Figure 1-2**) includes tying into the existing 300mm diameter watermain on Richmond Road during the first phase of the development and subsequently tying the existing 300mm diameter watermains on Hilson Avenue and Byron Avenue in the second phase of the development. The proposed watermains are to be of 250mm in diameter.

Figure 1-2: Proposed Servicing Plan



Phase 1 includes 3 mixed-use nine-storey buildings. A total of 291 residential units and 33,352 sq. ft. of commercial space will be created during Phase 1.

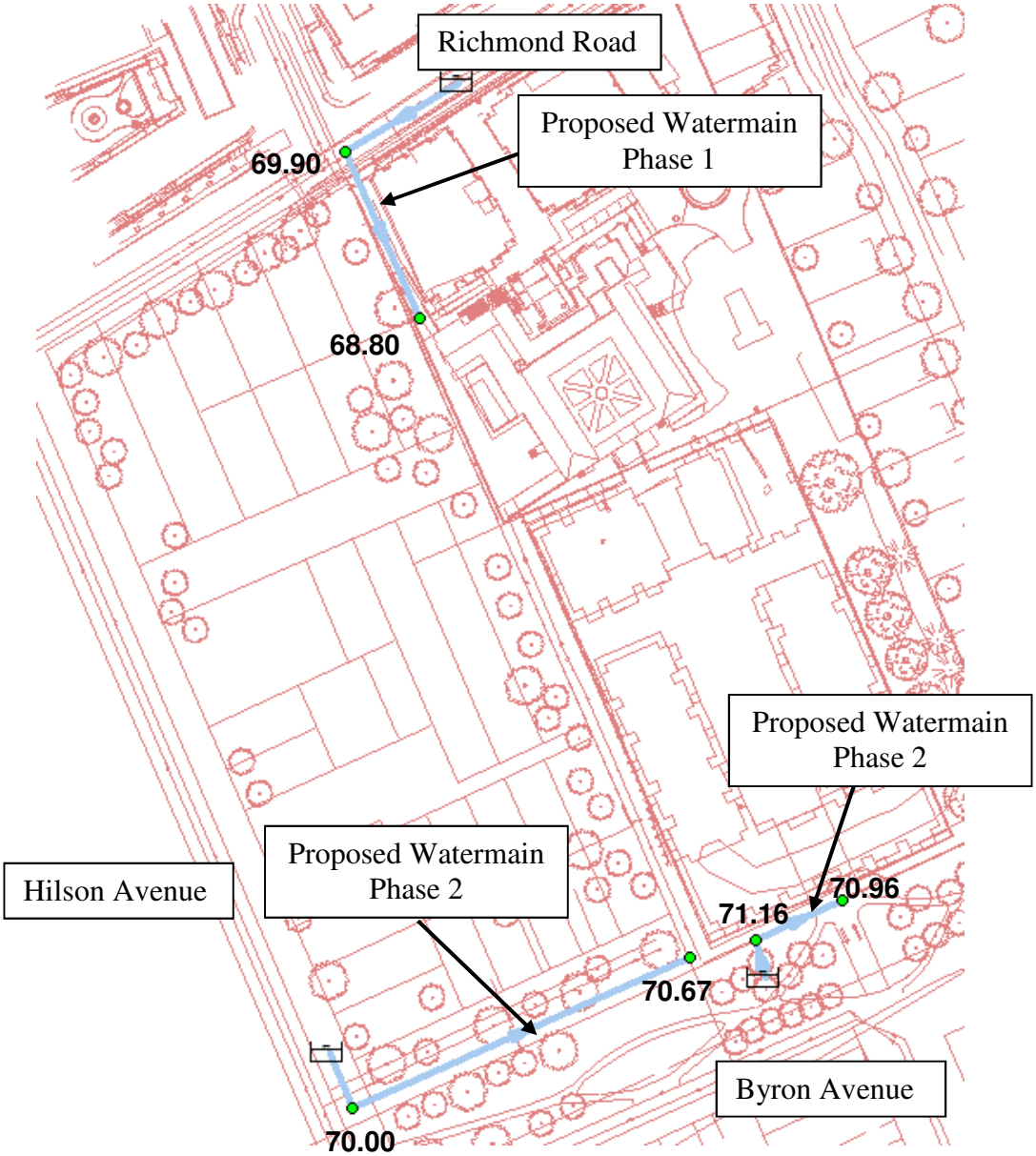
Phase 2 will encompass 4 four-storey buildings dedicated to senior living and 2 nine-storey building for residential use. A total of 419 residential units are created during Phase 2.

The watermain from Richmond Road will supply water to buildings constructed in Phase 1 and the watermains from Hilson Avenue and Byron Avenue will supply water to buildings constructed in Phase 2.

1.2 GROUND ELEVATIONS

The existing ground elevations of the proposed development range from approximately 68.80m and 72.20m. The elevations shown on **Figure 1-3** were interpolated from elevations provided as part of the boundary conditions from the City of Ottawa and assigned to the nodes in the hydraulic model.

Figure 1-3: Ground elevations (m) in area of proposed development



1.3 ALLOWABLE PRESSSURES

The City of Ottawa Water Distribution Design Guidelines state that the design objective for system pressures under normal demand conditions (i.e. average day, maximum day and peak hour) shall remain between the range of 275 to 690 kPa (40 to 100 psi) at the ground elevation in the streets (i.e. at hydrant level). Under emergency fire flow conditions, the minimum pressure in the distribution system is allowed to drop to 140 kPa (20 psi).

1.4 EXISTING & PROPOSED WATERMAIN NETWORK

Potable water supply for Phase 1 will be provided by the existing 300mm diameter watermain on Richmond Road through a 250mm service line. Phase 2 will be serviced off two existing 300mm diameter watermains, one on Hilson Avenue and one on Byron Avenue through 250mm service lines, respectively (**Figure 1-3**).

New watermains were added to the hydraulic model to simulate the proposed distribution system. Hazen-Williams coefficients ("C-Factors") were applied to the new watermain in accordance with the City of Ottawa's Water Distribution Design Guidelines:

Table 1: C-Factors used for applied watermain based on pipe diameter

Pipe Diameter (mm)	C-Factor
150	100
200 to 300	110
350 to 600	120
> 600	130

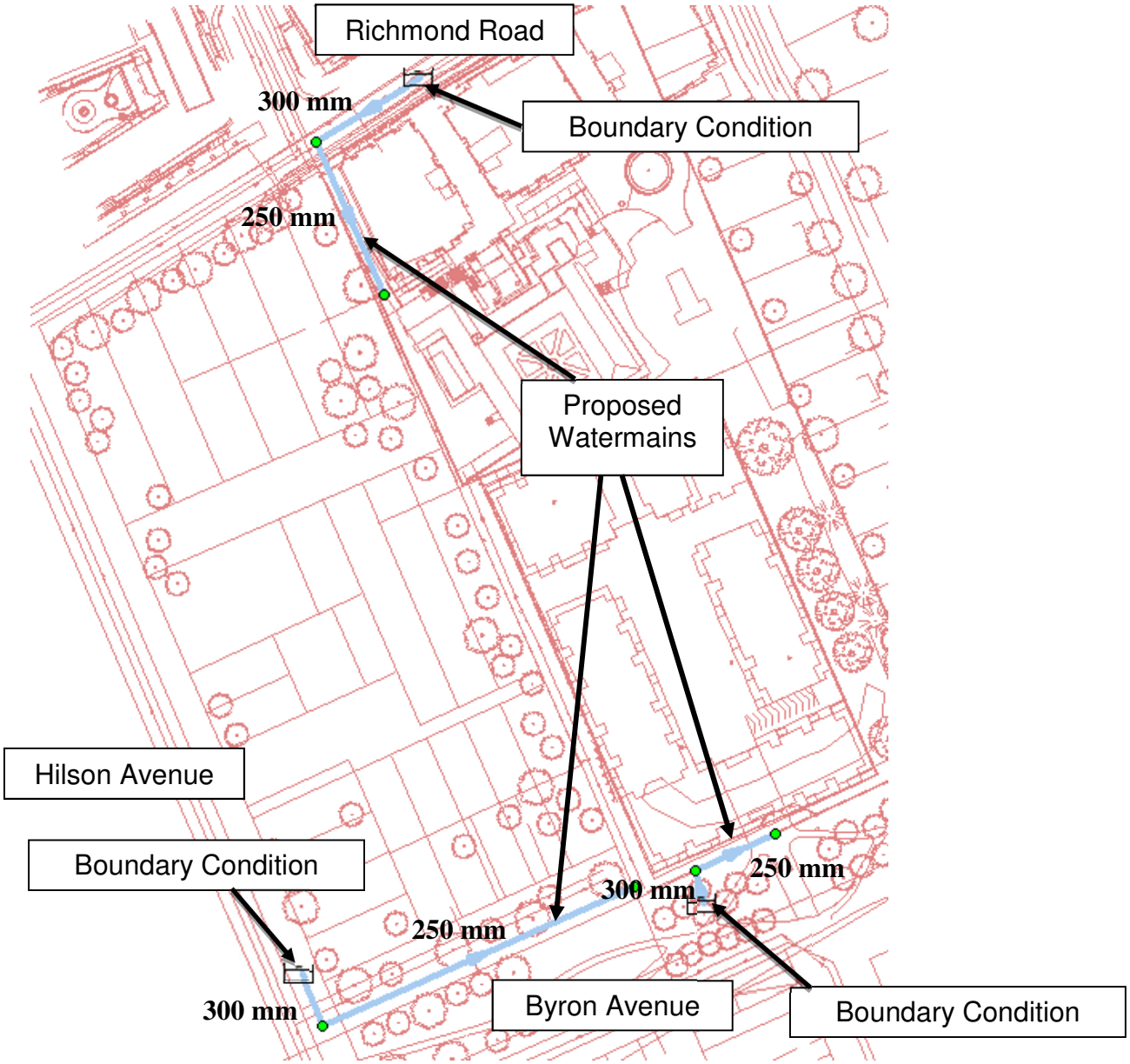
1.5 BOUNDARY CONDITIONS

The hydraulic model used for this analysis was created by Stantec. The boundary conditions provided by the City were based on computer model stimulations and are summarized in **Table 2**. Fixed head reservoirs simulating these boundary conditions were placed on Richmond Road, Hilson Avenue, and Byron Avenue near the proposed servicing watermains as shown in **Figure 1-4**.

Table 2: Boundary conditions based on computer model stimulations

Phase	Location	AVDY (m)	PKHR (m)	MXDY+FF (m)
1	Richmond Road	114.2	108.5	105.1
2	Byron Avenue	114.9	108.1	106.1
2	Hilson Avenue	114.9	108.1	106.1

Figure 1-4: Existing and Proposed watermain network pipe diameters



1.6 WATER DEMAND

Water demands for the development were estimated using the City of Ottawa's Water Distribution Design Guidelines. The estimated household size of an average apartment is **1.8 persons**. Therefore, the total projected population for the proposed mixed-use development shall be of **1278 people** for Phase 1 and 2 of development.

For residential developments, the average day per capita water demand is **350 L/(cap*d)**. The average day demand of a commercial space of the "Shopping Center" type is **2,500 L/(1,000m^2/d)**.

Based on these design guidelines, it is estimated that Phase 1 of the development will generate an average day residential demand of 2.12 L/s while the commercial demand will be equivalent to 0.09 L/s and an overall demand of 2.21 L/s. The average day residential demand for Phase 2 will be 3.06 L/s with no commercial demands. The demand for Phase 2 was allocated such that 50% will be distributed from Hilson Avenue and 50% will be distributed from Byron Avenue.

For maximum daily demand, residential demands were multiplied by a factor of 2.5 times average day demand and commercial demands were multiplied by a factor of 1.5 times average day demand. **Table 3** provides a summary of the demand allocation for various scenarios (see **Figure 1-5** for location of proposed nodes).

Table 3: Population and demand projections for proposed development for Phase 1 and Phase 2.

Model Node	Building	People	Commercial Area (sq. ft.)	Demand		Total Demand		
				Residential (L/s)	Commercial (L/s)	AVDY (L/s)	MXDY (L/s)	PKHR (L/s)
J3	A	524	23015	2.12	0.09	2.21	5.44	11.91
J6	0.5B+0.5C+0.5D	377	0	1.53	0.00	1.53	3.82	8.40
J8	0.5B+0.5C+0.5D	377	0	1.53	0.00	1.53	3.82	8.40
					Total	3.74	9.26	20.31

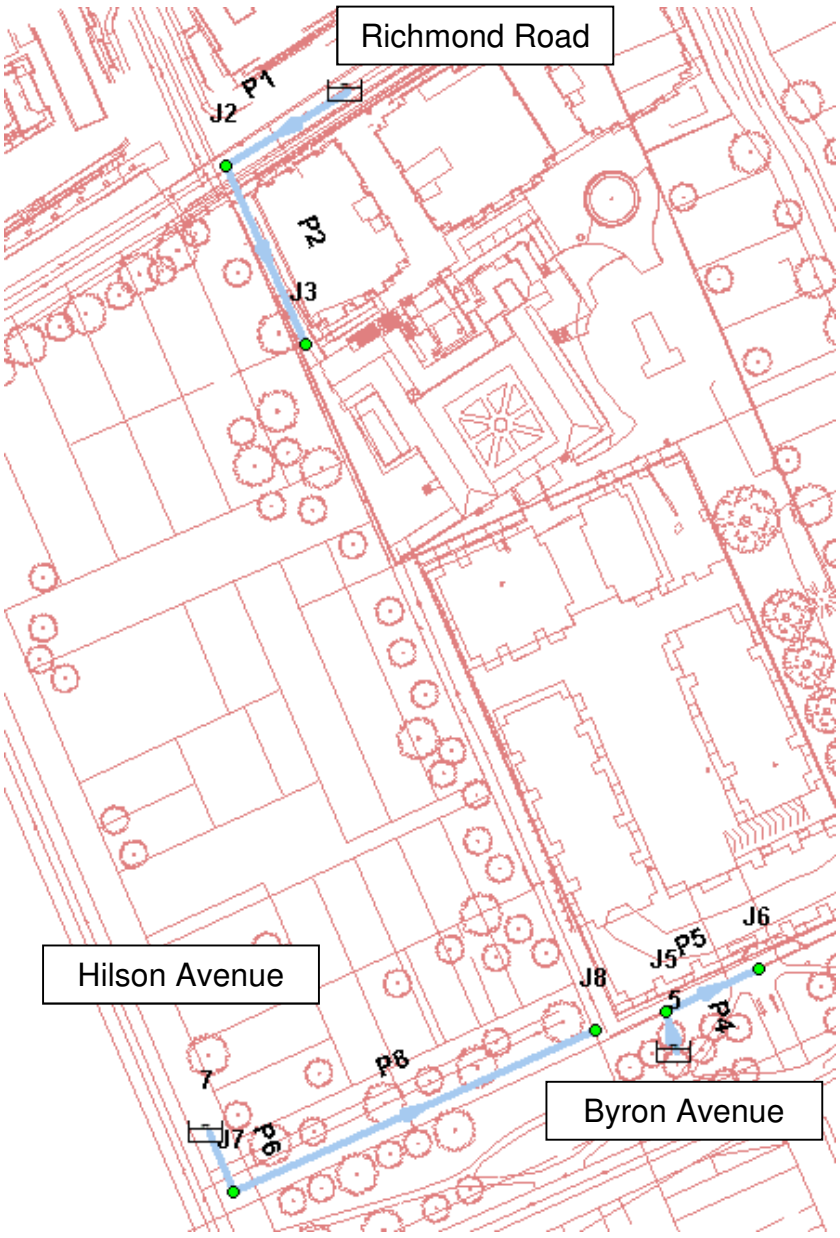
Phase 1
Phase 2

1.7 HYDRAULIC MODEL RESULTS

The software package used to carry out the analysis was H_2OMAP Water by MWHSoft. The model was tested under three different domestic demand conditions: average day (AVDY), peak hour (PKHR) and one emergency condition: maximum day plus fire (MXDY + FF).

Figure 1-5 provides the IDs of each of the proposed junctions and pipes inputted into the hydraulic model. These IDs are used to present the results in tabular format in the following sections.

Figure 1-5: Junction and Pipe IDs



1.7.1 Average Day

Table 4a and **Table 4b** present the model output results for the average day demand analysis. As shown, the typical operating pressures are anticipated to range between 427 kPa (62 psi) and 455 kPa (66 psi) based on the local ground elevations and pipe hydraulic conditions. The resulting pressures are within the allowable pressure range of 40 to 100 psi (275 kPa to 690 kPa) as recommended by the City of Ottawa's Water Distribution Design Guidelines.

Table 4a: Average Day Model Node Output Results

Node ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (psi)
J2	0.00	68	114	66
J3	2.21	69	114	65
J5	0.00	71	115	62
J6	1.53	71	115	62
J7	0.00	70	115	64
J8	1.53	71	115	63

Phase 1
Phase 2

Table 4b: Average Day Model Pipe Output Results

Pipe ID	From	To Node	Length	Diameter	Roughness	Flow (L/s)	Velocity (m/s)	Headloss	HL/1000
P1	1	J2	34.22	300	110	2.21	0.03	0.0	0.01
P2	J2	J3	45.97	250	110	2.21	0.05	0.0	0.02
P4	5	J5	10.01	300	110	1.53	0.02	0.0	0.00
P5	J5	J6	24.34	250	110	1.53	0.03	0.0	0.01
P6	7	J7	15.20	300	110	1.53	0.02	0.0	0.00
P8	J7	J8	93.77	250	110	1.53	0.03	0.0	0.01

1.7.2 Peak Hour

Table 5a and **Table 5b** present the model output results for the peak hour demand analysis. As shown in the results, typical operating pressures are anticipated within the range of 365 kPa (53 psi) to 400 kPa (58 psi) based on the local ground elevations and pipe hydraulic conditions. The resultant pressures are within the allowable pressure range of 40 to 100 psi (275 kPa to 690 kPa) as recommended by the City of Ottawa's Water Distribution Design Guidelines.

Table 5a: Peak Hour Model Node Output Results

Node ID	Demand (Lpm)	Elevation (m)	Head (m)	Pressure (psi)
J2	0.00	68	108	58
J3	11.91	69	108	56
J5	0.00	71	108	53
J6	8.40	71	108	53
J7	0.00	70	108	54
J8	8.40	71	108	53

Phase 1
Phase 2

Table 3b: Peak Hour Model Pipe Output Results

Pipe ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness	Flow (L/s)	Velocity (m/s)	Headloss (m)	HL/1000 (m/km)
P1	1	J2	34.22	300	110	11.91	0.17	0.01	0.17
P2	J2	J3	45.97	250	110	11.91	0.24	0.02	0.41
P4	5	J5	10.01	300	110	8.40	0.12	0.00	0.09
P5	J5	J6	24.34	250	110	8.40	0.17	0.01	0.22
P6	7	J7	15.20	300	110	8.40	0.12	0.00	0.09
P8	J7	J8	93.77	250	110	8.40	0.17	0.02	0.22

1.7.3 Maximum Day + Fire Flow Results

The City of Ottawa's design guidelines for water distribution systems require a minimum pressure of 140 kPa (20 psi) to be maintained at all points in the distribution system under a condition of maximum day and fire flow demand.

Historically, the City of Ottawa has used a fire flow of 15,000 L/min (250 L/s) as a fire flow objective for mixed-use & high density residential development for sizing watermains. However as per the 2010 City of Ottawa Design Guidelines for Water Distribution Systems: "When calculating the fire flow requirements and affected pipe sizing, designers shall use the method developed by the Fire Underwriters Survey (FUS)."

In regards to high rise buildings, the FUS guidelines do not have a limitation with respect to a maximum number of floors (i.e. building height) in the calculation. Without a floor limitation, the FUS formula results in fire flow requirements that is much greater than the City's fire flow objective.

In developing FUS fire flow requirements for high rise buildings, it is recommended to consider the definition of a "*building"* per the building code. According to the Ontario Building Code Section 1.1.3.2:

"If portions of a *building* are completely separated by a vertical fire separation, that has a fire-resistance rating of at least 1h and that extends by a vertical fire separation that has a fire-resistance rating of at least 1 h and that extends through all storeys and service spaces of the separate portions, each separated portion may be considered to be a separate building for the purpose of determining building height if each separated portion is not more than three storeys in building height and is used only for residential occupancies, and the unobstructed path of travel for a fire fighter from the nearest street to one entrance to each separated portion is not more than 45m."

The fire flow calculated based on FUS and in accordance to OBC Section 1.1.3.2 (for "*building*" height i.e. 3 floors max with vertical fire separations) was determined to be 10,000 L/min and

12,000 L/min for Phase 1 and Phase 2, respectively. Sample calculations are included in **Section 2**.

It should be noted for comparison that the calculated FUS fire flows are approximately two times the maximum water supply requirements for sprinkler systems (5678 L/min) per the National Fire Protection Agency guideline NFPA 13.

A hydraulic analysis was carried out using the hydraulic model to determine the anticipated amount of flow that could be provided at each of the nodes in the proposed development under maximum day demands while still maintain a residual pressure of 140 kPa (20 psi). This was accomplished using a steady-state maximum day demand scenario along with the automated fire flow simulation feature of the software.

Table 6a shows the fire flow analysis according to the historical fire flow objective value of 15,000 L/min and **Table 6b** shows the fire flow analysis according to FUS and OBC fire separation. The results presented show that a fire flow of greater than 15,000 L/min is achievable while still maintaining a residual pressure greater than 140kPa (20psi), thereby satisfying both fire flow conditions. For details on FUS and OBC calculation methods see **Section 2**.

Table 6a: Maximum Day Fire Flow Results Based on the City of Ottawa Objective

Node ID	Static Demand (L/s)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)
J3	5.44	52	105	15,000	41
J6	3.82	50	106	15,000	45
J8	3.82	50	106	15,000	39

Phase 1 Phase 2

Table 6b: Maximum Day Fire Flow Results Based on the FUS and OBC fire separations

Node ID	Static Demand (L/s)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)
J3	5.44	52	105	10,000	47
J6	3.82	50	106	12,000	47
J8	3.82	50	106	12,000	39

1.8 SUMMARY OF FINDINGS

The proposed mixed-use 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 computer modeling results, the objective fire flow of 15,000 L/min and those based on FUS in accordance with OCB section 1.1.3.2 are achievable for this development using the alignment and sizing of the watermains shown on **Figure 1-3**.

The minimum pressure modeled **365kPa (53 psi)** is within the recommended design guidelines for minimum pressure and the maximum pressure modeled **455 kPa (66 psi)** does not exceed the maximum allowable pressure.

The high-rise buildings will experience additional pressure loss due to the height of the buildings for the nine-storey buildings and will therefore require additional pumping at the building to maintain minimum pressures to each unit.

2.0 Fire Flow Calculations

2.1 FIRE UNDERWRITER'S SURVEY (FUS)

According the FUS (1999), the required fire flow is calculated using the following equation:

$$Fire\ Flow = 220C\sqrt{A} \quad 2.1$$

Where:
F = required fire flow (L/min)
C = coefficient related to the type of construction
A= total floor area excluding the basement (m^2)

Fire flow can be reduced if the building consists of a sprinkler system and can be reduced **or** increased based on fire hazards of the building and separation between buildings. The calculated fire flow should not exceed 45,000 L/min nor be less than 2,000 L/min.

Although, the buildings are more than three storeys high, the following FUS fire flow calculations are in accordance to the OBC section 1.1.3.2. in which "each separated portion is not more than three *storeys in building height*…".

Figures 2-1, 2-2, 2-2, and **2-4** represent the fire flow calculations for buildings A, B, C, and D, respectively. Fire flow values shown are rounded to the nearest thousandth. In addition, all buildings were classified as ordinary construction and non-combustible for reduction/increases due to factors that affect burning.

Figure 2-1: FUS Fire Flow Calculations for Building A

FUS Fire Flow Calculations

Calculations Based on 1999 Publication "*Water Supply for Public Fire Protection*" by Fire Underwriters' Survey (FUS)

Stantec Project #: 160400864
Project Name: 114 Richmond Rd
Date: February 12, 2013
Data input by: Val Hoang
Fire Flow Calculation #: 1
Building Type/Description/Name: Bldg A

Notes: The proposed building is a 9 storey high rise

Table A: Fire Underwriters Survey Determination of Required Fire Flow - Long Method

Step	Task	Term	Options	Multiplier Associated with Option	Choose:	Value Used	Unit	Total Fire Flow (L/min)
		Framing Material						
1	Choose Frame Used for Construction of Unit	Coefficient related to type of construction (C)	Wood Frame	1.5	Ordinary construction	1	m	
			Ordinary construction	1				
			Non-combustible construction	0.8				
			Fire resistive construction (< 2 hrs)	0.7				
			Fire resistive construction (> 2 hrs)	0.6				
		Floor Space Area						
2	Choose Type of Housing (if TH, Enter Number of Units Per TH Block)	Type of Housing	Single Family	1	Other (Comm, Ind, etc.)	1	Units	
			Townhouse - indicate # of units	3				
			Other (Comm, Ind, etc.)	1				
2.2	# of Storeys	Number of Floors/ Storeys in the Unit (do not include basement):			3	3	Storeys	
3	Enter Ground Floor Area of One Unit	Enter Ground Floor Area (A) of One Unit Only :			1,041	3,123	Area In Square Meters (m^2)	
		Measurement Units	Square Feet (ft^2)	0.09290304	Square Metres (m2)			
			Square Metres (m^2)	1				
			Hectares (ha)	10000				
4	Obtain Required Fire Flow without Reductions	Required Fire Flow(without reductions or increases per FUS) (F = 220 * C * √A) Round to nearest 1000L/min						12,000
5	Apply Factors Affecting Burning	**Reductions/Increases Due to Factors Affecting Burning**						
5.1	Choose Combustibility of Building Contents	Occupancy content hazard reduction or surcharge	Non-combustible	-0.25	Non-combustible	-0.25	N/A	9,000
			Limited combustible	-0.15				
			Combustible	0				
			Free burning	0.15				
			Rapid burning	0.25				
5.2	Choose Reduction Due to Presence of Sprinklers	Sprinkler reduction	Complete Automatic Sprinkler Protection	-0.3	Complete Automatic Sprinkler Protection	-0.3	N/A	-2,700
			None	0				
5.3	Choose Separation Distance Between Units	Exposure Distance Between Units	North Side	3.1 to 10.0m	0.2	0.4	m	3,600
			East Side	30.1 to 45.0m	0.05			
			South Side	20.1 to 30.1m	0.1			
			West Side	30.1 to 45.0m	0.05			
6	Obtain Required Fire Flow, Duration & Volume	*Total Required Fire Flow, rounded to nearest 1000 L/min, with max/min limits applied:*						10,000
		Total Required Fire Flow (above) in L/s:						167
		Required Duration of Fire Flow (hrs)						2.00
		Required Volume of Fire Flow (m^3)						1,200

Figure 2-2: FUS Fire Flow Calculations for Building B

FUS Fire Flow Calculations

Calculations Based on 1999 Publication "*Water Supply for Public Fire Protection*" by Fire Underwriters' Survey (FUS)

Stantec Project #: 160400864
Project Name: 114 Richmond Rd
Date: February 12, 2013
Fire Flow Calculation #: 1
Building Type/Description/Name: Bldg B
Data input by: Val Hoang

Notes: The proposed building is a 9 storey high rise.

Table A: Fire Underwriters Survey Determination of Required Fire Flow - Long Method

Step	Task	Term	Options	Multiplier Associated with Option	Choose:	Value Used	Unit	Total Fire Flow (L/min)
		Framing Material						
1	**Choose Frame Used for Construction of Unit**	Coefficient related to type of construction (C)	Wood Frame	1.5	Ordinary construction	1	m	
			Ordinary construction	1				
			Non-combustible construction	0.8				
			Fire resistive construction (< 2 hrs)	0.7				
			Fire resistive construction (> 2 hrs)	0.6				
		Floor Space Area						
2	**Choose Type of Housing (if TH, Enter Number of Units Per TH Block)**	Type of Housing	Single Family	1	Other (Comm, Ind, etc.)	1	Units	
			Townhouse - indicate # of units	3				
			Other (Comm, Ind, etc.)	1				
2.2	**# of Storeys**	Number of Floors/ Storeys in the Unit (do not include basement):			3	3	Storeys	
3	**Enter Ground Floor Area of One Unit**	Enter Ground Floor Area (A) of One Unit Only :			1,399	4,197	Area in Square Meters (m^2)	
		Measurement Units	Square Feet (ft^2)	0.09290304	Square Metres (m2)			
			Square Metres (m^2)	1				
			Hectares (ha)	10000				
4	**Obtain Required Fire Flow without Reductions**	Required Fire Flow(without reductions or increases per FUS) (F = 220 * C * √A) Round to nearest 1000L/min						**14,000**
5	**Apply Factors Affecting Burning**	**Reductions/Increases Due to Factors Affecting Burning**						
5.1	**Choose Combustibility of Building Contents**	Occupancy content hazard reduction or surcharge	Non-combustible	-0.25	Non-combustible	-0.25	N/A	**10,500**
			Limited combustible	-0.15				
			Combustible	0				
			Free burning	0.15				
			Rapid burning	0.25				
5.2	**Choose Reduction Due to Presence of Sprinklers**	Sprinkler reduction	Complete Automatic Sprinkler Protection	-0.3	Complete Automatic Sprinkler Protection	-0.3	N/A	**-3,150**
			None	0				
5.3	**Choose Separation Distance Between Units**	Exposure Distance Between Units	North Side	10.1 to 20.0m	0.15	0.4	m	**4,200**
			East Side	20.1 to 30.1m	0.1			
			South Side	30.1 to 45.0m	0.05			
			West Side	20.1 to 30.1m	0.1			
6	**Obtain Required Fire Flow, Duration & Volume**	***Total Required Fire Flow, rounded to nearest 1000 L/min, with max/min limits applied:***						**12,000**
		Total Required Fire Flow (above) in L/s:						**200**
		Required Duration of Fire Flow (hrs)						**2.50**
		Required Volume of Fire Flow (m^3)						**1,800**

Figure 2-3: FUS Fire Flow Calculations for Building C

FUS Fire Flow Calculations

Calculations Based on 1999 Publication "*Water Supply for Public Fire Protection*" by Fire Underwriters' Survey (FUS)

Stantec Project #: 160400864
Project Name: 114 Richmond Rd
Date: February 12, 2013
Fire Flow Calculation #: 1
Building Type/Description/Name: Bldg C
Data input by: Val Hoang

Notes: The proposed building is a 5 storey high rise.

Table A: Fire Underwriters Survey Determination of Required Fire Flow - Long Method

Step	Task	Term	Options	Multiplier Associated with Option	Choose:	Value Used	Unit	Total Fire Flow (L/min)
1	Choose Frame Used for Construction of Unit	**Framing Material**						
		Coefficient related to type of construction (C)	Wood Frame	1.5	Ordinary construction	1	m	
			Ordinary construction	1				
			Non-combustible construction	0.8				
			Fire resistive construction (< 2 hrs)	0.7				
			Fire resistive construction (> 2 hrs)	0.6				
2	Choose Type of Housing (if TH, Enter Number of Units Per TH Block)	**Floor Space Area**						
		Type of Housing	Single Family	1	Other (Comm, Ind, etc.)	1	Units	
			Townhouse - indicate # of units	3				
			Other (Comm, Ind, etc.)	1				
2.2	# of Storeys	Number of Floors/ Storeys in the Unit (do not include basement):			3	3	Storeys	
3	Enter Ground Floor Area of One Unit	Enter Ground Floor Area (A) of One Unit Only :			1,635	4,905	Area in Square Meters (m^2)	
		Measurement Units	Square Feet (ft^2)	0.09290304	Square Metres (m2)			
			Square Metres (m^2)	1				
			Hectares (ha)	10000				
4	Obtain Required Fire Flow without Reductions	Required Fire Flow(without reductions or increases per FUS) (F = 220 * C * √A) Round to nearest 1000L/min						15,000
5	Apply Factors Affecting Burning	**Reductions/Increases Due to Factors Affecting Burning**						
5.1	Choose Combustibility of Building Contents	Occupancy content hazard reduction or surcharge	Non-combustible	-0.25	Non-combustible	-0.25	N/A	11,250
			Limited combustible	-0.15				
			Combustible	0				
			Free burning	0.15				
			Rapid burning	0.25				
5.2	Choose Reduction Due to Presence of Sprinklers	Sprinkler reduction	Complete Automatic Sprinkler Protection	-0.3	Complete Automatic Sprinkler Protection	-0.3	N/A	-3,375
			None	0				
5.3	Choose Separation Distance Between Units	Exposure Distance Between Units	North Side	30.1 to 45.0m	0.05	0.2	m	2,250
			East Side	45.1m or greater	0			
			South Side	10.1 to 20.0m	0.15			
			West Side	45.1m or greater	0			
6	Obtain Required Fire Flow, Duration & Volume	***Total Required Fire Flow, rounded to nearest 1000 L/min, with max/min limits applied:***						**10,000**
		Total Required Fire Flow (above) in L/s:						**167**
		Required Duration of Fire Flow (hrs)						**2.00**
		Required Volume of Fire Flow (m^3)						**1,200**

Figure 2-4: FUS Fire Flow Calculations for Building D

FUS Fire Flow Calculations

Calculations Based on 1999 Publication "*Water Supply for Public Fire Protection*" by Fire Underwriters' Survey (FUS)

Stantec Project #: 160400864
Project Name: 114 Richmond Rd
Date: February 12, 2013
Fire Flow Calculation #: 1
Building Type/Description/Name: Bldg D
Data input by: Val Hoang

Notes: The proposed building is a 9 storey high rise.

Table A: Fire Underwriters Survey Determination of Required Fire Flow - Long Method

Step	Task	Term	Options	Multiplier Associated with Option	Choose:	Value Used	Unit	Total Fire Flow (L/min)
		Framing Material						
1	Choose Frame Used for Construction of Unit	Coefficient related to type of construction (C)	Wood Frame	1.5	Ordinary construction	1	m	
			Ordinary construction	1				
			Non-combustible construction	0.8				
			Fire resistive construction (< 2 hrs)	0.7				
			Fire resistive construction (> 2 hrs)	0.6				
		Floor Space Area						
2	Choose Type of Housing (if TH, Enter Number of Units Per TH Block)	Type of Housing	Single Family	1	Other (Comm, Ind, etc.)	1	Units	
			Townhouse - indicate # of units	3				
			Other (Comm, Ind, etc.)	1				
2.2	# of Storeys	Number of Floors/ Storeys in the Unit (do not include basement):			3	3	Storeys	
3	Enter Ground Floor Area of One Unit	Enter Ground Floor Area (A) of One Unit Only :			1,732	5,196	Area in Square Meters (m^2)	
		Measurement Units	Square Feet (ft^2)	0.09290304	Square Metres (m2)			
			Square Metres (m^2)	1				
			Hectares (ha)	10000				
4	Obtain Required Fire Flow without Reductions	Required Fire Flow(without reductions or increases per FUS) (F = 220 * C * √A) Round to nearest 1000L/min						16,000
5	Apply Factors Affecting Burning	**Reductions/Increases Due to Factors Affecting Burning**						
5.1	Choose Combustibility of Building Contents	Occupancy content hazard reduction or surcharge	Non-combustible	-0.25	Non-combustible	-0.25	N/A	12,000
			Limited combustible	-0.15				
			Combustible	0				
			Free burning	0.15				
			Rapid burning	0.25				
5.2	Choose Reduction Due to Presence of Sprinklers	Sprinkler reduction	Complete Automatic Sprinkler Protection	-0.3	Complete Automatic Sprinkler Protection	-0.3	N/A	-3,600
			None	0				
5.3	Choose Separation Distance Between Units	Exposure Distance Between Units	North Side	30.1 to 45.0m	0.05	0.2	m	2,400
			East Side	45.1m or greater	0			
			South Side	30.1 to 45.0m	0.05			
			West Side	20.1 to 30.1m	0.1			
6	Obtain Required Fire Flow, Duration & Volume	*Total Required Fire Flow, rounded to nearest 1000 L/min, with max/min limits applied:*						11,000
		Total Required Fire Flow (above) in L/s:						183
		Required Duration of Fire Flow (hrs)						2.25
		Required Volume of Fire Flow (m^3)						1,485

Appendix B: SANITARY SEWER

B.1 SANITARY SEWER DESIGN SHEET

Stantec

SUBDIVISION: **Q-WEST PHASE 2**

DATE: 1/4/2019
REVISION: 1
DESIGNED BY: DT
CHECKED BY: MJS

SANITARY SEWER DESIGN SHEET
(City of Ottawa)

FILE NUMBER: 160400864

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	1.8				

LOCATION			RESIDENTIAL AREA AND POPULATION									COMMERCIAL		INDUSTRIAL (L)		INDUSTRIAL (H)		INSTITUTIONAL		GREEN / UNUSED		C+I+I	INFILTRATION			TOTAL	PIPE							
AREA ID NUMBER	FROM M.H.	TO M.H.	AREA	SINGLE	UNITS TOWN	APT	POP.	CUMULATIVE AREA	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW	AREA	ACCU. AREA	AREA	ACCU. AREA	AREA	ACCU. AREA	AREA	ACCU. AREA	AREA	ACCU. AREA	PEAK FLOW	TOTAL AREA	ACCU. AREA	INFILT. FLOW	FLOW	LENGTH	DIA	MATERIAL	CLASS	SLOPE	CAP. (FULL)	CAP. V PEAK FLOW	VEL. (FULL)	VEL. (ACT.)
			(ha)					(ha)			(l/s)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(l/s)	(ha)	(ha)	(l/s)	(l/s)	(m)	(mm)			(%)	(l/s)	(%)	(m/s)	(m/s)
SITE	STUB	1	0.00	0	0	764	1375	0.00	1375	3.17	14.1	0.38	0.38	0.00	0.00	0.00	0.00	0.00	0.00	1.84	1.84	0.1	2.22	2.22	0.7	15.0	16.0	375	PVC	SDR 35	1.14	173.3	**8.63%**	1.64	0.84
	1	2	0.00	0	0	0	0	0.00	1375	3.17	14.1	0.00	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.84	0.1	0.00	2.22	0.7	15.0	69.1	375	PVC	SDR 35	2.00	229.5	**6.52%**	2.18	1.02
																												375							

B.2 BACKGROUND REPORT EXCERPTS (SANITARY SEWER)

3.0 Water Servicing

A Potable Water Servicing Study was prepared by Stantec Consulting on February 12, 2013 and revised on April 10, 2013 to reflect servicing changes. A 250mm watermain connection is proposed within Richmond Road to service phase 1 of the development. The remaining development area will be serviced with a 250mm watermain connection in Hilson Avenue and another 250mm connection in Byron Avenue. The report outlines estimated water demands and residual pressures under average day, maximum day and peak hour demand conditions. The report indicates that minimum pressures are maintained during all demand scenarios. Fire flow calculations as per the Fire Underwriters Survey (FUS) indicate a required fire flow of 250L/s. The hydraulic analysis indicated that the proposed water servicing could provide the required fire flow while meeting minimum pressure requirements of 20psi (140kPa). Due to additional losses in the high rise buildings, additional pumping will be required at these buildings to maintain minimum pressures to each unit.For the detailed report see **Appendix D**.

4.0 Wastewater Servicing

As illustrated on **Drawing SP-1**, a 250mm diameter sanitary sewer exists within Richmond Road which flows easterly towards the intersection of Richmond Road and Leighton Terrace. A 450mm diameter sanitary sewer exists at the intersection of Patricia Avenue and Richmond Road which runs northerly down Patricia Avenue. This existing sanitary sewer is a 450mm diameter pipe with a slope of minimum 1%. Based upon the size and slope of the existing pipe it is determined that this sewer has a flow capacity of 300 l/s. The existing sanitary service lateral from the existing building within the 114 Richmond Road property is currently serviced through this outlet at Patricia Avenue and will be removed.

It is proposed that the development will be constructed in 3 separate phases. The first Phase of the development will consist of construction of three - nine storey mixed use buildings and renovations to the existing 3 storey building. The second phase will consist of construction of 5 buildings consisting of residential and mixed use. The third phase will consist of 1 building with a mix of residential and commercial use. The entire site will be serviced through one connection onto Richmond Road. Residential unit counts and commercial areas were determined from the October 22, 2012 site plan and stats prepared by Roderick Lahey Architects in **Appendix A** of this report.

It is proposed to service the entire development through a new 375mm diameter sanitary sewer connection to Richmond Road. The servicing for the first phase will be connected within the building mechanical room via the 375mm diameter pipe, as illustrated in **Drawing SP-2**. The transition between PVC material and cast iron will occur within the building and will be designed

by the mechanical engineer. The cast iron sewer will continue southerly within the Phase 1 building servicing corridor and exit the foundation wall. This 375mm diameter sanitary sewer will be extended within a common trench, with the storm and utilities, along the westerly property edge to service the Phase 2 and 3 developments. The 375mm diameter sewer will be constructed between two existing manholes in Richmond Road, as indicated on Drawing SP-1. It is proposed to install a 1200mm diameter manhole within the Richmond road right of way which will connect to the existing 450mm diameter sanitary through the existing manhole located at the intersection of Patricia Avenue and Richmond Road. As there is insufficient room for the placement of a monitoring manhole for phase 1 commercial, a monitoring port will be placed within the outlet sewer pipe for the commercial areas.

A sanitary drainage area plan and sanitary sewer design sheets were prepared by Novatech Engineering Consultants on behalf of the City of Ottawa in May 2005, which identified the 114 Richmond road property tributary to the Patricia Avenue sanitary sewer. (See **Appendix C**.)

The calculations outlined below represent the flows anticipated for each phase of this development.

Phase 1

The City of Ottawa's Sewer Design Guidelines for commercial development indicate the allocation of capacity in the receiving sanitary sewer required.

Total Site Area = 0.829ha
Peaking Factor Commercial 1.5
Commercial Average Peak Flow = 50000 L/gross ha/d
Commercial Operational Flow = 17000 L/gross ha/d
Infiltration Rate = 0.28 L/s/ha
Total Infiltration Flow = (Area x infiltration rate) = 0.23 L/s
Total Flow = (Peak Flow x Site Area /86400) x Peak Factor + Infiltration Flow
Total Flow as per guidelines = 0.95 L/s.

By implementing the City of Ottawa's sewer design guidelines the following sanitary flows are calculated for the proposed condominium development.

Residential (Apartment)	Population	= 276 units x 1.8 persons/unit = 497 people
		= 497 x 350 L/c/d
		≈ 2.01 L/s average residential sanitary flow using a peaking factor of 4;
		≈ 8.05 L/s

Total peak sewage flow for commercial and residential Phase 1 ≈ 9.00 L/s

Phase 2

The City of Ottawa's Sewer Design Guidelines for commercial development indicate the allocation of capacity in the receiving sanitary sewer required.

Total Commercial Area = 0.49ha
Infiltration area = 0.45ha
Peaking Factor Commercial 1.5
Commercial Average Peak Flow = 50000 L/gross ha/d
Commercial Operational Flow = 17000 L/gross ha/d
Infiltration Rate = 0.28 L/s/ha
Total Infiltration Flow = (Area x infiltration rate) = 0.13 L/s
Total Flow = (Peak Flow x Site Area /86400) x Peak Factor + Infiltration Flow
Total Flow as per guidelines = 0.56 L/s.

By implementing the City of Ottawa's sewer design guidelines the following sanitary flows are calculated for the proposed condominium development.

Residential (Apartment)

1 Bedroom:

Population 282 units x 1.4 person/unit
= 394.8 persons
(394.8 persons x 350L/p/d)/86400s/day
= 1.60 L/s average residential sanitary flow
using a peaking factor of 4;
= 6.40 L/s

2 Bedroom:

Population 138 units x 2.1 person/unit
= 289.8
(193.2 persons x 350L/p/d)/86400s/day
= 1.17
using a peaking factor of 4;
= 4.70 L/s

Total peak sewage flow for commercial and residential Phase 2 ≈ **11.66L/s**

Phase 3

The City of Ottawa's Sewer Design Guidelines for commercial development indicate the allocation of capacity in the receiving sanitary sewer required.

Total Commercial Area = 0.26ha
Infiltration area = 0.26ha
Peaking Factor Commercial 1.5
Commercial Average Peak Flow = 50000 L/gross ha/d
Commercial Operational Flow = 17000 L/gross ha/d
Infiltration Rate = 0.28 L/s/ha
Total Infiltration Flow = (Area x infiltration rate) = 0.07 L/s
Total Flow = (Peak Flow x Site Area /86400) x Peak Factor + Infiltration Flow
Total Flow as per guidelines = 0.30 L/s.

By implementing the City of Ottawa's sewer design guidelines the following sanitary flows are calculated for the proposed condominium development.

Residential (Apartment)

1 Bedroom:

Population 24 units x 1.4 person/unit
= 33.6 persons
(33.6 persons x 350L/p/d)/86400s/day
= 0.14 L/s average residential sanitary flow
using a peaking factor of 4;
= 0.54 L/s

Total peak sewage flow for commercial and residential Phase 3 ≈ **0.84L/s**

Total anticipated peak flow from phase 1, 2 and 3 is approximately **21.5L/s**

A review of the downstream sanitary sewers was completed from the intersection of Patricia Avenue and Richmond Road to the connection to the West Nepean Collector located at the intersection of Island Park Drive and Scott Street (approx 320 metres).

Included in **Appendix C** is a sanitary sewer design sheet that was prepared for the City of Ottawa in 2005 during the reconstruction of Richmond Road. In the design sheet associated sanitary drainage area plan, the proposed site is denoted as area B3.

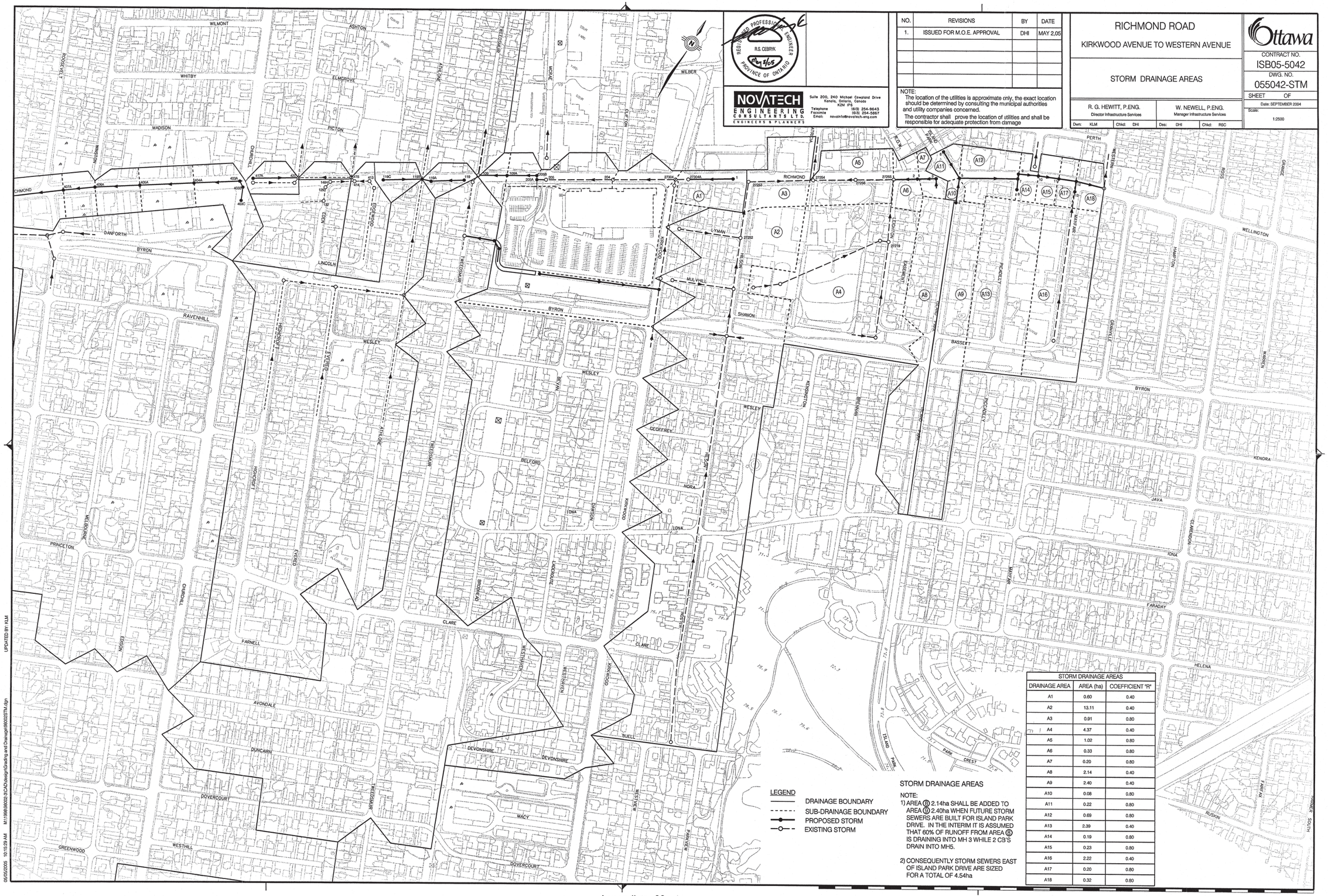
This information was expanded to include additional sanitary areas on Patricia Avenue to the collector sewer. The estimated sewage flows into the existing manhole at the intersection of

Patricia Avenue and Richmond Road are 73 L/sec (existing) + 23 L/sec (114 Richmond Rd). Additional commercial flows and residential flows of 17 L/sec are accumulated along Patricia Avenue.

An existing 450mm & 750mm sanitary sewer is present on Patricia Avenue, with a slope of between 1% and 2%. Based on this the minimum capacity for a 450mm sanitary sewer at 1.0% is 300 L/sec.

The total estimated sewage flows along Patricia Avenue including the new flows from the development of 114 Richmond Road are 111 L/sec. As the capacity of the existing 450mm sanitary sewer is approximately 300 L/sec the receiving sanitary sewer has adequate capacity to convey the necessary flow generated as a result to the proposed development.

Refer to **Appendix C** of this report for sanitary sewer design sheet and drainage areas indicating downstream flows within the 450mm diameter at Patricia Avenue indicating capacity within the receiving sewer for the 114 Richmond Road Development.



REGISTERED PROFESSIONAL ENGINEER
R.S. CEBRYK
PROVINCE OF ONTARIO

NOVATECH ENGINEERING CONSULTANTS LTD.
ENGINEERS & PLANNERS

Suite 200, 240 Michael Cowpland Drive
Kanata, Ontario, Canada
K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Email: novatech@novatech-eng.com

NO.	REVISIONS	BY	DATE
1.	ISSUED FOR M.O.E. APPROVAL	DHI	MAY 2,05

NOTE:
The location of the utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned.
The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage

RICHMOND ROAD

KIRKWOOD AVENUE TO WESTERN AVENUE

STORM DRAINAGE AREAS

Ottawa

CONTRACT NO.
ISB05-5042
DWG. NO.
055042-STM
SHEET OF
Date: SEPTEMBER 2004
Scale:
1:2500

R. G. HEWITT, P.ENG.
Director Infrastructure Services

W. NEWELL, P.ENG.
Manager Infrastructure Services

Dwn: KLM | Chkd: DHI | Des: DHI | Chkd: RSC

UPDATED BY: KLM
M:\1998\98002\3CAD\design\Grading and Drainage\98002STM.dgn
05/05/2005 10:15:29 AM

LEGEND
- DRAINAGE BOUNDARY
- SUB-DRAINAGE BOUNDARY
- PROPOSED STORM
- EXISTING STORM

STORM DRAINAGE AREAS

NOTE:
1) AREA (A) 2.14ha SHALL BE ADDED TO AREA (A) 2.40ha WHEN FUTURE STORM SEWERS ARE BUILT FOR ISLAND PARK DRIVE. IN THE INTERIM IT IS ASSUMED THAT 60% OF RUNOFF FROM AREA (A) IS DRAINING INTO MH 3 WHILE 2 CB'S DRAIN INTO MH5.

2) CONSEQUENTLY STORM SEWERS EAST OF ISLAND PARK DRIVE ARE SIZED FOR A TOTAL OF 4.54ha

STORM DRAINAGE AREAS

DRAINAGE AREA	AREA (ha)	COEFFICIENT "R"
A1	0.60	0.40
A2	13.11	0.40
A3	0.91	0.80
A4	4.37	0.40
A5	1.02	0.80
A6	0.33	0.80
A7	0.20	0.80
A8	2.14	0.40
A9	2.40	0.40
A10	0.08	0.80
A11	0.22	0.80
A12	0.69	0.80
A13	2.39	0.40
A14	0.19	0.80
A15	0.23	0.80
A16	2.22	0.40
A17	0.20	0.80
A18	0.32	0.80

98002STM.dgn 05/05/2005 10:15:29 AM

STORM SEWER DESIGN SHEET

DESIGNED BY : DHI
CHECKED BY : RSC

PROJECT: Richmond Road
DEVELOPER: City of Ottawa

DATE: 2-May-05
REVISION:

LOCATION			AREA (ha)			INDIV	ACCUM	TIME OF	RAINFALL	PEAK FLOW	PROPOSED SEWER							
STREET	FROM M.H.	TO M.H.	R= 0.40	R = 0.60	R= 0.80	2.78 AR	2.78 AR	CONC (min)	INTENSITY (mm/hr)	Q (l/s)	TYPE OF PIPE	PIPE SIZE (mm)	PIPE ID (mm)	GRADE %	LENGTH (m)	CAPACITY (L/s)	FULL FLOW VELOCITY	TIME OF FLOW (min)
Richmond Road	1	27304 A	0.600			0.67	0.67	10.00	122.14	81.5	DR 35	300	299	1.47	71.5	116.6	1.66	0.72
Richmond Road (sized for current conditions)	3	2	1.280		0.200	1.87	1.87	10.00	122.14	228.3	CONC	525	533	0.30	27.5	245.2	1.10	0.42
Richmond Road	2	27255			0.330	0.73	2.60	10.42	119.61	311.2	CONC	525	533	0.50	32.7	316.6	1.42	0.38
Leighton Terrace	*27219*	*27255*	*4.370*			*4.86*	*4.86*	*16.50*	*79.00*	*383.9*	*CONC*	*525*	*533*	*1.62*	*75.0*	*569.9*	*2.55*	*0.49*
Richmond Road	*27255*	*27254*			*1.020*	*2.27*	*9.00*	*16.50*	*92.50*	*832.1*	*CONC*	*600*	*610*	*0.80*	*128.4*	*574.9*	*1.96*	*1.09*
Hilson Avenue	*27252*	*27253*	*13.110*			*14.58*	*14.58*	*25.00*	*60.90*	*887.8*	*CONC*	*1050*	*1067*	*0.57*	*85.0*	*2151.9*	*2.41*	*0.59*
Richmond Road	*27253*	*27254*			*0.910*	*2.02*	*16.60*	*25.00*	*71.22*	*1182.5*	*CONC*	*1050*	*1067*	*0.93*	*93.0*	*2748.7*	*3.07*	*0.50*
Patricia Avenue	*27254*	*EXIST*			*0.000*	*0.00*	*25.60*	*25.50*	*60.10*	*2192.5*	*CONC*	*900*	*914*	*1.24*	*110.0*	*2100.6*	*3.20*	*0.57*
Island Park Drive (Sized for future conditions)	4	5	4.540		0.080	5.23	5.23	24.00	73.15	382.3	CONC	525	533	0.90	35.0	424.8	1.90	0.31
Island Park Drive	6	5			0.220	0.49	0.49	10.00	122.14	59.8	DR 35	300	299	0.50	34.0	68.0	0.97	0.59
Richmond Road	5	7			0.690	1.53	7.25	24.31	72.55	526.0	CONC	675	685	0.45	94.0	586.4	1.59	0.98
Picadilly Avenue	8	7	2.390			2.66	2.66	16.50	79.00	210.0	DR 35	450	448	0.60	11.0	218.1	1.38	0.13
Richmond Road	7	9				0.00	9.91	25.29	70.68	700.3	CONC	750	762	0.60	5.0	899.6	1.97	0.04
	9	10			0.190	0.42	10.33	25.33	70.61	729.4	CONC	750	762	0.60	28.0	899.6	1.97	0.24
	10	11			0.230	0.51	10.84	25.57	70.17	760.8	CONC	750	762	0.60	34.0	899.6	1.97	0.29
	11	12			0.200	0.44	11.29	25.86	69.66	786.2	CONC	750	762	0.60	27.0	899.6	1.97	0.23
Mayfair Avenue	*EXIST*	13	*2.220*			*2.47*	*2.47*	*16.50*	*79.00*	*195.0*	*DR 35*	*450*	*448*	*1.60*	*53.0*	*356.1*	*2.26*	*0.39*
Mayfair Avenue	13	12				0.00	0.00	16.50	79.00	0.0	DR 35	450	448	1.60	10.0	356.1	2.26	0.07
Richmond Road	12	EXIST			0.32	0.71	12.00	26.09	69.25	830.9	CONC	900	914	0.60	40.0	1461.2	2.23	0.30
Western Avenue	*EXIST*	*EXIST*			*0.000*	*0.00*	*12.00*	26.38	*58.77*	*705.2*	*CONC*	*900*	*914*	*0.50*	*16.0*	*1333.9*	*2.03*	*0.13*

Q = 2.78*A*I*R
Intensity / Duration Curve = 10 years
Inlet Time = 10 min. (Minimum)
Manning's Coefficient = 0.013

Italic Text = Existing

Grey Tone = Under Sized Sewer

NOTE: 10 years storm is used for Richmond Road and 5 year storm for Local Streets

LICENSED PROFESSIONAL ENGINEER
R. S. CEBRYK
May 3/05
PROVINCE OF ONTARIO

Appendix C : STORM SEWER

C.1 STORM SEWER DESIGN SHEET

Stantec

Q-WEST PHASE 2

DATE: 2019-04-01
REVISION: 1
DESIGNED BY: DT
CHECKED BY: MJS

STORM SEWER DESIGN SHEET
(City of Ottawa)

FILE NUMBER: 160400864

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
b =	6.199	6.053	6.014	6.014
c =	0.810	0.814	0.816	0.820

MANNING'S n = 0.013
MINIMUM COVER: 2.00 m
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 DIAMETEI (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)
A2, EXT1	502	200	0.00	0.22	0.00	0.00	0.00	0.00	0.58	0.00	0.00	0.000	0.000	0.128	0.128	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	36.9	57.0	250	250	CIRCULAR	PVC	-	1.00	60.4	**61.10%**	1.22	1.10	0.86
																				10.86																			
A5	501	200	0.00	0.10	0.00	0.00	0.00	0.00	0.90	0.00	0.00	0.000	0.000	0.090	0.090	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	26.0	24.7	200	200	CIRCULAR	PVC	-	1.00	33.3	**78.20%**	1.05	1.03	0.40
																				10.40																			
	200	STUB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.218	0.000	0.000	0.000	0.000	10.86	73.65	99.86	117.04	171.06	0.0	0.0	60.3	8.4	375	375	CIRCULAR	PVC	-	1.00	164.8	**36.60%**	1.56	1.22	0.12
																				10.98										375	375								
A4	500	109	0.00	0.05	0.00	0.00	0.00	0.00	0.90	0.00	0.00	0.000	0.000	0.045	0.045	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	13.0	12.7	200	200	CIRCULAR	PVC	-	1.00	33.3	**39.10%**	1.05	0.83	0.25
A1, EXT2	109	107	0.00	0.48	0.00	0.00	0.00	0.00	0.43	0.00	0.00	0.000	0.000	0.207	0.252	0.000	0.000	0.000	0.000	10.25	75.84	102.87	120.58	176.27	0.0	0.0	72.0	64.7	375	375	CIRCULAR	PVC	-	1.00	164.8	**43.67%**	1.56	1.28	0.84
A3	106	3	0.00	0.52	0.00	0.00	0.00	0.00	0.81	0.00	0.00	0.000	0.000	0.421	0.673	0.000	0.000	0.000	0.000	11.09	72.85	98.75	115.73	169.15	0.0	0.0	184.6	16.5	450	450	CIRCULAR	CONCRETE	-	4.40	623.9	**29.59%**	3.80	2.78	0.10
																				11.19										525	525								
COURT1-3, ROOF B,C,D, A2, A5, EXT1	CISTERN	2	0.00	0.00	0.00	0.00	0.50	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	67.6	67.6	67.6	18.8	375	375	CIRCULAR	PVC	-	1.13	175.2	**38.58%**	1.66	1.31	0.24
ROOF A	2	MAIN	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.24	75.90	102.94	120.67	176.40	9.2	76.8	76.8	64.5	375	375	CIRCULAR	PVC	-	0.50	116.6	**65.89%**	1.11	1.03	1.05
																				11.29										600	600								

C.2 MODIFIED RATIONAL METHOD CALCULATIONS

Stormwater Management Calculations

160400864
Q-WEST PHASE 2
01-Apr-19

Post-Development Site Conditions:

Overall Runoff Coefficient for Site and Sub-Catchment Areas

Runoff Coefficient Table					
Catchment Type	Sub-catchment Area ID / Description	Area (ha) "A"	Runoff Coefficient "C"	"A x C"	Overall Runoff Coefficient
Total		2.610		1.948	
Overall Runoff Coefficient= C:					0.75

Total Roof Areas	0.750 ha
Total Tributary Surface Areas (Controlled and Uncontrolled)	1.710 ha
Total Tributary Area to Outlet	2.460 ha
Total Uncontrolled Areas (Non-Tributary)	0.150 ha
Total Site	2.610 ha

Stormwater Management Calculations

Project #160400864, Q-WEST PHASE 2
Modified Rational Method Calculatons for Storage

5 yr Intensity
City of Ottawa

t (min)	I (mm/hr)

5 YEAR Predevelopment Target Release from Portion of Site

Subdrainage Area:
Area (ha):
C:

tc (min)	I (5 yr) (mm/hr)	Qtarget (L/s)
		205

5 YEAR Modified Rational Method for Entire Site

Subdrainage Area:
Area (ha):
C:

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
					4.0

Subdrainage Area:
Area (ha):
C:

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)

Project #160400864, Q-WEST PHASE 2
Modified Rational Method Calculatons for Storage

100 yr Intensity
City of Ottawa

t (min)	I (mm/hr)

100 YEAR Predevelopment Target Release from Portion of Site

Subdrainage Area:
Area (ha):
C:

tc (min)	I (5 yr) (mm/hr)	Qtarget (L/s)
		205

100 YEAR Modified Rational Method for Entire Site

Subdrainage Area:
Area (ha):
C:

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
					13.0

Subdrainage Area:
Area (ha):
C:

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)

Stormwater Management Calculations

Project #160400864, Q-WEST PHASE 2
Modified Rational Method Calculatons for Storage

Subdrainage Area:
Area (ha):
C:

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)

106.7

Subdrainage Area:
Area (ha):
C:

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)

69.8

Subdrainage Area:
Area (ha):
C:

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)	Depth (mm)

33.4

Subdrainage Area:
Area (ha):
C:

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)	Depth (mm)

27.6

Project #160400864, Q-WEST PHASE 2
Modified Rational Method Calculatons for Storage

Subdrainage Area:
Area (ha):
C:

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)

271.3

Subdrainage Area:
Area (ha):
C:

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)

222.4

Subdrainage Area:
Area (ha):
C:

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)	Depth (mm)

78.4

Subdrainage Area:
Area (ha):
C:

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)	Depth (mm)

65.7

Stormwater Management Calculations

Project #160400864, Q-WEST PHASE 2
Modified Rational Method Calculatons for Storage

Subdrainage Area:
Area (ha):
C:

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)	Depth (mm)
					17.9	

Subdrainage Area:
Area (ha):
C:

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)	Depth (mm)
					44.2	

SUMMARY TO OUTLET

Tributary Area
Total 5yr Flow to Sewer

Non-Tributary Area
Total 5yr Flow Uncontrolled

Total Area
Total 5yr Flow
Target

Project #160400864, Q-WEST PHASE 2
Modified Rational Method Calculatons for Storage

Subdrainage Area:
Area (ha):
C:

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)	Depth (mm)
					41.8	

Subdrainage Area:
Area (ha):
C:

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)	Depth (mm)
					83.6	

SUMMARY TO OUTLET

Tributary Area
Total 100yr Flow to Sewer

Non-Tributary Area
Total 100yr Flow Uncontrolled

Total Area
Total 100yr Flow
Target

Project #160400864, Q-WEST PHASE 2
Roof Drain Design Sheet, Area RFA
Standard Zurn Model Z-105-5 Control-Flo Single Notch Roof Drain

Rating Curve				Volume Estimation				

Drawdown Estimate

Rooftop Storage Summary

From Zurn Drain Catalogue

Calculation Results	5yr	100yr	Available

Project #160400864, Q-WEST PHASE 2
Roof Drain Design Sheet, Area RFB
Watts 'Accutrol' Single Notch Roof Drain

Rating Curve				Volume Estimation				

Drawdown Estimate

Rooftop Storage Summary

From Watts Drain Catalogue

Calculation Results	5yr	100yr	Available

Project #160400864, Q-WEST PHASE 2
Roof Drain Design Sheet, Area RFC
Watts 'Accutrol' Single Notch Roof Drain

Rating Curve				Volume Estimation				

Drawdown Estimate

Rooftop Storage Summary

From Watts Drain Catalogue

Calculation Results	5yr	100yr	Available

Project #160400864, Q-WEST PHASE 2
Roof Drain Design Sheet, Area RFD
Watts 'Accutrol' Single Notch Roof Drain

Rating Curve				Volume Estimation				

Drawdown Estimate

Rooftop Storage Summary

From Watts Drain Catalogue

Calculation Results	5yr	100yr	Available

C.3 BACKGROUND REPORT EXCERPTS (STORM SEWER)

5.0 Stormwater Management and Servicing

The stormwater management (SWM) criteria for 114 Richmond Road were established in a report titled "Assessment of Adequacy of Public Services Report" prepared by Trow Associates Inc. and dated March 12, 2010. This report indicated a 5-year predevelopment release rate of 194.3L/s based on a site area of 2.21ha and a pre-development runoff coefficient of 0.45. (see **Appendix C** for Excerpts from Trow's report). As per the City of Ottawa's request in an email received September 6, 2011, the allowable release rate has been revised to reflect a calculated time of concentration of 23.8 minutes, based on existing site conditions. Note that the proposed site also receives external drainage from neighbouring properties. These external flows will be captured and conveyed by the proposed system. The target rate for the site is therefore **205 L/s** when external drainage areas are included.

This SWM analysis will demonstrate that the proposed development meets the above criteria, as well as the following:

- Maximum permitted hydraulic grade line (HGL) to be a minimum of 0.30 m below building foundation will be addressed through installation of pumps.
- Size storm sewers to convey 5 year storm event under free-flow conditions using 2004 City of Ottawa I-D-F parameters *(City of Ottawa).* Due to servicing restrictions on the west side of the site, the sewers connecting to Richmond Road are sized to convey the 100 year restricted release rate from roof tops and the underground storm reservoir.
- All flows in excess of the allowable release rate, up to and including the 100-year storm, are to be detained onsite.
- Where possible, maximum ponding depth of 0.30 m (*City of Ottawa*). Note that due to grading restrictions a depression exists within the treed area that is to be preserved and cannot be regraded. No overland flow route is available from this area and as such maximum ponding depths of 0.3m cannot be achieved.
- Standing water depths at parking lot sags not to cause surface flooding on any building or structure *(City of Ottawa)*
- Subdrains required in swales where longitudinal gradient is less than 1.5% *(City of Ottawa)*
- Where possible, major flow from the site is to be safely conveyed by surface routing towards Leighton Terrace and Richmond Road. A depression exists currently within the treed area that is to be preserved and cannot be regraded. Due to elevation changes across the site no overland flow route can be provided at this location. Flows in this area will be captured in a catchbasin and conveyed through the proposed storm sewers but no overland flow route can be provided.