WETLAND WATER BALANCE RISK ASSESSMENT

BOLTON NORTH HILL
OPTION 1 & OPTION 2 LANDS

TOWN OF CALEDON
REGION OF PEEL

PREPARED FOR:

BOLTON NORTH HILL LANDOWNERS GROUP

PREPARED BY:

C.F. CROZIER & ASSOCIATES INC.
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APRIL 2022

CFCA FILE NO. 708-3446

CROZIER
CONSULTING ENGINEERS

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1.0 INTRODUCTION

C.F. Crozier & Associates Inc. (Crozier) was retained by the Bolton North Hill Landowners Group (BNHLG) to prepare a Wetland Water Balance Risk Evaluation. Crozier will address comments received from Town of Caledon via email dated February 7, 2022, in accordance with the Toronto and Region Conservation Authority (TRCA) guidelines.

The Bolton North Hill study area is generally located north of Columbia Way, in the vicinity of Regional Road 50 within the Town of Bolton.

The following feature-based risk assessment pertains to the Option 1 and Option 2 Lands, herein referred to as the Subject Lands, which are part of six (6) parcels of potential development areas around the existing community of Bolton (Options 1 to 6).

Please refer to Figure 1 for a site location plan and landowner boundaries.

Per the TRCA Wetland Water Balance Risk Evaluation guide (November 2017), there are four (4) steps in evaluating wetland water balance risk, as follows:

- Step 1: Determine which retained wetland(s) may be impacted
- Step 2: Determine the magnitude of potential hydrological change
- Step 3: Determine the sensitivity of the wetland
- Step 4: Risk characterization

In preparing this letter, the following background documents were referenced and reviewed:

- Concept Plan prepared by Bousfields Inc. (December 20, 2021)
- Wetland Water Balance Risk Evaluation Guide prepared by TRCA (November 2017)
- Town of Caledon Zoning By-Law (July 2018)
- Housing Statistics, Statistics Canada (December 2021)
- Groundwater by Freeze and Cherry (1979)
- Secondary Plan Natural Heritage Study Report prepared by Dillion Consulting Ltd. (December 2021)
- Hydrogeological Investigation prepared by C.F. Crozier & Associates Inc. (April 2022)

The following sections (1.1 to 1.4) outline each of the steps undertaken to assess the risk associated with the proposed development on the wetland communities in the Bolton North Hill study area.

1.1 Determine which Retained Wetland(s) may be Impacted

Dillon Consulting has been retained by the Bolton North Hill Landowners Group to prepare a Secondary Plan Natural Heritage Study Report (December 2021) for the Subject Lands.

Based on the findings of the Natural Heritage Report, Dillon identified a total of 12 wetlands in the vicinity of the Site, which may be impacted by the proposed development. Each of these 12 wetlands was assigned a unique identifier (A, B, C, etc.) as shown on Figure 2 – Wetland Communities, enclosed with this letter.

A summary of the wetlands, their respective areas, and Ecological Land Classifications communities is provided in Table 1.

Table 1: Wetland Summary

Wetland ID	ELC Community	Area (ha)
A	MAM: Meadow Marsh	0.83
B	SWD: Deciduous Swamp	0.76
C	SWD: Deciduous Swamp	0.54
D	MAM: Meadow Marsh	0.91
E	MAM: Meadow Marsh	0.16
F	MAM: Meadow Marsh	0.15
G	MAMM1: Graminoid Mineral Meadow Marsh	0.27
H	MAMM1: Graminoid Mineral Meadow Marsh	0.17
I	OAO: Open Aquatic	0.49
J	MAMM1: Graminoid Mineral Meadow Marsh	0.29
K	MAMM1: Graminoid Mineral Meadow Marsh	0.47
L	OAO: Open Aquatic	0.75

1.2 Determine the Magnitude of Potential Hydrological Change

Surface Water

Based on the existing topography, the pre-development catchment areas to each of the 12 wetlands was delineated by Crozier. The total development area tributary to each wetland and the total area owned by the proponent was outlined as part of the risk evaluation process.

Precent imperviousness was assigned to each catchment area based on the proposed Concept Plan (Bousfields, 2021). Impervious scores were then calculated for each wetland using Equation 1 from the Wetland Water Balance Risk Evaluation guide (TRCA, November 2017).

$$S = \frac{IC(C_{dev})}{C}$$

Where: S = Impervious Cover Score

IC = Proportion of Impervious Cover within the Proponent's Holdings (%)

C_{dev} = Total Development Area of the Catchment (ha)

C = Size of the Wetland's Catchment (ha)

In addition to the impervious score calculations, the proposed increase or decrease to catchment size post development was assessed. The impervious cover score and increase/decrease in catchment size and the resulting sensitivity of the wetland is summarized in Table 2. Figures 3 and 4, showing the pre- and post-development drainage areas, are provided as an attachment to this report. Detailed calculations are provided in Appendix A.

Groundwater

To determine the potential sensitivity to water taking, construction dewatering volumes were estimated for the proposed developments within 500 m of each wetland. At the time of preparation of this assessment, the proposed development was at the conceptual stage of Site Plan Development.

Therefore, details such as finished floor elevations or excavation depths were unknown in preparing this memo and several assumptions were made in calculating the proposed water taking. The assumptions are summarized in Appendix A.

Construction dewatering rates were estimated using the DuPuy equation as described in Construction Dewatering and Groundwater Control: New Methods and Applications by Powers et al. 2007.

The Dupuit equation assumed a steady linear flow from all four sides of an excavation and is described by the following equation:

$$Q_w = \frac{\pi K(H^2 - h_w^2)}{ln\frac{R_0}{r_w}}$$

Where:

Q_w = discharge rate in m^3/s

K = hydraulic conductivity in m/s

H = static groundwater elevation in masl

h_w = head above base of the excavation at maximum dewatering in masl

R_0 = radius of influence of point source from the centre of excavation in m

r_w = equivalent radius of the well in m

The estimated construction dewatering rates within 500 m of each wetland ranged from approximately 150,000 L/day to 94,000 L/day considering a safety factor of 2 to account for heterogeneity of the soils and precipitation during construction. A risk level was assigned for each wetland based on total anticipated water taking volumes and anticipated duration of the water taking activity. Results are summarized in Table 2. Detailed calculations are enclosed with this letter in Appendix A.

According to Ministry of Environment, Conservation and Parks (MECP) Source Protection mapping, areas of significant groundwater recharge are located within the study area boundaries, within 500 m of Wetlands A and D as shown in Figure 5. Based on proposed land use outlined in the Concept Plan (Bousfields, 2021), the areas of significant recharge are estimated to be over 25% paved post-development and hence been assigned a high magnitude risk as shown in Appendix A.

Risk levels associated with each of the hydrologic parameters as previously mentioned were assigned based on criteria in Table 2 of the Wetland Water Balance Risk Evaluation guide.

Detailed calculations for the hydrologic changes to each wetland are provided in Appendix A and results are summarized in Table 2.

Table 2 : Hydrologic Changes Risk Evaluation Summary

Wetland ID	Impervious Cover Score Sensitivity	Increase/Decrease in Catchment Size Sensitivity	Water Taking Discharge Sensitivity	Impact to Recharge Areas Sensitivity	Highest Level of Hydrologic Sensitivity
A	Medium	Low	Medium	High	Medium
B	Low	Low	Low	Low	Low
C	Low	Low	Low	Low	Low
D	High	Low	Medium	High	High
E	Low	Low	Low	Low	Low
F	Low	Low	Low	Low	Low
G	Medium	High	Medium	Low	High
H	Medium	Medium	Medium	Low	Medium
I	Medium	Medium	Medium	Low	Medium
J	High	High	Medium	Low	High
K	Medium	Low	Medium	Low	Medium
L	Medium	Low	Medium	Low	Medium

1.3 Determine the Sensitivity of the Wetland

Dillon Consulting conducted surveys of vegetation communities, flora species, and fauna species at the identified wetlands to evaluate the sensitivity of each wetland feature to hydrologic changes. Access to Wetlands A, B, C, and D was not available to facilitate Flora and Fauna species surveys, therefore Dillon has recommended that conservative assumptions be made for sensitivity of these wetlands (i.e., Assume 'High' risk). It is further noted that the Ecological Land Classifications (ELC) for Wetlands E and F were aerial interpreted.

Detailed survey results are enclosed with this letter and sensitivity results for each category of vegetation, fauna, and flora are summarized in Table 3.

Table 3: Wetland Sensitivity Evaluation Summary

Wetland ID	Vegetation Community Sensitivity	Fauna Sensitivity	Flora Sensitivity	Highest Level of Sensitivity
A	Low	No survey access. Assume High Sensitivity.		High
B	Low	No survey access. Assume High Sensitivity.		High
C	Low	No survey access. Assume High Sensitivity.		High
D	Low	No survey access. Assume High Sensitivity.		High
E	Low	High	Low	High
F	Low	High	Low	High
G	Low	High	Medium	High
H	Low	High	Medium	High
I	Low	High	Low	High
J	Low	High	Medium	High
K	Low	High	Medium	High
L	Low	High	Low	High

As can be seen from the summary table above, each of the 12 wetlands has been classified as a high sensitivity risk to hydrologic change.

1.4 Risk Characterization

Based on the results of the hydrologic and sensitivity analyses an overall level of risk/sensitivity has been assigned to each of the 12 wetlands. The overall level of risk/sensitivity is based on the highest level of risk associated with any category of the wetland evaluation. Refer to summary presented in Table 4.

Table 4: Highest Level of Risk

Wetland ID	Highest Level of Risk	Notes
A	High	
B	High	No impacts to groundwater or surface water catchments are anticipated
C	High	No impacts to groundwater or surface water catchments are anticipated
D	High	
E	High	No impacts to groundwater or surface water catchments are anticipated
F	High	
G	High	
H	High	
I	High	
J	High	
K	High	
L	High	

As per the Table 4, each of the 12 wetlands has been identified as high risk. It is noted that there is no drainage from the Subject Lands that drain to Wetlands B, C, or E. Therefore, it is anticipated there will be no impact to Wetlands, B, C, or E from the proposed development.

For each of the remaining wetlands (Wetlands A, D and F-L), pre-development monitoring of wetland hydrology is required per Wetland Water Balance Monitoring Protocol (TRCA, 2016). Crozier has completed a preliminary hydrogeological investigation for the Subject Lands (April 2022) and future updates will include wetland and stream monitoring.

To establish baseline conditions, it is proposed to monitor each wetland inlet and outlet using shallow piezometers and staff gauges within standing water locations prior to construction. Manual measurements will be taken at each monitoring location on at least a bi-monthly basis for a minimum of 1-year to establish seasonally high conditions. Automatic water level recording devices will be installed at selected locations to collect a comprehensive data set for modelling purposes. Proposed monitoring locations are shown in Figure 6.

Prior to construction, it is recommended a mitigation and contingency plan be prepared. The mitigation and contingency plan should identify each high-risk feature and measures to maintain the water balance at that location and mitigate the impacts. If the period between construction and implementation of any mitigation measures will exceed 2 -years, an interim mitigation plan may also be required.

It is recommended monitoring of the wetlands continue throughout construction and post - construction at Wetlands A, D and F – L to observe local conditions and detect in real-time any impact to the wetland communities. It should be noted that Wetlands A and D are not within the subject lands and access to these wetlands could be limited. From aerial imagery, Wetlands A and D appear to be hydrologically connected. Therefore, it is recommended if access is limited that only A or D be monitored, as it is anticipated any impacts to one of the wetlands (A or D) will impact the other. Prior to pre-construction monitoring, it should be confirmed if and how Wetland A or D can be accessed by the landowner.

A continuous hydrological model will be prepared and calibrated using monitoring data. It is possible that an integrated model may be required (to be determined through consultation with TRCA) if it is determined that groundwater constitutes a significant portion of the total inflows or outflows to the feature.

Should you have any questions or require any further information, please do not hesitate to contact the undersigned.

Sincerely,

C.F. CROZIER & ASSOCIATES INC.

Rebecca Archer, P.Eng.
Senior Project Engineer

RA/cj

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APPENDIX A

Wetland Water Balance Risk Assessment Calculations

CROZIER CONSULTING ENGINEERS

Project:	Bolton North Hill (Option 1 & 2 Lands)
Project No.:	0708-3446
Date:	March 16, 2022
Created By:	J.N.L.
Checked By:	R.S.A.

Evaluation of Hydrologic Change to Wetlands

Impervious Cover Score (S) Equation:

$$S = \frac{IC \cdot C_{dev}}{C}$$

where: IC = Percent Impervious Cover planned within the Proponent's Holdings (%)
C_{dev} = Total Development Area within Wetland Catchment (ha)
C = Total Catchment Area to Wetland (ha)

		Impervious Cover Score						Wetland Catchment		Water Taking / Discharge				Impact to Recharge Areas		
Wetland ID[1]	**Wetland Area[1] (ha)**	**Pre-Development Catchment Area to Wetland (C, ha)**	**Total Development Area of Wetland Catchment (C_{Dev}, ha)**	**Area of the Wetland Catchment Owned by the Proponent (ha)**	**Accum. Area of the Wetland Catchment Owned by the Proponent (ha)**	**% Impervious Cover Planned within the Proponent's Holdings (IC, %)**	**Impervious Cover Score[2] (S)** Low Magnitude (<10%) Medium Magnitude (10-25%) High Magnitude (>25%)	**Post-Development Catchment Area to Wetland (C_{Post}, ha)**	**Percent Increase or Decrease in Catchment Size (%)** Low Magnitude (<10%) Medium Magnitude (10-25%) High Magnitude (>25%)	**Proposed Water Taking or Discharge (L/day)**	**Anticipated Duration of Water Taking or Discharge (# of months)**	**Notes/ Assumptions:**	**Hydrologic Risk Assessment Due to Water Taking or Discharge** Low Magnitude (50,000-400,000L/d for <6mos) Medium Magnitude (50,000-400,000L/d for >6mos OR >400,000L/d for <6mos) High Magnitude (>400,000L/d for >6mos)	**Locally Significant Recharge Area (ha)**	**Locally Significant Recharge Area to be Paved (ha)**	**Percent Impact to Recharge Areas (%)** Low Magnitude (<10%) Medium Magnitude (10-25%) High Magnitude (>25%)
A	0.83	71.73	18.12	18.12	18.12	54%	14%	73.03	2%	148,994	6	See Water Taking Calculations assumption table	MEDIUM	251,210	188,408	75%
B	0.76	4.33	0.28	0.28	0.28	0%	0%	4.33	0%	0	0	Not anticipated to be groundwater fed	LOW			0%
C	0.54	1.04	0.75	0.75	0.75	0%	0%	1.04	0%	0	0	Not anticipated to be groundwater fed	LOW			0%
D	0.91	62.75	43.95	41.45	42.47	49%	35%	61.24	2%	173,910	12	See Water Taking Calculations assumption table	MEDIUM	7,091	4,609	65%
E	0.16	-	-	-	-	-	0%	-	0%	0	0	Not anticipated to be groundwater fed	LOW			0%
F	0.15	2.80	0.04	0.04	0.04	51%	1%	2.77	1%	0	0	Not anticipated to be groundwater fed	LOW			0%
G	0.27	43.06	16.88	16.88	16.88	55%	22%	53.93	25%	105,136	6	See Water Taking Calculations assumption table	MEDIUM			0%
H	0.17	53.80	21.53	0.00	21.53	57%	23%	60.16	12%	105,136	6	See Water Taking Calculations assumption table	MEDIUM			0%
I	0.49	51.34	21.53	4.66	21.53	55%	23%	57.71	12%	131,896	6	See Water Taking Calculations assumption table	MEDIUM			0%
J	0.29	157.87	81.41	46.81	81.41	61%	31%	112.90	28%	94,076	6	See Water Taking Calculations assumption table	MEDIUM			0%
K	0.47	79.27	33.78	12.25	33.78	55%	24%	71.61	10%	94,076	6	See Water Taking Calculations assumption table	MEDIUM			0%
L	0.75	84.37	34.60	0.81	34.60	55%	23%	76.11	10%	108,038	6	See Water Taking Calculations assumption table	MEDIUM			0%

Notes: 1. Wetland IDs and Wetland Areas obtained from Figure 1 - Wetland Communities (Dillon Consulting, 2022-03-01)
2. Impervious cover scores calculated based on Equation 1 of the Wetland Water Balance Risk Evaluation (TRCA, November 2017)

PROJECT: Bolton North Hill
PROJECT No.: 0708-3446
CREATED BY: J.N.L.
CHECKED BY: R.S.A.
DATE: 2022.03.16
UPDATED: -

Post-Development Percent Impervious Calculations

Town of Caledon Standard Runoff Coefficients:

Landuse	C
Residential (Low-Density)	0.60
Residential (Medium-Density)	0.70
Residential (High-Density)	0.75
Commercial	0.90

Landuse	C
Institutional (Schools & Churches)	0.75
Parks / Open Space	0.25
Woodlot	0.25
SWM Pond	0.50

Runof coefficients, C, as per Town of Caledon Development Standards Manual 2019 - STD DWG 103.
CN Values as per MTO Design Chart 1.09, based on Soil Type 'King Clay Loam' from Ontario Soils Map

Proposed Site Conditions

TIMP = 100* (RC - 0.25) / (0.90 - 0.25)

Weighted Runoff Coefficient C:

Wetland Catchment	Landuse	Area (ha)	C	XIMP	TIMP
A	Residential (Low-Density)	4.72	0.60	36%	54%
	Residential (Medium-Density)	3.08	0.70	46%	69%
	Institutional (School)	2.49	0.75	77%	77%
	Parks and Open Space	2.34	0.25	0%	0%
	SWM Pond	0.96	0.50	50%	50%
	Roads	4.52	0.64	60%	60%
	Total/ Weighted C:	**18.12**	**0.60**	**45%**	**54%**
B	Parks and Open Space	0.28	0.25	0%	0%
	Total/ Weighted C:	**0.28**	**0.25**	**0%**	**0%**
C	Parks and Open Space	0.75	0.25	0%	0%
	Total/ Weighted C:	**0.75**	**0.67**	**0%**	**0%**
D	Residential (Low-Density)	3.71	0.60	36%	54%
	Residential (Medium-Density)	11.73	0.70	46%	69%
	Residential (High-Density)	3.75	0.75	77%	77%
	Institutional (School)	0.00	0.75	77%	77%
	Commercial	1.44	0.90	100%	100%
	Woodlot	3.07	0.25	0%	0%
	Parks and Open Space	6.59	0.25	0%	0%
	SWM Pond	1.84	0.50	50%	50%
	Roads	9.31	0.64	60%	60%
	Total/ Weighted C:	**41.45**	**0.58**	**42%**	**51%**
F	Residential (Low-Density)	0.01	0.60	36%	54%
	SWM Pond	0.03	0.50	50%	50%
	Total/ Weighted C:	**0.04**	**0.53**	**46%**	**51%**
G	Residential (Low-Density)	10.52	0.60	36%	54%
	SWM Pond	1.87	0.50	50%	50%
	Roads	4.48	0.64	60%	60%
	Total/ Weighted C:	**16.88**	**0.60**	**44%**	**55%**
I	Residential (Low-Density)	1.64	0.60	36%	54%
	Parks and Open Space	0.02	0.25	0%	0%
	Institutional (School)	1.72	0.75	77%	77%
	Roads	1.27	0.64	60%	60%
	Total/ Weighted C:	**4.66**	**0.66**	**57%**	**64%**
K	Residential (Low-Density)	4.53	0.60	36%	54%
	Residential (Medium-Density)	1.64	0.70	46%	69%
	Parks and Open Space	1.44	0.25	0%	0%
	Institutional (School)	0.65	0.75	77%	77%
	Roads	4.00	0.64	60%	60%
	Total/ Weighted C:	**12.25**	**0.59**	**43%**	**53%**
L	Residential (Low-Density)	0.56	0.60	36%	54%
	Roads	0.25	0.64	60%	60%
	Total/ Weighted C:	**0.81**	**0.61**	**43%**	**56%**
J	Residential (Low-Density)	4.89	0.60	36%	54%
	Residential (Medium-Density)	13.24	0.70	46%	69%
	Residential (High-Density)	10.94	0.75	77%	77%
	Institutional (School)	7.97	0.75	77%	77%
	Parks and Open Space	2.40	0.25	0%	0%
	SWM Pond	3.08	0.50	50%	50%
	Roads	4.29	0.64	60%	60%
	Total/ Weighted C:	**46.81**	**0.67**	**56%**	**65%**

CROZIER CONSULTING ENGINEERS

Project:	Bolton North Hill (Option 1 &2 Lands)
Project No.:	0708-3446
Date:	March 23, 2022
Created By:	J.N.L.
Checked By:	R.S.A

Evaluation of Wetland Sensitivity

Wetland ID[1]	Notes/ Assumptions	Vegetation[2]			Fauna[3]								Flora[3]		
		Vegetation Community Type	ELC Code	Sensitivity	Herpetofauna Species	Sensitivity	Bird Species	Sensitivity	Mammal Species	Sensitivity	Fish Species	Sensitivity	Flora Species (Scientific Name)	Flora Species (Common Name)	Sensitivity
A	No Survey access to this wetland; Aerial only.	Meadow Marsh	MAM	Low											
B	No Survey access to this wetland; Aerial only.	Deciduous Swamp	SWD	Low											
C	No Survey access to this wetland; Aerial only.	Deciduous Swamp	SWD	Low											
D	No Survey access to this wetland; Aerial only.	Deciduous Swamp	SWD	Low											
E	ELC Aerial Interpreted	Meadow Marsh	MAM	Low	northern spring peeper	High									
					gray treefrog	High									
F	ELC Aerial Interpreted	Meadow Marsh	MAM	Low	northern spring peeper	High									
					gray treefrog	High									
G		Gramminoid Mineral Meadow Marsh	MAMM1	Low	northern spring peeper	High	Canada goose	Low					Symphyotrichum puniceum var. puniceum	swamp aster	Medium
					American toad	Medium	mallard	Low					Typha latifolia	broad-leaved cattail	Low
					green frog	Medium	great blue heron	Low							
					gray treefrog	High									
H		Gramminoid Mineral Meadow Marsh	MAMM1	Low	northern spring peeper	High	Canada goose	Low					Symphyotrichum puniceum var. puniceum	swamp aster	Medium
					American toad	Medium	mallard	Low					Typha latifolia	broad-leaved cattail	Low
					green frog	Medium									
I		Open Aquatic	OAO	Low	northern spring peeper	High	Canada goose	Low							
					American toad	Medium	mallard	Low							
					green frog	Medium									
J		Gramminoid Mineral Meadow Marsh	MAMM1	Low	northern spring peeper	High	Canada goose	Low					typha latifolia	broad-leaved cattail	Low
					American toad	Medium	mallard	Low					symphyotrichum puniceum var. puniceum	swamp aster	Medium
													impatiens capensis	orange touch-me-not	Medium
K		Gramminoid Mineral Meadow Marsh	MAMM1	Low	northern spring peeper	High	Canada goose	Low					typha latifolia	broad-leaved cattail	Low
							mallard	Low					symphyotrichum puniceum var. puniceum	swamp aster	Medium
L		Open Aquatic	OAO	Low	northern spring peeper	High	Canada goose	Low							
							mallard	Low							
							hooded merganser	High							
							wood duck	Medium							
							great blue heron	Low							

Notes:

1. Wetland IDs obtained from Figure 1 - Wetland Communities (Dillon Consulting, 2022-03-01)
2. Vegetation Community Types, ELC Codes, and sensitivity classified by Dillon Consulting based on Appendix 2 of the TRCA Wetland Water Balance Risk Evaluation Guide (Nov. 2017)
3. Flora and fauna Types and sensitivity classified by Dillon Consulting based on Appendix 3 of the TRCA Wetland Water Balance Risk Evaluation Guide (Nov. 2017)

Project:	Bolton North Hill
Project No.:	0708-3446
Date:	March 30, 2021
Created By:	C.M.
Checked By:	C.G.

WATER TAKING CALCULATIONS

Table 1: Evaluation of Groundwater Fed Wetlands

Wetland ID[1]	Wetland Area[1] (ha)	Avg. Ground Elevation[2] (masl)	Estimated Seasonal High Groundwater Elevation[3] (masl)	Nearest Monitoring Well[3]	Groundwater Flora Indicators[4]	Groundwater Fed (Y/N)	Reasoning
A	0.83	263	263	MW19		Y	groundwater elevation = ground elevation
B	0.76	275	266	MW17		N	
C	0.54	271	266	MW17		N	
D	0.91	264	266	MW8		Y	groundwater elevation > ground elevation
E	0.16	271	265	MW14		N	
F	0.15	271	265	MW14		N	
G	0.27	263	263	MW10	Orange Touch-Me-Not	Y	flora indicator; groundwater elevation = groundwater elevation
H	0.17	263	263	MW10		Y	connected to wetland G
I	0.49	261.5	263	MW10		Y	standing water; connected to wetland I
J	0.29	260	260	MW4		Y	groundwater elevation = ground elevation
K	0.47	260	260	MW4		Y	groundwater elevation = ground elevation
L	0.75	259	260	MW4		Y	standing water; connected to J & K

Notes:
1. Wetland IDs and Wetland Areas obtained from Figure 1 - Wetland Communities (Dillon Consulting, 2022-03-01)
2. Estimated average ground elevation of wetland area from Drone LIDAR Survey conducted by Drone Survey Canada (October 2021)
3. Estimated groundwater elevation from Hydrogeological Investigation (Crozier, 2022-04-01)
4. Flora and fauna classified by Dillon Consulting based on Appendix 3 of the TRCA Wetland Water Balance Risk Evaluation Guide (Nov. 2017)

Table 2: Summary Table

ESTIMATED DEWATERING VOLUMES

Wetland ID	Total Estimated Short Term Dewatering Volumes (L/day)		Estimated Duration of Open Excavation or Dewatering Activity
		with SF of 2	
A	74,497	148,994	12 months
B			
C			
D	86,955	173,910	24 months
E			
F			
G	52,568	105,136	12 months
H	52,568	105,136	12 months
I	65,948	131,896	12 months
J	47,038	94,076	12 months
K	47,038	94,076	12 months
L	54,019	108,038	12 months

Assumptions:

—Low density residential single family dwellings are estimated to be 10 m by 25 m based on an average home size of 250 m^2. (Concept Plan, Bousfields Inc., December 20, 2021) (Zoning By-Law, Town of Caledon, July 2018) (Housing Statistics, Statistics Canada, December 2021)

—Townhouses are estimated to be 6 m by 20 m based on an average home size of 120 m^2 (Concept Plan, Bousfields Inc., December 20, 2021) (Zoning By-Law, Town of Caledon, July 2018) (Housing Statistics, Statistics Canada, December 2021)

—Average basement ceiling height is estimated to be 7 ft or 2.25 m (Ontario Building Code)

—Average hydraulic conductivity value for silty clay to clayey silt till is approximately 7.5 x 10^{-8} cm/s to 2.5 x 10^{-6} cm/s based on literature values and regional testing (Freeze and Cherry, 1979) (Soil Engineers Ltd., January 2020)

—Calculation of short-term dewatering was chosen to represent greatest water taking as short-term volumes are greater than long-term values.

Table 3: Assumed Excavation Areas for Type of Development within 500 m of Wetland

	Area within 500 m of Wetland					Estimated Number of Homes within 500 m of	
Wetland ID	LD (m^2)	MD (m^2)	HD (m^2)	School (m^2)	Commerical (m^2)	LD	MD
A	25,000	18,000	0	25,000	0	100	150
B							
C							
D	12,500	12,000	15,600	0	9,300	50	100
E							
F							
G	50,000	9,000	0	0	0	200	75
H	50,000	9,000	0	0	0	200	75
I	50,000	9,000	0	0	0	200	75
J	50,000	3,000	0	0	0	200	25
K	50,000	3,000	0	0	0	200	25
L	50,000	3,000	0	0	0	200	25

CALCULATION TABLES

TABLE 4a - LOW DENSITY DWELLING

ESTIMATE CONSTRUCTION DEWATERING VOLUME CALCULATIONS

Based on Dupuit Equation for Radial Flow to a Well or Point Source Excavation in an Unconfined Aquifer

Component	Variable	Units	Value	Note
Hydraulic Conductivity of Soil	K	m/s	2.50E-07	estimated based on regional studies and literature values, ranges from 7.5 x 10^{-8} m/s to 2.5 x 10^{-7} m/s.
Base of Aquifer		masl	253.75	elevation of extent of excavation - 1.0 m (estimated based on borehole logs).
Groundwater Elevation		masl	260.00	estimated seasonal high groundwater level based on Hydrogeological Investigation by Crozier (April 2022).
Elevation Requiring Dewatering		masl	254.75	assumed to be 2.0 m below the extent of excavation.
Extent of Excavation		masl	256.75	estimated to be approximately 7 ft or 2.25 mbgs based on Ontario Building Code minimum of 6.5 ft.
Equivalent Radius of the Well	r_w	m	126.19	squareroot of excavation area divided by pi.
Excavation Area		m^2	50000	estimated from the Concpet Plan prepared by Bousfields Inc. December 2021 per single family home.
Calculations				
Hydraulic Head of Water Table	H	m	6.25	
Hydraulic Head at Max. Dewatering	h	m	1.00	
Radius of Influence	R_0	m	134.06	
Pumping Rate	Q	m^3/s	4.94E-04	
Dewatering Volume per Day	Q	L/day	42644.40	

TOTAL ESTIMATED CONSTRUCTION DEWATERING VOLUME	**Q =**	**42644 L/day**
TOTAL ESTIMATED CONSTRUCTION DEWATERING VOLUME W/ SAFETY FACTOR OF 2.0	**Q =**	**85289 L/day**

TABLE 4b - MEDIUM DENSITY DWELLING

ESTIMATE CONSTRUCTION DEWATERING VOLUME CALCULATIONS

Based on Dupuit Equation for Radial Flow to a Well or Point Source Excavation in an Unconfined Aquifer

Component	Variable	Units	Value	Note
Soil	K	m/s	2.50E-07	estimated based on regional studies and literature values, ranges from 7.5 x 10^{-8} m/s to 2.5 x 10^{-7} m/s.
Base of Aquifer		masl	253.75	elevation of extent of excavation - 1.0 m (estimated based on borehole logs).
Groundwater Elevation		masl	260.00	estimated seasonal high groundwater level based on Hydrogeological Investigation by Crozier (April 2022).
Dewatering		masl	254.75	assumed to be 2.0 m below the extent of excavation.
Extent of Excavation		masl	256.75	estimated to be approximately 7 ft or 2.25 mbgs based on Ontario Building Code minimum of 6.5 ft.
Well	r_w	m	30.91	squareroot of excavation area divided by pi.
Excavation Area		m^2	3000	estimated from the Concpet Plan prepared by Bousfields Inc. December 2021 per townhouse.
Calculations				
Hydraulic Head of Water	H	m	6.25	
Hydraulic Head at Max.	h	m	1.00	
Radius of Influence	R_0	m	38.78	
Pumping Rate	Q	m^3/s	1.32E-04	
Dewatering Volume per	Q	L/day	11374.71	

TOTAL ESTIMATED CONSTRUCTION DEWATERING VOLUME	**Q =**	**11375 L/day**
TOTAL ESTIMATED CONSTRUCTION DEWATERING VOLUME W/ SAFETY FACTOR OF 2.0	**Q =**	**22749 L/day**

TABLE 4c - HIGH DENSITY DWELLING

ESTIMATE CONSTRUCTION DEWATERING VOLUME CALCULATIONS

Based on Dupuit Equation for Radial Flow to a Well or Point Source Excavation in an Unconfined Aquifer

Component	Variable	Units	Value	Note
Soil	K	m/s	2.50E-07	estimated based on regional studies and literature values, ranges from 7.5 x 10^{-8} m/s to 2.5 x 10^{-7} m/s.
Base of Aquifer		masl	259.75	elevation of extent of excavation - 1.0 m (estimated based on borehole logs).
Groundwater Elevation		masl	266.00	estimated seasonal high groundwater level based on Hydrogeological Investigation by Crozier (April 2022).
Dewatering		masl	260.75	assumed to be 2.0 m below the extent of excavation.
Extent of Excavation		masl	262.75	estimated to be approximately 1 level of underground parking, or 3 m parking lot height.
Well	r_w	m	70.49	squareroot of excavation area divided by pi.
Excavation Area		m^2	15600	estimated from the Concpet Plan prepared by Bousfields Inc. December 2021 per apartment complex
Calculations				
Hydraulic Head of Water	H	m	6.25	
Hydraulic Head at Max.	h	m	1.00	
Radius of Influence	R_0	m	78.36	
Pumping Rate	Q	m^3/s	2.82E-04	
Dewatering Volume per	Q	L/day	24374.15	

TOTAL ESTIMATED CONSTRUCTION DEWATERING VOLUME	**Q =**	**24374 L/day**
TOTAL ESTIMATED CONSTRUCTION DEWATERING VOLUME W/ SAFETY FACTOR OF 2.0	**Q =**	**48748 L/day**

TABLE 4d - SCHOOLS

ESTIMATE CONSTRUCTION DEWATERING VOLUME CALCULATIONS

Based on Dupuit Equation for Radial Flow to a Well or Point Source Excavation in an Unconfined Aquifer

Component	Variable	Units	Value	Note
Soil	K	m/s	2.50E-07	estimated based on regional studies and literature values, ranges from 7.5 x 10^{-8} m/s to 2.5 x 10^{-7} m/s.
Base of Aquifer		masl	257.75	elevation of extent of excavation - 1.0 m (estimated based on borehole logs).
Groundwater Elevation		masl	263.00	estimated seasonal high groundwater level based on Hydrogeological Investigation by Crozier (April 2022).
Dewatering		masl	258.75	assumed to be 2.0 m below the extent of excavation.
Extent of Excavation		masl	260.75	estimated to be approximately 7 ft or 2.25 mbgs based on Ontario Building Code minimum of 6.5 ft.
Well	r_w	m	89.23	squareroot of excavation area divided by pi.
Excavation Area		m^2	25000	estimated from the Concpet Plan prepared by Bousfields Inc. December 2021 per school
Calculations				
Hydraulic Head of Water	H	m	5.25	
Hydraulic Head at Max.	h	m	1.00	
Radius of Influence	R_0	m	95.60	
Pumping Rate	Q	m^3/s	3.02E-04	
Dewatering Volume per	Q	L/day	26106.49	

TOTAL ESTIMATED CONSTRUCTION DEWATERING VOLUME	**Q =**	**26106 L/day**
TOTAL ESTIMATED CONSTRUCTION DEWATERING VOLUME W/ SAFETY FACTOR OF 2.0	**Q =**	**52213 L/day**

TABLE 4e - COMMERCIAL

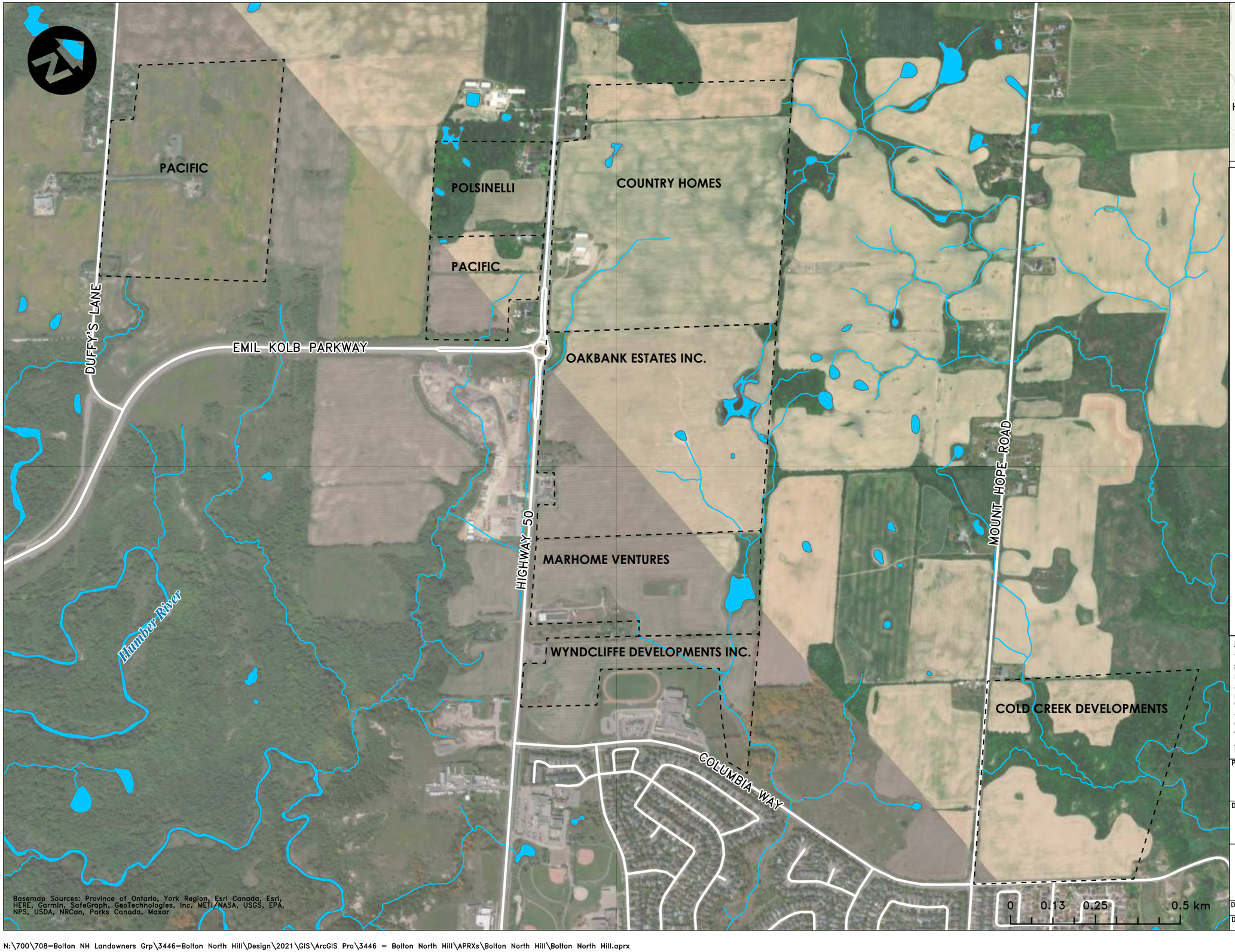
ESTIMATE CONSTRUCTION DEWATERING VOLUME CALCULATIONS

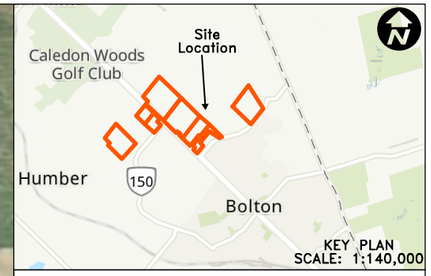
Based on Dupuit Equation for Radial Flow to a Well or Point Source Excavation in an Unconfined Aquifer

Component	Variable	Units	Value	Note
Soil	K	m/s	2.50E-07	estimated based on regional studies and literature values, ranges from 7.5 x 10^{-8} m/s to 2.5 x 10^{-7} m/s.
Base of Aquifer		masl	259.75	elevation of extent of excavation - 1.0 m (estimated based on borehole logs).
Groundwater Elevation		masl	266.00	estimated seasonal high groundwater level based on Hydrogeological Investigation by Crozier (April 2022).
Dewatering		masl	260.75	assumed to be 2.0 m below the extent of excavation.
Extent of Excavation		masl	262.75	assuming no basement
Well	r_w	m	54.42	squareroot of excavation area divided by pi.
Excavation Area		m^2	9300	estimated from the Concpet Plan prepared by Bousfields Inc. December 2021 per development.
Calculations				
Hydraulic Head of Water	H	m	6.25	
Hydraulic Head at Max.	h	m	1.00	
Radius of Influence	R_0	m	62.30	
Pumping Rate	Q	m^3/s	2.21E-04	
Dewatering Volume per	Q	L/day	19102.20	

TOTAL ESTIMATED CONSTRUCTION DEWATERING VOLUME	**Q =**	**19102 L/day**
TOTAL ESTIMATED CONSTRUCTION DEWATERING VOLUME W/ SAFETY FACTOR OF 2.0	**Q =**	**38204 L/day**

FIGURES





LEGEND

- Subject Lands
- Road
- Watercourse
- Waterbody
- Road Label
- Landowner

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Project

BOLTON NORTH HILL
TOWN OF CALEDON

Drawing

SITE LOCATION PLAN

CROZIER CONSULTING ENGINEERS
2800 High Point Drive
Suite 100
Milton, ON L9T 6P4
905-875-0026 T
905-875-4915 F
www.cfcrozier.ca

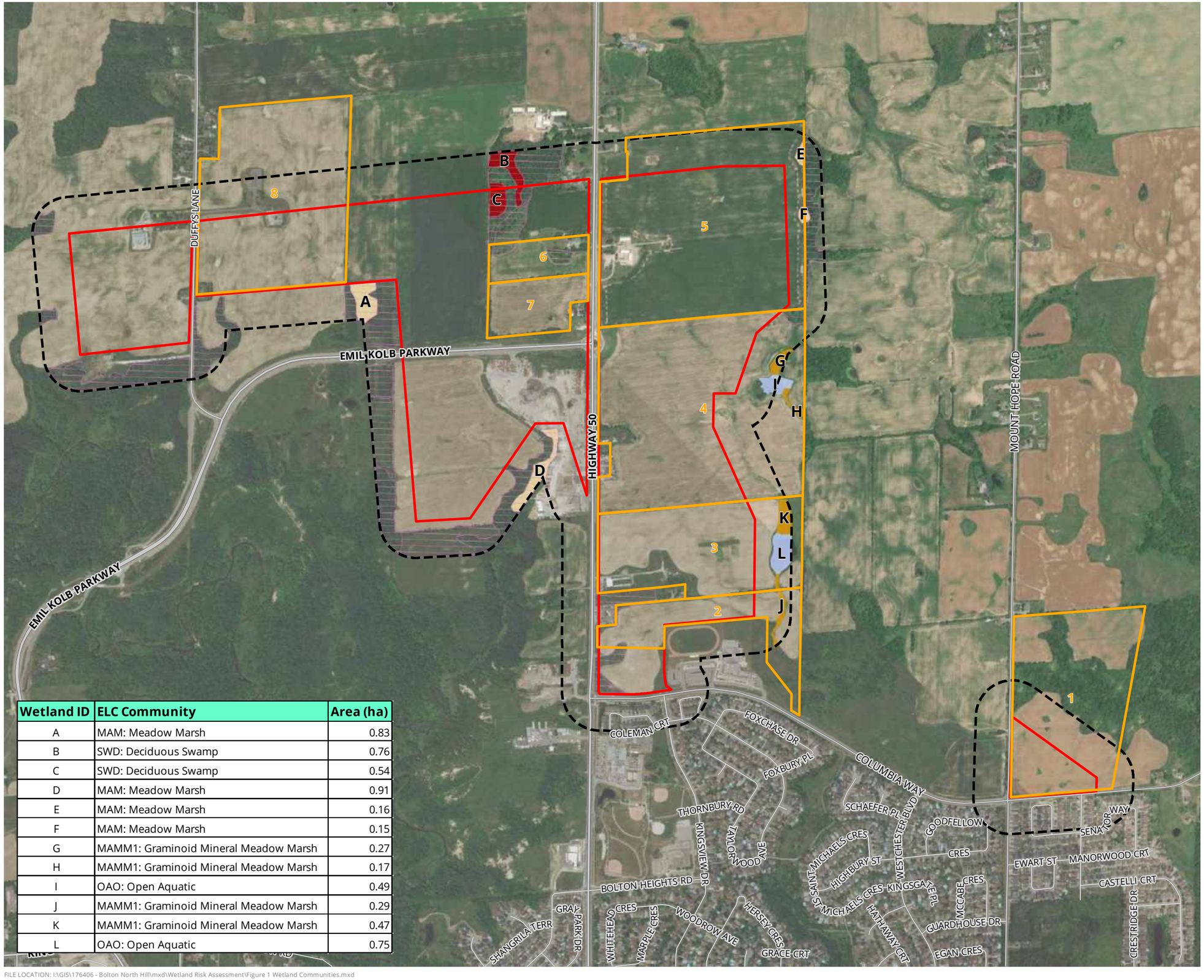
Drawn	Design	Project No.
C.M.	R.A.	0708-3446
Date	Projection	Scale
22.04.12	EPSG:26917	1:10,500

Dwg. FIG. 1

N:\700\708-Bolton NH Landowners Grp\3446-Bolton North Hill\Design\2021\GIS\ArcGIS Pro\3446 - Bolton North Hill\APRXs\Bolton North Hill\Bolton North Hill.aprx

BOLTON NORTH HILL SECONDARY PLAN

FIGURE 1
WETLAND COMMUNITIES



Wetland ID	ELC Community	Area (ha)
A	MAM: Meadow Marsh	0.83
B	SWD: Deciduous Swamp	0.76
C	SWD: Deciduous Swamp	0.54
D	MAM: Meadow Marsh	0.91
E	MAM: Meadow Marsh	0.16
F	MAM: Meadow Marsh	0.15
G	MAMM1: Graminoid Mineral Meadow Marsh	0.27
H	MAMM1: Graminoid Mineral Meadow Marsh	0.17
I	OAO: Open Aquatic	0.49
J	MAMM1: Graminoid Mineral Meadow Marsh	0.29
K	MAMM1: Graminoid Mineral Meadow Marsh	0.47
L	OAO: Open Aquatic	0.75

- Participating Landowner Property Boundary
- Option 1/2 Lands
- Study Area (120 m Setback)
- Aerial Interpretation

Wetland

- MAM: Meadow Marsh
- MAMM1: Graminoid Mineral Meadow Marsh
- OAO: Open Aquatic
- SWD: Deciduous Swamp

1:12,000

0 100 200 m

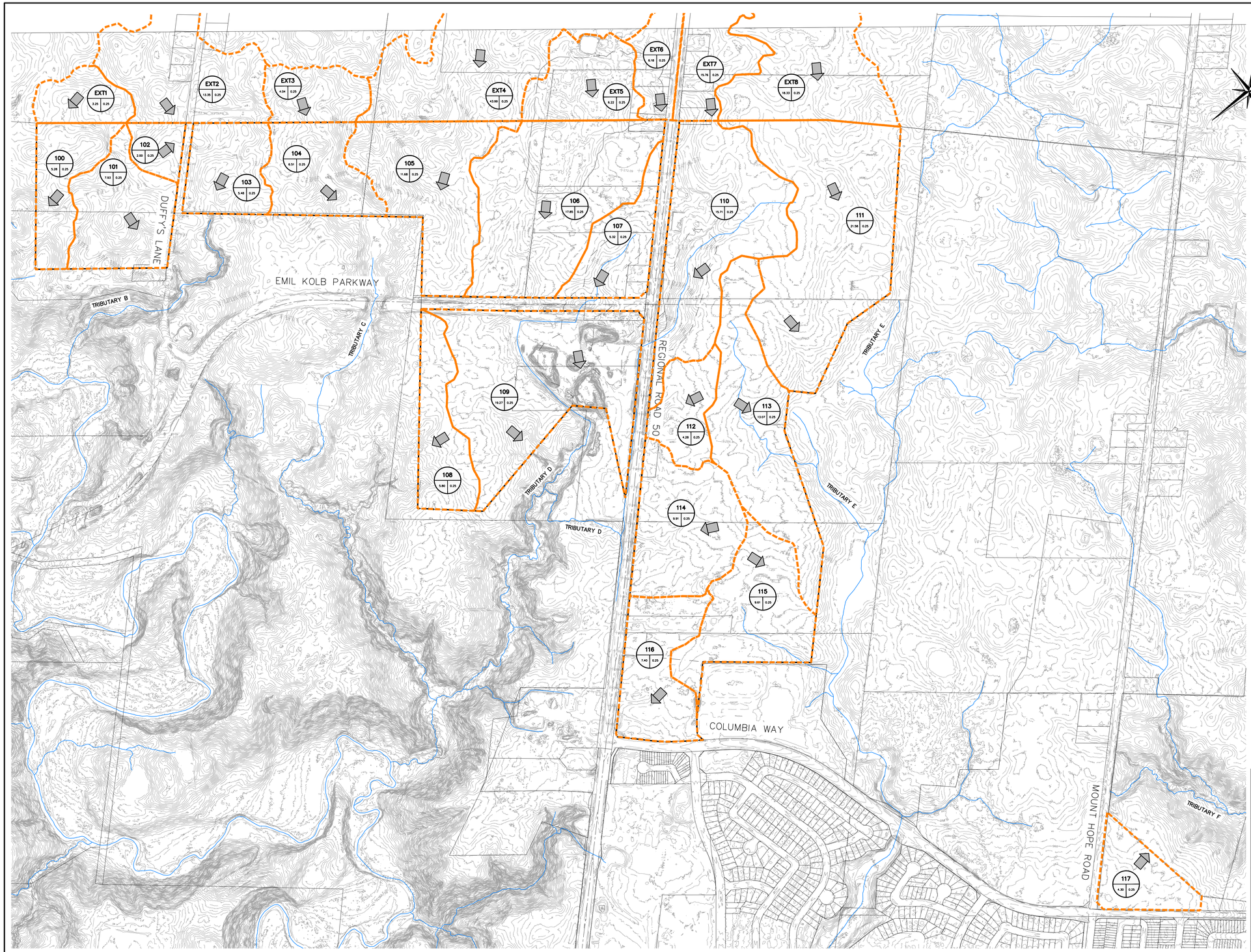
MAP DRAWING INFORMATION:
DATA PROVIDED BY MNRF, REGION OF PEEL, TRCA

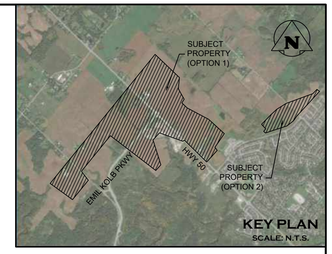
MAP CREATED BY: GM
MAP CHECKED BY: WM
MAP PROJECTION: NAD 1983 UTM Zone 17N

DILLON CONSULTING

PROJECT: 176406
STATUS: DRAFT
DATE: 2022-03-01

FILE LOCATION: I:\GIS\176406 - Bolton North Hill\mxd\Wetland Risk Assessment\Figure 1 Wetland Communities.mxd





LEGEND

- EXISTING MAJOR CONTOURS (198.00)
- EXISTING MINOR CONTOURS (198.50)
- EXISTING ELEVATION (x199.11)
- PROPERTY BOUNDARY
- DRAINAGE AREA
- EXISTING OVERLAND FLOW ARROW
- CATCHMENT ID (100)
- RUNOFF COEFFICIENT (0.50)
- CATCHMENT AREA (ha) (1.68)
- REGIONAL FLOODLINE
- 6.0m EROSION ACCESS SETBACK
- 100 YR FLOODLINE
- WATER COURSE

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TEMPORARY BENCHMARKS

TBM#1–
TBM#2–
TBM#3–

No.	ISSUE	DATE: MM/DD/YYYY
0	ISSUED FOR 1st SUBMISSION	MM/DD/YYYY

Engineer

Engineer

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Project

BOLTON NORTH HILL
TOWN OF CALEDON

Drawing

PRE–DEVELOPMENT
DRAINAGE PLAN

CROZIER
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SUITE 100
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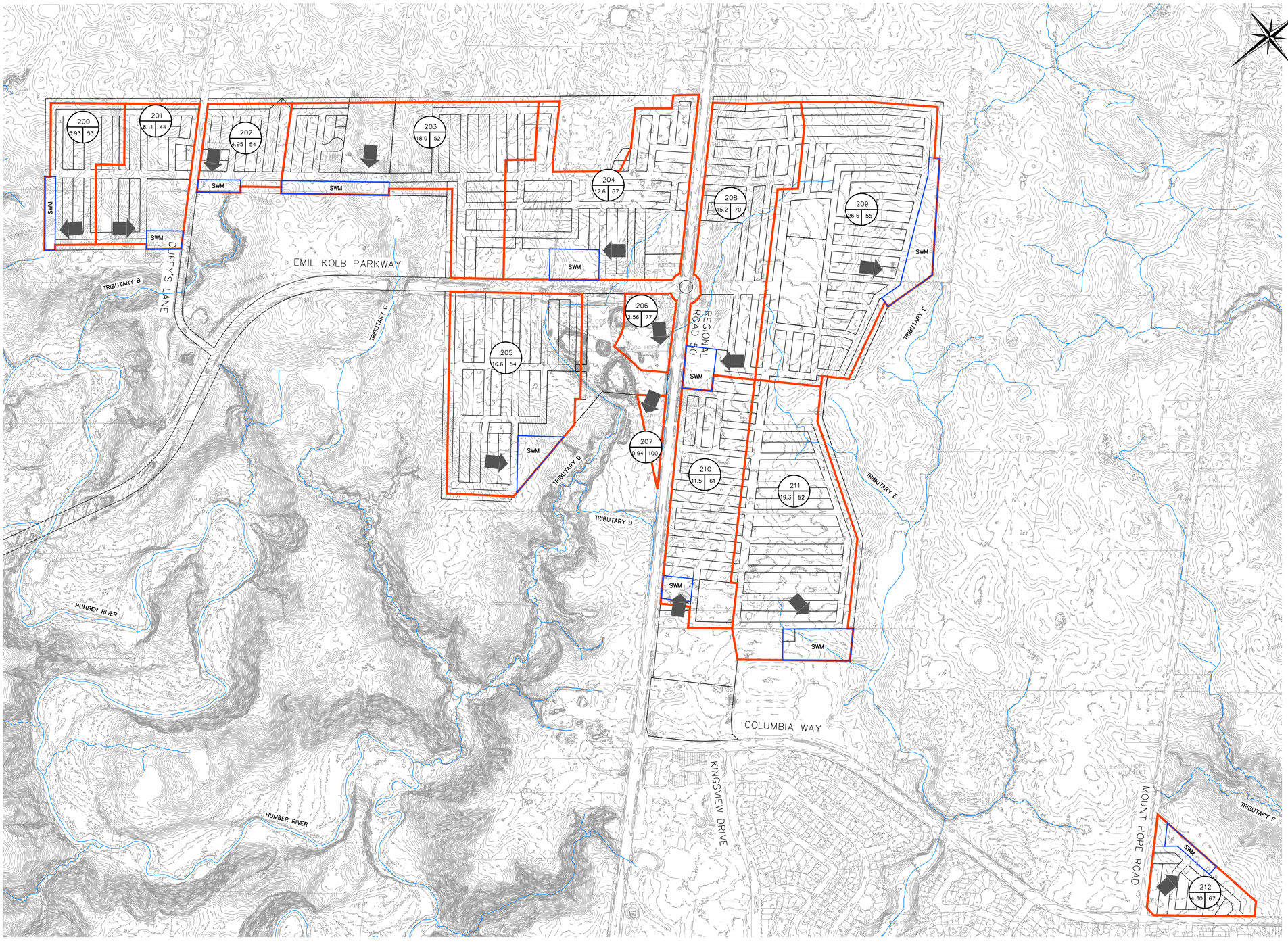
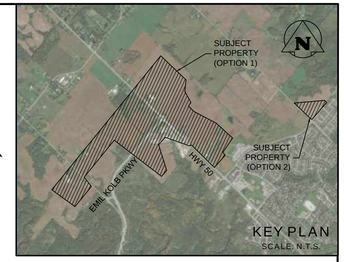
S.C.	T.G.		708–3446
Check By	Check By	Scale	Drawing
T.G.	S.C.	1:5000	DRN





LEGEND

- EXISTING MAJOR CONTOURS
- EXISTING MINOR CONTOURS
- PROPERTY BOUNDARY
- DRAINAGE AREA
- OVERLAND FLOW ARROW
- CATCHMENT ID
- PERCENT IMPERVIOUS (%)
- CATCHMENT AREA (ha)
- PROPOSED STORM SEWER

REGI
6.0m
100
WATI

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EXISTING GROUND CONTOURS DERIVED FROM AERIAL SURVEY BY DRONE SURVEY CANADA (JULY 2021). ADDITIONAL CONTOUR DATA ADAPTED FROM THE ONTARIO DIGITAL TERRAIN MODEL (LIDAR-DERIVED) LAND INFORMATION ONTARIO (LIO) DATASET (MINISTRY OF NATURAL RESOURCES AND FORESTRY, 2017).

No.	ISSUE	DATE: MM/DD/YYYY
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Engineer

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Project

BOLTON NORTH HILL
TOWN OF CALEDON
PRELIMINARY STORM
DRAINAGE PLAN

Drawing

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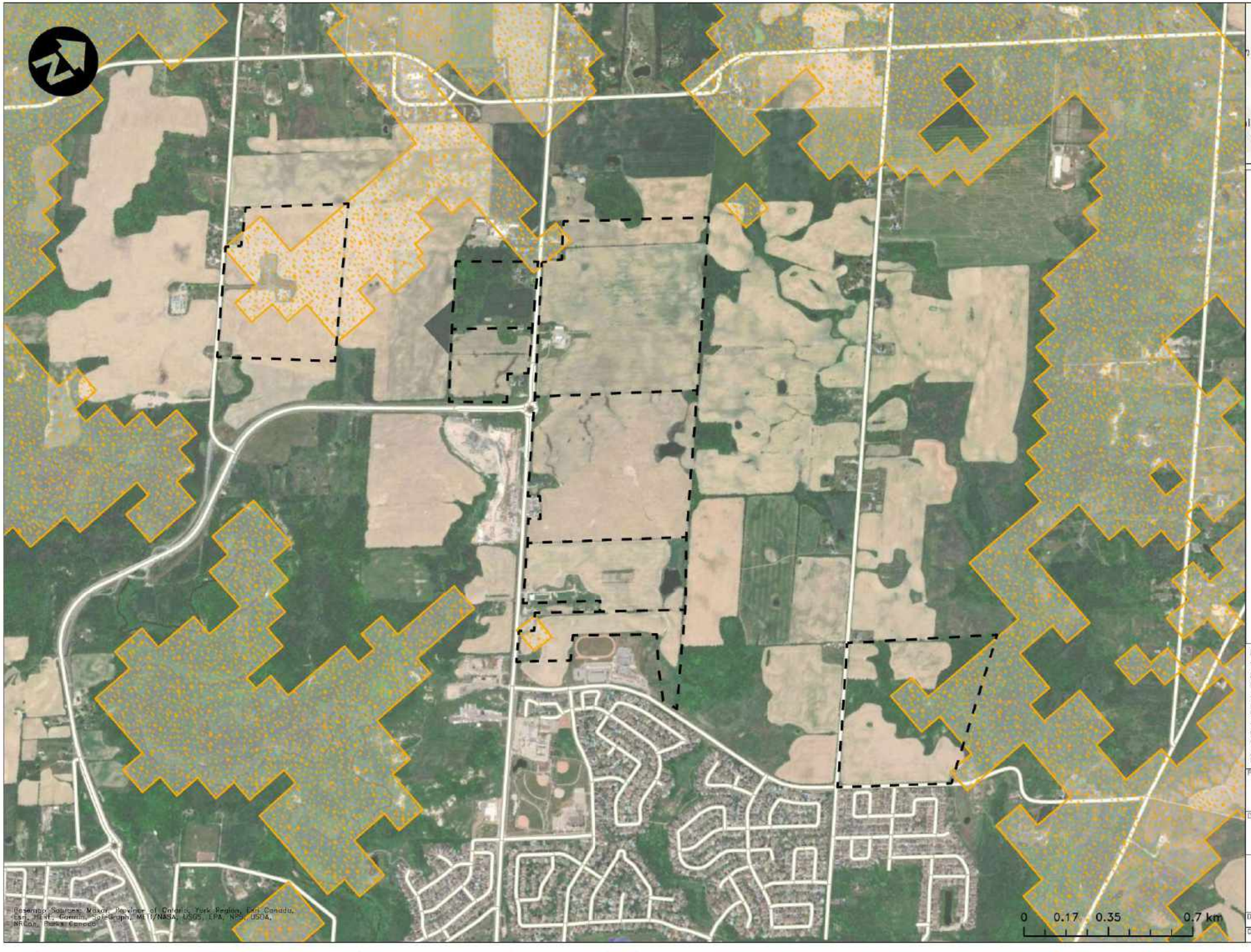
S.C.	T.G.		708-3446
Check By	Check By	Scale	Drawing
T.G.	S.C.	1:5000	STM



LEGEND

- Roads
- Accessible Lands
- Highly Vulnerable Aquifers

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ALL EXISTING UNDERGROUND UTILITIES TO BE VERIFIED IN THE FIELD BY THE CONTRACTOR PRIOR TO CONSTRUCTION.

Project

BOLTON NORTH HILL
TOWN OF CALEDON

Drawing

HIGHLY VULNERABLE AQUIFERS

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905-875-4915 F
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C.M. / E.F.	C.O.	0708-3446
Date	Projection	Scale
22-02-25	EPSG:25917	1:15,000

Dwg. FIG. 2

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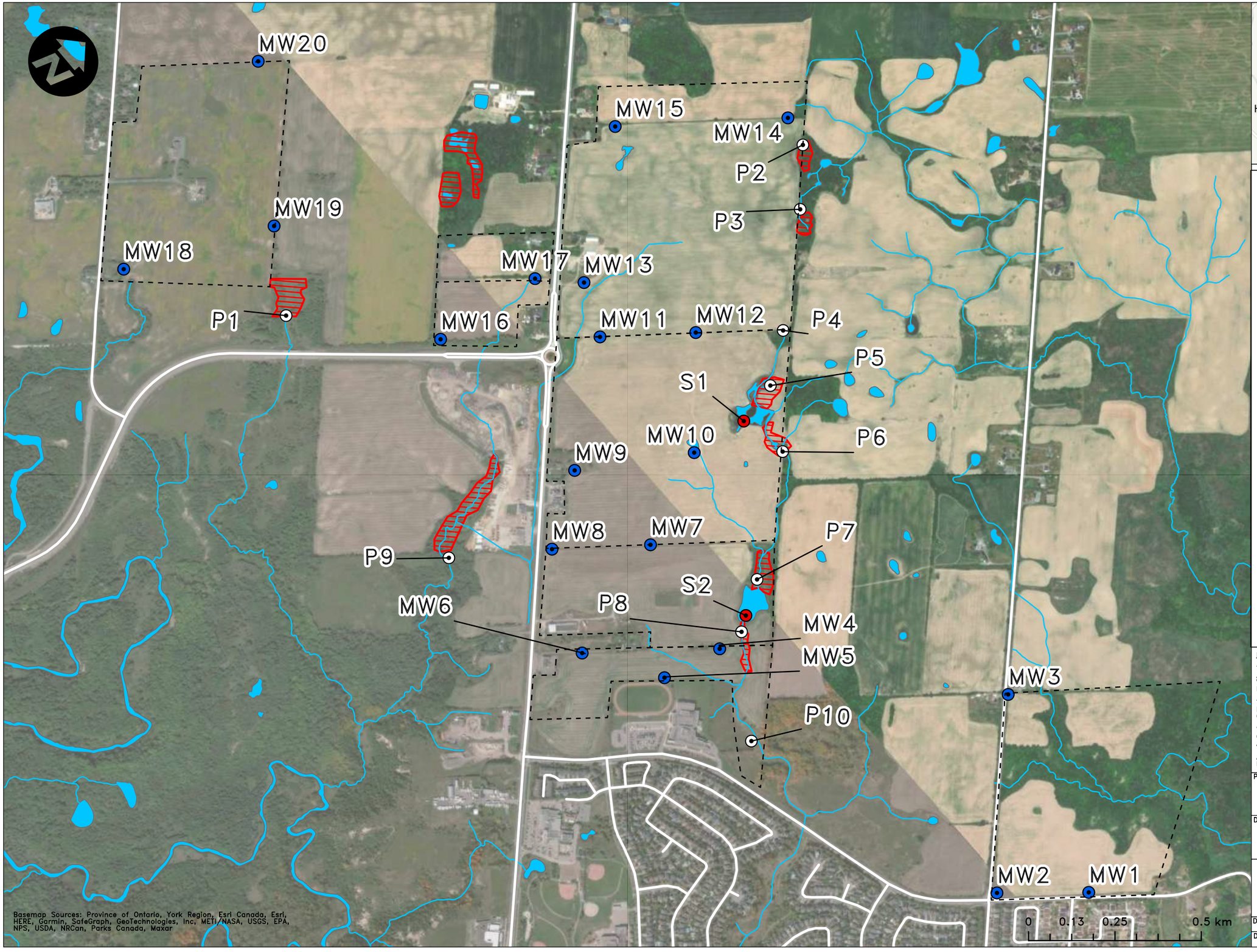

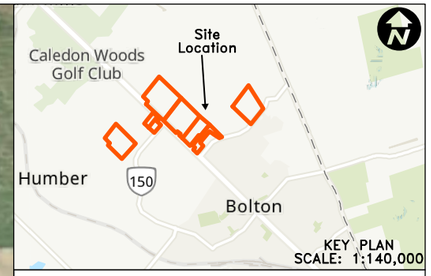

LEGEND

- Subject Lands
- Staff Gauge
- Piezometer
- 2021 Monitoring Well
- Road
- Watercourse
- Wetlands
- Waterbody
- MW1 Monitoring Well Label
- S1 Stream Gauge Label
- P1 Piezometer Label

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Project

BOLTON NORTH HILL
TOWN OF CALEDON

Drawing

PROPOSED MONITORING LOCATION PLAN

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2800 High Point Drive
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Milton, ON L9T 6P4
905-875-0026 T
905-875-4915 F
www.cfcrozier.ca

Drawn	Design	Project No.
C.M.	R.A.	0708-3446
Date	Projection	Scale
22.04.12	EPSG:26917	1:10,500

Dwg. FIG. 6

N:\700\708-Bolton NH Landowners Grp\3446-Bolton North Hill\Design\2021\GIS\ArcGIS Pro\3446 - Bolton North Hill\APRXs\Bolton North Hill\Bolton North Hill.aprx