Appendix A WATER SUPPLY SERVICING

A.1 DOMESTIC WATER DEMAND ESTIMATE

966-968 Fisher Avenue - Domestic Water Demand Estimates

- Based on M.David Blakely Architect Inc. Site Plan SP1 (160401198)

Building ID	Area (m^2)	Population	Daily Rate of Demand [1]	Avg Day Demand [2]		Max Day Demand [3]		Peak Hour Demand [3]	
				(L/min)	(L/s)	(L/min)	(L/s)	(L/min)	(L/s)
BLDG	1092	74.2	350	18.0	0.30	45.1	0.75	99.2	1.65
Total Site :				**18.0**	**0.30**	**45.1**	**0.75**	**99.2**	**1.65**

1 For the purpose of this study it is predicted that residential facilities will be operated 12 hours per day.

2 RMOC water demand criteria used to estimate peak demand rates for residential areas are as follows:
maximum day demand rate = 2.5 x average day demand rate
maximum hour demand rate = 2.2 x maximum day demand rate

A.2 FIRE FLOW REQUIREMENTS PER FUS

FUS Fire Flow Calculation

Calculations based on: "*Water Supply for Public Fire Protection*" by Fire Underwriters' Survey, 1999

Stantec Project #: 1604-01198
Project Name: 966-968 Fisher Avenue
Date: March 7, 2018
Data input by: Warren Johnson

Fire Flow Calculation #: 1
Building Type/Description/Name: Apartment Building
Building 1

Notes:
2hr fire separation between buildings and on north face of BLDG 1

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	-	
			Ordinary construction	1				
			Non-combustible construction	0.8				
			Fire resistive construction (> 3 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, Apt etc.)	1	Units	
			Townhouse - indicate # of units	8				
			Other (Comm, Ind, Apt 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	Average Floor Area (A) based on fire resistive building design when vertical openings are inadequately protected:			545	1,636	Area in Square Meters (m^2)	
					Square Metres (m2)			
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						**9,000**
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	Limited combustible	-0.15	N/A	**7,650**
			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	Adequate Sprinkler conforms to NFPA13	-0.3	None	0	N/A	**0**
			None	0				
		Water Supply Credit	Water supply is standard for sprinkler and fire dept. hose line	-0.1	Water supply is not standard or N/A	0	N/A	**0**
			Water supply is not standard or N/A	0				
		Sprinkler Supervision Credit	Sprinkler system is fully supervised	-0.1	Sprinkler not fully supervised or N/A	0	N/A	**0**
			Sprinkler not fully supervised or N/A	0				
5.3	Choose Separation Distance Between Units	Exposure Distance Between Units	North Side	Fire Wall	0.1	0.3	m	**2,295**
			East Side	45.1m or greater	0			
			South Side	Fire Wall	0.1			
			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:***						**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**

Stantec

FUS Fire Flow Calculation

Calculations based on: "*Water Supply for Public Fire Protection*" by Fire Underwriters' Survey, 1999

Stantec Project #: 1604-01198
Project Name: 966-968 Fisher Avenue
Date: March 7, 2018
Data input by: Warren Johnson

Fire Flow Calculation #: 1
Building Type/Description/Name: Apartment Building Building 2

Notes:
2hr fire separation between two proposed buildings

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	-	
			Ordinary construction	1				
			Non-combustible construction	0.8				
			Fire resistive construction (> 3 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, Apt etc.)	1	Units	
			Townhouse - indicate # of units	8				
			Other (Comm, Ind, Apt 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	Average Floor Area (A) based on fire resistive building design when vertical openings are inadequately protected:			546 Square Metres (m2)	1,638	Area in Square Meters (m^2)	
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						9,000
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	Limited combustible	-0.15	N/A	7,650
			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	Adequate Sprinkler conforms to NFPA13	-0.3	None	0	N/A	0
			None	0				
		Water Supply Credit	Water supply is standard for sprinkler and fire dept. hose line	-0.1	Water supply is not standard or N/A	0	N/A	0
			Water supply is not standard or N/A	0				
		Sprinkler Supervision Credit	Sprinkler system is fully supervised	-0.1	Sprinkler not fully supervised or N/A	0	N/A	0
			Sprinkler not fully supervised or N/A	0				
5.3	Choose Separation Distance Between Units	Exposure Distance Between Units	North Side	Fire Wall	0.1	0.35	m	2,678
			East Side	45.1m or greater	0			
			South Side	10.1 to 20.0m	0.15			
			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:*						**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**

A.3 BOUNDARY CONDITIONS

Thiffault, Dustin

From: Oram, Cody <Cody.Oram@ottawa.ca>
Sent: Thursday, March 09, 2017 1:41 PM
To: Johnson, Warren
Cc: Kilborn, Kris
Subject: RE: Hydraulic Boundary Conditions - 966-968 Fisher Avenue
Attachments: 966-968 Fisher March 2017.pdf

Hi Warren,

The following are boundary conditions, HGL, for hydraulic analysis at 966-968 Fisher (zone 2W) assumed to be connected to the 305mm on Fisher (see attached PDF for location).

Minimum HGL = 120.6m

Maximum HGL = 137.3m; the maximum pressure is estimated to be above 80 psi. A pressure check at completion of construction is recommended to determine if pressure control is required.

Max day (0.76 L/s) + FireFlow (167 L/s) = 114.8m

These are for current conditions and are based on computer model simulation.

Disclaimer: The boundary condition information is based on current operation of the city water distribution system. The computer model simulation is based on the best information available at the time. The operation of the water distribution system can change on a regular basis, resulting in a variation in boundary conditions. The physical properties of watermains deteriorate over time, as such must be assumed in the absence of actual field test data. The variation in physical watermain properties can therefore alter the results of the computer model simulation.

Regards,

Cody Oram, P.Eng. Senior Engineer
Development Review, South Services
Planning, Infrastructure and Economic Development Department | Services de planification, d'infrastructure et de développement économique
City of Ottawa | Ville d'Ottawa
110 Laurier Avenue West. Ottawa, ON | 110, avenue. Laurier Ouest. Ottawa (Ontario) K1P 1J1
613.580.2424 ext./poste **13422**, fax/téléc:613-580-2576, cody.oram@ottawa.ca

Boundary Condition for 966-968 Fisher

Appendix B WASTEWATER SERVICING

B.1 SANITARY SEWER DESIGN SHEET

	SUBDIVISION: 966-968 Fisher Avenue	SANITARY SEWER DESIGN SHEET (City of Ottawa)
Stantec	DATE: 8/3/2018	
	REVISION: 1	
	DESIGNED BY: WAJ	FILE NUMBER: 160401198
	CHECKED BY:	

DESIGN PARAMETERS

MAX PEAK FACTOR (RES.)=	4.0	AVG. DAILY FLOW / PERSON	350 l/p/day	MINIMUM VELOCITY	0.60 m/s
MIN PEAK FACTOR (RES.)=	2.0	COMMERCIAL	50,000 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 (COMM., INST.):	1.5	INDUSTRIAL (LIGHT)	35,000 l/ha/day	BEDDING CLASS	B
PERSONS / SINGLE	3.4	INSTITUTIONAL	50,000 l/ha/day	MINIMUM COVER	2.50 m
PERSONS / ONE BEDROOM APT	1.4	INFILTRATION	0.28 l/s/Ha		
PERSONS / TWO BEDROOM APT	2.1				

LOCATION			RESIDENTIAL AREA AND POPULATION									COMMERCIAL		INDUSTRIAL (L)	
AREA ID NUMBER	FROM M.H.	TO M.H.	AREA (ha)	UNITS SINGLE	UNITS ONE BED	UNITS TWO BED	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)
R4A	BLDG	MAIN	0.110	0	22	3	37	0.11	37	4.00	0.60	0.00	0.00	0.00	0.00
R4B	BLDG	MAIN	0.100	0	22	3	37	0.10	37	4.00	0.60	0.00	0.00	0.00	0.00
	2	1	0.000	0	0	0	0	0.21	74	4.00	1.20	0.00	0.00	0.00	0.00
	1	EX3	0.000	0	0	0	0	0.21	74	4.00	1.20	0.00	0.00	0.00	0.00

LOCATION			INDUSTRIAL (H)		INSTITUTIONAL		GREEN / UNUSED		C+I+I	INFILTRATION			TOTAL	PIPE									
AREA ID NUMBER	FROM M.H.	TO M.H.	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	PEAK FLOW (l/s)	TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	FLOW (l/s)	LENGTH (m)	DIA (mm)	MATERIAL	CLASS	SLOPE (%)	CAP. (FULL) (l/s)	CAP. V PEAK FLOW (%)	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
R4A	BLDG	MAIN	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.11	0.11	0.03	0.63	7.8	135	PVC	DR 28	1.00	11.5	**5.48%**	0.80	0.35
															135							
R4B	BLDG	MAIN	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.10	0.10	0.03	0.63	7.8	135	PVC	DR 28	1.00	11.5	**5.46%**	0.80	0.35
															135							
	2	1	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.21	0.06	1.26	29.9	200	PVC	SDR 35	0.32	18.9	**6.67%**	0.60	0.28
	1	EX3	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.21	0.06	1.26	6.0	200	PVC	SDR 35	0.32	18.9	**6.67%**	0.60	0.28

Appendix C STORMWATER MANAGEMENT

C.1 STORM SEWER DESIGN SHEET

966-968 FISHER AVENUE	
DATE:	2018-03-08
REVISION:	1
DESIGNED BY:	WAJ
CHECKED BY:	

STORM SEWER DESIGN SHEET
(City of Ottawa)

FILE NUMBER: **160401198**

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	BEDDING CLASS = B
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

LOCATION / DRAINAGE AREA

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) (-)
BLDG1	STUB	112	0.00	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.00
BLDG2	STUB	112	0.00	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.00
L112A	112	111	0.08	0.00	0.00	0.00	0.00	0.53	0.00	0.00	0.00
	111	110	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	110	EX 103	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DRAINAGE AREA (continued)

AREA ID NUMBER	FROM M.H.	TO M.H.	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-YEAR} (mm/h)	I_{5-YEAR} (mm/h)	$I_{10-YEAR}$ (mm/h)	$I_{100-YEAR}$ (mm/h)	$Q_{CONTROL}$ (L/s)	ACCUM. $Q_{CONTROL}$ (L/s)	Q_{ACT} (CIA/360) (L/s)
BLDG1	STUB	112	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	1.9	1.9	1.9
											10.13							
BLDG2	STUB	112	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	1.9	1.9	1.9
											10.13							
L112A	112	111	0.042	0.042	0.000	0.000	0.000	0.000	0.000	0.000	10.13	76.29	103.49	121.31	177.33	0.0	3.8	12.8
	111	110	0.000	0.042	0.000	0.000	0.000	0.000	0.000	0.000	10.96	73.29	99.37	116.46	170.21	0.0	3.8	12.4
	110	EX 103	0.000	0.042	0.000	0.000	0.000	0.000	0.000	0.000	11.13	72.71	98.57	115.52	168.83	0.0	3.8	12.3
											12.15							

PIPE SELECTION

AREA ID NUMBER	FROM M.H.	TO M.H.	LENGTH (m)	PIPE WIDTH OR DIAMETER (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)
BLDG1	STUB	112	3.9	150	150	CIRCULAR	PVC	-	1.00	15.3	**12.35%**	0.86	0.48	0.13
				300	300									
BLDG2	STUB	112	3.9	150	150	CIRCULAR	PVC	-	1.00	15.3	**12.35%**	0.86	0.48	0.13
				300	300									
L112A	112	111	26.9	300	300	CIRCULAR	PVC	-	0.35	56.9	**22.44%**	0.81	0.54	0.83
	111	110	5.5	300	300	CIRCULAR	PVC	-	0.35	56.9	**21.82%**	0.81	0.54	0.17
	110	EX 103	28.4	375	375	CIRCULAR	PVC	-	0.25	82.4	**14.98%**	0.78	0.46	1.02
				375	375									

C.2 RATIONAL METHOD CALCULATIONS

Stormwater Management Calculations

File No: **160401198**
Project: **966-968 Fisher Ave**
Date: **05-Jun-17**

SWM Approach:
Post-development to Pre-development flows

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**
Uncontrolled - Non-Tributary	U1A	Hard	0.019		0.9	0.017		
		Soft	0.021		0.2	0.004		
		Subtotal		0.04			0.0216	0.540
Roof	BLDG2	Hard	0.040		0.9	0.036		
		Soft	0.000		0.2	0.000		
		Subtotal		0.04			0.036	0.900
Roof	BLDG1	Hard	0.040		0.9	0.036		
		Soft	0.000		0.2	0.000		
		Subtotal		0.04			0.036	0.900
Controlled - Tributary	L112A	Hard	0.038		0.9	0.034		
		Soft	0.042		0.2	0.008		
		Subtotal		0.08			0.0424	0.530
Total				**0.200**			**0.136**	
Overall Runoff Coefficient= C:								**0.68**

Total Roof Areas	**0.080 ha**
Total Tributary Surface Areas (Controlled and Uncontrolled)	**0.080 ha**
Total Tributary Area to Outlet	**0.160 ha**
Total Uncontrolled Areas (Non-Tributary)	**0.040 ha**
Total Site	**0.200 ha**

Stormwater Management Calculations

Project #160401198, 966-968 Fisher Ave
Modified Rational Method Calculatons for Storage

2 yr Intensity I = a/(t + b)^c
City of Ottawa

a =	732.951	
b =	6.199	
c =	0.810	

t (min)	I (mm/hr)
5	103.57
10	76.81
15	61.77
20	52.03
25	45.17
30	40.04
35	36.06
40	32.86
45	30.24
50	28.04
55	26.17
60	24.56

2 YEAR Predevelopment Target Release from Portion of Site

Subdrainage Area: Predevelopment Tributary Area to Outlet
Area (ha): 0.2000
C: 0.50

Typical Time of Concentration

tc (min)	I (2 yr) (mm/hr)	Qtarget (L/s)
10	76.81	**21.4**

2 YEAR Modified Rational Method for Entire Site

Subdrainage Area: U1A — Uncontrolled - Non-Tributary
Area (ha): 0.04
C: 0.54

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	76.81	4.6	4.6		
20	52.03	3.1	3.1		
30	40.04	2.4	2.4		
40	32.86	2.0	2.0		
50	28.04	1.7	1.7		
60	24.56	1.5	1.5		
70	21.91	1.3	1.3		
80	19.83	1.2	1.2		
90	18.14	1.1	1.1		
100	16.75	1.0	1.0		
110	15.57	0.9	0.9		
120	14.56	0.9	0.9		

Subdrainage Area: BLDG2 — Roof
Area (ha): 0.04 — Maximum Storage Depth: 150 mm
C: 0.90

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)	Depth (mm)	
10	76.81	7.7	1.5	6.2	3.7	90.5	0.00
20	52.03	5.2	1.6	3.7	4.4	96.7	0.00
30	40.04	4.0	1.6	2.4	**4.4**	97.0	0.00
40	32.86	3.3	1.5	1.7	4.2	94.9	0.00
50	28.04	2.8	1.5	1.3	3.8	91.8	0.00
60	24.56	2.5	1.5	1.0	3.4	88.1	0.00
70	21.91	2.2	1.5	0.7	3.0	84.2	0.00
80	19.83	2.0	1.5	0.5	2.6	80.1	0.00
90	18.14	1.8	1.4	0.4	2.1	75.9	0.00
100	16.75	1.7	1.4	0.3	1.7	70.1	0.00
110	15.57	1.6	1.3	0.2	1.4	63.9	0.00
120	14.56	1.5	1.3	0.1	1.0	58.0	0.00

Storage: Roof Storage

	Depth (mm)	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Discharge Check
2-year Water Level	96.97	0.10	1.6	4.4	16.0	0.00

Subdrainage Area: BLDG1 — Roof
Area (ha): 0.04 — Maximum Storage Depth: 150 mm
C: 0.90

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)	Depth (mm)	
10	76.81	7.7	1.5	6.2	3.7	90.5	0.00
20	52.03	5.2	1.6	3.7	4.4	96.7	0.00
30	40.04	4.0	1.6	2.4	**4.4**	97.0	0.00
40	32.86	3.3	1.5	1.7	4.2	94.9	0.00
50	28.04	2.8	1.5	1.3	3.8	91.8	0.00
60	24.56	2.5	1.5	1.0	3.4	88.1	0.00
70	21.91	2.2	1.5	0.7	3.0	84.2	0.00
80	19.83	2.0	1.5	0.5	2.6	80.1	0.00
90	18.14	1.8	1.4	0.4	2.1	75.9	0.00
100	16.75	1.7	1.4	0.3	1.7	70.1	0.00
110	15.57	1.6	1.3	0.2	1.4	63.9	0.00
120	14.56	1.5	1.3	0.1	1.0	58.0	0.00

Storage: Roof Storage

	Depth (mm)	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Discharge Check
2-year Water Level	96.97	0.10	1.6	4.4	16.0	0.00

Project #160401198, 966-968 Fisher Ave
Modified Rational Method Calculatons for Storage

100 yr Intensity I = a/(t + b)^c
City of Ottawa

a =	1735.688	
b =	6.014	
c =	0.820	

t (min)	I (mm/hr)
5	242.70
10	178.56
15	142.89
20	119.95
25	103.85
30	91.87
35	82.58
40	75.15
45	69.05
50	63.95
55	59.62
60	55.89

100 YEAR Modified Rational Method for Entire Site

Subdrainage Area: U1A — Uncontrolled - Non-Tributary
Area (ha): 0.04
C: 0.68

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	178.56	13.4	13.4		
20	119.95	9.0	9.0		
30	91.87	6.9	6.9		
40	75.15	5.6	5.6		
50	63.95	4.8	4.8		
60	55.89	4.2	4.2		
70	49.79	3.7	3.7		
80	44.99	3.4	3.4		
90	41.11	3.1	3.1		
100	37.90	2.8	2.8		
110	35.20	2.6	2.6		
120	32.89	2.5	2.5		

Subdrainage Area: BLDG2 — Roof
Area (ha): 0.04 — Maximum Storage Depth: 150 mm
C: 1.00

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)	Depth (mm)	
10	178.56	19.9	1.8	18.1	10.9	130.9	0.00
20	119.95	13.3	1.8	11.5	13.8	141.8	0.00
30	91.87	10.2	1.9	8.3	15.0	146.4	0.00
40	75.15	8.4	1.9	6.5	15.5	148.3	0.00
50	63.95	7.1	1.9	5.2	**15.7**	148.8	0.00
60	55.89	6.2	1.9	4.3	15.6	148.5	0.00
70	49.79	5.5	1.9	3.7	15.4	147.7	0.00
80	44.99	5.0	1.9	3.1	15.0	146.4	0.00
90	41.11	4.6	1.9	2.7	14.6	144.9	0.00
100	37.90	4.2	1.9	2.4	14.2	143.3	0.00
110	35.20	3.9	1.8	2.1	13.7	141.5	0.00
120	32.89	3.7	1.8	1.8	13.2	139.6	0.00

Storage: Roof Storage

	Depth (mm)	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Discharge Check
100-year Water Level	148.81	0.15	1.9	15.7	16.0	0.00

Subdrainage Area: BLDG1 — Roof
Area (ha): 0.04 — Maximum Storage Depth: 150 mm
C: 1.00

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)	Depth (mm)	
10	178.56	19.9	1.8	18.1	10.9	130.9	0.00
20	119.95	13.3	1.8	11.5	13.8	141.8	0.00
30	91.87	10.2	1.9	8.3	15.0	146.4	0.00
40	75.15	8.4	1.9	6.5	15.5	148.3	0.00
50	63.95	7.1	1.9	5.2	**15.7**	148.8	0.00
60	55.89	6.2	1.9	4.3	15.6	148.5	0.00
70	49.79	5.5	1.9	3.7	15.4	147.7	0.00
80	44.99	5.0	1.9	3.1	15.0	146.4	0.00
90	41.11	4.6	1.9	2.7	14.6	144.9	0.00
100	37.90	4.2	1.9	2.4	14.2	143.3	0.00
110	35.20	3.9	1.8	2.1	13.7	141.5	0.00
120	32.89	3.7	1.8	1.8	13.2	139.6	0.00

Storage: Roof Storage

	Depth (mm)	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Discharge Check
100-year Water Level	148.81	0.15	1.9	15.7	16.0	0.00

Stormwater Management Calculations

Project #160401198, 966-968 Fisher Ave
Modified Rational Method Calculatons for Storage

Subdrainage Area: L112A Controlled - Tributary
Area (ha): 0.08
C: 0.53

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	76.81	7.7	2.0	5.7	3.4
20	52.03	5.2	2.1	3.1	**3.7**
30	40.04	4.0	2.0	2.0	3.5
40	32.86	3.3	2.0	1.3	3.2
50	28.04	2.8	1.9	0.9	2.8
60	24.56	2.5	1.8	0.7	2.5
70	21.91	2.2	1.6	0.6	2.3
80	19.83	2.0	1.5	0.4	2.1
90	18.14	1.8	1.5	0.4	2.0
100	16.75	1.7	1.4	0.3	1.8
110	15.57	1.6	1.3	0.2	1.6
120	14.56	1.5	1.2	0.2	1.5

Storage: e Above CB

Orifice Diameter: LMF60 mm
Invert Elevation 77.13 m
Obvert Elevation: 77.73 m
Max Storage Depth 0.41 m
Downstream W/L 76.58 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
5-year Water Level	78.14	0.41	2.1	3.7	11.4	OK

SUMMARY TO OUTLET

		Vrequired	Vavailable*	
Tributary Area	0.16 ha			
Total 2yr Flow to Sewer	5.2 L/s	4	11 m^3	Ok
Non-Tributary Area	0.04 ha			
Total 2yr Flow Uncontrolled	4.6 L/s			
Total Area	0.20 ha			
Total 2yr Flow	9.8 L/s			
Target	21.4 L/s			

Project #160401198, 966-968 Fisher Ave
Modified Rational Method Calculatons for Storage

Subdrainage Area: L112A Controlled - Tributary
Area (ha): 0.08
C: 0.66

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	178.56	19.9	4.0	15.9	9.5
20	119.95	13.3	4.0	9.4	11.3
30	91.87	10.2	4.0	6.3	**11.3**
40	75.15	8.4	4.0	4.4	10.6
50	63.95	7.1	4.0	3.2	9.5
60	55.89	6.2	4.0	2.3	8.1
70	49.79	5.5	4.0	1.6	6.6
80	44.99	5.0	3.3	1.7	8.1
90	41.11	4.6	3.3	1.3	6.8
100	37.90	4.2	3.3	0.9	5.4
110	35.20	3.9	3.2	0.7	4.9
120	32.89	3.7	3.0	0.6	4.6

Storage: Surface Storage Above CB

Orifice Diameter: LMF60 mm
Invert Elevation 77.13 m
Obvert Elevation: 77.73 m
Max Storage Depth 1.50 m
Downstream W/L 76.58 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
100-year Water Level	79.23	1.50	4.0	11.3	11.4	OK
					0.13	

SUMMARY TO OUTLET

		Vrequired	Vavailable*	
Tributary Area	0.16 ha			
Total 100yr Flow to Sewer	7.7 L/s	11	11 m^3	Ok
Non-Tributary Area	0.04 ha			
Total 100yr Flow Uncontrolled	13.4 L/s			
Total Area	0.20 ha			
Total 100yr Flow	21.1 L/s			
Target	21.4 L/s			

Project #160401198, 966-968 Fisher Ave
Roof Drain Design Sheet, Area BLDG1
Watts Model R1100 Accuflow Roof Drain

Rating Curve				Volume Estimation				
Elevation (m)	Discharge Rate (cu.m/s)	Outlet Discharge (cu.m/s)	Storage (cu. m)	Elevation (m)	Area (sq. m)	Volume (cu. m) Increment	Volume (cu. m) Accumulated	Water Depth (m)
0.000	0.0000	0.0000	0	0.000	0	0	0	0.000
0.025	0.0003	0.0006	0	0.025	9	0	0	0.025
0.050	0.0006	0.0013	1	0.050	36	1	1	0.050
0.075	0.0007	0.0014	2	0.075	80	1	2	0.075
0.100	0.0008	0.0016	5	0.100	142	3	5	0.100
0.125	0.0009	0.0017	9	0.125	222	5	9	0.125
0.150	0.0009	0.0019	16	0.150	320	7	16	0.150

Drawdown Estimate

Total Volume (cu.m)	Total Time (sec)	Vol (cu.m)	Detention Time (hr)
0.0	0.0	0.0	0
0.5	410.9	0.5	0.11415
1.9	991.5	1.4	0.38955
4.7	1737.7	2.7	0.87224
9.2	2604.4	4.5	1.59567
15.9	3561.4	6.7	2.58496

Rooftop Storage Summary

Total Building Area (sq.m)		400
Assume Available Roof Area (sq.	80%	320
Roof Imperviousness		0.99
Roof Drain Requirement (sq.m/Notch)		232
Number of Roof Notches*		2
Max. Allowable Depth of Roof Ponding (m)		0.15
Max. Allowable Storage (cu.m)		16
Estimated 100 Year Drawdown Time (h)		2.5

* As per Ontario Building Code section OBC 7.4.10.4.(2)(c).

* Note: Number of drains can be reduced if multiple-notch drain used.

From Watts Drain Catalogue

Head (m) L/s

Head (m)	Open	75%	50%	**25%**	Closed
0.025	0.3155	0.3155	0.3155	**0.3155**	0.3155
0.050	0.6309	0.6309	0.6309	**0.6309**	0.6309
0.075	0.9464	0.8675	0.7886	**0.7098**	0.6309
0.100	1.2618	1.1041	0.9464	**0.7886**	0.6309
0.125	1.5773	1.3407	1.1041	**0.8675**	0.6309
0.150	1.8927	1.5773	1.2618	**0.9464**	0.6309

Calculation Results

	5yr	100yr	Available
Qresult (cu.m/s)	0.002	0.002	-
Depth (m)	0.097	0.149	0.150
Volume (cu.m)	4.4	15.7	16.0
Draintime (hrs)	0.8	2.5	

Project #160401198, 966-968 Fisher Ave
Roof Drain Design Sheet, Area BLDG2
Watts Model R1100 Accuflow Roof Drain

Rating Curve				Volume Estimation				
Elevation (m)	Discharge Rate (cu.m/s)	Outlet Discharge (cu.m/s)	Storage (cu. m)	Elevation (m)	Area (sq. m)	Volume (cu. m) Increment	Volume (cu. m) Accumulated	Water Depth (m)
0.000	0.0000	0.0000	0	0.000	0	0	0	0.000
0.025	0.0003	0.0006	0	0.025	9	0	0	0.025
0.050	0.0006	0.0013	1	0.050	36	1	1	0.050
0.075	0.0007	0.0014	2	0.075	80	1	2	0.075
0.100	0.0008	0.0016	5	0.100	142	3	5	0.100
0.125	0.0009	0.0017	9	0.125	222	5	9	0.125
0.150	0.0009	0.0019	16	0.150	320	7	16	0.150

Drawdown Estimate

Total Volume (cu.m)	Total Time (sec)	Vol (cu.m)	Detention Time (hr)
0.0	0.0	0.0	0
0.5	410.9	0.5	0.11415
1.9	991.5	1.4	0.38955
4.7	1737.7	2.7	0.87224
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Rooftop Storage Summary

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Max. Allowable Storage (cu.m)		16
Estimated 100 Year Drawdown Time (h)		2.5

* As per Ontario Building Code section OBC 7.4.10.4.(2)(c).

* Note: Number of drains can be reduced if multiple-notch drain used.

From Watts Drain Catalogue

Head (m) L/s	Open	75%	50%	**25%**	Closed
0.025	0.3155	0.3155	0.3155	**0.3155**	0.3155
0.050	0.6309	0.6309	0.6309	**0.6309**	0.6309
0.075	0.9464	0.8675	0.7886	**0.7098**	0.6309
0.100	1.2618	1.1041	0.9464	**0.7886**	0.6309
0.125	1.5773	1.3407	1.1041	**0.8675**	0.6309
0.150	1.8927	1.5773	1.2618	**0.9464**	0.6309

Calculation Results

	5yr	100yr	Available
Qresult (cu.m/s)	0.002	0.002	-
Depth (m)	0.097	0.149	0.150
Volume (cu.m)	4.4	15.7	16.0
Draintime (hrs)	0.8	2.5	

Appendix D GEOTECHNICAL INVESTIGATION

Geotechnical Engineering

Environmental Engineering

Hydrogeology

Geological Engineering

Materials Testing

Building Science

Archaeological Services

patersongroup

Geotechnical Investigation

Proposed Multi-Storey Buildings
966 - 974 Fisher Avenue
Ottawa, Ontario

Prepared For

Mr. David Toscano

February 16, 2017

Report PG4029-1

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Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by Mr. David Toscano to conduct a geotechnical investigation for the proposed multi-storey residential buildings to be located at 966 to 974 Fisher Avenue, in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan in Appendix 2).

The objectives of the current investigation were to:

❑ determine the subsurface soil and groundwater conditions by means of boreholes.

❑ provide geotechnical recommendations for the design of the proposed development including construction considerations which may affect the design.

The following report has been prepared specifically and solely for the aforementioned project which is described herein. This report contains the findings and includes geotechnical recommendations pertaining to the design and construction of the subject development as understood at the time of writing this report.

Investigating the presence or potential presence of contamination on the subject property was not part of the scope of work of this present investigation. A report addressing environmental issues for the subject site was prepared under a separate cover.

2.0 Proposed Development

It is our understanding that the proposed development consists of two four (4) storey structures of slab on grade construction. Parking areas, access lanes and landscaped areas are also anticipated for this development.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the investigation was carried out on January 11, 2017. At that time, three (3) boreholes were drilled to a maximum depth of 7.0 m. The borehole locations were distributed in a manner to provide general coverage of the subject site taking into consideration site features and underground utilities. The locations of the boreholes are shown on Drawing PG4029-1 - Test Hole Location Plan included in Appendix 2.

The boreholes completed for the current investigation were drilled using a truck-mounted auger drill rig operated by a two-person crew. All fieldwork was conducted under the full-time supervision of Paterson personnel under the direction of a senior engineer. The drilling procedure consisted of augering to the required depths at the selected locations, sampling and testing the overburden.

Sampling and In Situ Testing

Soil samples were recovered from a 50 mm diameter split-spoon or the auger flights. The split-spoon and auger samples were classified on site and placed in sealed plastic bags. All samples were transported to our laboratory. The depths at which the split-spoon and auger samples were recovered from the boreholes are presented as SS and AU, respectively, on the Soil Profile and Test Data sheets.

Standard Penetration Tests (SPT) were conducted and recorded as “N” values on the Soil Profile and Test Data sheets. The “N” value is the number of blows required to drive the split-spoon sample 300 mm into the soil after the initial penetration of 150 mm using a 63.5 kg hammer falling from a height of 760 mm.

The subsurface conditions observed in the boreholes were recorded in detail in the field. The soil profiles are presented on the Soil Profile and Test Data sheets in Appendix 1.

Groundwater

A flexible standpipe was installed in BH 1 and groudwater monitoring wells were installed in BH 2 and BH 3 to permit the monitoring of water levels subsequent to the completion of the sampling program.

Sample Storage

All samples will be stored in the laboratory for a period of one month after issuance of this report. They will then be discarded unless otherwise directed.

3.2 Field Survey

The test hole locations and elevations were surveyed in the field by Paterson. The ground surface elevations at the test hole locations were referenced to a temporary benchmark (TBM), consisting of the top spindle of the fire hydrant located at the northwest corner of the intersection of Fisher Avenue and Shillington Avenue. An arbitrary elevation of 100.00 m was assigned to the TBM.

The locations and ground surface elevations of the test holes are presented on Drawing PG4029-1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

Soil samples recovered from the subject site were visually examined in our laboratory to review the field logs.

3.4 Analytical Testing

One soil sample from the subject site was submitted for analytical testing to assess the corrosion potential for exposed ferrous metals and the potential of sulphate attacks against subsurface concrete structures. The analytical test results are presented in Appendix 1 and discussed in Subsection 6.7.

4.0 Observations

4.1 Surface Conditions

The subject site is currently occupied by existing two storey residential dwellings which will be demolished as part of the aforementioned development. The site is relatively flat and at grade with Fisher Avenue and the surrounding properties. The site is bordered to the north, west and south by residential dwellings and to the east by Fisher Avenue.

4.2 Subsurface Profile

Generally, the subsurface profile at the borehole locations consists of either topsoil and fill or a layer of asphalt overlying a loose silty sand to sandy silt followed by a compact to dense glacial till deposit. The glacial till deposit consists of silty sand with gravel, cobbles and boulders. Practical refusal to augering was noted in all boreholes at depths ranging between 5.9 and 6.9 m. Specific details of the subsurface profile at each test hole location are presented on the Soil Profile and Test Data sheets in Appendix 1.

Based on available geological mapping, the subject site is located in an area where the bedrock consists of limestone of the Bobcaygeon formation with an overburden drift thickness of 5 to 10 m depth.

4.3 Groundwater

Groundwater levels were recorded at the piezometers installed at the borehole locations on January 20, 2017. The groundwater level readings noted at that time are presented in Table 1 on the following page. It should be noted that water can become perched within a backfilled borehole that leads to higher than normal groundwater level readings. Groundwater conditions can also be estimated based on the observed colour, moisture levels and consistency of the recovered soil samples. Based on these observations, it is estimated that the long-term groundwater level can be expected between 2.5 to 3 m below existing ground surface. It should be noted that groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater levels could vary at the time of construction.

Table 1 - Summary of Groundwater Level Readings

Test Hole Number	Ground Elevation, m	Groundwater Levels, m		Recording Date
		Depth	Elevation	
BH 1	98.72	2.13	96.59	January 20, 2017
BH 2	98.97	1.82	97.15	January 20, 2017
BH 3	98.72	2.12	96.60	January 20, 2017

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is adequate for the proposed multi-storey residential buildings. The proposed buildings are expected to be founded on conventional footings placed over an undisturbed, compact to dense glacial till bearing surface.

The above and other considerations are discussed in the following sections.

5.2 Site Grading and Preparation

Stripping Depth

Asphalt, topsoil and deleterious fill, such as material containing organic materials, should be stripped from under any building and other settlement sensitive structures.

Existing foundation walls and other construction debris should be entirely removed from within the proposed building perimeter. Under paved areas, existing construction remnants such as foundation walls should be excavated to a minimum of 1 m below final grade.

Fill Placement

Fill placed for grading beneath the building areas should consist, unless otherwise specified, of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. The imported fill material should be tested and approved prior to delivery. The fill should be placed in maximum 300 mm thick loose lifts and compacted by suitable compaction equipment. Fill placed beneath the building should be compacted to a minimum of 98% of the standard Proctor maximum dry density (SPMDD).

Non-specified existing fill along with site-excavated soil could be placed as general landscaping fill where settlement of the ground surface is of minor concern. These materials should be spread in lifts with a maximum thickness of 300 mm and compacted by the tracks of the spreading equipment to minimize voids. Non-specified existing fill and site-excavated soils are not suitable for placement as backfill against foundation walls, unless used in conjunction with a geocomposite drainage membrane, such as Miradrain G100N or Delta Drain 6000.

5.3 Foundation Design

Bearing Resistance Values

Footings placed on an undisturbed, compact glacial till bearing surface can be designed using a bearing resistance value at serviceability limit states (SLS) of **150 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **200 kPa**. A geotechnical resistance factor of 0.5 was applied to the above noted bearing resistance value at ULS.

An undisturbed soil bearing surface consists of a surface from which all topsoil and deleterious materials, such as loose, frozen or disturbed soil, whether in situ or not, have been removed, in the dry, prior to the placement of concrete for footings.

Lateral Support

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Adequate lateral support is provided to a glacial till above the groundwater table when a plane extending down and out from the bottom edge of the footing at a minimum of 1.5H:1V passes only through in situ soil of the same or higher capacity as the bearing medium soil.

Settlement

The bearing resistance values at SLS will be subjected to potential post-construction total and differential settlements of 25 and 20 mm, respectively.

5.4 Design for Earthquakes

Based on the subsoil profile encountered across the subject site, foundation design at the subject site can be designed using a seismic site classification **Class C** according to Table 4.1.8.4.A of the Ontario Building Code 2012. The soils underlying the site are not susceptible to liquefaction.

5.5 Slab on Grade Construction

With the removal of all topsoil and deleterious fill, containing organic matter, within the footprints of the proposed buildings, the native soil surface, free of deleterious and organic materials, will be considered to be an acceptable subgrade on which to commence backfilling for floor slab construction. Any soft areas should be removed and backfilled with appropriate backfill material. OPSS Granular B Type II, with a maximum particle size of 50 mm, are recommended for backfilling below the floor slab. It is recommended that the upper 200 mm of sub-slab fill consist of an OPSS Granular A crushed stone.

5.6 Pavement Structure

For design purposes, the pavement structure presented in the following tables could be designed for car only parking areas and access lanes.

Table 2 - Recommended Pavement Structure - Car Only Parking Areas

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

Table 3 - Recommended Pavement Structure - Access Lanes

Thickness (mm)	Material Description
40	**Wear Course -** HL-3 or Superpave 12.5 Asphaltic Concrete
50	**Binder Course -** HL-8 or Superpave 19.0 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
400	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either fill, in situ soil or OPSS Granular B Type I or II material placed over in situ soil or fill	

Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project.

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be sub-excavated and replaced with OPSS Granular B Type II material.

The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 98% of the SPMDD with suitable vibratory equipment.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

A perimeter foundation drainage system is recommended to be provided for the proposed structure. The system should consist of a 150 mm diameter perforated corrugated plastic pipe, surrounded on all sides by 150 mm of 19 mm clear crushed stone, placed at the footing level around the exterior perimeter of the structure. The pipe should have a positive outlet, such as a gravity connection to the storm sewer.

Backfill against the exterior sides of the foundation walls should consist of free-draining non frost susceptible granular materials. The greater part of the site excavated materials will be frost susceptible and, as such, are not recommended for placement as backfill against the foundation walls unless used in conjunction with a composite drainage system, such as Delta Drain 6000 or Miradrain G100N. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should be placed for this purpose.

6.2 Protection of Footings Against Frost Action

Perimeter footings of heated structures are recommended to be protected against the deleterious effects of frost action. A minimum of 1.5 m of soil cover alone, or a combination of soil cover and foundation insulation should be provided.

Exterior unheated footings, such as those for isolated exterior piers, are more prone to deleterious movement associated with frost action than the exterior walls of the structure proper and require additional protection, such as soil cover of 2.1 m or a combination of soil cover and foundation insulation.

6.3 Excavation Side Slopes

The temporary excavation side slopes anticipated should either be excavated to acceptable slopes or retained by shoring systems from the beginning of the excavation until the structure is backfilled.

The excavation side slopes above the groundwater level extending to a maximum depth of 3 m should be cut back at 1H:1V or flatter. The flatter slope is required for excavation below groundwater level. The subsurface soil is considered to be mainly a Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects. Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should maintain safe working distance from the excavation sides.

Slopes in excess of 3 m in height should be periodically inspected by the geotechnical consultant in order to detect if the slopes are exhibiting signs of distress.

A trench box is recommended to be installed at all times to protect personnel working in trenches with steep or vertical sides. Services are expected to be installed by “cut and cover” methods and excavations should not remain exposed for extended periods of time.

6.4 Pipe Bedding and Backfill

At least 150 mm of OPSS Granular A should be used for pipe bedding for sewer and water pipes. The bedding should extend to the spring line of the pipe. Cover material, from the spring line to at least 300 mm above the obvert of the pipe should consist of OPSS Granular A. The bedding and cover materials should be placed in maximum 300 mm thick lifts compacted to a minimum of 95% of the material’s SPMDD.

Where hard surface areas are considered above the trench backfill, the trench backfill material within the frost zone (about 1.8 m below finished grade) should match the soils exposed at the trench walls to reduce the potential differential frost heaving. The trench backfill should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% of the SPMDD.

6.5 Groundwater Control

Groundwater Control for Building Construction

The contractor should be prepared to direct water away from all bearing surfaces and subgrades, regardless of the source, to prevent disturbance to the founding medium.

Infiltration levels are anticipated to be low through the excavation face. The groundwater infiltration will be controllable with open sumps and pumps.

A temporary Ministry of the Environment and Climate Change (MOECC) permit to take water (PTTW) may be required for this project if more than 400,000 L/day of ground and/or surface water is to be pumped during the construction phase. A minimum 4 to 5 months should be allowed for completion of the PTTW application package and issuance of the permit by the MOECC.

For typical ground or surface water volumes, being pumped during the construction phase, between 50,000 to 400,000 L/day, it is required to register on the Environmental Activity and Sector Registry (EASR). A minimum of two to four weeks should be allotted for completion of the EASR registration and the Water Taking and Discharge Plan to be prepared by a Qualified Person as stipulated under O.Reg. 63/16. If a project qualifies for a PTTW based upon anticipated conditions, an EASR will not be allowed as a temporary dewatering measure while awaiting the MOECC review of the PTTW application.

6.6 Winter Construction

The subsurface conditions at this site mostly consist of frost susceptible materials. In presence of water and freezing conditions ice could form within the soil mass. Heaving and settlement upon thawing could occur. Precautions should be taken if winter construction is considered for this project.

In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the use of straw, propane heaters, tarpaulins or other suitable means. In this regard, the base of the excavations should be insulated from sub-zero temperatures immediately upon exposure and until such time as heat is adequately supplied to the building and the footings are protected with sufficient soil cover to prevent freezing at the founding level.

The trench excavations should be constructed in a manner that will avoid the introduction of frozen materials into the trenches. As well, pavement construction is difficult during winter. The subgrade consists of frost susceptible soils which will experience total and differential frost heaving as the work takes place. In addition, the introduction of frost, snow or ice into the pavement materials, which is difficult to avoid, could adversely affect the performance of the pavement structure. Additional information could be provided, if required.

6.7 Corrosion Potential and Sulphate

The results of analytical testing show that the sulphate content is less than 0.1%. These results are indicative that Type 10 Portland cement (normal cement) would be appropriate for this site. The results of the chloride content, pH and resistivity indicate the presence of a non-aggressive to slightly aggressive environment for exposed ferrous metals at this site.

7.0 Recommendations

A materials testing and observation services program is a requirement for the provided foundation design data to be applicable. The following aspects of the program should be performed by the geotechnical consultant:

❏ Observation of all bearing surfaces prior to the placement of concrete.

❏ Sampling and testing of the concrete and fill materials used.

❏ Periodic observation of the condition of unsupported excavation side slopes in excess of 3 m in height, if applicable.

❏ Observation of all subgrades prior to backfilling.

❏ Field density tests to determine the level of compaction achieved.

❏ Sampling and testing of the bituminous concrete including mix design reviews.

A report confirming that these works have been conducted in general accordance with our recommendations could be issued, upon request, following the completion of a satisfactory materials testing and observation program by the geotechnical consultant.

8.0 Statement of Limitations

The recommendations provided in this report are in accordance with our present understanding of the project.

A geotechnical investigation is a limited sampling of a site. The recommendations are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around the test locations. Should any conditions at the site be encountered which differ from those at the test locations, Paterson requests notification immediately in order to permit reassessment of the recommendations.

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than Mr. David Toscano, or their agent(s) is not authorized without review by Paterson Group for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

Feb. 16-2017

Colin Belcourt, M.Eng.

David J. Gilbert, P.Eng.

Report Distribution:

❑ Mr. David Toscano (2 copies)
❑ Paterson Group (1 copy)

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ANALYTICAL TESTING RESULTS

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigaiton
Proposed Residential Development
966-974 Fisher Avenue, Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located on the southwest corner of Fisher Ave. and Shillington Ave. An arbitrary elevation of 100.00m was assigned to the TBM.

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE January 11, 2017

FILE NO. PG4029

HOLE NO. BH 1

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	98.72
Asphaltic concrete	0.05						
FILL: Brown fine to coarse sand with crushed stone	0.51	AU	1				
Loose to compact, brown **SILTY SAND**	1.78	SS	2	71	8	1	97.72
GLACIAL TILL: Compact, brown silty sand, some gravel	3.05	SS	3	75	15	2	96.72
		SS	4	50	19	3	95.72
GLACIAL TILL: Compact to very dense, grey silty sand, some gravel, cobbles and boulders	6.96	SS	5	50	12	4	94.72
		SS	6	50	27	5	93.72
		SS	7	42	14	6	92.72
		SS	8	17	62		
		SS	9	94	50+		

End of Borehole

Practical refusal to augering at 6.96m depth

(GWL @ 2.13m-Jan. 20, 2017)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone
○ Water Content %
20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigaiton
Proposed Residential Development
966-974 Fisher Avenue, Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located on the southwest corner of Fisher Ave. and Shillington Ave. An arbitrary elevation of 100.00m was assigned to the TBM.

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE January 11, 2017

FILE NO. PG4029

HOLE NO. BH 2

SOIL DESCRIPTION	Strata depth (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
FILL: Brown silty sand with crushed stone, trace asphalt	0.86	AU	1		
TOPSOIL	1.12	SS	2	92	6
Loose, brown **SILTY FINE SAND to SANDY SILT**	1.88	SS	3	79	7
GLACIAL TILL: Dense to very dense, brown silty sand, some gravel, cobbles and boulders - grey by 3.4m depth	5.94	SS	4	62	32
		SS	5	54	30
		SS	6	71	16
		SS	7	50	17
		SS	8	86	63

DEPTH (m)	ELEV. (m)
0	98.97
1	97.97
2	96.97
3	95.97
4	94.97
5	93.97

End of Borehole

Practical refusal to augering at 5.94m depth

(GWL @ 1.82m-Jan. 20, 2017)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone
○ Water Content %
20 40 60 80

Monitoring Well Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigaiton
Proposed Residential Development
966-974 Fisher Avenue, Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located on the southwest corner of Fisher Ave. and Shillington Ave. An arbitrary elevation of 100.00m was assigned to the TBM.

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE January 11, 2017

FILE NO. PG4029

HOLE NO. BH 3

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	98.72
Asphaltic concrete (0.05)						
FILL: Brown silty sand with crushed stone (0.60)	AU	1				
Loose, brown **SILTY FINE SAND** (1.60)	SS	2	100	6	1	97.72
GLACIAL TILL: Loose to compact, brown sandy silt with gravel, trace clay (2.44)	SS	3	75	8	2	96.72
GLACIAL TILL: Compact to very dense, grey silty sand, some gravel, cobbles and boulders (6.58)	SS	4	42	19	3	95.72
	SS	5	42	12	4	94.72
	SS	6	42	17	5	93.72
	SS	7	58	20	6	92.72
	SS	8	92	33		
	SS	9	100	50+		

End of Borehole

Practical refusal to augering at 6.58m depth

(GWL @ 2.12m-Jan. 20, 2017)

SYMBOLS AND TERMS

SOIL DESCRIPTION

Behavioural properties, such as structure and strength, take precedence over particle gradation in describing soils. Terminology describing soil structure are as follows:

Desiccated	-	having visible signs of weathering by oxidation of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure.
Varved	-	composed of regular alternating layers of silt and clay.
Stratified	-	composed of alternating layers of different soil types, e.g. silt and sand or silt and clay.
Well-Graded	-	Having wide range in grain sizes and substantial amounts of all intermediate particle sizes (see Grain Size Distribution).
Uniformly-Graded	-	Predominantly of one grain size (see Grain Size Distribution).

The standard terminology to describe the strength of cohesionless soils is the relative density, usually inferred from the results of the Standard Penetration Test (SPT) ‘N’ value. The SPT N value is the number of blows of a 63.5 kg hammer, falling 760 mm, required to drive a 51 mm O.D. split spoon sampler 300 mm into the soil after an initial penetration of 150 mm.

Relative Density	‘N’ Value	Relative Density %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe the strength of cohesive soils is the consistency, which is based on the undisturbed undrained shear strength as measured by the in situ or laboratory vane tests, penetrometer tests, unconfined compression tests, or occasionally by Standard Penetration Tests.

Consistency	Undrained Shear Strength (kPa)	‘N’ Value
Very Soft	<12	<2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

Cohesive soils can also be classified according to their "sensitivity". The sensitivity is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil.

Terminology used for describing soil strata based upon texture, or the proportion of individual particle sizes present is provided on the Textural Soil Classification Chart at the end of this information package.

ROCK DESCRIPTION

The structural description of the bedrock mass is based on the Rock Quality Designation (RQD).

The RQD classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be a result of closely-spaced discontinuities (resulting from shearing, jointing, faulting, or weathering) in the rock mass and are not counted. RQD is ideally determined from NXL size core. However, it can be used on smaller core sizes, such as BX, if the bulk of the fractures caused by drilling stresses (called "mechanical breaks") are easily distinguishable from the normal in situ fractures.

RQD %	ROCK QUALITY
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

SAMPLE TYPES

SS	-	Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT))
TW	-	Thin wall tube or Shelby tube
PS	-	Piston sample
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size AXT, BXL, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

GRAIN SIZE DISTRIBUTION

MC%	-	Natural moisture content or water content of sample, %
LL	-	Liquid Limit, % (water content above which soil behaves as a liquid)
PL	-	Plastic limit, % (water content above which soil behaves plastically)
PI	-	Plasticity index, % (difference between LL and PL)
Dxx	-	Grain size which xx% of the soil, by weight, is of finer grain sizes These grain size descriptions are not used below 0.075 mm grain size
D10	-	Grain size at which 10% of the soil is finer (effective grain size)
D60	-	Grain size at which 60% of the soil is finer
Cc	-	Concavity coefficient = $(D30)^2 / (D10 \times D60)$
Cu	-	Uniformity coefficient = D60 / D10

Cc and Cu are used to assess the grading of sands and gravels:
Well-graded gravels have: $1 < Cc < 3$ and $Cu > 4$
Well-graded sands have: $1 < Cc < 3$ and $Cu > 6$
Sands and gravels not meeting the above requirements are poorly-graded or uniformly-graded.
Cc and Cu are not applicable for the description of soils with more than 10% silt and clay (more than 10% finer than 0.075 mm or the #200 sieve)

CONSOLIDATION TEST

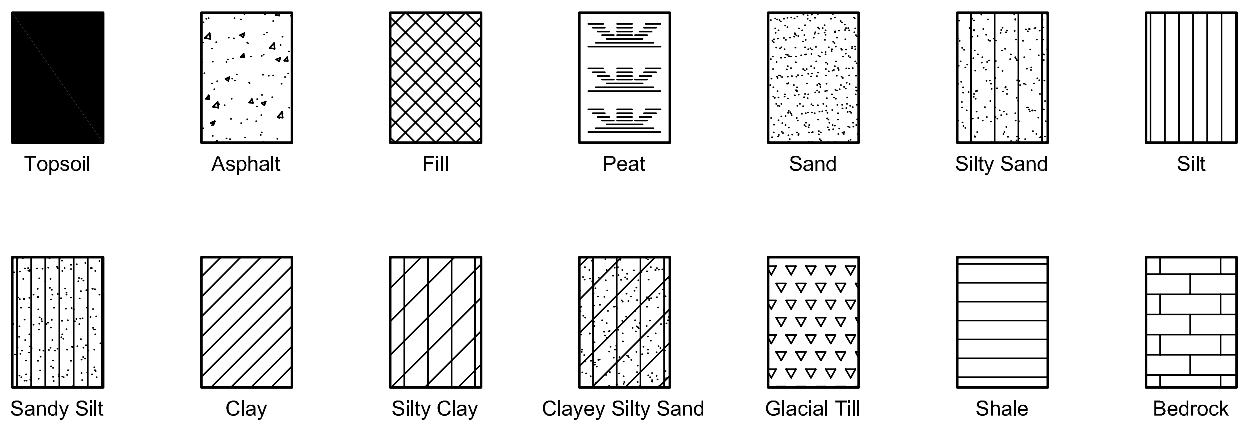
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void Ratio		Initial sample void ratio = volume of voids / volume of solids
Wo	-	Initial water content (at start of consolidation test)

PERMEABILITY TEST

k	-	Coefficient of permeability or hydraulic conductivity is a measure of the ability of water to flow through the sample. The value of k is measured at a specified unit weight for (remoulded) cohesionless soil samples, because its value will vary with the unit weight or density of the sample during the test.

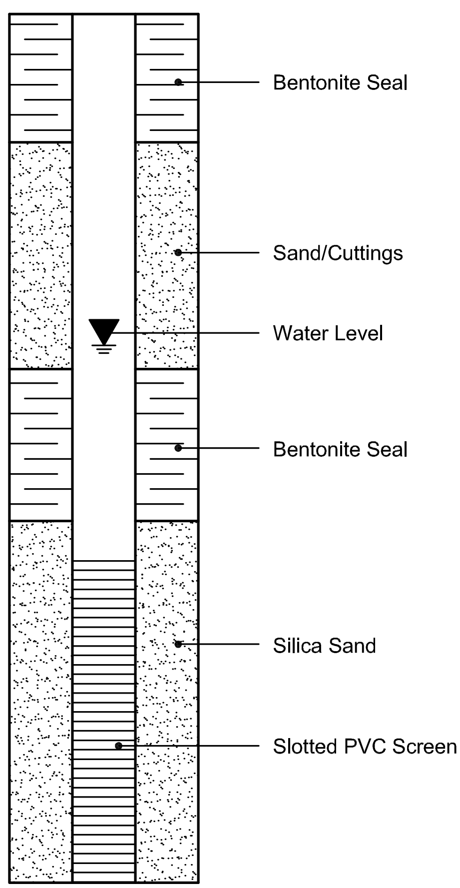
SYMBOLS AND TERMS (continued)

STRATA PLOT

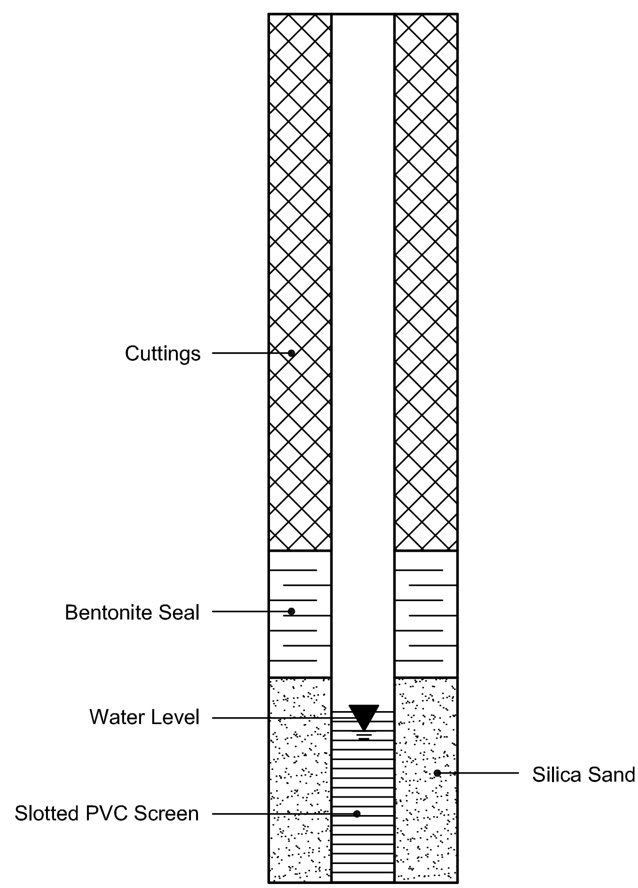


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



Certificate of Analysis

Client: Paterson Group Consulting Engineers

Client PO: 21321

Report Date: 19-Jan-2017

Order Date: 13-Jan-2017

Project Description: PG4029

	Client ID:	BH1 SS4	-	-	-
	Sample Date:	11-Jan-17	-	-	-
	Sample ID:	1702337-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	90.7	-	-	-
General Inorganics					
pH	0.05 pH Units	7.99	-	-	-
Resistivity	0.10 Ohm.m	94.5	-	-	-
Anions					
Chloride	5 ug/g dry	10	-	-	-
Sulphate	5 ug/g dry	19	-	-	-

APPENDIX 2

FIGURE 1 - KEY PLAN

DRAWING PG4029-1 - TEST HOLE LOCATION PLAN

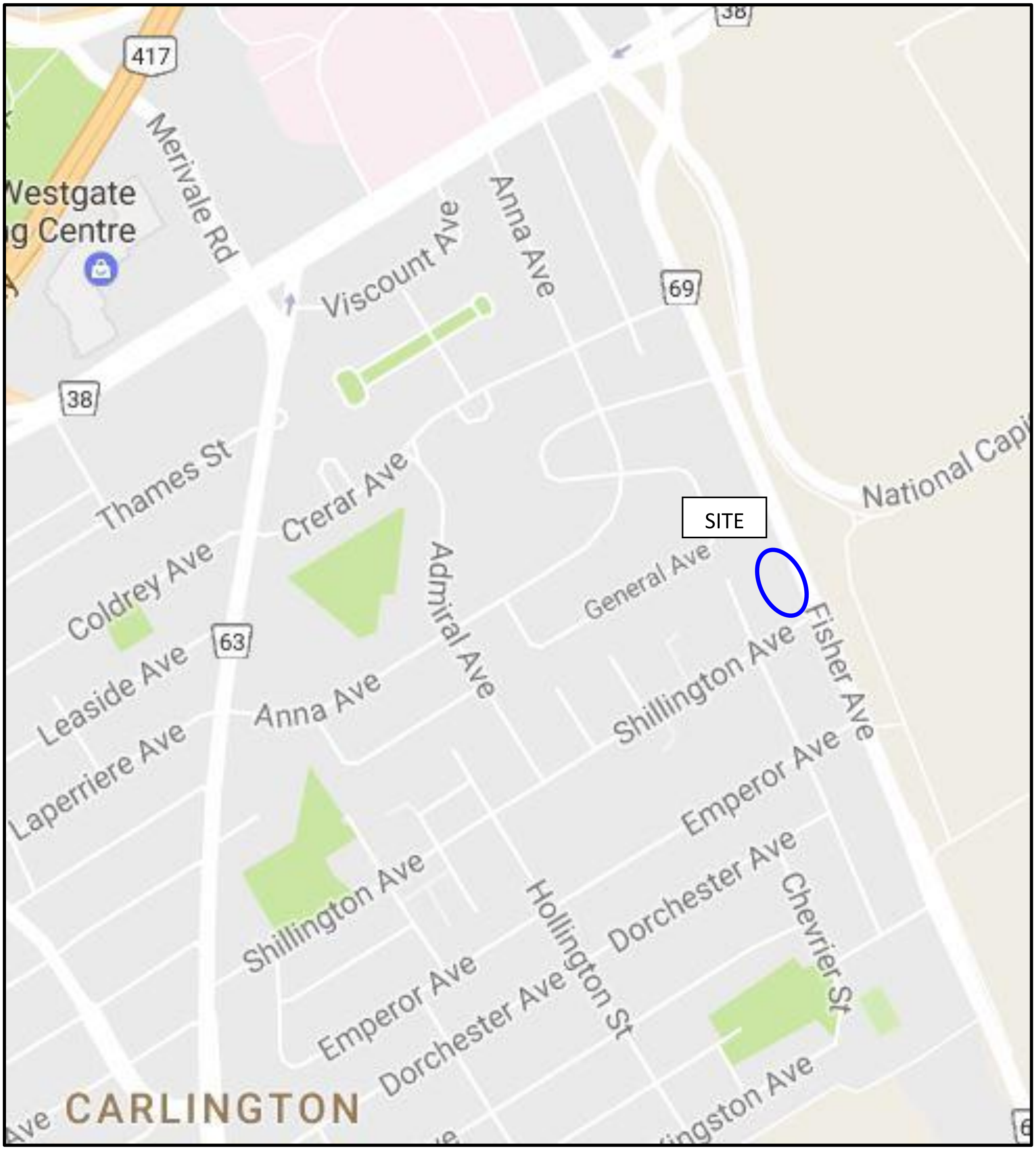
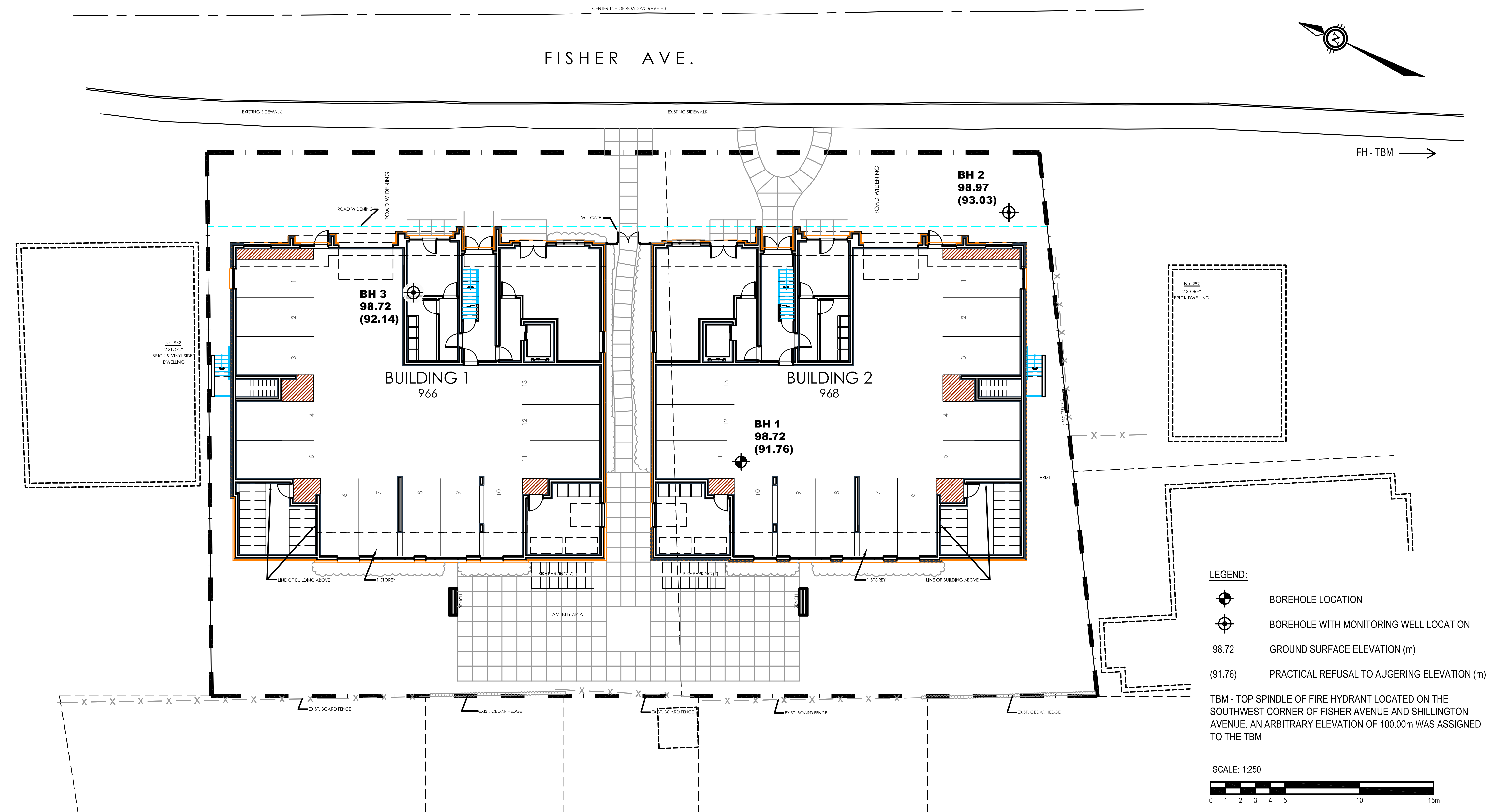


FIGURE 1

KEY PLAN

patersongroup



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NO.	REVISIONS	DATE	INITIAL
0			

MR. DAVID TOSCANO

GEOTECHNICAL INVESTIGATION
PROP. RESIDENTIAL DEVELOPMENT - 966-974 FISHER AVE.

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:250	Date: 01/2017
Drawn by: MPG	Report No.: PG4029-1
Checked by: SB	Dwg. No.: PG4029-1
Approved by: DJG	Revision No.: 0

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Appendix E DRAWINGS