CHUNG & VANDER DOELEN
ENGINEERING LTD.

311 VICTORIA STREET NORTH
KITCHENER / ONTARIO / N2H 5E1
519-742-8979

February 19, 2022
File No.: H22197

180 Groh Cambridge Limited
Attention: Mr. Steve Charest

Dear Mr. Charest:

Re: Chloride Impact Assessment
180 Groh Ave Development, Cambridge ON

This report presents a Chloride Impact Assessment for the proposed townhouse development at 180 Groh Avenue in Cambridge, Ontario. This assessment has been required as a planning approval condition from the Region of Waterloo since the development property is located within a wellhead protection area for drinking water supply that includes an "Issue Contributing Area" for chloride.

1.0 Background

The subject development proposal is supported by the following previous reports that have been submitted to the Region for review and are used for background information in this current assessment:

- A geotechnical investigation report (Geopro Consulting, February 21, 2017)
- A hydrogeological site assessment report (Geopro Consulting, April 18, 2017)
- Functional Servicing and Stormwater Management report (IBI Group, November 2021)

Reference to the above reports is required for a full description of the site subsurface geological and hydrogeological conditions as well as a full description of the development proposal. The information from these reports is not reiterated here.

2.0 Pre & Post Development Groundwater Recharge

The SWM report provides pervious and impervious areas for the pre- and post-development conditions at the 4.514-ha (45,140 m^2) property. These areas are used along with some basic hydrogeological assumptions regarding groundwater recharge rates (i.e., based on soil type, vegetation cover, and slope conditions) to calculated pre- and post-development groundwater recharge amounts.

<u>Pre-Development</u>

Impervious Area = 36.3% (16,386 m^2)
Pervious Area (PA) = 63.7% (28,754 m^2)
Annual Groundwater Recharge Rate (RR) = 0.2 m/yr
(based on sand/silt fill soil, mix grass/tree cover, and modest slope)
Annual Recharge from Pervious Areas = PA x RR = **5,751 m^3/y**

<u>Post-Development</u>

Impervious Area = 62.1% (28,032 m^2)
- Roof-Top Area (RTA) = 6,800 m^2
- Parking Area = 15,700 m^2
- Other Impervious Area = 5,532 m^2

Pervious Area (PA) = 37.9% (17,108 m^2)
Annual Groundwater Recharge Rate (RR) = 0.2 m/yr
(based on sand/silt fill soil, grass cover, and modest slopes)
Annual Recharge from Pervious Areas = PA x RR = **3,422 m^3/yr**
Enhanced Recharge Rate (ERR) = 0.75 m/yr
(up to 25-mm storm events, which is about 85% of annual precipitation)
Annual Recharge from Rooftop Galleries = RTA x ERR = **5,100 m^3/yr**
Total Annual Recharge = 3,422 + 5,100 = **8,522 m^3/yr**

Without any enhanced recharge facilities, the post-development groundwater recharge rate for the development would be <u>reduced</u> to about 60% of the pre-development amount, based on the increased imperviousness cover of the developed lands (i.e., reduced from 5,751 to 3,422 m^3/yr). However, with inclusion of roof-top infiltration galleries throughout the development (in boulevards and/or beneath parking areas), to provide enhanced groundwater recharge of all storm events up to the 25-mm event, the total annual recharge at the property will <u>increase</u> by about 48% (i.e., increased from 5,751 to 8,522 m^3/yr). This increased groundwater recharge will not only benefit groundwater flow systems, but it will also be an important way to reduce the potential impacts of salt.

3.0 Chloride Impact Assessment

This chloride impact assessment and associated calculations follow the Region of Waterloo 'draft' 2013 guideline in this regard. It is the Region's intent that the future chloride loading to groundwater from proposed developments be predicted, so that measures (specifically, enhanced clean-water recharge and salt management plans) will be proposed to reduce the potential impact to groundwater resources that are used for water supply. The Ontario Drinking Water Standard (ODWS) for chloride is 250 mg/L and a <u>conservative</u> objective to protect groundwater is the Reasonable Use Policy, which specifies that the maximum concentration of chloride would be the background concentration plus 50% the ODWS.

All baseline hydrogeological information required in the draft guideline (i.e., borehole logs, cross-sections, water table contours, background chloride concentrations, etc.) are provided in the 2017 Hydrogeological Assessment report.

Water table monitoring well BH4, located in the approximate centre of the property, was sampled by Geopro and the chloride concentration was 15 mg/L. This is considered a reasonable indicator of the background chloride concentration beneath the property. Based on this background concentration and the ODWS, the Reasonable Use maximum objective would be approximately 140 mg/L chloride for this property.

Table 1 summarizes the salt loading calculations for the subject development based on the assumptions cited in the Guideline, the planned parking lot / driveway area, and the annual post-development groundwater recharge volume calculated in Section 2.0. As indicated, the 'worst-case' calculated resultant chloride concentration in the groundwater recharge is **1169 mg/L**, assuming the salt usage and "loss" to groundwater cited in the Region's guideline (15 tonnes/yr/ha of parking lot and an assumed "loss" of 28% to groundwater).

With the proposed roof-top 'enhanced' groundwater recharge described above, the worst-case chloride concentration would be significantly reduced to about **469 mg/L**. It is important to recognize that groundwater cross-flow has not been included in the calculation. Given the background concentration of 15 mg/L, it is very likely that the average chloride concentration leaving the property would be less than this calculated value.

4.0 Recommendation for Salt Management

The Region has also required that a Salt Management Plan (SMP) be submitted during the final design stage of the development approval. There are many best management practices (BMPs) that can be incorporated into the SMP by the condominium corporation to significantly reduce the salt use at the property (e.g., use of alternative low-chloride salt products, require snow-removal contractors to clean-up and re-use residual salt, require snow-removal contractors to practice judicious placement of snow piles on paved areas vs. pervious areas, etc.).

As indicated in Table 1, with incorporation of the enhanced recharge measures described in this report and with development of an effective SMP, the salt usage can be further reduced and in doing so can achieve the Reasonable-Use maximum concentration objective of **140 mg/L** that is desired by the Region.

Respectfully submitted,
CHUNG & VANDER DOELEN ENGINEERING LTD.

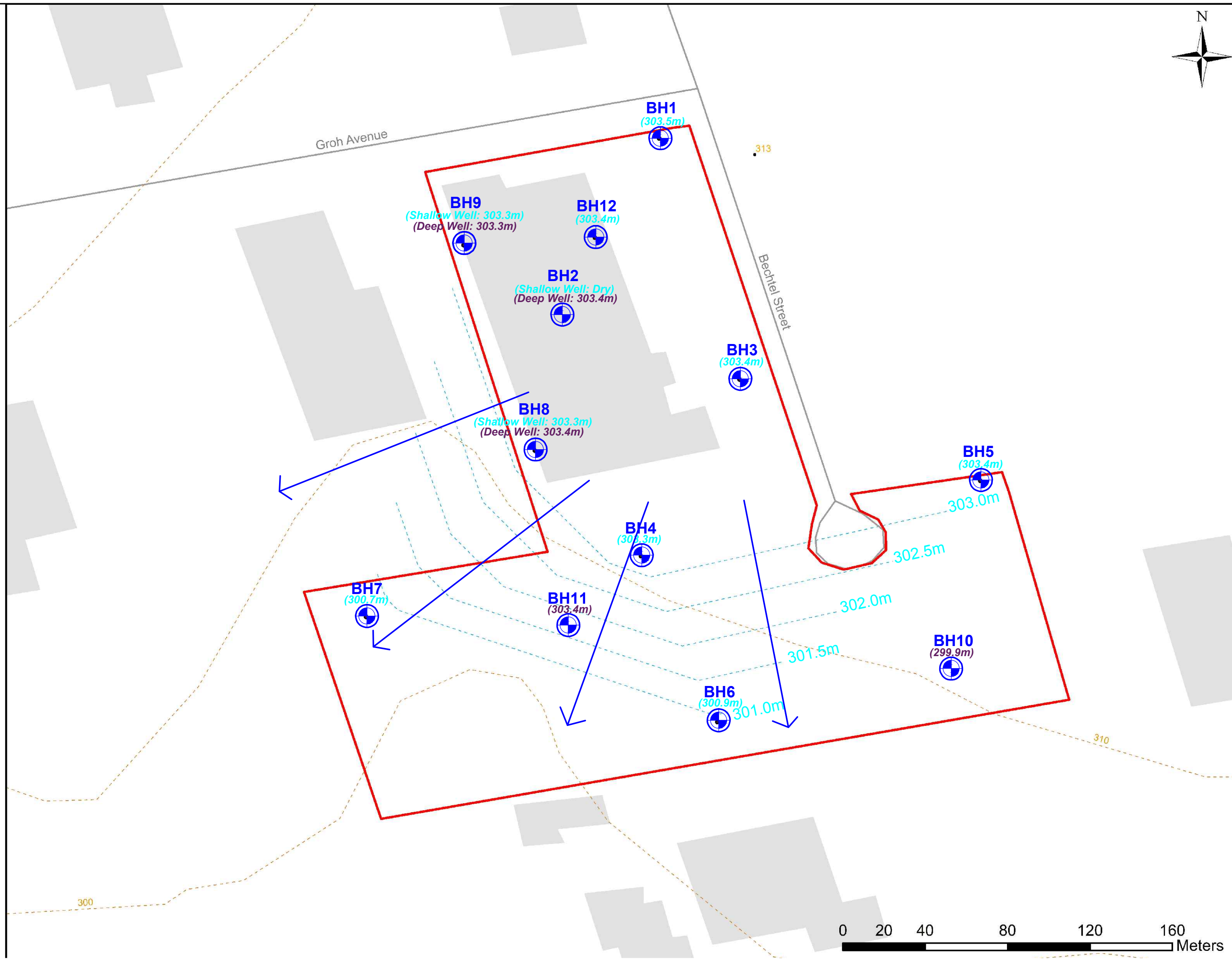
William (Sandy) Anderson, M.Sc., P.Eng.
Senior Hydrogeologist and Engineer

Table 1 - Summary of Post-Development Salt Loading

CVD Project H22197
February 19, 2022

Salt Loading Scenario	Annual Salt Loading Rate (Parking Lots - tonnes/ha)	Parking Lot Area (ha)	Annual Salt Total Mass Applied (tonnes/yr)	Annual **Salt** Mass Infiltrating (28% of Total) (tonnes/yr)	Annual **Chloride** Mass Infiltrating (60.6% of Salt) (tonnes/yr)	Resultant Chloride Concentration (mg/L)
Region's Parking Lot Loading (only pervious area infilration)	15.0	1.57	23.6	6.6	4.0	**1169**
Region's Parking Lot Loading & Enhanced Infiltration (Note 1)	15.0	1.57	23.6	6.6	4.0	**469**
SMP Objective Loading & Enhanced Infiltration (Note 2)	4.5	1.57	7.1	2.0	1.2	**141**

Notes:
1) Loading Rate from Region of Waterloo, Salt Impact Assessment Guidelines (2013)
2) Reduced Loading Rate Objective with Salt Management Plan (SMP)
3) 1 tonne (1000 kg) of NaCl (Salt) contains 393.4 kg Sodium and 606.6 kg Chloride (i.e., chloride is 60.6 % of salt mass)
4) Total Site Annual Recharge Volume (Pervious Recharge + Enhanced Recharge) = Pervious 3,422.0 m3/yr | Enhanced 5,100.0 m3/yr | Total 8,522.0 m3/yr
5) Reasonable Use Limit (RUL) for Chloride assuming Background Concentration is 15 mg/L (BH4 sample) and Ontario Drinking Water Standard (ODWS) is 250 mg/L
RUL = Background + 0.5 (ODWS) = 140 mg/L



Legend:

Monitoring Well Location

77.0 m Shallow Groundwater Elevation Contour

(300.9 m) Groundwater Elevation (m) in Shallow Well Dated Mar. 15, 2017

(299.9 m) Groundwater Elevation (m) in Deep Well Dated Mar. 15, 2017

Inferred Shallow Groundwater Flow Direction

Client: **JD Development Group**		Project No.: **17-1764H**	Drawing No.: **6**
Drawn: **KY**	Approved: **BG**	Title: **Shallow Groundwater Elevation Contour and Inferred Shallow Groundwater Flow Direction**	
Date: **April 2017**	Scale: **As shown**	Project: **Preliminary Hydrogeological Site Assessment Proposed Townhouse and Apartment Building Development 180 Groh Avenue, Cambridge, Ontario**	
Original Size: **Letter**	Rev: **BG**	GeoPro Consulting Limited	

LOG OF BOREHOLE BH4

PROJECT: Geotechnical Investigation for Proposed Development
CLIENT: JD Development Group
PROJECT LOCATION: 180 Groh Avenue, Cambridge, Ontario
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan N 4807552.216 E 555066.227

DRILLING DATA
Method: Continuous Flight Auger- Auto Hammer
Diameter: 205 mm
Date: Feb/03/2017

REF. NO.: 17-1764G
ENCL NO.: 5

(m) ELEV DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION
309.1						
309.0	**TOPSOIL:** (150 mm)				Concrete	
0.2	**FILL:** sandy silt, to silty sand, trace clay, trace gravel, containing asphalt pieces, trace organics, brown, moist, loose to compact	1	SS	15		
		2	SS	6		308
	--layer of organic silt	3	SS	8		
306.9 / 2.2	**PEAT:** trace sand, trace gravel, some silt, trace rootlets, containing wood fragments, black, moist, loose	4	SS	10	Bentonite	307
306.2 / 3.0	**SANDY SILT:** trace clay, trace gravel, trace organic, brown to dark brown, moist, loose to dense	5	SS	5		306
	---containing cobbles and boulders, brown, wet, compact to dense	6	SS	14		305 / 304
		7	SS	41	W. L. 303.0 m Feb 17, 2017; Sand; Screen	303
302.0 / 7.2	**SAND:** trace to some gravel, trace silt, brown, wet, very dense	8	SS	80	Natural Pack	302 / 301
300.9 / 8.2	**END OF BOREHOLE**					

Notes
1) Water encountered at 7.6 m below the existing ground surface (mBGS) during drilling.
2) 51 mm dia. monitoring well was installed in borehole upon completion of drilling

Water Level Readings

Date	W. L. Depth (mBGS)
2017/02/17	6.08

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH (kPa): ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100
PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L; WATER CONTENT (%): 10 20 30
POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m^3)
REMARKS AND GRAIN SIZE DISTRIBUTION (%): GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

GeoPro Consulting Limited (Richmond Hill)
ATTN: BuJing Guan
40 Vogell Road
Unit 57
Richmond Hill ON L4B 3N6

Date Received: 16-MAR-17
Report Date: 23-MAR-17 14:59 (MT)
Version: FINAL

Client Phone: 905-237-8336

Certificate of Analysis

Lab Work Order #: L1902043

Project P.O. #: NOT SUBMITTED
Job Reference: 17-1764H
C of C Numbers: 15-575193
Legal Site Desc: 180 Groh Avenue Cambridge Ontario

Emerson Omar Perez

Emerson Perez, B.S.E
Account Manager

ANALYTICAL GUIDELINE REPORT

Sample Details Grouping	Analyte	Result	Qualifier	D.L.	Units	Analyzed	Guideline Limits #1	#2
L1902043-1	BH4							
Sampled By:	Willsun on 15-MAR-17 @ 11:30							
Matrix:	Ground Water							
Physical Tests								
	pH	7.03		0.10	pH units	18-MAR-17	5.5-9.5	6-9
	Total Suspended Solids	11.0		2.0	mg/L	22-MAR-17	350	15
Anions and Nutrients								
	Chloride (Cl)	15.4		0.50	mg/L	17-MAR-17	1500	
	Fluoride (F)	0.044		0.020	mg/L	17-MAR-17	10	
	Total Kjeldahl Nitrogen	3.22		0.15	mg/L	17-MAR-17	100	
	Phosphorus, Total	0.0177		0.0030	mg/L	20-MAR-17	10	
	Sulfate (SO4)	12.1		0.30	mg/L	17-MAR-17	1500	
Cyanides								
	Cyanide, Total	<0.0020		0.0020	mg/L	20-MAR-17	2	
Bacteriological Tests								
	Fecal Coliforms	0		0	CFU/100mL	18-MAR-17		200
Total Metals								
	Aluminum (Al)-Total	0.549		0.010	mg/L	17-MAR-17	50	
	Antimony (Sb)-Total	0.00024		0.00010	mg/L	17-MAR-17	5	
	Arsenic (As)-Total	0.00172		0.00010	mg/L	17-MAR-17	1	
	Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	17-MAR-17	5	
	Cadmium (Cd)-Total	0.000063		0.000010	mg/L	17-MAR-17	0.5	0.05
	Chromium (Cr)-Total	0.00176		0.00050	mg/L	17-MAR-17	5	0.2
	Cobalt (Co)-Total	0.0106		0.00010	mg/L	17-MAR-17	5	
	Copper (Cu)-Total	0.0039		0.0010	mg/L	17-MAR-17	3	1
	Iron (Fe)-Total	0.535		0.050	mg/L	17-MAR-17	50	
	Lead (Pb)-Total	0.00114		0.00010	mg/L	17-MAR-17	5	0.05
	Manganese (Mn)-Total	2.46	DLHC	0.0050	mg/L	17-MAR-17	5	
	Mercury (Hg)-Total	<0.000010		0.000010	mg/L	17-MAR-17	0.1	0.001
	Molybdenum (Mo)-Total	0.00295		0.000050	mg/L	17-MAR-17	5	
	Nickel (Ni)-Total	0.0151		0.00050	mg/L	17-MAR-17	3	0.5
	Selenium (Se)-Total	0.000228		0.000050	mg/L	17-MAR-17	5	
	Silver (Ag)-Total	<0.000050		0.000050	mg/L	17-MAR-17	2	
	Tin (Sn)-Total	0.00015		0.00010	mg/L	17-MAR-17	5	
	Titanium (Ti)-Total	0.0227		0.00030	mg/L	17-MAR-17	5	
	Vanadium (V)-Total	0.00143		0.00050	mg/L	17-MAR-17	5	
	Zinc (Zn)-Total	0.0216		0.0030	mg/L	17-MAR-17	3	0.5
Aggregate Organics								
	BOD Carbonaceous	<2.0		2.0	mg/L	22-MAR-17	300	
	Oil and Grease, Total	<2.0		2.0	mg/L	20-MAR-17		
	Animal/Veg Oil & Grease	<2.0		2.0	mg/L	22-MAR-17	100	
	Mineral Oil and Grease	<1.0		1.0	mg/L	20-MAR-17	15	
	Phenols (4AAP)	0.0023		0.0010	mg/L	20-MAR-17	1	

** Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
* Analytical result for this parameter exceeds Guideline Limit listed on this report. Guideline Limits applied:

Ontario Region of Waterloo Sanitary and Storm Sewer Bylaw #50-92 (MAY,1992) = [Suite] - Waterloo Sanitary and Storm Sewer Bylaw

#1: Region of Waterloo Sanitary Sewer ByLaw **#2: Region of Waterloo Storm Sewer ByLaw**

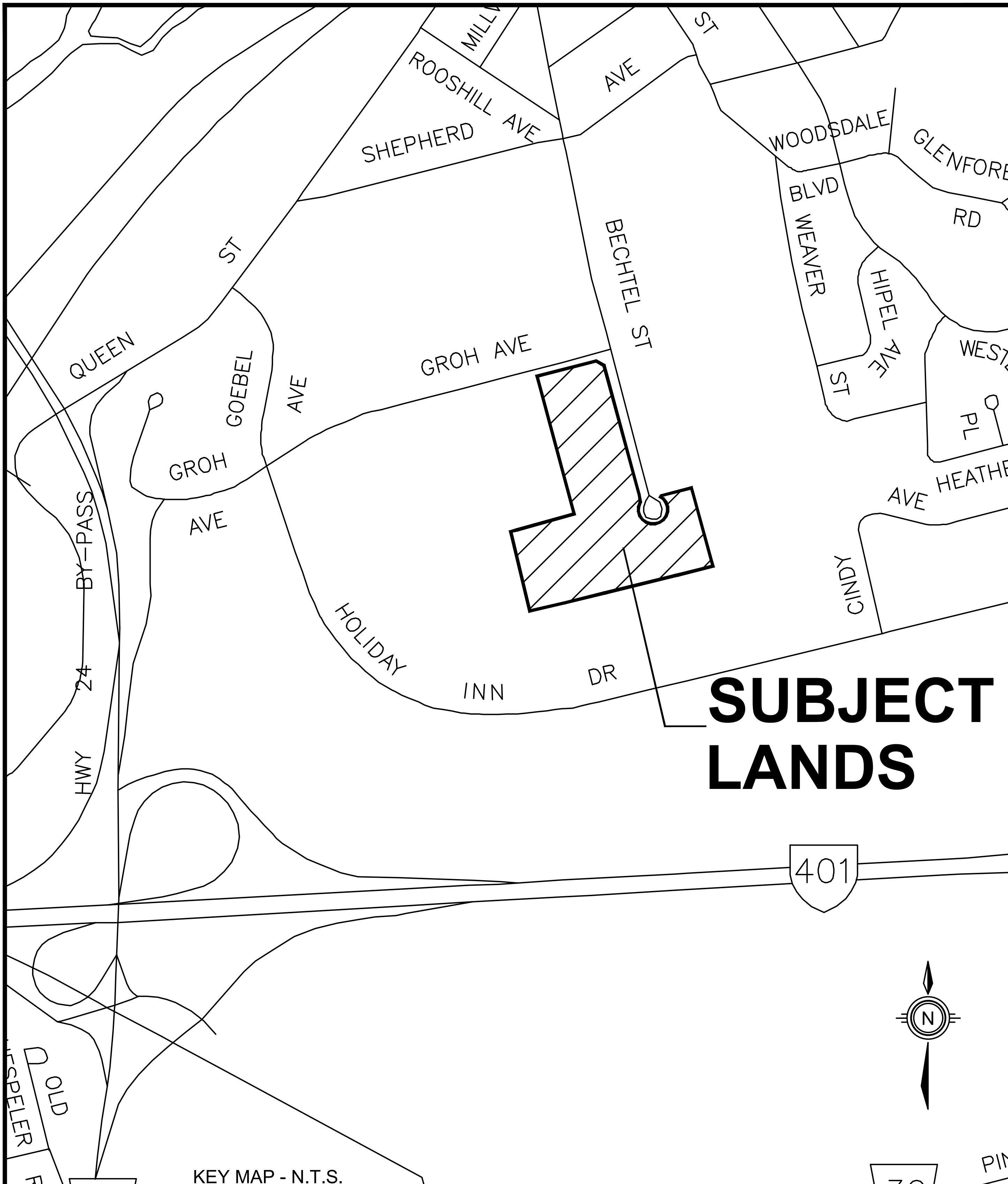


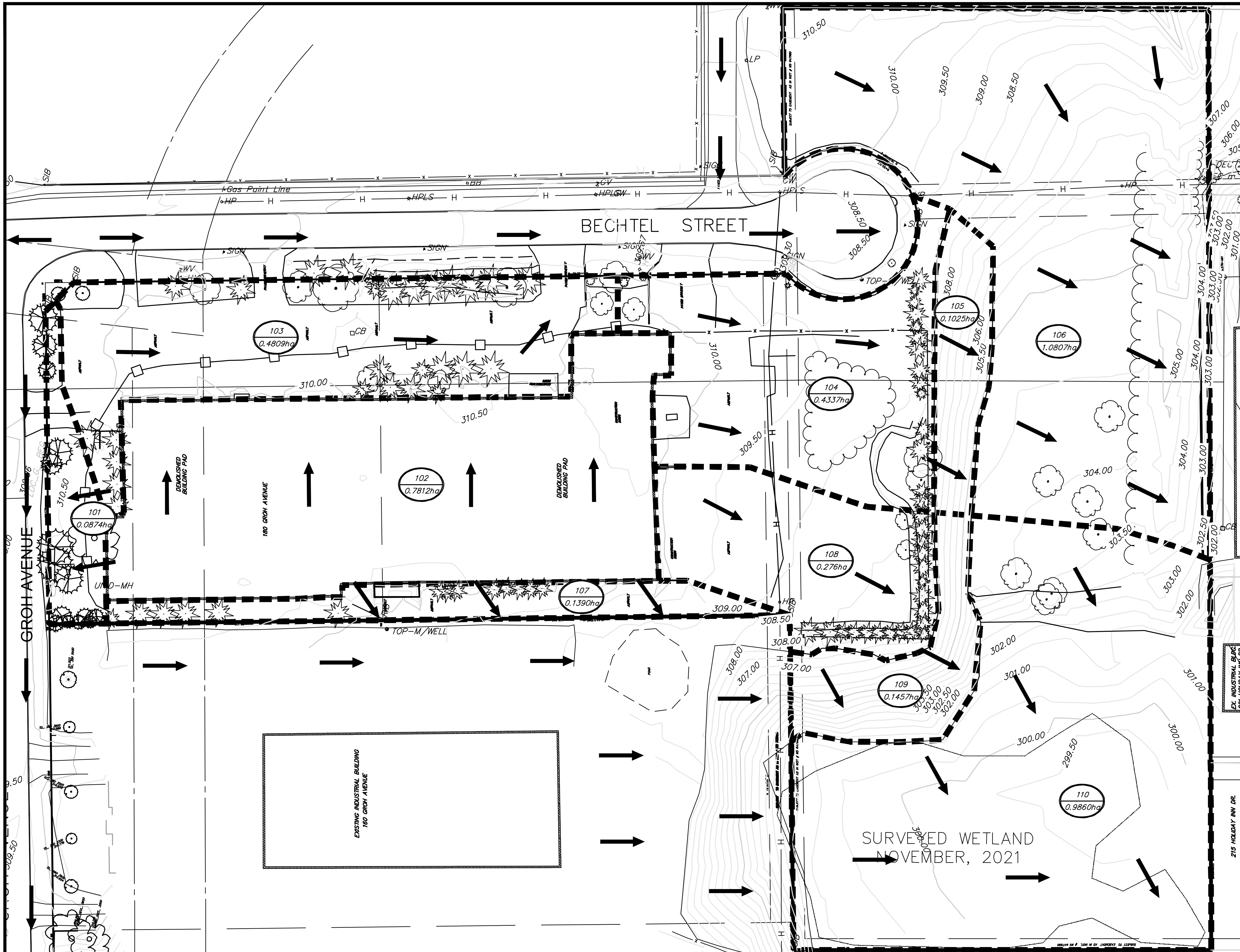
FIGURE 1
SITE LOCATION

180 GROH AVENUE
CITY OF CAMBRIDGE

SCALE	NTS
DATE	OCT 2021
PROJECT No.	121913

IBI

IBI GROUP
101 - 410 Albert Street
Waterloo ON N2L 3V3 Canada
tel 519 585 2255
ibigroup.com



15 0 10 20 40
1:1000 (m)

LEGEND

EXISTING CATCHMENT BOUNDARIES

DRANIAGE ARROWS

EX. CATCHMENT SYMBOL
CATCHMENT AREA NUMBER
AREA (ha)

101
0.0359ha

IBI GROUP
101 - 410 Albert Street
Waterloo ON N2L 3V3 Canada
tel 519 585 2255
ibigroup.com

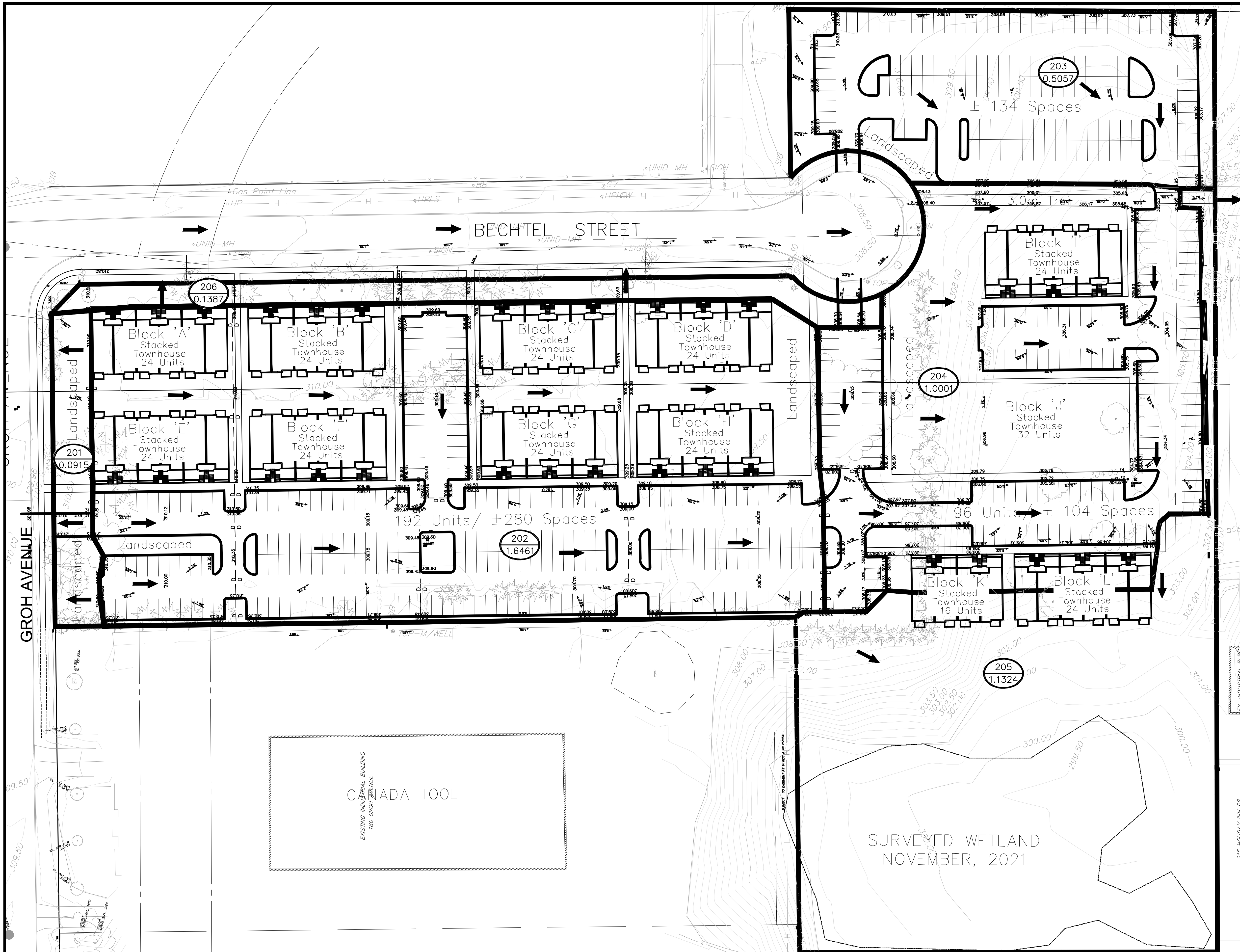
SCALE	1:1000
DATE	NOVEMBER 2021
PROJECT No.	121913

CITY OF CAMBRIDGE
REGIONAL MUNICIPALITY
OF WATERLOO

180 GROH AVENUE
RESIDENTIAL DEVELOPMENT

EXISTING STORM
CATCHMENT AREAS

FIGURE 2



CONSTRUCTION NORTH

15 0 10 20 40
1:1000 (m)

LEGEND

PROPOSED CATCHMENT BOUNDARIES

DRAINAGE ARROWS

PROP. CATCHMENT SYMBOL
201 — CATCHMENT AREA NUMBER
0.0563 — AREA (ha)

IBI
IBI GROUP
101 - 410 Albert Street
Waterloo ON N2L 3V3 Canada
tel 519 585 2255
ibigroup.com

SCALE	1:1000
DATE	NOVEMBER 2021
PROJECT No.	105931

CITY OF CAMBRIDGE
REGIONAL MUNICIPALITY
OF WATERLOO

180 GROH AVENUE
RESIDENTIAL DEVELOPMENT

PROPOSED STORM
CATCHMENT AREAS

FIGURE 3