79 GOWAN STREET STREET
PROPOSED 7 UNIT CONDO BUILDING
FUNCTIONAL SERVICING & SWM REPORT
CITY OF BARRIE

Prepared by:

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December 12th, 2019
19-11478B– rev. 0

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1.0 INTRODUCTION

1.1 General

The subject site is 0.0924 hectares in area and is located southwest of the intersection of Bayview Drive and Gowan Street (see Figure 1). The site is currently vacant and consists of unimproved lands which generally consist of native grasses and gravel with sporadic tree cover. The site was previously developed with a driveway, pool, and shed. This was removed around year 2014. The site is bounded by Gowan Street to the north and existing residential to the south, east, and west. The site is legally described as Part 2 or Registered Plan 40 in the City of Barrie, County of Simcoe.

The proposed development will include a 4-storey condo building with 7 residential units. Access to the development will be provided by a single driveway connection to Gowan Street. Parking for the development will be provided via a surface parking lot consisting of 9 spaces at the front of the building. The conceptual site plan prepared by Innovative Planning Solutions is included in Appendix A for further details.

1.2 Purpose and Scope

Pinestone Engineering Ltd. (PEL) has been retained by developer to provide professional engineering services related to the preparation of a Functional Servicing Report in support of a Zoning By-Law Amendment application

The purpose of this report is to describe the existing servicing infrastructure in the vicinity of the site and provide recommendations for the provision of sanitary drainage, water distribution, and storm water management in accordance with City of Barrie criteria.

1.3 Reference Reports

The following reports and studies have been used for reference in the preparation of this report:

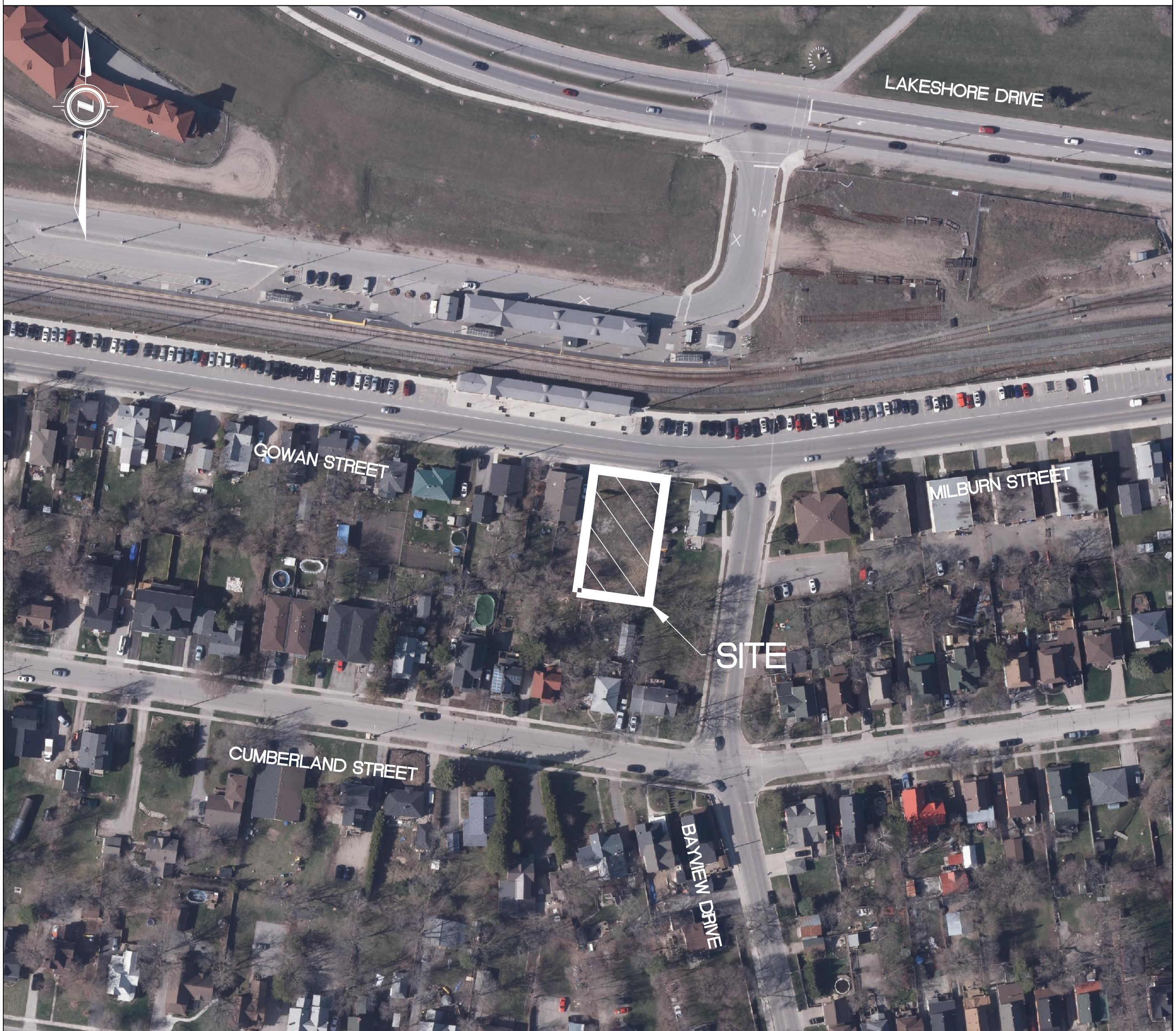
i) *City of Barrie Storm Drainage and Storm Water Management Policies and Design Guidelines, prepared by Valdor Engineering Inc., November 2009*

ii) *LSCRA Technical Guidelines for Storm Water Management Submissions, Effective Date: September 1, 2016*

iii) *City of Barrie Urban Design Manual, April 2007*

iv) *Lake Simcoe Protection Plan, June 2009*

v) *City of Barrie Sanitary Sewage Collection System Polices and Design Guideline, October 2017*



PEL
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79 GOWAN STREET			
LOCATION MAP			
DATE: DEC 2019	SCALE: 1:2000	PROJECT No. 19-11478	FIGURE No. FIGURE 1

vi) *City of Barrie Water Transmission and Distribution Polices and Design Guidelines, May 2015.*

vii) *Ministry of the Environment Storm Water Management Planning and Design Manual, March 2003.*

viii) *Low Impact Development Manual prepared by Credit Valley Conservation and Toronto and Region Conservation, 2010*

ix) *City of Barrie Secondary Plan, Background Studies & Infrastructure Master Plans prepared by amec, October 2013*

x) *City of Barrie Wastewater Collection Master Plan Update, Cole Engineering, April 2019*

2.0 SANITARY SERVICING

2.1 Existing Sanitary Infrastructure

A 250mm diameter sanitary sewer currently exists along Gowan Street and conveys flow easterly towards a 600mm diameter trunk sewer along Bayview Drive. Sewage flows from Bayview Drive discharge to the Lakeshore trunk sanitary sewer system, ultimately discharging to the Barrie Water Pollution Control Centre.

The proposed development is located within the Bayview drainage area and based on our review of the City of Barrie's Infrastructure Master Plan Update prepared by Cole dated April 2019, no downstream surcharging of the existing infrastructure is noted. A copy of the sanitary mapping prepared by Cole is included in Appendix C for further information.

Existing sizes and locations of sanitary sewer infrastructure in the area of the subject site were determined using available City data including GIS information and record plan and profile drawings.

2.2 Proposed Sanitary Flows

Contributing sanitary flows from the proposed development were calculated using the following City of Barrie design criteria as follows:

- A residential average sewage flow of 225 litres/capita/day
- A residential population density of 1.67 persons/unit for apartment units
- An extraneous flow rate of 0.1 litres/sec/ha
- A peaking factor based on Harmon's equation

The proposed development includes 7 apartment units with a population of 12. Incorporating extraneous flows, the peak sewage flow generated by the development is calculated to be 0.14 L/sec. Sanitary calculations are attached in Appendix C.

The immediate downstream reach of 250mm diameter sanitary sewer on Gowan Street installed at 0.43% has a conveyance capacity of approximately 39 L/sec. The proposed peak flow from the development represents 0.34% of the capacity of the immediate downstream reach of sewer and on this basis, it is expected available capacity exists within the existing infrastructure to support the development with no external sanitary upgrades anticipated.

2.3 Proposed Sanitary Servicing

The proposed development will be serviced via a new 150mm diameter gravity service connection to the existing 250mm diameter sanitary sewer located on Gowan Street. Gravity servicing from the Gowan Street sanitary sewer can be provided to the building. It is understood from the developer that the proposed building will not include a basement level.

Final servicing details will conform to City of Barrie standards and the exact size and location of the service lateral will be determined during detailed design to the support the Site Plan Application once the site plan is finalized.

A conceptual servicing plan illustrating the proposed sanitary servicing strategy is included in Appendix D.

3.0 WATER SERVICING

3.1 Existing Water Infrastructure

A 200mm diameter watermain exists along the property frontage on the south side of Gowan Street. A hydrant flow test has not been completed, however based on the size of water infrastructure we do not anticipate any pressure or volume concerns to service this small development. A hydrant flow test will be provided at the detailed design stage for Site Plan Approval if required by City engineering staff.

3.2 Proposed Water Demands

Based on the City of Barrie’s Water Transmission and Distribution Policies and Design Guidelines dated May 2015 and the MOECC Design Guidelines for water distribution systems, the following conditions apply:

- Max day factor of 1.50 and peak hour factor of 2.25 based on MOECC Guidelines Table 3-1 in the Design Guidelines for Drinking Water Systems, 2008
- Minimum operating pressure of 345 kPa (50 psi).
- Maximum operating pressure of 620 kPa (90 psi).

- Minimum operating pressure of 140 kPa (20 psi) during fire flow and max day.
- Residential water demand of 225 L/cap/day.
- Fire flows calculated using the Fire Underwriters Survey 1999. Preliminary fire flow calculations using FUS indicate a fire flow of approximately 65 L/sec is required for the development. Preliminary fire flow calculations are included in Appendix C. Detailed fire flow calculations will be provided at Site Plan Approval once the construction materials for the building are known.

Based on the above conditions, Table 2 illustrates the proposed domestic demands for the development:

Table 2: Residential Water Demand

Population	**Per Capita Flow (L/day)**	**Peaking Factors (based on MOECC Guidelines)**		**Flows (L/sec)**	
		Peak Hour	Maximum Day	Peak Hour	Maximum Day
12	225	2.25	1.50	0.66	0.44

3.3 Proposed Water Servicing

The proposed development will be serviced via a new 50mm diameter domestic service connection to the existing 200mm diameter watermain located on Gowan Street. An existing fire hydrant is located in the northeast portion of the site on Gowan Street and provides fire protection for the development. Servicing details will conform to City of Barrie standards and the exact size and location of the water services will be determined during detailed design to the support the Site Plan Application once the site plan has been finalized.

A conceptual servicing plan illustrating the proposed water servicing strategy is included in Appendix D.

4.0 STORM DRAINAGE

4.1 Existing Storm Drainage and Topography

A 1.8m x 1.2m trunk storm box culvert exists on Gowan Street and conveys storm sewer easterly along Gowan Street. Drainage from the subject site is directed in the form of uncontrolled sheet flow easterly towards the low point on the property.

The site is located within the Lake Simcoe watershed; however, it is not located within a regulated area based on their mapping. Review of the topographic survey completed by Pinestone Engineering Ltd. in November 2019 indicates the property slopes moderately from the west and south perimeter towards the north east corner of the site. Ground elevations above sea level range from 225.50m from the south site boundary to 224.72m at the lowest point within the site.

4.2 Site Geology

The Simcoe County Soil Map, Soil Survey Report 29 was reviewed for preliminary geotechnical information. The soils survey indicates that the subject site is comprised of Tioga, Loamy Sand (Map symbol: TIS).

Based on our review of the soils information provided by the Simcoe County Soil Map we have classified the site material as a Type BC under the Soil Conservation Service, hydrologic soil group as outlined in the *MTO Drainage Manual Volume 3, Design Chart 1.08*. Reference to this design chart is included in Appendix C.

A soils report prepared by a qualified geotechnical engineer is required for Site Plan Approval to ascertain soil composition and suitability for detailed design LID measures.

4.3 Storm Water Management Criteria

The subject development is not classified as a “Major Development” provided in the definitions in the Lake Simcoe Protection Plan, therefore LSRCA Water Budget and Phosphorus Offsetting Policies don’t apply to this site. Based on a review of the City of Barrie’s Storm Water Management (SWM) Guidelines, the following criteria applies:

Quantity Control:

- Peak flow attenuation for the 2-year through 100-year storm events to pre-development rates based on the Rational Method using the City of Barrie’s IDF parameters.
- Maintain existing drainage patterns, ensuring adjacent properties are not adversely affected.

Quality Control:

- Water quality enhancement to an “enhanced” level of protection or 80% total suspended solids removal (TSS).

Water Balance:

- Infill or Re-developments Infiltration facilities for small infill or re-developments (< 5ha) shall be designed to minimize any anticipated changes in the water balance between pre-development and post-development conditions and to infiltrate as a minimum the first 5 mm rainfall volume from the subject development.

Phosphorus Mitigation:

- Evaluation of anticipated changes in phosphorus loadings between pre-development and post-development. Phosphorus offsetting requirements per LSRCA policy is required for this development.

4.4 Pre-Development and Post Development Flow Rates

We have selected the 2-yr through 100-yr design storms as part of our evaluation. Peak flows have been calculated using the Rational Method as recommended in the City of Barrie's SWM Guidelines. In order to determine the peak flows generated from the site, one (1) pre-development and three (3) post-development catchments were delineated using the catchment parameters listed in Table 3.

Table 3: Sub-catchment Parameters

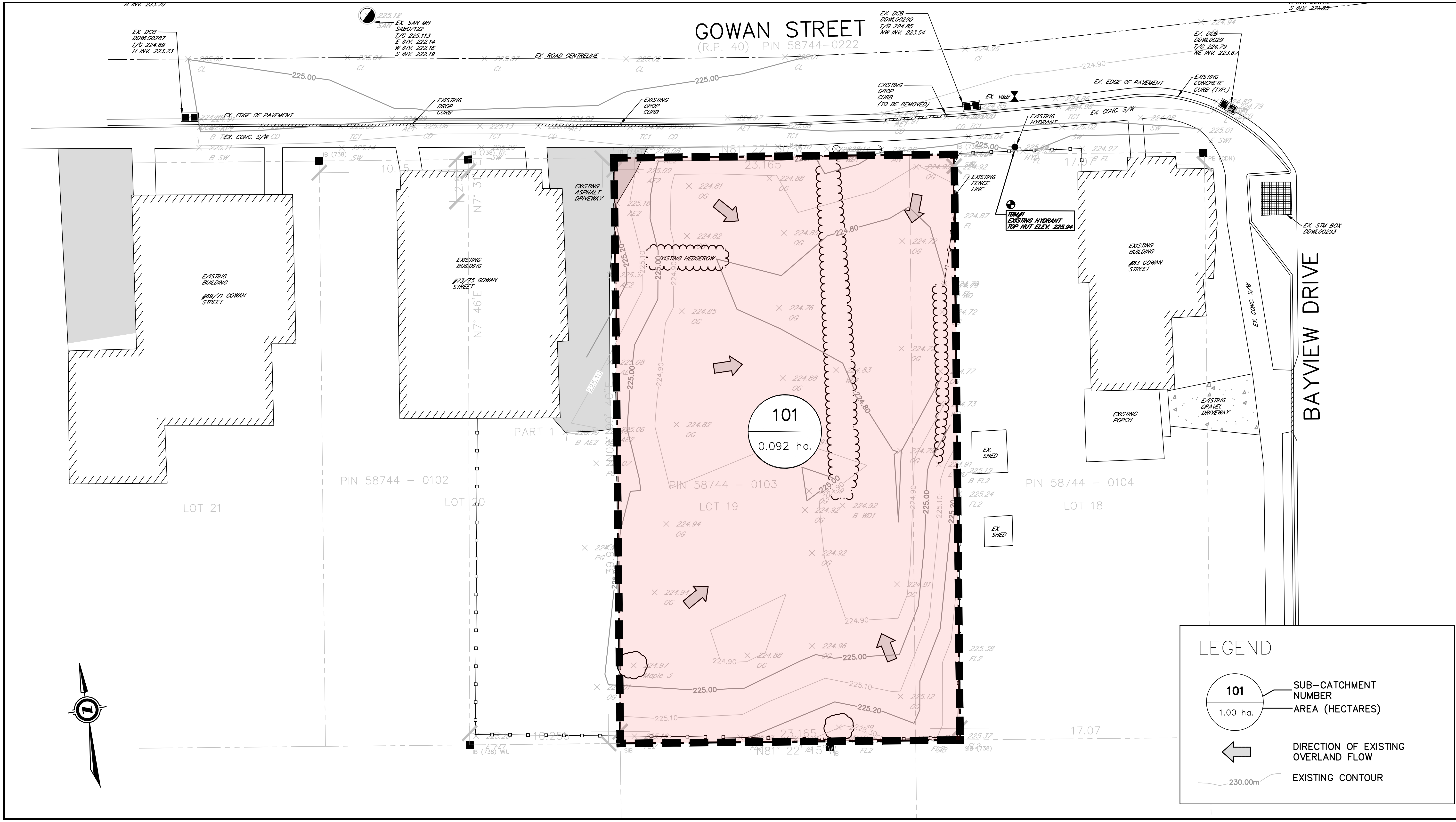
Catchments	Area (m^2)	Slope (%)	Composite Runoff Coefficient "C"
Pre-Development			
101	924	2.3	0.16
Post-Development			
201	410	2.0	0.95
202	360	0.5	0.86
203	154	0.9	0.11

Pre-development and post development catchment areas are illustrated on Figures 3 and 4 respectively. The results from the 2 through 100-year peak storm events are listed in Table 4 below.

Table 4: Rational Method – Peak Flows

	2Yr	5Yr	10Yr	25Yr	50Yr	100Yr
Pre-Development (m^3/sec)						
Catchment 101	0.003	0.004	0.005	0.006	0.008	0.009
Total Pre-Development	**0.003**	**0.004**	**0.005**	**0.006**	**0.008**	**0.009**
Post Development (m^3/sec)						
Catchment 201	0.009	0.012	0.014	0.017	0.019	0.021
Catchment 202	0.007	0.009	0.011	0.014	0.016	0.018
Catchment 203	0.000	0.001	0.001	0.001	0.001	0.001
Total Post Development	**0.017**	**0.022**	**0.025**	**0.032**	**0.036**	**0.040**

Based on the calculated results using the Rational Method, it is expected that post development flows will increase as a result of the proposed development and increased site imperviousness value. Rational Method design calculations are included in Appendix C.



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79 GOWAN STREET
4-STOREY RESIDENTIAL DEVELOPMENT
CITY OF BARRIE

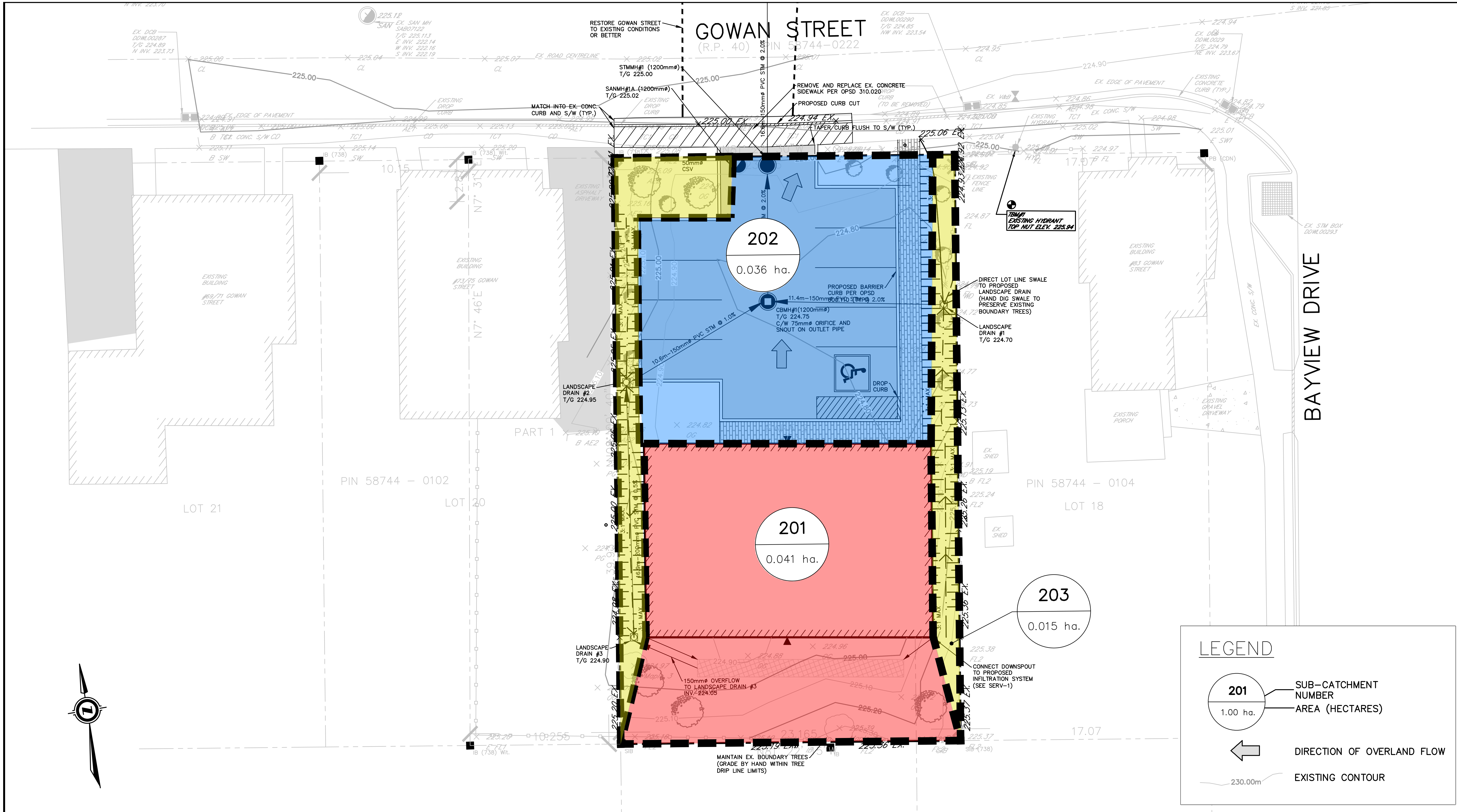
PRE DEVELOPMENT STORM CATCHMENT PLAN

PROJECT NO. 19-11478

SCALE: 1:250

DATE: DEC 2019

DRAWING NO. FIGURE 2



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79 GOWAN STREET
4-STOREY RESIDENTIAL DEVELOPMENT
CITY OF BARRIE

POST DEVELOPMENT STORM CATCHMENT PLAN

PROJECT NO. 19-11478

SCALE: 1: 250 DATE: DEC 2019

DRAWING NO. **FIGURE 3**

4.5 Quantity Control

As noted in the comparison of the pre-development and post development flows, an increase in run-off will occur due to the proposed construction of the buildings and paved driveway. To satisfy the selected design criteria, peak flow attenuation of post development flows to pre-development levels for all storm events up to and including the 100-year storm event will be provided by directing roof drainage to a rear-yard soakaway pit, construction of permeable paved surfaces and grassed swales, and parking lot storage.

Peak flow attenuation for catchment 201 (building rooftop and portion of landscape amenity area) will be achieved using a subsurface soakaway pit located at the rear of the building. This limits the uncontrolled flow of storm water into the Gowan Street storm sewer system by allowing runoff to infiltrate into the underlying soils. The soakaway pit will consist of interlocking ACO StormBrixx storage cells, configured to remain out of the tree protection areas. Major overflows from the soakaway pit will discharge via the downspouts and be directed to the side yard swales and into the proposed storm sewer system onsite.

Catchment 202 includes the parking area and peak flow attenuation will be provided by providing parking lot storage using a plate office installed on the grate at CBMH#1. Maximum ponding levels will reach 0.24m before overflowing out of the proposed entrance an into the Gowan Street ROW.

Catchment 203 includes landscape area surrounding the development. Runoff from catchment 203 will be collected in enhanced grassed swales and conveyed to proposed landscape drains. Due to the grading constraints associated with matching into the surrounding properties, the swale grades have been designed with a minimum slope of 0.5% with French drains beneath.

The final configuration of the flow control facilities along with stage storage discharge curves will be detailed at the Site Plan Approval Stage.

4.6 Quality Control

In order to provide water quality enhancement to an “enhanced” level of protection (80% TSS removal) for this development, we have incorporated a “treatment train” approach consisting of the following elements:

- Provision of “soft” landscaping where feasible.
- Construction of a soak away pit to infiltrate roof water.
- Yard grading using minimal surface slopes where possible to promote infiltration.
- Construction of enhanced grassed swales along the property boundaries.

- The installation of a “snout” treatment device (or equivalent) within CBMH#1 to treat storm water from the parking area before discharging to the Gowan Street trunk storm sewer.

- Suitable construction mitigation measures to be utilized during the site development.

The proposed quality control plan will provide the minimum 80% TSS removal required. Due to the size of the development area (924m^2), the subject site will have negligible impact on the receiving Gowan Street trunk storm sewer from both a quantity and quality control aspect. Detailed calculations for quality control devices will be provided through the Site Plan Approval process.

4.7 Water Budget

As per City policy 4.1.3 of the Storm Water Policy and Design Guidelines, sites less than 5 ha shall minimize any anticipated changes in the water balance between pre-development and post development conditions and shall provide a minimum infiltration equivalent to the first 5mm of rainfall. Based on a total site area of 924m^2, the first 5mm of rainfall to be retained on the site for infiltration equates to 4.6m^3. Initial abstraction values provided in the City’s SWM guidelines on Table 7.5 are as follows:

Table 5: Initial Abstraction Values

Cover	Initial Abstraction / Depression Storage (mm)
Woods	10
Meadows	8
Cultivated	7
Lawns	5
Impervious areas	3

Adapted from UNESCO, Manual on Drainage in Urbanized Areas, 1987

Using the values provided in the Table 5 above, approximately 3.2m^3 of rainfall will be retained on the site through initial abstraction. To make up the 1.4m^3 deficiency to retain the first 5mm of rainfall on the site, enhanced grass swales and a soak away pit will be constructed which will provide more than the required volume to meet the water budget requirements. Details will be provided at the Site Plan Approval Stage.

4.8 Phosphorus Budget

As part of the Lake Simcoe Protection Plan, all new developments must be accompanied with an evaluation of anticipated changes in phosphorus loadings between pre-development and post-development.

The MOE’s P-Tool was utilized to determine pre and post development phosphorus loadings. In the pre-development condition, transition area was used in the modelling. For the post development condition, low intensity residential development was used to represent the building and parking area due to the negligible size of the development.

Per the Lake Simcoe Protection Plan, major developments are required to demonstrate the removal of 80% of the annual total phosphorus load. The proposed development incorporates low impact development measures including infiltration via a soak away pit and enhanced swales to control phosphorus which will meet or exceed the phosphorus mitigation criteria.

Technical details related to the proposed phosphorus mitigation facilities will be provided at the Site Plan Approval stage.

4.9 Sediment and Erosion Control

Sedimentation and erosion control measures are required during construction and until such a time that site development has been completed and the driveway/entrance has been resurfaced.

The use of various siltation control measures will be implemented to protect the adjacent properties and receiving waterbodies from migrating sediments. These works include but may not be limited to:

- Installation of siltation fencing along perimeter of the development area.
- Filter cloth / silt sack placement over drains.
- Installation of vehicle tracking mud mats at the entrance to the site.

Prior to carrying out site grading the siltation barriers and mud mats shall be in place. Any onsite storm sewer works will not be permitted to outlet to the municipal sewers until the site has been stabilized.

Other temporary installations of silt fence or other appropriate measures may be required during grading to minimize silt migration from the site. The measures will need to be removed, replaced and relocated as required during the construction period until the site works have been completed and vegetation established. During construction all stockpiled material will be placed up-gradient of the siltation controls.

It is the responsibility of the contractor and owner to maintain the siltation control devices until suitable grass cover has been established. A regular review of the facilities by the contractor shall be carried out during the construction period to ensure that the facilities are being properly maintained, and if necessary, replaced. The contractor should inspect the siltation devices immediately after each rainfall. Damaged devices should be repaired immediately, and additional devices installed if necessary.

5.0 UTILITIES

Correspondence was received from both Enbridge Gas and Alectra. Gas and hydro are available to support the proposed development. Correspondence with the utility agencies is included in Appendix C.

6.0 CONCLUSION

Based on the above findings, the proposed development can be serviced utilizing the existing surrounding infrastructure on Gowan Street. The proposed servicing for the development can be achieved without any adverse impact to the existing municipal services in the surrounding areas.

We trust this is satisfactory and should you have any questions, please call.

All of which is respectfully submitted by,

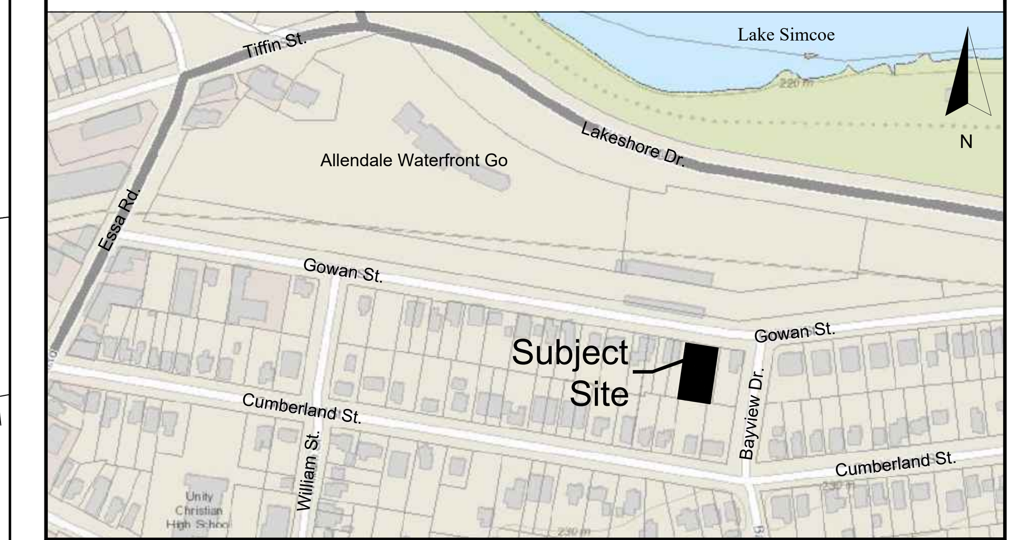
PINESTONE ENGINEERING LTD.

Joe Voisin, P.Eng.
Senior Engineer, Partner

APPENDIX A

Proposed Site Plan Concept – Innovative Planning Solutions Inc.

KEY MAP



CONCEPTUAL SITE PLAN

Part 2, Registered Plan 40
IN THE
CITY OF BARRIE
COUNTY OF SIMCOE

Scale

0 5 10 15 20 25m

LEGEND

- Subject Lands Area: 924.43m^2
- Proposed 4-Storey Walk-Up Apartment
  - Building Footprint: 258.11m^2
  - 7 units
- ▲ Main Entrance
- △ Secondary Entrance
- Amenity Area (Area: 162.4m^2)
- Open Space
- Sidewalk

Zoning Table - RM2

	Required	Provided
Lot Area (min.)	720.0m2	924.4m2
Lot Frontage (min.)	21.0m	23.2m
Front Yard (min.)	7.0m	19.7m
Side Yard (min.)	1.8m	1.8m
Rear Yard (min.)	7.0m	7.0m
Landscape Open Space (min.)	35%	42%
Lot Coverage (max.)	35%	28%
Gross Floor Area (max.)	60%	112%
Height of Bldg. (max.)	20.0m	15.0m
Density	53	76
Parking Spaces	7 (1 / unit)	9
Amenity Area	84.0m^2	162.4m^2
Landscaped Buffer Areas	3.0m	1.5

Source: Simcoe County Interactive Mapping, 2016
Note: Information shown is for discussion purposes only.

CONCEPTUAL SITE PLAN - 7 UNITS

75 GOWAN STREET, BARRIE

SCHEDULE OF REVISIONS

No.	Date	Description	By

IPS
INNOVATIVE PLANNING SOLUTIONS
PLANNERS • PROJECT MANAGERS • LAND DEVELOPERS
647 WELHAM RD., UNIT 9, BARRIE, ONTARIO, L4N 0B7
tel: 705 • 812 • 3281 fax: 705 • 812 • 3438 e: info@ipsconsultinginc.com www.ipsconsultinginc.com

Date: December 23, 2019
Drawn By: A.S.
File: 19-842
Checked: GB

APPENDIX B

Soils Mapping

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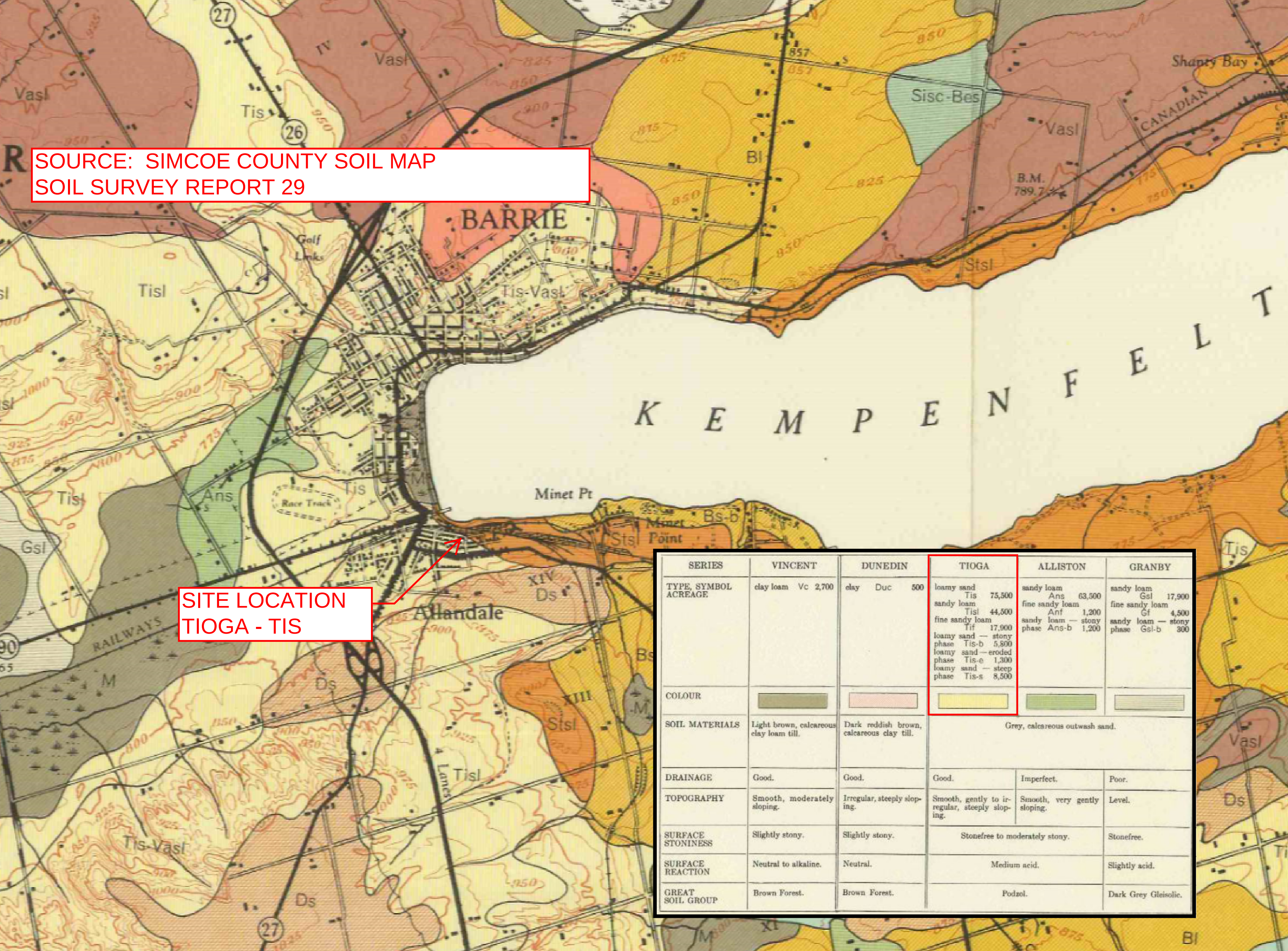


SERIES	VINCENT	DUNEDIN	TIOGA	ALLISTON	GRANBY
TYPE, SYMBOL ACREAGE	clay loam Vc 2,700	clay Duc 500	loamy sand Tis 75,500 sandy loam Tisl 44,500 fine sandy loam Tif 17,900 loamy sand — stony phase Tis-b 5,800 loamy sand — eroded phase Tis-e 1,300 loamy sand — steep phase Tis-s 8,500	sandy loam Ans 63,500 fine sandy loam Anf 1,200 sandy loam — stony phase Ans-b 1,200	sandy loam Gsl 17,900 fine sandy loam Gf 4,500 sandy loam — stony phase Gsl-b 300
COLOUR					
SOIL MATERIALS	Light brown, calcareous clay loam till.	Dark reddish brown, calcareous clay till.	Grey, calcareous outwash sand.		
DRAINAGE	Good.	Good.	Good.	Imperfect.	Poor.
TOPOGRAPHY	Smooth, moderately sloping.	Irregular, steeply sloping.	Smooth, gently to irregular, steeply sloping.	Smooth, very gently sloping.	Level.
SURFACE STONINESS	Slightly stony.	Slightly stony.	Stonefree to moderately stony.		Stonefree.
SURFACE REACTION	Neutral to alkaline.	Neutral.	Medium acid.		Slightly acid.
GREAT SOIL GROUP	Brown Forest.	Brown Forest.	Podzol.		Dark Grey Gleisolic.

Design Chart 1.08: Hydrologic Soil Groups (Continued)

- Based on Soil Texture

Sands, Sandy Loams and Gravels	
- overlying sand, gravel or limestone bedrock, very well drained	A
- ditto, imperfectly drained	AB
- shallow, overlying Precambrian bedrock or clay subsoil	B
Medium to Coarse Loams	
- overlying sand, gravel or limestone, well drained	AB
- shallow, overlying Precambrian bedrock or clay subsoil	B
Medium Textured Loams	
- shallow, overlying limestone bedrock	B
- overlying medium textured subsoil	BC
Silt Loams, Some Loams	
- with good internal drainage	BC
- with slow internal drainage and good external drainage	C
Clays, Clay Loams, Silty Clay Loams	
- with good internal drainage	C
- with imperfect or poor external drainage	C
- with slow internal drainage and good external drainage	D

Source: U.S. Department of Agriculture (1972)

APPENDIX C

Design Calculations

PINESTONE ENGINEERING LTD.

<u>Fire Flow Calculations – Fire Underwriters Survey 1999</u>

<u>19-11478B - 79 Gowan Street</u>

Building Area = 258 sm @ 4 floors = 1,032 sm

Fire demands for the proposed development were calculated in accordance with the Fire Underwriters Survey (FUS) as follows:

$$F = 220C(A)^{0.5}$$

Where,	F =	the required fire flow in litres per minute.
	C =	coefficient related to the type of construction.
	A =	total floor area of building (excluding basements) calculated as per FUS

C = 0.6 for fire resistive construction

F = 220*0.6(1032)^0.5 L/min
F = 4,000 L/min
F = 67 L/sec

<u>Reductions:</u>

Reduction for low hazard occupancy (-25%)
Fire Flow = 50.25 L/sec

Exposure charge for existing building to the east (+15%)
Exposure charge for existing building to the west (+15%)

Total charge = 30% or 15.08 L/sec on the 50.25 L/sec fire flow

Required fire flow as per FUS 1999 calculation = 65.3 *L/sec*

79 Gowan Street 7-Unit Condo	SANITARY SEWER DESIGN SHEET	Design Parameters	
City of Barrie	ENGINEERING AND PUBLIC WORKS	Average Daily Flow: Residential 0.0026 L/s/c; Commercial 0.326 L/s/ha	Mannings "n" 0.0130; Min. Velocity 0.75 m/sec; Max. Velocity 3.0 m/sec; Residential Harmon Peaking Factor (F); Infiltration 0.10 L/s/ha
Project Number: 19-11478B	Drainage Area Plan No: N/A		
Date: December 11, 2019			
Design By: JHV			
Checked By: JHV			
File: Z:\Project Documents\11478 79 Gowan Street\FSR\Sanitary Sewer Design Sheet.xls			

PINESTONE ENGINEERING LTD.

LOCATION				RESIDENTIAL AREAS and POPULATION						SCHOOL, INSTITUTIONAL			COMMERCIAL			INDUSTRIAL				INFILTRATION			DESIGN						
										HECTARES AND FLOW OF EACH ZONING																			
										0.00 L/s/ha			0.326 L/s/ha			0.00 L/s/ha													
STREET	AREA NO.	MANHOLE LOCATION FROM MH	TO MH	AREA	UNITS	POPUL.	CUMUL POPUL.	PEAK FACTOR "F"	PEAK RES. FLOW	AREA	CUMUL AREA	PEAK FLOW	AREA	CUMUL AREA	PEAK FLOW	AREA	CUMUL AREA	PEAK FLOW	TOTALS-C-I FLOW	AREA	CUMUL AREA	INFIL FLOW	TOTAL VOLUME FLOW	LENGTH	SLOPE	PIPE SIZE	CAPACITY	FULL FLOW VELOCITY	ACTUAL VELOCITY
				ha		1000s	1000s		L/sec	ha	ha	L/sec	ha	ha	L/sec	ha	ha	L/sec	L/sec	ha	ha	L/sec	L/sec	m	%	mm	L/sec.	m/s	m/s
Proposed Development				0.09	7.00	0.012	0.012	4.4079	0.1342											0.09	0.09	0.0094	0.1436						
																Capacity of Immediate Downstream Reach of 250mm dia. Sanitary Sewer =								64.6	0.43	250	38.9757	0.794	
																Proposed Development utilizes 0.4% of the capacity of the immendiate downstream reach of sewer													

High Density	Apartment dwellings	54 - 300 units/hectare @ 1.67ppu

- Typical zoning designations for High Density Development may include RA1 and RA2. It should be noted that zoning designations are subject to change, and it is the responsibility of the designer to ensure that the most current zoning by-laws and designations are being used.

The method of determining design population for residential flows will depend upon the particular stage that is being considered and the appropriate detail required for the desired level of design accuracy. Reference shall be made to current zoning policies.

Development Details Basis

When the details regarding the proposed uses on individual lots are known, or can be assumed with reasonable certainty, a more detailed approach to design population and associated design flow estimation is required. This approach involves the determination of individual design flows for the various areas in the tributary area which will contribute to an individual sewer reach. The actual number of units shall be used and the design population estimated using the following people per unit (ppu) values.

Low Density	3.13 ppu
Medium Density	2.34 ppu
High Density	1.67 ppu

3.3.1.2. Average Daily Flow

Average daily domestic flow = 225 L/day/person (excluding extraneous flows)

3.3.1.3. Peak Flow

Peak domestic flow is to be calculated using the following formula:

$$\mathrm{Qp} = \frac{\mathrm{P \times q \times M}}{86.4} + \mathrm{I \times A}$$

Where Qp = Peak residential sanitary sewage flow, including peak extraneous flows (L/s)

P = Design population in thousands (see Section 3.3.1.1)

q = Average daily domestic flow per capita (L/day/person) (see Section 3.3.1.2)

M = Peaking factor (see Section 3.3.1.3)

I = Peak extraneous flow (L/s/ha) (see Section 3.3.4)

A = Tributary area (ha) (see Section 3.2.2)

As per the MOECC Design Guidelines for Sewage Works, 2008 (MOE Guidelines), the peaking factor, M, can be calculated using the Harmon Formula or Babbit Formula. The Babbit Formula gives peaking factors that are more representative of instantaneous peaks, and the Harmon Formula gives peaking factors that are more representative of peak hour. The Babbit Formula shall only be used to assess the upstream reaches of the sewer shed where depth of flow and minimum scour is a concern for partial flow conditions where depth of flow is less than 30% of the pipe diameter.

Harmon Formula

$$\mathrm{M} = 1 + \frac{14}{4 + \mathrm{P}^{0.5}}$$

Babbit Formula

$$M = 5/P^{0.2}$$

Where P = Design population in thousands

The minimum permissible peaking factor M is 2.0 per the MOECC Guidelines.

3.3.2. Commercial and Institutional Flows

3.3.2.1. Average Daily Flow

Due to the high variability of sanitary flows between various commercial and institutional establishments, design flows for specific commercial and institutional uses are to be based on actual flow records for similar uses whenever possible. In the absence of historical data for estimation, the designer may refer the common commercial sewage flow rates recommended in the most current Ministry of the Environment Guidelines. For more general applications, where the specific use is not known, a minimum average design flow rate of 28 m^3/day/ha shall be used. This does not include an allowance for extraneous flows.

3.3.2.2. Peak Flow

Whenever possible, peaking factors should be based on an individual assessment of each type of use. Peak values and peak times vary greatly between various commercial and institutional establishments. so the designer must consider the intended use and design accordingly. Peak sewage flows will often correspond to water usage rates for most establishments. For more general applications, where specific information is not known, a factor of two (2) may be used.

3.3.3. Industrial Flows

3.3.3.1. Average Daily Flow

Sanitary sewage flows from industrial areas are industry/process specific and can vary greatly. Where possible, design flows should be based on an individual assessment of expected flow rates or actual flow records for each individual industrial use. In the absence of such information, the following average day design flows shall be used for industrial development:

General Industrial	= 35 m3/day/ha
Heavy or Special Industrial Use	= 55 m3/day/ha
Unknown Mix of General & Heavy	= 50 m3/day/ha

These rates do not include extraneous flows.

3.3.3.2. Peak Flow

Peak sewage flow rates vary greatly depending on the type of industry, production schedules and processes used. As such, peak sewage flow rates shall be based on an individual assessment of expected peak flow rates or actual flow records whenever possible. In the absence of such information, a peaking factor between two (2) and four (4) may be used based on the designer's best judgement. Industrial uses, which have the potential to produce higher than average sewage flow rates, may be required to provide flow monitoring devices and/or flow equalization with off-peak discharge facilities as determined by the City.

3.3.4. Extraneous Flows

When designing a sanitary sewer system, an allowance should be made for the infiltration of groundwater into the sewers and sanitary service connections (infiltration) and for other extraneous water entering the sewers from sources such as maintenance hole covers (inflow).

The amount of groundwater leakage into the sewer system will vary with the quality of construction, type of joints, ground conditions, and level of groundwater in relation to pipe. Although such infiltration can be reduced by proper design, construction, and maintenance, it cannot be completely eliminated and an allowance should be made in the design sewage flows to incorporate this flow component.

An extraneous flow rate of 0.1 L/s/ha shall be used for sanitary sewer design.

The above rate assumes strict adherence to construction standards in the installation of sanitary sewers and building connections, and does not account for any other extraneous flows such as foundation drain connections, excessive flooding through maintenance hole covers, significant groundwater problems, etc.

Where collection system infrastructure is being designed to convey flows from existing developed areas, the extraneous flow allowance used may be increased based on flow monitoring data and/or system modelling, as directed by the City of Barrie.

Where a sewer is located within the floodplain of a watercourse, maintenance hole covers are to be raised above the maximum flood elevations, or watertight maintenance hole covers with associated air vents may be required as directed by the City.

3.4. Sanitary Sewer Design

3.4.1. Hydraulic Design Sheets

The design of sanitary sewers shall be completed using the City of Barrie's Sanitary Sewer Design Sheets as provided in Appendix C, or a similar format as deemed appropriate by the City.

3.4.2. Minimum Pipe Diameter

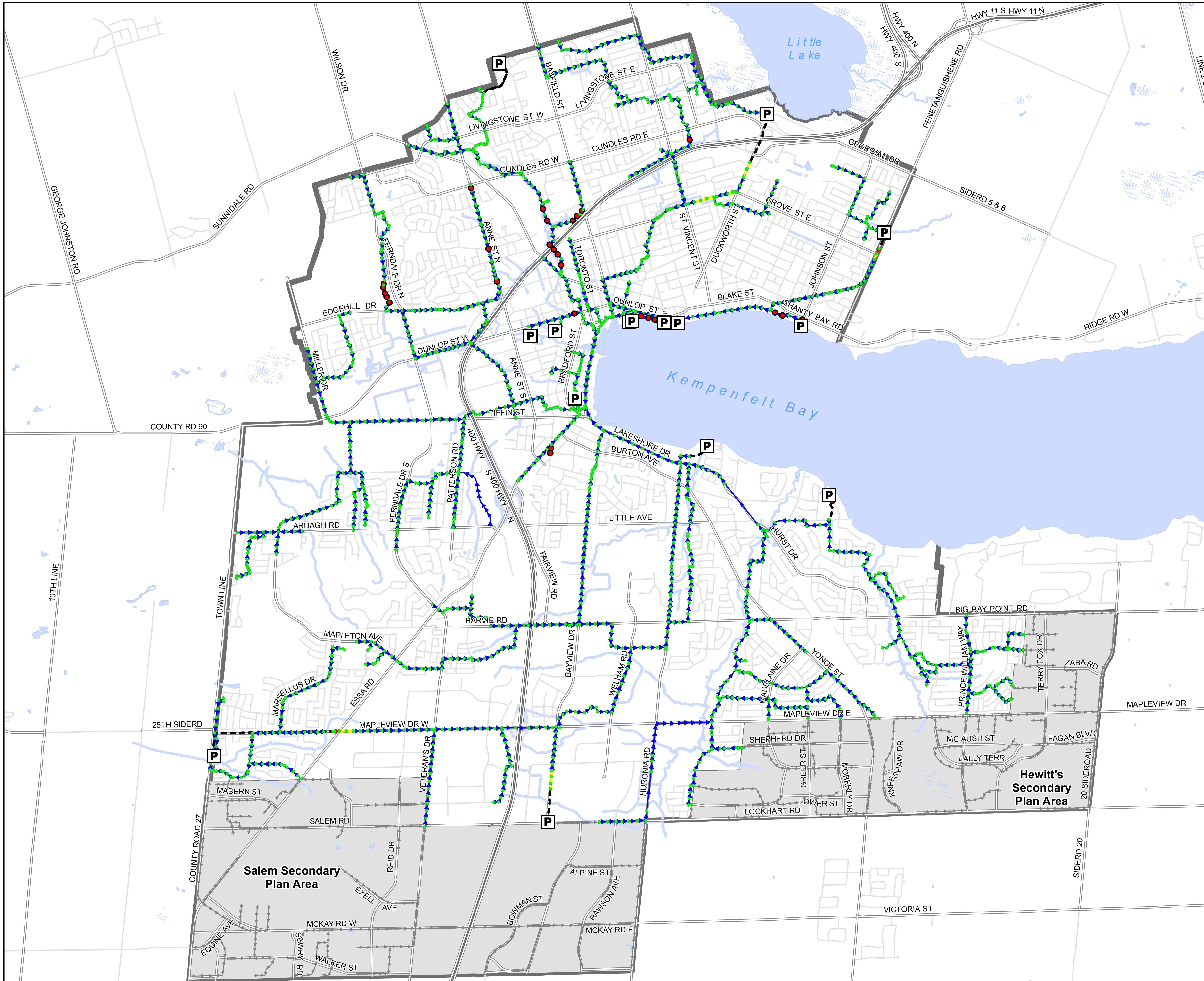
The minimum diameter for sanitary sewers conveying raw sewage from residential areas with no potential for future intensification or sanitary sewer shall be no less than 200mm in diameter (NPS-8). Sanitary sewers located in Industrial, Commercial, Institutional, and mixed land use areas shall be no less than 250 mm in diameter (NPS-10). The downstream sanitary sewer diameter shall be no less than the upstream sanitary sewer diameter.

3.4.3. Minimum and Maximum Velocities

Sanitary sewers shall be designed such that a minimum sewage flow velocity of 0.60 m/s is achieved without including inflow and infiltration flows. The actual velocity at peak flow conditions should be calculated and slope increased to ensure adequate flushing velocities are maintained. A sample spreadsheet is available on City of Barrie website, and can be reviewed in Appendix C.

In order to reduce pipe scour, the maximum flow velocity shall be 3 m/s. Velocities in excess of 3 m/s may be permitted in special situations, provided that slope anchors are used to prevent pipe separation, and measures are taken to protect against scour. If velocities above 3 m/s are proposed, documentation must be submitted to the City for approval, indicating potential risks and mitigative measures required to ensure the long term integrity of the collection system. Minimum calculated velocities shall not exceed full flow velocities.

Figure 6-2
City of Barrie
Existing Wastewater Collection System Performance Peak Dry Weather Flow Conditions



Updated: 4/5/2019

79 GOWAN STREET APARTMENT DEVELOPMENT

MODIFIED RATIONAL METHOD: PRE-DEVELOPMENT CATCHMENT 101

City of Barrie

Project Number: 19-11478B
Date: December 12, 2019
Design By: JHV
File: Z:\Project Documents\11478 79 Gowan Street\FSR\MRM Calculations.xls

IDF Curve Parameters				Intensity
Storm Event	A	B	C	(mm/hr)
2 year	678.085	4.699	0.7810	83.11
5 year	853.608	4.699	0.7660	108.92
10 year	975.865	4.699	0.7600	126.55
25 year	1146.275	4.922	0.7570	148.15
50 year	1236.152	4.699	0.7510	164.22
100 year	1426.408	5.273	0.7590	180.15

Tc = 10.0 minutes

$$i = \frac{A}{(t_c + B)^c}$$

I = average rainfall intensity (mm/hr)
A,B,C, = the IDF equation coefficients (dimensionless)
T_c = time of concentration (min)
(see time of concentration calculations for values)

Runoff Coefficients	
Land Use	Soil Type "BC"
Cultivated Land	0.35
Unimproved Area	0.20
Woodlot	0.25
Ponds / Swamps	0.05
Impervious Area	0.95
Building Area	0.95
Gravel	0.50
Lawn	0.11
X	0.00
Y	0.00
Z	0.00

Catchment Parameters			
Catchment ID	=	101	
Catchment Area	=	0.092	ha
Flow Length	=	30	m
Slope	=	0.023	m/m
Weighted Runoff Coefficient	=	0.16	

Pre-Development Runoff Coefficients:

Catchment	Total Area (m^2)	Cultivated Area (m^2)	Unimproved Area (m^2)	Woodlot Area (m^2)	Ponds/Swamps Area (m^2)	Impervious Area (m^2)	Building Area (m^2)	Gravel Area (m^2)	Lawn Area (m^2)	X Area (m^2)	Y Area (m^2)	Z Area (m^2)	Weighted C
101	924		462						462				0.16

Runoff Coefficient Adjustment for 25-100 yr Storm Events:

Catchment	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
101	0.16	0.16	0.16	0.17	0.19	0.19

Pre-Development Peak Flow Rates:

Catchment	2-Year (m^3/s)	5-Year (m^3/s)	10-Year (m^3/s)	25-Year (m^3/s)	50-Year (m^3/s)	100-Year (m^3/s)
101	0.003	0.004	0.005	0.006	0.008	0.009

Notes:
1) Runoff coefficients from LSRCA SWM Guidelines Section 21.0 and Section 22.0
2) Runoff coefficients for events greater than the 10 year storm have been adjusted per MTO Drainage Manual

79 GOWAN STREET APARTMENT DEVELOPMENT

MODIFIED RATIONAL METHOD: POST-DEVELOPMENT CATCHMENT 201

City of Barrie

Project Number: 19-11478B
Date: December 12, 2019
Design By: JHV
File: Z:\Project Documents\11478 79 Gowan Street\FSR\MRM Calculations.xls

IDF Curve Parameters				Intensity
Storm Event	A	B	C	(mm/hr)
2 year	678.085	4.699	0.7810	83.11
5 year	853.608	4.699	0.7660	108.92
10 year	975.865	4.699	0.7600	126.55
25 year	1146.275	4.922	0.7570	148.15
50 year	1236.152	4.699	0.7510	164.22
100 year	1426.408	5.273	0.7590	180.15

Tc = 10.0 minutes

$$i = \frac{A}{(t_c + B)^c}$$

I = average rainfall intensity (mm/hr)
A,B,C, = the IDF equation coefficients (dimensionless)
T_c = time of concentration (min)
(see time of concentration calculations for values)

Runoff Coefficients	
Land Use	Soil Type "BC"
Cultivated Land	0.60
Unimproved Area	0.30
Woodlot	0.42
Ponds / Swamps	0.05
Impervious Area	0.95
Building Area	0.95
Gravel	0.60
Lawn	0.22
X	0.00
Y	0.00
Z	0.00

Catchment Parameters			
Catchment ID	=	201	
Catchment Area	=	0.041	ha
Flow Length	=	13	m
Slope	=	0.02	m/m
Weighted Runoff Coefficient	=	0.95	

Pre-Development Runoff Coefficients:

Catchment	Total Area (m^2)	Cultivated Area (m^2)	Unimproved Area (m^2)	Woodlot Area (m^2)	Ponds/Swamps Area (m^2)	Impervious Area (m^2)	Building Area (m^2)	Gravel Area (m^2)	Lawn Area (m^2)	X Area (m^2)	Y Area (m^2)	Z Area (m^2)	Weighted C
201	410					410							0.95

Runoff Coefficient Adjustment for 25-100 yr Storm Events:

Catchment	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
201	0.95	0.95	0.95	1.00	1.00	1.00

Pre-Development Peak Flow Rates:

Catchment	2-Year (m^3/s)	5-Year (m^3/s)	10-Year (m^3/s)	25-Year (m^3/s)	50-Year (m^3/s)	100-Year (m^3/s)
201	0.009	0.012	0.014	0.017	0.019	0.021

Notes:
1) Runoff coefficients from LSRCA SWM Guidelines Section 21.0 and Section 22.0
2) Runoff coefficients for events greater than the 10 year storm have been adjusted per MTO Drainage Manual

79 GOWAN STREET APARTMENT DEVELOPMENT
MODIFIED RATIONAL METHOD: POST-DEVELOPMENT CATCHMENT 202
City of Barrie

Project Number: 19-11478B
Date: December 12, 2019
Design By: JHV
File: Z:\Project Documents\11478 79 Gowan Street\FSR\MRM Calculations.xls

IDF Curve Parameters				Intensity
Storm Event	A	B	C	(mm/hr)
2 year	678.085	4.699	0.7810	83.11
5 year	853.608	4.699	0.7660	108.92
10 year	975.865	4.699	0.7600	126.55
25 year	1146.275	4.922	0.7570	148.15
50 year	1236.152	4.699	0.7510	164.22
100 year	1426.408	5.273	0.7590	180.15

Tc = 10.0 minutes

$$i = \frac{A}{(t_c + B)^c}$$

I = average rainfall intensity (mm/hr)
A,B,C, = the IDF equation coefficients (dimensionless)
T_c = time of concentration (min)
(see time of concentration calculations for values)

Runoff Coefficients	
Land Use	Soil Type "BC"
Cultivated Land	0.60
Unimproved Area	0.30
Woodlot	0.42
Ponds / Swamps	0.05
Impervious Area	0.95
Building Area	0.95
Gravel	0.60
Lawn	0.22
X	0.00
Y	0.00
Z	0.00

Catchment Parameters			
Catchment ID	=	202	
Catchment Area	=	0.036	ha
Flow Length	=	13	m
Slope	=	0.005	m/m
Weighted Runoff Coefficient	=	0.86	

Pre-Development Runoff Coefficients:

Catchment	Total Area (m^2)	Cultivated Area (m^2)	Unimproved Area (m^2)	Woodlot Area (m^2)	Ponds/Swamps Area (m^2)	Impervious Area (m^2)	Building Area (m^2)	Gravel Area (m^2)	Lawn Area (m^2)	X Area (m^2)	Y Area (m^2)	Z Area (m^2)	Weighted C
202	360					315			46				0.86

Runoff Coefficient Adjustment for 25-100 yr Storm Events:

Catchment	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
202	0.86	0.86	0.86	0.94	1.00	1.00

Pre-Development Peak Flow Rates:

Catchment	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)
202	0.007	0.009	0.011	0.014	0.016	0.018

Notes:
1) Runoff coefficients from LSRCA SWM Guidelines Section 21.0 and Section 22.0
2) Runoff coefficients for events greater than the 10 year storm have been adjusted per MTO Drainage Manual

79 GOWAN STREET APARTMENT DEVELOPMENT

MODIFIED RATIONAL METHOD: POST-DEVELOPMENT CATCHMENT 203

City of Barrie

Project Number: 19-11433B
Date: December 12, 2019
Design By: JHV
File: Z:\Project Documents\11478 79 Gowan Street\FSR\MRM Calculations.xls

Storm Event	IDF Curve Parameters A	B	C	Intensity (mm/hr)
2 year	678.085	4.699	0.7810	83.11
5 year	853.608	4.699	0.7660	108.92
10 year	975.865	4.699	0.7600	126.55
25 year	1146.275	4.922	0.7570	148.15
50 year	1236.152	4.699	0.7510	164.22
100 year	1426.408	5.273	0.7590	180.15

Tc = 10.0 minutes

$$i = \frac{A}{(t_c + B)^c}$$

I = average rainfall intensity (mm/hr)
A,B,C, = the IDF equation coefficients (dimensionless)
T_c = time of concentration (min)
(see time of concentration calculations for values)

Runoff Coefficients	
Land Use	Soil Type "BC"
Cultivated Land	0.35
Unimproved Area	0.20
Woodlot	0.25
Ponds / Swamps	0.05
Impervious Area	0.95
Building Area	0.95
Gravel	0.50
Lawn	0.11
X	0.00
Y	0.00
Z	0.00

Catchment Parameters			
Catchment ID	=	203	
Catchment Area	=	0.015	ha
Flow Length	=	35	m
Slope	=	0.009	m/m
Weighted Runoff Coefficient	=	0.11	

Pre-Development Runoff Coefficients:

Catchment	Total Area (m^2)	Cultivated Area (m^2)	Unimproved Area (m^2)	Woodlot Area (m^2)	Ponds/Swamps Area (m^2)	Impervious Area (m^2)	Building Area (m^2)	Gravel Area (m^2)	Lawn Area (m^2)	X Area (m^2)	Y Area (m^2)	Z Area (m^2)	Weighted C
203	154								154				0.11

Runoff Coefficient Adjustment for 25-100 yr Storm Events:

Catchment	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
203	0.11	0.11	0.11	0.12	0.13	0.14

Pre-Development Peak Flow Rates:

Catchment	2-Year (m^3/s)	5-Year (m^3/s)	10-Year (m^3/s)	25-Year (m^3/s)	50-Year (m^3/s)	100-Year (m^3/s)
203	0.000	0.001	0.001	0.001	0.001	0.001

Notes:
1) Runoff coefficients from LSRCA SWM Guidelines Section 21.0 and Section 22.0
2) Runoff coefficients for events greater than the 10 year storm have been adjusted per MTO Drainage Manual

79 GOWAN STREET APARTMENT DEVELOPMENT
MODIFIED RATIONAL METHOD - PRE TO POST DEVELOPMENT FLOW SUMMARY
City of Barrie

PINESTONE ENGINEERING LTD.

Project Number: 19-11478B
Date: December 12, 2019
Design By: JHV
File: Z:\Project Documents\11478 79 Gowan Street\FSR\MRM Calculations.xls

Storm Event	2 Year (m^3/s)	5 Year (m^3/s)	10 Year (m^3/s)	25 Year (m^3/s)	50 Year (m^3/s)	100 Year (m^3/s)
Pre-Development Catchment 101	0.003	0.004	0.005	0.006	0.008	0.009
Total Pre-Development Flow	**0.003**	**0.004**	**0.005**	**0.006**	**0.008**	**0.009**
Post Development Catchment 201 (building rooftop and amenity area)	0.009	0.012	0.014	0.017	0.019	0.021
Post Development Catchment 202 (parking area)	0.007	0.009	0.011	0.014	0.016	0.018
Post Development Catchment 203 (landscape area)	0.000	0.001	0.001	0.001	0.001	0.001
Total Post Development Flow	**0.017**	**0.022**	**0.025**	**0.032**	**0.036**	**0.040**

3.2.1 Service Area

The drainage system shall be designed to accommodate all upstream drainage areas plus any external area tributary to the system for the existing, interim and ultimate development conditions, as determined by the delineation of appropriate topographic mapping and the preparation of drainage plans.

3.2.2 Design Flow

Storm sewer systems with a drainage area ≤ 50 ha shall be designed to convey the 1:5 year (minimum) design storm using the Rational Method and the City's IDF regression equation for rainfall intensity unless otherwise approved or directed by the City. Storm sewer systems with a drainage area > 50 ha shall be designed using an approved computer program and verified with the Rational Method. The storm sewer design shall be based on the larger of the two flows calculated using the computer model and the Rational Method. Under no circumstances shall the storm system be designed in a surcharged condition.

The design of the storm sewers shall be computed using the City of Barrie's Storm Sewer Design Sheet as provided in **Appendix A.**

All storm sewers shall be designed according to the Rational Formula where:

$$Q = \frac{(C)(i)(A)}{360}$$

where,

Q = the design flow in (m^3/s)
C = the site specific runoff coefficient
A = the drainage area (ha)
i = rainfall intensity (mm/hr)

The rainfall intensity shall be calculated in accordance with the following table and equation:

Table 3.1: Barrie WPCC IDF Curve Parameters - Adjusted to Account for Climate Change

Parameter	Return Period					
	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
A	678.085	853.608	975.865	1146.275	1236.152	1426.408
B	4.699	4.699	4.699	4.922	4.699	5.273
C	0.781	0.766	0.760	0.757	0.751	0.759

Rainfall Intensity, I (mm/hr) = $A/(t+B)^C$, where t is time duration in minutes
Parameters based on rain gauge data for the period 1979 – 2003 for the Barrie WPCC Station #6110557
Based on a review of the literature, the IDF intensity values for Barrie WPCC Station were increased by 15% before calculating a, b, c values to account for climate change.

$$i = \frac{A}{(t_d + B)^C}$$

where,

i = the rainfall intensity (mm/hr)
t_d = the storm duration (minutes)
A, B, C = a function of the local intensity-duration data.

The storm duration is set to the time of concentration (i.e. the sewer inlet time plus the time of travel in the pipe or channel) for the total cumulative drainage area to the node of interest. The maximum inlet time for the first pipe of a storm sewer system is 10 minutes.

The runoff coefficient shall be calculated in accordance with the following table:

Table 3.2: Runoff Coefficients (Rational *C*) (5-yr to 10-yr) Based on Hydrologic Soil Group

Land Use	Runoff Coefficient "C"		
	A-AB	**B-BC**	**C-D**
Cultivated Land, 0 - 5% grade	0.22	0.35	0.55
Cultivated Land, 5 - 10% grade	0.30	0.45	0.60
Cultivated Land, 10 - 30% grade	0.40	0.65	0.70
Pasture Land, 0 - 5% grade	0.10	0.28	0.40
Pasture Land, 5 - 10% grade	0.15	0.35	0.45
Pasture Land, 10 - 30% grade	0.22	0.40	0.55
Woodlot or Cutover, 0 – 5% grade	0.08	0.25	0.35
Woodlot or Cutover, 5 - 10% grade	0.12	0.30	0.42
Woodlot or Cutover, 10 - 30% grade	0.18	0.35	0.52
Lakes and Wetlands	0.05	0.05	0.05
Impervious Area (i.e., buildings, roads, parking lots, etc.)	0.95	0.95	0.95
Gravel (not to be used for proposed parking or storage areas)	0.40	0.50	0.60
Residential – Single Family	0.30	0.40	0.50
Residential – Multiple (i.e., semi, townhouse, apartment)	0.50	0.60	0.70
Industrial – light	0.55	0.65	0.75
Industrial – heavy	0.65	0.75	0.85
Commercial	0.60	0.70	0.80
Unimproved Areas	0.10	0.20	0.30
Lawn, < 2% grade	0.05	0.11	0.17
Lawn, 2 - 7% grade	0.10	0.16	0.22
Lawn, > 7% grade	0.15	0.25	0.35

Adapted from Design Chart 1.07, Ontario Ministry of Transportation, “MTO Drainage Management Manual,” MTO. (1997)

An approximation of the runoff coefficient can be calculated based on the following relationship with:

$$c = (0.7)(TIMP) + 0.2$$

where,

c = the runoff coefficient

TIMP = total impervious fraction (dimensionless)

The runoff coefficient shall be adjusted for return period events greater than the 10-yr storm per the following table:

Ontario

MINISTRY OF THE ENVIRONMENT

Database Version: V 2.0 Release Update
Update Date: 30-Mar-12

Project DEVELOPMENT Summary

DEVELOPMENT: **Gowan Street**
Subwatershed: **Barrie Creeks**

Total Pre-Development Area (ha):	**0.0920**	Total Pre-Development Phosphorus Load (kg/yr):	**0.01**

Pre-Development Land Use	Area (ha)	P coeff. (kg/ha)	P Load (kg/yr)
Transition	0.092	0.06	0.01

POST-DEVELOPMENT LOAD

Post-Development Land Use	Area (ha)	P coeff. (kg/ha)	Best Management Practice applied with P Removal Efficiency		P Load (kg/yr)
Low Intensity Development	0.092	0.13	NONE	0%	0.01

Post-Development Area Altered: **0.09**
Total Pre-Development Area: **0.09**
Unaffected Area: **0**

	P Load (kg/yr)
Pre-Development:	**0.01**
Post-Development:	**0.01**
Change (Pre - Post):	**-0.01**
	117% Net Increase in Load
Post-Development (with BMPs):	**0.01**
Change (Pre - Post):	**-0.01**
	116.67% Net Increase in Load

PERMEABLE PAVEMENT

CVC/TRCA LOW IMPACT DEVELOPMENT
PLANNING AND DESIGN GUIDE - FACT SHEET

GENERAL DESCRIPTION

Permeable pavements, an alternative to traditional impervious pavement, allow stormwater to drain through them and into a stone reservoir where it is infiltrated into the underlying native soil or temporarily detained. They can be used for low traffic roads, parking lots, driveways, pedestrian plazas and walkways. Permeable pavement is ideal for sites with limited space for other surface stormwater BMPs. Examples of permeable pavement types include:

- permeable interlocking concrete pavers (i.e., block pavers);
- plastic or concrete grid systems (i.e., grid pavers);
- pervious concrete; and
- porous asphalt.

Depending on the native soils and physical constraints, the system may be designed with no underdrain for full infiltration, with an underdrain for partial infiltration, or with an impermeable liner and underdrain for a no infiltration or detention and filtration only practice.

DESIGN GUIDANCE

GEOMETRY & SITE LAYOUT

Permeable pavement systems can be used for entire parking lot areas or driveways or can be designed to receive runoff from adjacent impervious pavement. For example, the parking spaces of a parking lot or road can be permeable pavers while the drive lanes are impervious asphalt. In general, the impervious area should not exceed 1.2 times the area of the permeable pavement which receives the runoff (GVRD, 2005).

PRE-TREATMENT

In most permeable pavement designs, the pavement bedding layer acts as pretreatment to the stone reservoir below. Periodic vacuum sweeping and preventative measures like not storing snow or other materials on the pavement are critical to prevent clogging. An optional pretreatment element can be a pea gravel choking layer above the coarse gravel storage reservoir.

CONVEYANCE AND OVERFLOW

All designs require an overflow outlet connected to a storm sewer with capacity to convey larger storms. One option is to set storm drain inlets slightly above the surface elevation of the pavement, which allows for temporary shallow ponding above the surface. Another design option is an overflow edge, which is a gravel trench along the downgradient edge of the pavement surface that drains to the stone reservoir below.

Pavements designed for full infiltration, where native soil infiltration rate is 15 mm/hr or greater, do not require incorporation of a perforated pipe underdrain. Pavements designed for partial infiltration, where native soil infiltration rate is less than 15 mm/hr, should incorporate a perforated pipe underdrain placed near the top of the granular stone reservoir. Partial infiltration designs can also include a flow restrictor assembly on the underdrain to optimize infiltration with desired drawdown time between storm events.

MONITORING WELLS

A capped vertical standpipe consisting of an anchored 100 to 150 mm diameter perforated pipe with a lockable cap installed to the bottom of the facility is recommended for monitoring the length of time required to fully drain the facility between storms.

STONE RESERVOIR

The stone reservoir must be designed to meet both runoff storage and structural support requirements. Clean washed stone is recommended as any fines in the aggregate material will migrate to the bottom and may prematurely clog the native soil. The bottom of the reservoir should be flat so that runoff will be able to infiltrate evenly through the entire surface. If the system is not designed for infiltration, the bottom should be sloped at 1 to 5% toward the underdrain.

GEOTEXTILE

A non-woven needle punched, or woven monofilament geotextile fabric should be installed between the stone reservoir and native soil to maintain separation.

EDGE RESTRAINTS

Pavers must abut tightly against the restraints to prevent rotation under load and any consequent spreading of joints. The restraints must be able to withstand the impact of temperature changes, vehicular traffic and snow removal equipment. Metal or plastic stripping is acceptable in some cases, but concrete edges are preferred. Concrete edge restraints should be supported on a minimum base of 150 mm of aggregate.

LANDSCAPING

Adjacent landscaping areas should drain away from permeable pavement to prevent sediments from running onto the surface. Urban trees also benefit from being surrounded by permeable pavement rather than impervious cover, because their roots receive more air and water.

OPERATION AND MAINTENANCE

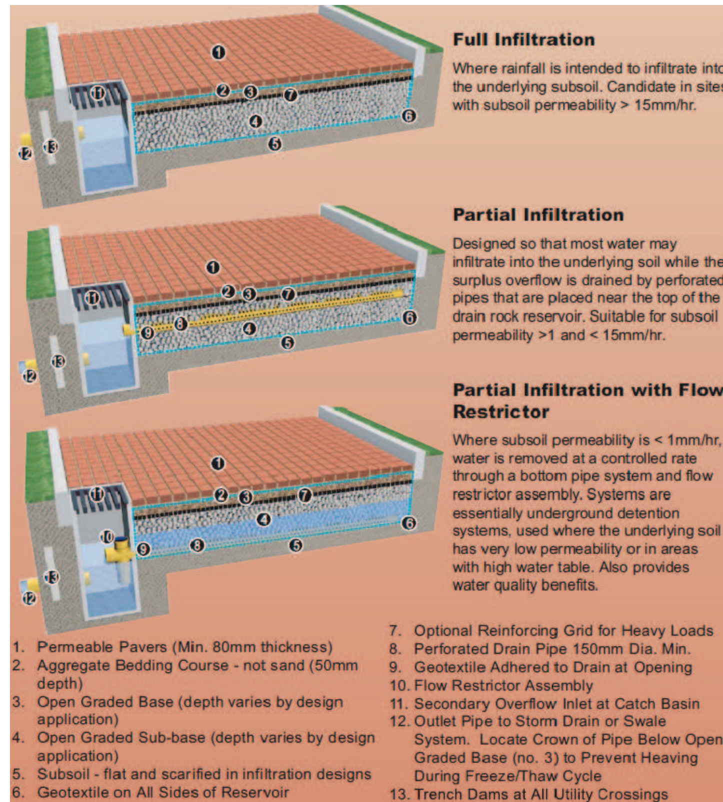
Annual inspections of permeable pavement should be conducted in the spring to ensure continued infiltration performance. Check for deterioration and whether water is draining between storms. The pavement reservoir should drain completely within 72 hours of the end of the storm event. The following maintenance procedures and preventative measures should be incorporated into a maintenance plan:

Surface Sweeping: Sweeping should occur once or twice a year with a commercial vacuum sweeping unit. Permeable pavement should not be washed with high pressure water systems or compressed air units.

Inlet Structures: Drainage pipes and structures within or draining to the subsurface bedding beneath permeable pavement should be cleaned out on regular intervals.







Source: GVRD

ABILTY TO MEET SWM OBJECTIVES

BMP	Water Balance Benefit	Water Quality Improvement	Stream Channel Erosion Control Benefit
Permeable pavement with no underdrain	Yes	Yes - size for water quality storage requirement	Partial - based on available storage volume and soil infiltration rate
Permeable pavement with underdrain	Moderate - based on native soil infiltration rates and storage beneath the underdrain	Yes - size for water quality storage requirement	Partial - based on available storage volume and soil infiltration rate
Permeable pavement with underdrain and liner	No - some volume reduction occurs through evapotranspiration	Moderate - limited filtering and settling of sediments	Partial - based on available storage volume and soil infiltration rate

Heavy Vehicles: Trucks and other heavy vehicles should be prevented from tracking or spilling dirt onto the permeable pavement.

Construction and Hazardous Materials: Due to the potential for groundwater contamination, all construction or hazardous material carriers should be prohibited from entering a permeable pavement site.

Drainage Areas: Impervious areas contributing to the permeable pavement should be regularly swept and kept clear of litter and debris. Flows from any landscaped areas should be diverted away from thepavement or be well stabilized with vegetation.

Grid Pavers: Grid paver systems that have been planted with grass should be mowed regularly with the clippings removed. Grassed grid pavers may require periodic watering and fertilization to establish and maintain healthy vegetation.

Winter Maintenance: Sand should not be spread on permeable pavement as it can quickly lead to clogging. Deicers should only be used in moderation and only when needed. Pilot studies have found that permeable pavement requires 75% less de-icing salt than conventional pavement over the course of a typical winter season. Permeable pavement is plowed for snow removal like any other pavement. Plowed snow piles should not be stored on permeable pavement systems.

GENERAL SPECIFICATIONS

Material	Specification	Quantity
Pervious Concrete	• NO4-RG-S7 mix with air entrainment proven to have the best freeze-thaw durability after 300 freeze-thaw cycles. • 28 day compressive strength = 5.5 to 20 MPa • Void ratio = 14% - 31% • Permeability = 900 to 21,500 mm/hr	Thickness will range from 100mm - 150 mm depending on the expected loads
Porous Asphalt	• Open-graded asphalt mix with a minimum of 16% air voids • Polymers can be added to provide additional strength for heavy loads • The University of New Hampshire Stormwater Center has detailed design specifications for porous asphalt on their webpage: http://www.unh.edu/erg/cstev/pubs_specs_info	Thickness will range from 50 mm to 100 mm depending on the expected loads.
Permeable Pavers	• Permeable pavers should conform to manufacturer specifications. • ASTM No. 8 (5 mm dia.) crushed aggregate is recommended for fill material in the paver openings. For narrow joints between interlocking shapes, a smaller sized aggregate may be used (Smith, 2006). • Pavers shall meet the minimum material and physical properties set forth in CAN 3-A231.2, Standard Specification for Precast Concrete Pavers. • Pigment in concrete pavers shall conform to ASTM C 979. • Maximum allowable breakage of product is 5%.	For vehicular applications, the minimum paver thickness is 80 mm and for pedestrian applications is 60 mm. Joint widths should be no greater than 15 mm for pedestrian applications.
Stone Reservoir	All aggregates should meet the following criteria: • Maximum wash loss of 0.5% • Minimum durability index of 35 • Maximum abrasion of 10% for 100 revolutions and maximum of 50% for 500 revolutions Granular Subbase The granular subbase material shall consist of granular material graded in accordance with ASTM D 2940. Material should be clear crushed 50 mm diameter stone with void space ratio of 0.4. Granular Base The granular base material shall be crushed stone conforming to ASTM C 33 No 57. Material should be clear crushed 20 mm diameter stone. Bedding The granular bedding material shall be graded in accordance with the requirements of ASTM C 33 No 8. The typical bedding thickness is between 40 mm and 75 mm. Material should be 5 mm diameter stone or as determined by the Design Engineer (Smith, 2006).	See BMP Sizing section for aggregate bed depth and multiply by application are to get total volume.
Geotextile	Material specifications should conform to Ontario Provincial Standard Specification (OPSS) 1860 for Class II geotextile fabrics. Should be woven monofilament or non-woven needle punched fabrics. Woven slit film and non-woven heat bonded fabrics should not be used as they are prone to clogging. Primary considerations are: • Suitable apparent opening size (AOS) for non-woven fabrics, or percent open area (POA) for woven fabrics, to maintain water flow even with sediment and microbial film build-up; • Maximum forces that will be exerted on the fabric (i.e., what tensile, tear and puncture strength ratings are required?); • Load bearing ratio of the underlying native soil (i.e., is geotextile needed to prevent downward migration of aggregate into the native soil?); • Texture (i.e., grain size distribution) of the overlying aggregate material; and • Permeability of the native soil. For further guidance see CVC/TRCA LID SWM Planning and Design Guide, Table 4.7.3.	Between stone reservoir and native soil.
Underdrain (optional)	• HDPE or equivalent material, continuously perforated with smooth interior and a minimum inside diameter of 100 mm. • Perforations in pipes should be 10 mm in diameter. • A standpipe from the underdrain to the pavement surface can be used for monitoring and maintenance of the underdrain. The top of the standpipe should be covered with a screw cap and a vandal-proof lock.	Pipes should terminate 0.3 m short from the sides of the base.

SITE CONSIDERATIONS

Wellhead Protection

Permeable pavement should not be used for road or parking surfaces within two (2) year time-of-travel wellhead protection areas.

Site Topography

Permeable pavement surface should be at least 1% and no greater than 5%.

Water Table

The base of permeable pavement stone reservoir should be at least one (1) metre above the seasonally high water table or top of bedrock elevation.

Soil

Systems located in native soils with an infiltration rate of less than 15 mm/hr (i.e., hydraulic conductivity of less than 1x10-6 cm/s) require a perforated pipe underdrain. Native soil infiltration rate at the proposed location and depth should be confirmed through measurement of hydraulic conductivity under field saturated conditions.

Drainage Area & Runoff Volume

In general, the impervious area treated should not exceed 1.2 times the area of the permeable pavement which receives the runoff.

Setback from Buildings

Should be located downslope from building foundations. If the pavement does not receive runoff from other surfaces, no setback is required. If the pavement receives runoff from other surfaces a minimum setback of four (4) metres downgradient is recommended.

Pollution Hot Spot Runoff

To protect groundwater from possible contamination, runoff from pollution hot spots should not be treated by permeable pavement.

CONSTRUCTION CONSIDERATIONS

SEDIMENT CONTROL

The treatment area should be fully protected during construction so that no sediment reaches the permeable pavement system. Construction traffic should be blocked from the permeable pavement and its drainage areas once the pavement has been installed.

BASE CONSTRUCTION

In parking lots, the stone aggregate should be placed in 100 mm to 150 mm lifts and compacted with a minimum 9,070 kg (10 ton) steel drum roller.

WEATHER

Porous asphalt and pervious concrete will not properly pour and set in extremely high and low temperatures.

PAVEMENT PLACEMENT

Properly installed permeable pavement requires trained and experienced producers and construction contractors.

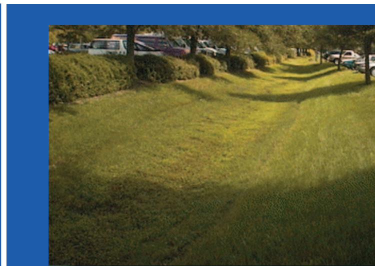
TORONTO AND REGION Conservation for The Living City

CVC CREDIT VALLEY CONSERVATION

FOR FURTHER DETAILS SEE SECTION 4.7 OF THE CVC/TRCA LID SWM GUIDE

ENHANCED GRASS SWALES

CVC/TRCA LOW IMPACT DEVELOPMENT
PLANNING AND DESIGN GUIDE - FACT SHEET



GENERAL DESCRIPTION

Enhanced grass swales are vegetated open channels designed to convey, treat and attenuate stormwater runoff (also referred to as enhanced vegetated swales). Check dams and vegetation in the swale slows the water to allow sedimentation, filtration through the root zone and soil matrix, evapotranspiration, and infiltration into the underlying native soil. Simple grass channels or ditches have long been used for stormwater conveyance, particularly for roadway drainage. Enhanced grass swales incorporate design features such as modified geometry and check dams that improve the contaminant removal and runoff reduction functions of simple grass channel and roadside ditch designs.

Where development density, topography and depth to water table permit, enhanced grass swales are a preferred alternative to both curb and gutter and storm drains as a stormwater conveyance system. When incorporated into a site design, they can reduce impervious cover, accent the natural landscape, and provide aesthetic benefits.

DESIGN GUIDANCE

GEOMETRY AND SITE LAYOUT

- Shape: Should be designed with a trapezoidal or parabolic cross section. Trapezoidal swales will generally evolve into parabolic swales over time, so the initial trapezoidal cross-section design should be checked for capacity and conveyance assuming it is a parabolic cross-section. Swale length between culverts should be 5 metres or greater.
- Bottom Width: Should be designed with a bottom width between 0.75 and 3.0 metres. Should allow for shallow flows and adequate water quality treatment, while preventing flows from concentrating and creating gullies.
- Longitudinal Slope: Slopes should be between 0.5% and 4%. Check dams should be incorporated on slopes greater than 3%.
- Length: When used to convey and treat road runoff, the length simply parallels the road, and therefore should be equal to, or greater than the contributing roadway length.
- Flow Depth: A maximum flow depth of 100 mm is recommended during a 4 hour, 25 mm Chicago storm event.
- Side Slopes: Should be as flat as possible to aid in providing pretreatment for lateral incoming flows and to maximize the swale filtering surface. Steeper side slopes are likely to have erosion gullying from incoming lateral flows. A maximum slope of 2.5:1 (H:V) is recommended and a 4:1 slope is preferred where space permits.

PRE-TREATMENT

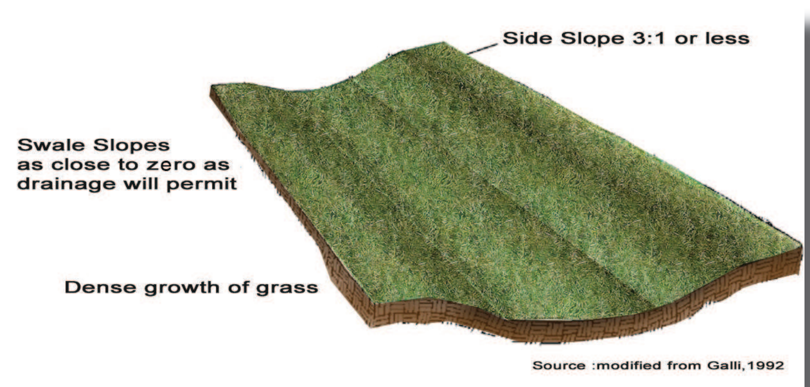
A pea gravel diaphragm located along the top of each bank can be used to provide pretreatment of any runoff entering the swale laterally along its length. Vegetated filter strips or mild side slopes (3:1) also provide pretreatment for any lateral sheet flow entering the swale. Sedimentation forebays at inlets to the swale are also a pretreatment option.

CONVEYANCE AND OVERFLOW

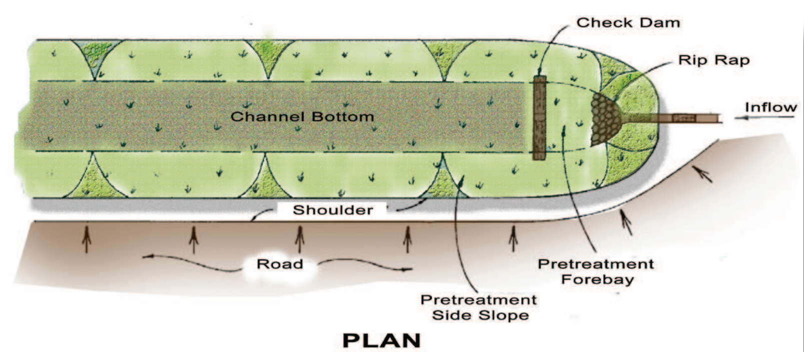
Grass swales must be designed for a maximum velocity of 0.5 m/s or less for the 4 hour 25 mm Chicago storm event. The swale should also convey the locally required design storm (usually the 10 year storm) at non-erosive velocities.

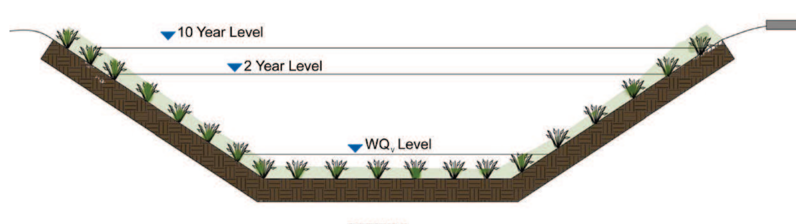
SOIL AMENDMENTS

If soils along the location of the swale are highly compacted, or of such low fertility that vegetation cannot become established, they should be tilled to a depth of 300 mm and amended with compost to achieve an organic content of 8 to 15% by weight or 30 to 40% by volume.



PLAN VIEW OF A GRASS SWALE





PLAN AND PROFILE VIEWS

ABILITY TO MEET SWM OBJECTIVES

BMP	Water Balance Benefit	Water Quality Improvement	Stream Channel Erosion Control Benefit
Enhanced Grass Swale	Partial - depends on soil infiltration rate	Yes, if design velocity is 0.5 m/s or less for a 4 hour, 25 mm Chicago storm	Partial - depends on soil infiltration rate

GENERAL SPECIFICATIONS

Component	Specification	Quantity
Check Dams	Constructed of a non-erosive material such as suitably sized aggregate, wood, gabions, riprap, or concrete. All check dams should be underlain with geotextile filter fabric. Wood used for check dams should consist of pressure treated logs or timbers, or water-resistant tree species such as cedar, hemlock, swamp oak or locust.	Spacing should be based on the longitudinal slope and desired ponding volume.
Gravel Diaphragm	Washed stone between 3 and 10 mm in diameter.	Minimum of 300 mm wide and 600 mm deep.

CONSTRUCTION CONSIDERATIONS

Grass swales should be clearly marked before site work begins to avoid disturbance during construction. No vehicular traffic, except that specifically used to construct the facility, should be allowed within the swale site. Any accumulation of sediment that does occur within the swale must be removed during the final stages of grading to achieve the design cross-section. Final grading and planting should not occur until the adjoining areas draining into the swale are stabilized. Flow should not be diverted into the swale until the banks are stabilized.

Preferably, the swale should be planted in the spring so that the vegetation can become established with minimal irrigation. Installation of erosion control matting or blanketing to stabilize soil during establishment of vegetation is highly recommended. If sod is used, it should be placed with staggered ends and secured by rolling the sod. This helps to prevent gullies.

OPERATION AND MAINTENANCE

Generally, routine maintenance will be the same as for any other landscaped area; weeding, pruning, and litter removal. Grassed swales should be mown at least twice yearly to maintain grass height between 75 and 150 mm. The lightest possible mowing equipment should be used to prevent soil compaction. Routine roadside ditch maintenance practices such as scraping and re-grading should be avoided. Regular watering may be required during the first two years until vegetation is established. Routine inspection is very important to ensure that dense vegetation cover is maintained and inlets and pretreatment devices are free of debris.

For the first two years following construction the swale should be inspected at least quarterly and after every major storm event (> 25 mm). Subsequently, inspections should be conducted in the spring and fall of each year and after major storm events. Inspect for vegetation density (at least 80% coverage), damage by foot or vehicular traffic, accumulation of debris, trash and sediment, and structural damage to pretreatment devices.

Trash and debris should be removed from pretreatment devices and the surface of the swale at least twice annually. Other maintenance activities include weeding, replacing dead vegetation, repairing eroded areas, dethatching and aerating as needed. Remove accumulated sediment on the swale surface when dry and exceeding 25 mm depth.

SITE CONSIDERATIONS

Available Space
Grass swales usually consume about 5 to 15% of their contributing drainage area. A width of at least 2 metres is needed.

Site Topography
Site topography constrains the application of grass swales. Longitudinal slopes between 0.5 and 6% are allowable. This prevents ponding while providing residence time and preventing erosion. On slopes steeper than 3%, check dams should be used.

Drainage Area & Runoff Volume
The conveyance capacity should match the drainage area. Sheet flow to the grass swale is preferable. If drainage areas are greater than 2 hectares, high discharge through the swale may not allow for filtering and infiltration, and may create erosive conditions. Typical ratios of impervious drainage area to treatment facility area range from 5:1 to 10:1.

Soil
Grass swales can be applied on sites with any type of soils.

Pollution Hot Spot Runoff
To protect groundwater from possible contamination, source areas where land uses or human activities have the potential to generate highly contaminated runoff (e.g., vehicle fueling, servicing and demolition areas, outdoor storage and handling areas for hazardous materials and some heavy industry sites) should not be treated by grass swales.

Proximity to Underground Utilities
Utilities running parallel to the grass swale should be offset from the centerline of the swale. Underground utilities below the bottom of the swale are not a problem.

Water Table
The bottom of the swale should be separated from the seasonally high water table or top of bedrock elevation by at least one (1) metre.

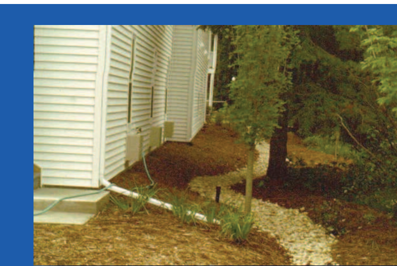
Setback from Buildings
Should be located a minimum of four (4) metres from building foundations to prevent water damage.

Toronto and Region Conservation for The Living City
CVC Credit Valley Conservation

FOR FURTHER DETAILS SEE SECTION 4.8 OF THE CVC/TRCA LID SWM GUIDE

Source: Lanark Consultants Ltd

Source: Pennsylvania Department of Environmental Protection



SOAKAWAYS, INFILTRATION TRENCHES AND CHAMBERS

CVC/TRCA LOW IMPACT DEVELOPMENT PLANNING AND DESIGN GUIDE - FACT SHEET

GENERAL DESCRIPTION

Soakaways are rectangular or circular excavations lined with geotextile fabric and filled with clean granular stone or other void forming material that receive runoff from a perforated pipe inlet and allow it to infiltrate into the native soil. They typically service individual lots and receive only roof and walkway runoff but can also be designed to receive overflows from rainwater harvesting systems. Soakaways can also be referred to as infiltration galleries, dry wells or soakaway pits.

Infiltration trenches are rectangular trenches lined with geotextile fabric and filled with clean granular stone or other void forming material. Like soakaways, they typically service an individual lot and receive only roof and walkway runoff. This design variation on soakaways is well suited to sites where available space for infiltration is limited to narrow strips of land between buildings or properties, or along road rights-of-way. They can also be referred to as infiltration galleries or linear soakaways.

Infiltration chambers are another design variation on soakaways. They include a range of proprietary manufactured modular structures installed underground, typically under parking or landscaped areas that create large void spaces for temporary storage of stormwater, allowing it to infiltrate into the underlying native soil. Structures typically have open bottoms, perforated side walls and optional underlying granular stone reservoirs. They can be installed individually or in series in trench or bed configurations. They can infiltrate roof, walkway, parking lot and road runoff with adequate pretreatment. Due to the large volume of underground void space they create in comparison to a soakaway of the same dimensions, and the modular nature of their design, they are well suited to sites where available space for other types of BMPs is limited, or where it is desirable for the facility to have little or no surface footprint (e.g., high density development contexts). They can also be referred to as infiltration tanks.

DESIGN GUIDANCE

MONITORING WELLS

Capped vertical non-perforated pipes connected to the inlet and outlet pipes are recommended to provide a means of inspecting and flushing them out as part of routine maintenance. A capped vertical standpipe consisting of an anchored 100 to 150 mm diameter perforated pipe with a lockable cap installed to the bottom of the facility is also recommended for monitoring the length of time required to fully drain the facility between storms. Manholes and inspection ports should be installed in infiltration chambers to provide access for monitoring and maintenance activities.

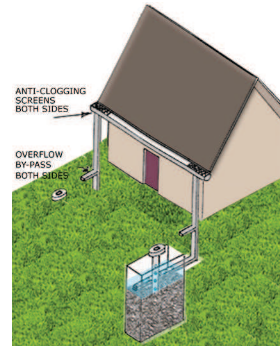
PRE-TREATMENT

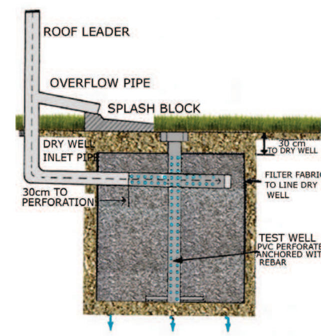
It is important to prevent sediment and debris from entering infiltration facilities because they could contribute to clogging and failure of the system. The following pretreatment devices are options:

- Leaf screens: Leaf screens are mesh screens installed either on the building eavestroughs or roof downspouts and are used to remove leaves and other large debris from roof runoff.
- In-ground devices: Devices placed between a conveyance pipe and the facility (e.g., oil and grit separators, sedimentation chamber or goss traps), that can be designed to remove both large and fine particulate from runoff. A number of proprietary stormwater filter designs are available
- Vegetated filter strips or grass swales: Road and parking lot runoff can be pretreated with vegetated filter strips or grass swales prior to entering the infiltration practice

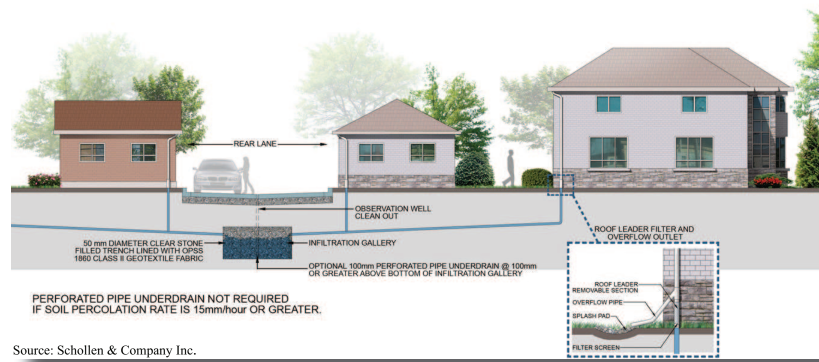
FILTER MEDIA

- Stone reservoir: Soakaways and infiltration trenches should be filled with uniformly-graded, washed stone that provides 30 to 40% void space. Granular material should be 50 mm clear stone
- Geotextile: A non-woven needle punched, or woven monofilament geotextile fabric should be installed around the stone reservoir of soakaways and infiltration trenches with a minimum overlap at the top of 300 mm. Woven slit film and non-woven heat bonded fabrics should not be used as they are prone to clogging. Specification of geotextile fabrics should consider the apparent opening size (AOS) for non-woven fabrics, or percent open area (POA) for woven fabrics, which affect the long term ability to maintain water flow. Other factors that need consideration include maximum forces to be exerted on the fabric, and the load bearing ratio, texture (i.e., grain size distribution) and permeability of the native soil in which they will be installed.





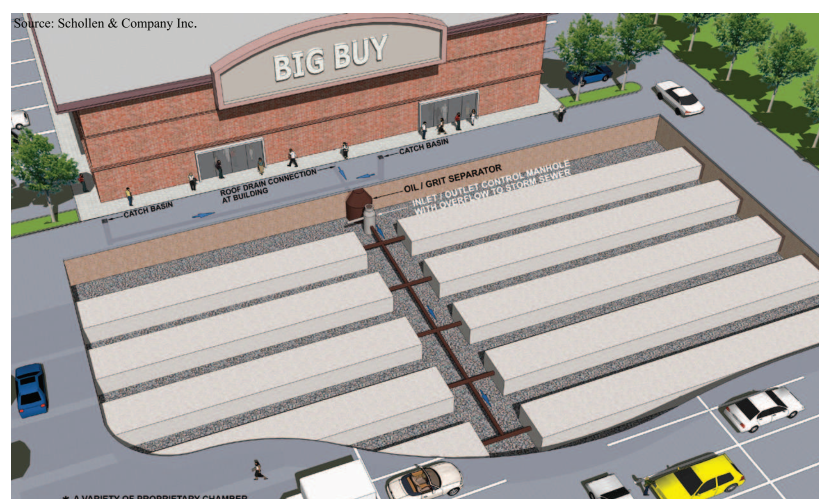
DRY WELL SYSTEM



Source: Schollen & Company Inc.

INFILTRATION TRENCH BELOW A LANEWAY

Source: Schollen & Company Inc.



INFILTRATION CHAMBER SYSTEM UNDER A PARKING LOT

GEOMETRY AND SITE LAYOUT

Soakaways and infiltration chambers can be designed in a variety of shapes, while infiltration trenches are typically rectangular excavations with a bottom width generally between 600 and 2400 mm. Facilities should have level or nearly level bed bottoms.

CONVEYANCE AND OVERFLOW

Inlet pipes to soakaways and infiltration trenches are typically perforated pipe connected to a standard non-perforated pipe or eavestrough that conveys runoff from the source area to the facility. The inlet and overflow outlet to the facility should be installed below the maximum frost penetration depth to prevent freezing. The overflow outlet can simply be the perforated pipe inlet that backs up when the facility is at capacity and discharges to a splash pad and pervious area at grade or can be a pipe that is at the top of the gravel layer and is connected to a storm sewer. Outlet pipes must have capacity equal to or greater than the inlet.

ABILITY TO MEET SWM OBJECTIVES

BMP	Water Balance Benefit	Water Quality Improvement	Stream Channel Erosion Control Benefit
Soakaways, Infiltration Trenches and Chambers	Yes	Yes	Partial, depends on soil infiltration rate

CONSTRUCTION CONSIDERATIONS

SOIL DISTURBANCE AND COMPACTION: Before site work begins, locations of facilities should be clearly marked. Only vehicular traffic used for construction of the infiltration facility should be allowed close to the facility location.

EROSION AND SEDIMENT CONTROL: Infiltration practices should never serve as a sediment control device during construction. Construction runoff should be directed away from the proposed facility location. After the site is vegetated, erosion and sediment control structures can be removed.

COMMON CONCERNS

RISK OF GROUNDWATER CONTAMINATION

Most pollutants in urban runoff are well retained by infiltration practices and soils and therefore, have a low to moderate potential for groundwater contamination. To minimize risk of groundwater contamination the following management approaches are recommended:

- infiltration practices should not receive runoff from high traffic areas where large amounts of de-icing salts are applied (e.g., busy highways), nor from pollution hot spots;
- prioritize infiltration of runoff from source areas that are comparatively less contaminated such as roofs, low traffic roads and parking areas; and,
- apply sedimentation pretreatment practices (e.g., oil and grit separators) before infiltration of road or parking area runoff.

RISK OF SOIL CONTAMINATION

Available evidence from monitoring studies indicates that small distributed stormwater infiltration practices do not contaminate underlying soils, even after 10 years of operation.

ON PRIVATE PROPERTY

Property owners or managers will need to be educated on their routine maintenance needs, understand the long-term maintenance plan, and be subject to a legally binding maintenance agreement. An incentive program such as a storm sewer user fee based on the area of impervious cover on a property that is directly connected to a storm sewer could be used to encourage property owners or managers to maintain existing practices. Alternatively, infiltration practices could be located in an expanded road right-of-way or "stormwater easement" so that municipal staff can access the facility in the event it fails to function properly.

WINTER OPERATION

Soakaways, infiltration trenches and chambers will continue to function during winter months if the inlet pipe and top of the facility is located below the local maximum frost penetration depth.

OPERATION AND MAINTENANCE

Maintenance typically consists of cleaning out leaves, debris and accumulated sediment caught in pretreatment devices, inlets and outlets annually or as needed. Inspection via an monitoring well should be performed to ensure the facility drains within the maximum acceptable length of time (typically 72 hours) at least annually and following every major storm event (>25 mm). If the time required to fully drain exceeds 72 hours, drain via pumping and clean out the perforated pipe underdrain, if present. If slow drainage persists, the system may need removal and replacement of granular material and/or geotextile fabric.

SITE CONSIDERATIONS

Wellhead Protection

Facilities receiving road or parking lot runoff should not be located within two (2) year time-of-travel wellhead protection areas.

Site Topography

Facilities cannot be located on natural slopes greater than 15%.

Water Table

The bottom of the facility should be vertically separated by one (1) metre from the seasonally high water table or top of bedrock elevation.

Soil

Soakaways, infiltration trenches and chambers can be constructed over any soil type, but hydrologic soil group A or B soils are best for achieving water balance and channel erosion control objectives. If possible, facilities should be located in portions of the site with the highest native soil infiltration rates. Designers should verify the soil infiltration rate at the proposed location and depth through field measurement of hydraulic conductivity under field saturated conditions.

Drainage Area

Typically are designed with an impervious drainage area to treatment facility area ratio of between 5:1 and 20:1. A maximum ratio of 10:1 is recommended for facilities receiving road or parking lot runoff.

Pollution Hot Spot Runoff

To protect groundwater from possible contamination, runoff from pollution hot spots should not be treated by soakaways, infiltration trenches or chambers.

Setback from Buildings

Facilities should be setback a minimum of four (4) metres from building foundations.

Proximity to Underground Utilities

Local utility design guidance should be consulted to define the horizontal and vertical offsets. Generally, requirements for underground utilities passing near the practice will be no different than for utilities in other pervious areas. However, the designer should consider the need for long term maintenance when locating infiltration facilities near other underground utilities.

TORONTO AND REGION Conservation for The Living City

CVC CREDIT VALLEY CONSERVATION

FOR FURTHER DETAILS SEE SECTION 4.4 OF THE CVC/TRCA LID SWM GUIDE

From:	David Smith
To:	Joe Voisin; Stephen Cranley
Cc:	Arthur Liu
Subject:	RE: 79 Gowan Street Development
Date:	November 28, 2019 10:17:53 AM

Hi Joe.

Gas is available for this site. Let me know when you are ready to apply for gas.

Thanks.

David Smith
Customer Connections Representative

ENBRIDGE
TEL: 705-739-5254 | CELL: 705-220-5997 | FAX: 705-739-5200
10 Churchill Dr. Barrie ON L4N 8Z5

enbridge.com
Safety. Integrity. Respect.

From: Joe Voisin [mailto:jvoisin@pel.ca]
Sent: Monday, November 25, 2019 3:48 PM
To: Stephen Cranley; David Smith
Cc: Arthur Liu
Subject: [External] 79 Gowan Street Development

Good afternoon,

We have been retained by the property owner at 79 Gowan Street to complete a functional servicing brief for a proposed 7 unit condo building. I have attached the concept site plan for your information.

Please let me know if there is adequate gas and electrical servicing for this proposal.

Thanks in advance.

Joe Voisin, P.Eng.
Senior Engineer, Partner

PEL
PINESTONE ENGINEERING LTD.

20 Bell Farm Road, Unit 1, Barrie, ON, L4M 6E4
jvoisin@pel.ca | PEL.ca

From:	Stephen Cranley
To:	Joe Voisin
Cc:	Arthur Liu
Subject:	RE: 79 Gowan Street Development
Date:	December 5, 2019 10:08:14 AM

Hi Joe,

Alectra has an existing pole line with a single 4.16kV distribution circuit attached along the north side of Gowan Street across the road from 79 Gowan Street. This circuit would have sufficient capacity to service the proposed 4 storey, 7 unit residential condo building.

Can we assume there will be EV charging units installed within this development?

Regards,

alectra utilities
Discover the possibilities

Stephen Cranley, C.E.T.
Supervisor, Distribution Design, ICI & Service Layouts
55 Patterson Road, Barrie, ON L4N 3V9
t 705.722.7244 x31297 | **m** 705.241.7950
alectrautilities.com

From: Joe Voisin <jvoisin@pel.ca>
Sent: Monday, November 25, 2019 3:48 PM
To: Stephen Cranley <stephen.cranley@alectrautilities.com>; David Smith <David.Smith@enbridge.com>
Cc: Arthur Liu <aliu@pel.ca>
Subject: 79 Gowan Street Development

Good afternoon,

We have been retained by the property owner at 79 Gowan Street to complete a functional servicing brief for a proposed 7 unit condo building. I have attached the concept site plan for your information.

Please let me know if there is adequate gas and electrical servicing for this proposal.

Thanks in advance.

Joe Voisin, P.Eng.
Senior Engineer, Partner

PEL
PINESTONE ENGINEERING LTD.

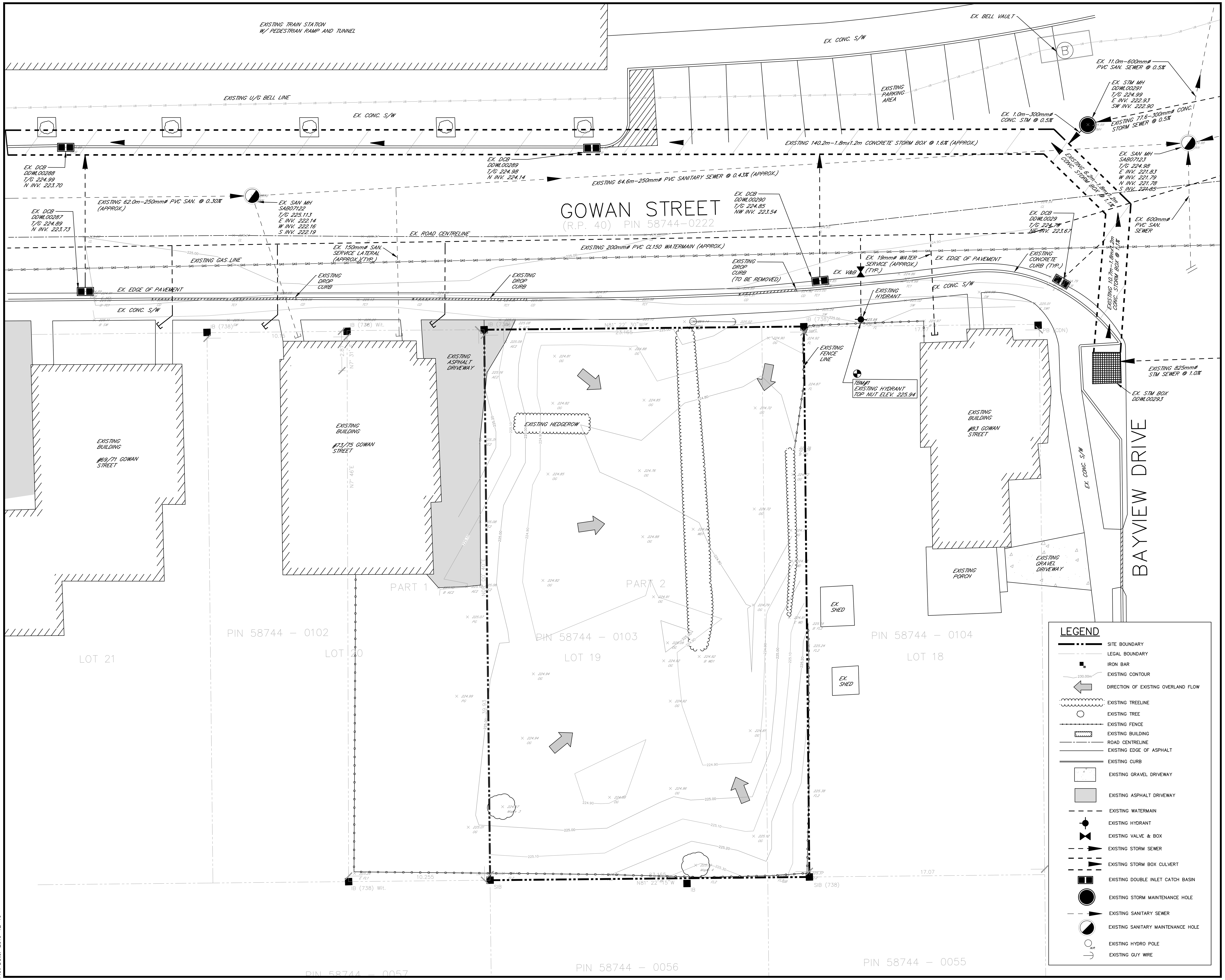
20 Bell Farm Road, Unit 1, Barrie, ON, L4M 6E4
jvoisin@pel.ca | PEL.ca

T: 705-641-8301
F: 705-645-7262

APPENDIX D

Concept Engineering Drawings

PEL
PINESTONE ENGINEERING LTD.



Filename: R:\BARRIE ACAD FILES\19-11478 79 GOWAN STREET\01-CIVIL\SHEETS\19-11478 EX-1.DWG
Plot Date: 2019-12-16

PINESTONE ENGINEERING LIMITED | www.pel.ca

The position of existing above ground and underground utilities and facilities are not necessarily shown on the drawings, and where shown, the accuracy of the position of such utilities and facilities is not guaranteed. Before starting work, the contractor shall confirm the exact location of all existing utilities and facilities, and shall assume all liability for damage to them

Drawings shall not be used for construction unless sealed and signed. All work to be performed in accordance with the Occupational Health & Safety Act 1990.

Any errors and/or omissions shall be reported to Pinestone Engineering Ltd. without delay.

KEY MAP 1:5000

NOTES

1. TOPOGRAPHIC SURVEY COMPLETED BY PINESTONE ENGINEERING LTD. USING CITY OF BARRIE HORIZONTAL AND VERTICAL CONTROL MONUMENTS, NOV. 2019
2. LEGAL SURVEY PROVIDED BY PETER J. MANSFIELD, O.L.S., SEPT. 2014, AND IS APRROXIMATE

BENCHMARK

TBM#1 EXISTING HYDRANT LOCATED NORTH EAST OF SITE BOUNDARY, TOP OF NUT ELEV. 225.94

NO.	YY.MM.DD	REVISION	BY

SEAL

NORTH ARROW

DESIGN BY:	J.V.
DRAWN BY:	A.L.
CHECKED BY:	J.V.
DATE:	Dec. 11, 2019
SCALE:	1:125

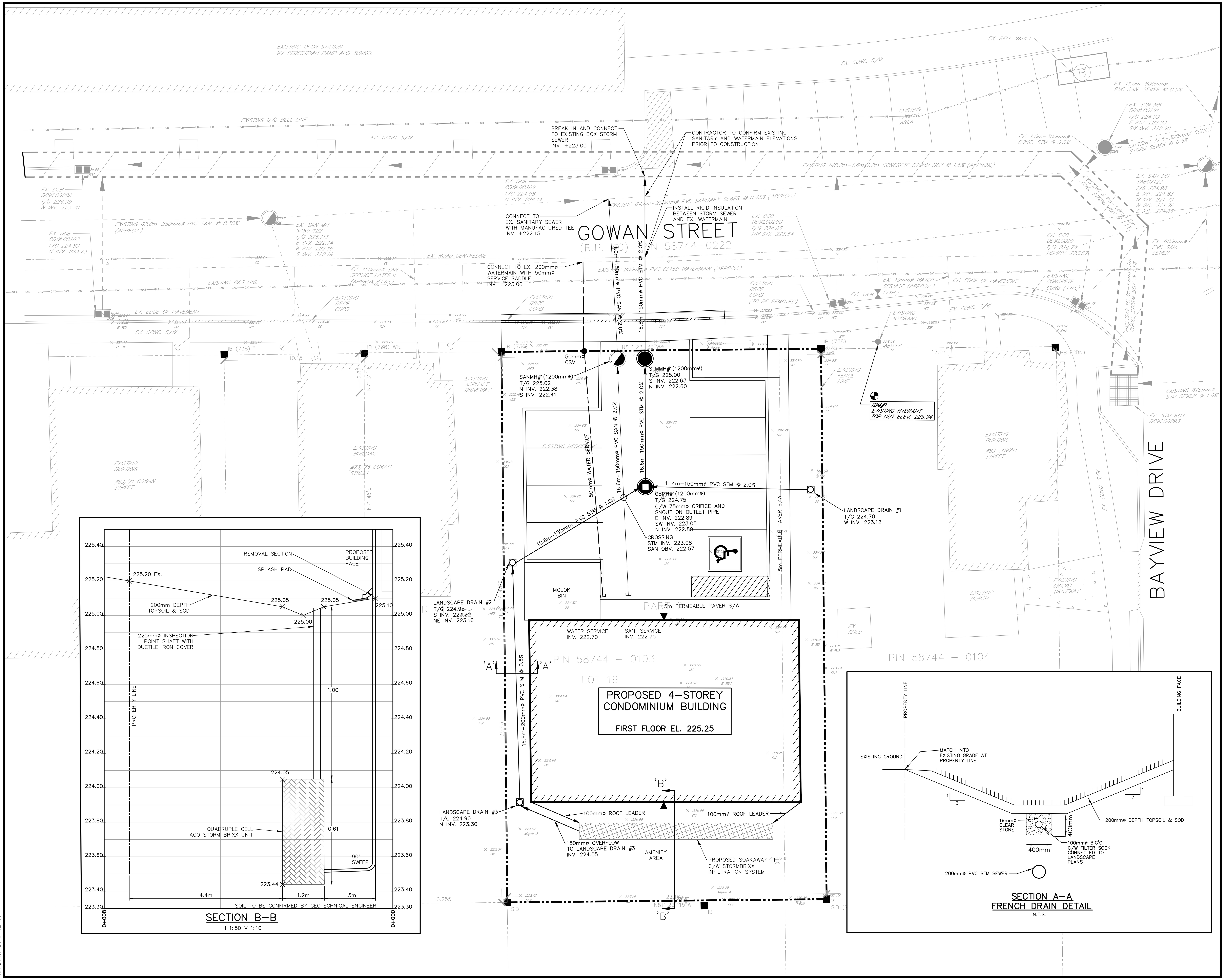
CLIENT/PROJECT

79 GOWAN STREET
4-STOREY RESIDENTIAL DEVELOPMENT
CITY OF BARRIE

DRAWING TITLE

EXISTING CONDITIONS

PROJECT NO.	DRAWING NO.	REVISION
19-11478	EX-1	0



PEL
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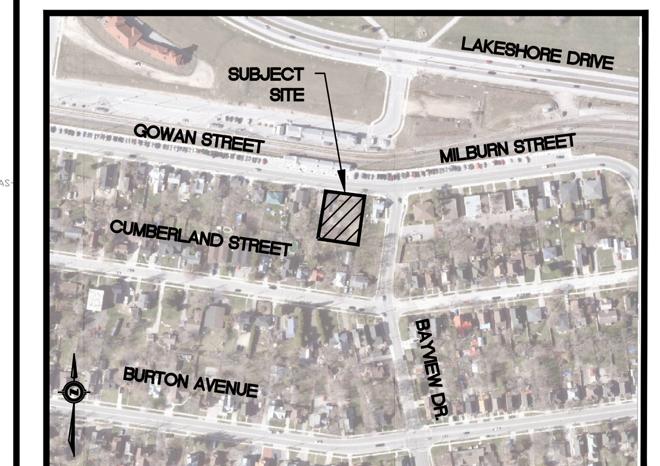

KEY MAP 1:5000

NOTES

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2. LEGAL SURVEY PROVIDED BY PETER J. MANSFIELD, O.L.S., SEPT. 2014, AND IS APPROXIMATE

LEGEND

- SITE BOUNDARY
- LEGAL BOUNDARY
- PROPOSED LANDSCAPE DRAIN
- PROPOSED STORM SEWER
- PROPOSED STORM MAINTENANCE HOLE
- PROPOSED CATCH BASIN MAINTENANCE HOLE
- PROPOSED SANITARY MANHOLE
- PROPOSED SANITARY SEWER
- PROPOSED 50mmø WATER SERVICE

BENCHMARK

TBM#1 EXISTING HYDRANT LOCATED NORTH EAST OF SITE BOUNDARY, TOP OF NUT ELEV. 225.94

NO.	YY.MM.DD	REVISION	BY

SEAL

NORTH ARROW

DESIGN BY:	J.V.
DRAWN BY:	A.L.
CHECKED BY:	J.V.
DATE:	Dec. 16, 2019
SCALE:	1:125

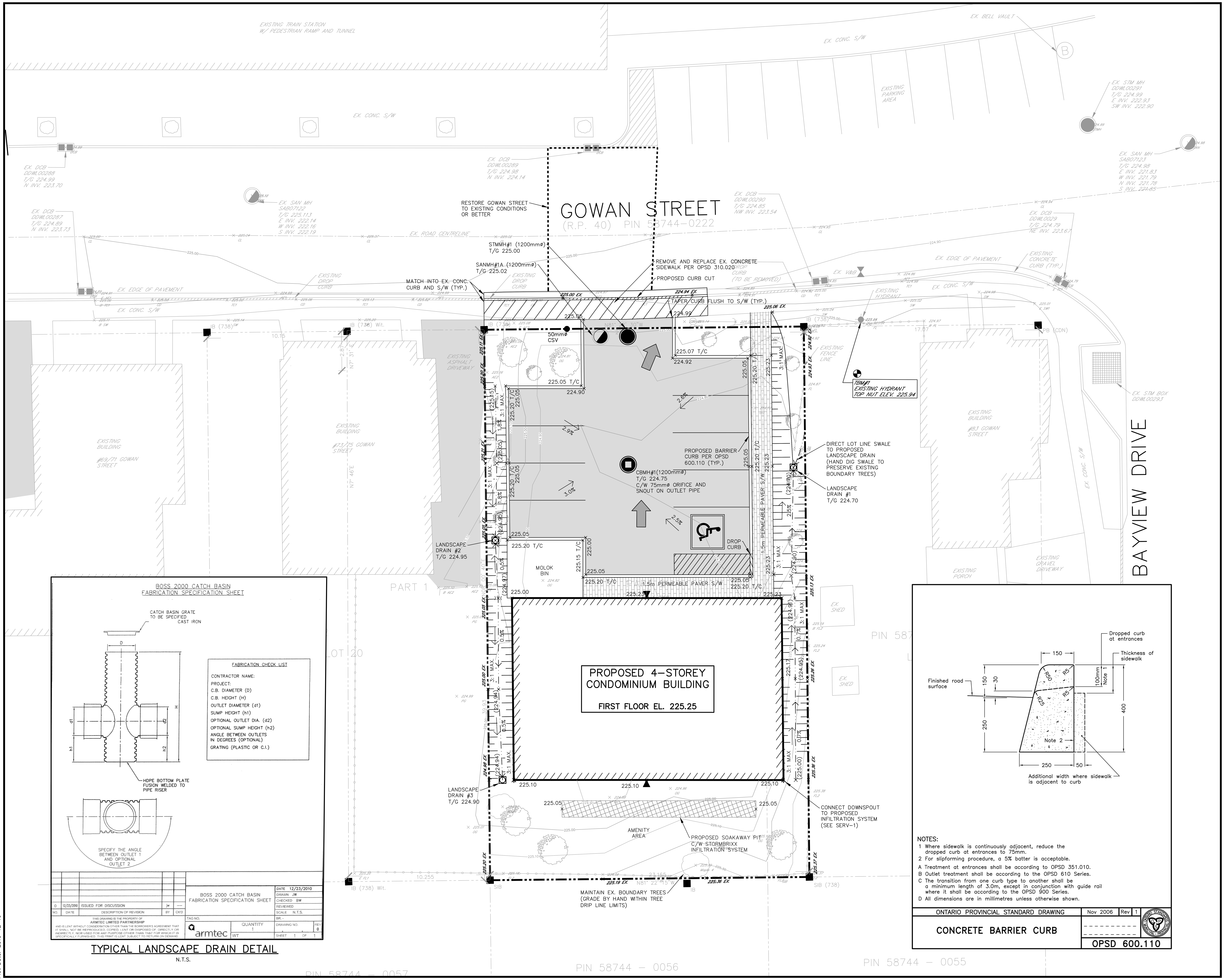
CLIENT/PROJECT

79 GOWAN STREET
4-STOREY RESIDENTIAL DEVELOPMENT
CITY OF BARRIE

DRAWING TITLE

SITE SERVICING PLAN

PROJECT NO.	DRAWING NO.	REVISION
19-11478	SERV-1	0



PINESTONE ENGINEERING LIMITED | www.pel.ca

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KEY MAP 1:5000

NOTES

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2. LEGAL SURVEY PROVIDED BY PETER J. MANSFIELD, O.L.S., SEPT. 2014, AND IS APRROXIMATE

LEGEND

SITE BOUNDARY
LEGAL BOUNDARY
× 247.75 PROPOSED ELEVATION POINT
× 247.90 T/C PROPOSED TOP OF CURB ELEVATION
× (300.00) PROPOSED DITCH ELEVATION
230.00m EXISTING CONTOUR
DIRECTION OF MAJOR OVERLAND FLOW
0.00% PROPOSED GRADE
PROPOSED EMBANKMENT
PROPOSED SWALE
PROPOSED CATCH BASIN MAINTENANCE HOLE
PROPOSED LANDSCAPE DRAIN
PROPOSED STORM MAINTENANCE HOLE
PROPOSED SANITARY MAINTENANCE HOLE
PROPOSED ASPHALT PAVEMENT
PROPOSED ROOF LEADER DOWNSPOUT

BENCHMARK

TBM#1 EXISTING HYDRANT LOCATED NORTH EAST OF SITE BOUNDARY, TOP OF NUT ELEV. 225.94

NO.	YY.MM.DD	REVISION	BY

SEAL

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DESIGN BY:	J.V.
DRAWN BY:	A.L.
CHECKED BY:	J.V.
DATE:	Dec. 16, 2019
SCALE:	1:125

CLIENT/PROJECT

79 GOWAN STREET
4-STOREY RESIDENTIAL DEVELOPMENT
CITY OF BARRIE

DRAWING TITLE

SITE GRADING PLAN

PROJECT NO.	DRAWING NO.	REVISION
19-11478	GP-1	0

Filename: R:\BARRIE ACAD FILES\19-11478 79 GOWAN STREET\01-CIVIL\SHEETS\19-11478 GP-1.DWG
Plot Date: 2019-12-16