

HYDROGEOLOGICAL STUDY 6688 FRANKTOWN ROAD



Project No.: CP-17-0503

Prepared for:

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Executive Summary

McIntosh Perry Consulting Engineers Ltd. (McIntosh Perry) was retained by Mr. Bingfeng Li of Bing Professional Engineering Inc. (Bing Professional Engineering) to conduct a Hydrogeological Assessment and Terrain Analysis on a parcel of land located at 6688 Franktown Road in Ottawa, Ontario (the Site). The Site currently consists of forested land, with a cleared portion that will be utilized for future development of a place of worship. The total area of the Site is approximately 39.89 hectares (ha), while the proposed development will have a footprint of approximately 2.71 ha.

Ground surface at the Site is generally relatively flat. Regional relief appears to be sloped toward the Richmond Fen (Non-Sensitive Provincially Significant Wetland), which is located approximately 685 m south of the Site. Ground surface elevation at the Site varies between 106 and 113 m asl (above sea level). Drainage in the area of proposed development is interpreted to reflect surface topography, and is likely controlled by ditches along Jinkinson Road. Other areas of the Site likely drain to the south, toward the Richmond Fen. Regional groundwater is interpreted to flow to the south and east, toward the Jock River.

To satisfy the requirements of this hydrogeological assessment, McIntosh Perry tested a newly drilled, on-site water supply well (Test Well 1, TW1) for water quality and quantity. TW1 was pumped for approximately six hours, and was sampled twice during this time. The pumping rate during the pumping test (approximately 92 L/min) is considered more than sufficient to supply the proposed development.

No analyzed parameters in either pre-test or post-test samples (TW1_1 and TW1_2, respectively) exceed Ontario Drinking Water Quality Standards (ODWS). From a quality and quantity perspective, TW1 can supply sufficient water to support development.

On-site soils in the area of the proposed development appear to consist of a thick layer of sand with some areas of silt and clay. Overburden was observed to generally become coarser with depth, and limestone bedrock was encountered between 4.9 – 5.7 m below ground surface (bgs). Based on the general characterization of overburden in the vicinity of the proposed septic leaching bed, imported fill materials are likely necessary to provide the required vertical separation from groundwater. Further investigation of soil will likely be required to support the MOECP Sewage Works application process.

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1.0 INTRODUCTION

McIntosh Perry Consulting Engineers Ltd. (McIntosh Perry) was retained by Mr. Bingfeng Li of Bing Professional Engineering Inc. (Bing Professional Engineering) to conduct a Hydrogeological Assessment and Terrain Analysis on a parcel of land located at 6688 Franktown Road in Ottawa, Ontario (the Site). The Site currently consists of forested land, with a cleared portion that will be utilized for the future development of a place of worship. The total area of the Site is approximately 39.89 hectares (ha), while the proposed development will have a footprint of approximately 2.71 ha. Figures 1 and 2 present plans that depict the Site Location and Site Layout.

This work was conducted in general accordance with Ontario Ministry of Environment, Conservation and Parks (MOECP) guidance as follows:

- Procedure D-5-5: Technical Guideline for Private Wells: Water Supply Assessment (August 1996)

The Site address is 6688 Franktown Road (Ottawa, Ontario). The planned future use of the Site is as a place of worship, and will consist of two institutional structures and a large paved parking lot with an associated laneway.

The Site is legally described as Part Lot 19, Concession 3 East, Rural Plan 4R-7040; Part 1. A site plan of the proposed severance, prepared by Susan D. Smith Architect (March, 2018), has been submitted under separate cover (Appendix A).

This assessment considers the Site suitability for only the proposed development, which is located in the northwestern portion of the Site. The proposed development is approximately 2.71 ha, leaving a non-developed area of approximately 37.18 ha. This Hydrogeological Assessment addresses the following:

- General site setting information
- Geological and hydrogeological background
- Site specific conditions
- Water treatment options, and wastewater treatment and disposal options

2.0 INVESTIGATION

2.1 Site Setting

The Site is located within the City of Ottawa, and is designated as ‘Rural General Industrial’ (proposed development area), ‘Rural Countryside’ (non-developed portion), ‘Environmental Protection’ (non-developed portion – wetland), and ‘Parks and Open Space’ (non-developed portion – buried service corridor) in the City of Ottawa Zoning By-Law.

At the present time, the proposed development consists solely of cleared (previously forested) land, and is situated approximately 120 m from an on-site PSW, at its closest point. It is noted that the proposed building footprint is located significantly further from the PSW. The retained (non-developed) portion of the Site consists of forested areas (dry-fresh White Pine/Maple/Oak mixed forest), cultural meadows (buried service easement), and Provincially Significant Wetland (predominantly cattails). Based on a review of aerial photographs available on GeoOttawa, no signs of previous Site development can be seen (earliest photo is 1976). Based on Site conditions observed during fieldwork, it is further unlikely that the Site has seen any contemporary use, other than forest clearing for the gas easement.

The climate is humid continental with cool winters and warm summers. The 1981-2010 mean annual precipitation is approximately 919.5 mm with 175.4 cm as snow, and the mean daily temperature is 6.6 °C (Environment Canada Climate Normals for Ottawa, ON).

2.2 Neighbouring Properties and Land Uses

The Site is bound by forested land and low-density residential rural development to north and east, by agricultural fields to the south, and by a buried service corridor to the west (see Figure 3).

The nearest inhabited building relative to the proposed severance is located adjacent to the Site, at 6700 Franktown Road. Based on a review of MOECP well records, it appears that all serviced development in the area is privately serviced with wells and septic systems.

2.3 Hydrology

Ground surface at the Site is generally relatively flat. Regional relief appears to be sloped toward the Richmond Fen (Non-Sensitive Provincially Significant Wetland), which is located approximately 685 m south of the Site. Ground surface elevation at the Site varies between 106 and 113 m asl (above sea level). Drainage in the area of proposed development is interpreted to reflect surface topography, and is likely controlled by ditches along Jinkinson Road. Other areas of the Site likely drain to the south, toward the Richmond Fen. Regional groundwater is interpreted to flow to the south and east, toward the Jock River.

2.4 Terrain Analysis

2.4.1 General

A combination of hand auger probes and boreholes were advanced at various locations throughout the Site to assess the geotechnical characteristics and properties for the on-site overburden and underlying bedrock. In total, seven hand auger and three boreholes were utilized for this assessment.

2.4.2 On-Site Hand Auger Program

Based on a hand auger program carried out by McIntosh Perry personnel on May 2, 2018, shallow on-site soils can be generally described as coarse grained sand, with areas of silt and clay. From a surficial geology perspective, the Site can be delineated into three main zones (see Figure 4):

Zone 1: Medium brown sand, some to trace fines.

Zone 2: Silt and clay, trace sand.

Zone 3: Silty fine sand.

Details of the hand auger program can be found in Table 1.

2.4.3 On-Site Drilling Program

In addition to hand auger holes, McIntosh Perry personnel advanced three geotechnical boreholes (BH18-1, BH18-2, BH18-3) and three monitoring wells (MW18-1, MW18-2, MW18-3) at the Site on May 23-24, 2018 (see Figure 4).

Geotechnical borehole logs describe overburden in the vicinity of the proposed on-site structures as wet sand, with trace to some silt. Overburden was found to be approximately 4.6 – 5.7 m thick, after which point competent limestone bedrock was encountered.

Static water levels taken from MW18-1, MW18-2, and MW18-3 on May 29 and June 1, 2018 indicate that the on-site shallow groundwater gradient is small with groundwater flowing in a southeast direction. The static water levels were 0.3 m bgs for all three borehole locations.

2.5 Background Geology and Hydrology

2.5.1 Ontario Geological Survey (OGS) – Surficial Geology

Data taken from the OGS GIS Downloads website are generally consistent with on-site observations. Geological maps of the area classify the overburden at the Site as coarse-textured glaciomarine deposits, including sand, gravel, and minor silt and clay (see Figure 5). (OGS, 2018)

2.5.2 Ontario Geological Survey (OGS) – Bedrock Geology

Geological maps of the area classify the bedrock under the Site as limestone, dolostone, shale, arkose, and sandstone of the Ottawa Group, Simcoe Group, and/or of the Shadow Lake Formation (see Figure 6). (OGS, 2018)

2.5.3 Recharge and Discharge Areas

Based on a review of topographic data, geological maps, and a site visit, it is our interpretation that the Site is predominantly a groundwater discharge zone. Site drainage appears to be relatively poor in the area of proposed development; while no areas of ponded water were directly observed in the proposed building or laneway footprint, the Site was generally waterlogged during hand auger and drilling activities.

2.5.4 Hydrogeologically Sensitive Areas

The Site has soil thicknesses generally exceeding 4.5 m and there were no observed areas of bedrock outcrop or karst conditions. While the proposed development area appears to be poorly drained, there were no areas of groundwater upwelling or significant discharge noted. The Site is therefore not considered to be a hydrogeologically sensitive area.

2.5.5 Water Well Record Review

Forty-three water wells were located within approximately 500 m of the Site. Thirty-four were listed for water supply purposes, and other wells were for either test or 'other' purposes, or were unlisted. The MOECP Water Well Information System records are shown on Figure 7, and data are summarized in Appendix B.

The total well depths ranged from 6.7 to 85.3 m, with an average depth of 34.7 m. Overburden thickness ranged from 0 to 15.2 m, with the majority of observed overburden thicknesses listed above 3 m. Reported static water levels ranged from 0 (at surface) to 15.2 m bgs.

2.6 Potential Sources of Contamination

A windshield survey of the surrounding area was conducted in combination with a review of maps and zoning information. The Site is located in a predominantly forested area with rural-residential properties and agriculture. None of these uses appear to pose any significant source of contamination to the Site.

The Site and surrounding properties are not connected to the City of Ottawa's wastewater treatment system. As such, there are likely private on-site wastewater systems at nearby developments.

3.0 METHODOLOGY – HYDROGEOLOGICAL ASSESSMENT

McIntosh Perry conducted a detailed hydrogeological investigation at the Site to assess the feasibility of servicing the proposed development. As noted in the above sections, the work generally followed the Guidance of MOECP Procedure D-5-5: Technical Guideline for Private Wells: Water Supply Assessment.

McIntosh Perry tested a newly drilled, on-site water supply well (Test Well 1, TW1), which is believed to be representative of the hydrogeological conditions across the proposed development area. According to the MOECP well record, the well extends approximately 61.0 m bgs, with a 0.159 m (6 ¼ inch) diameter casing extending approximately 6.1 m bgs. The MOECP Well Record for TW1 is included in Appendix C.

The initial estimation of TW1 yield was made based on a 1-hour pumping test completed by the driller (>55 L/min). McIntosh Perry personnel pumped the well at a rate of approximately 92 L/min during a 360 minute pumping test.

The pumping test was conducted at TW1 by McIntosh Perry staff on July 13, 2018. During the testing period, water levels in the well were measured using an electronic water level tape. Water quality (pH, temperature, conductivity, turbidity, dissolved oxygen, and oxidation-reduction potential) was also monitored and recorded in the field during the test, and two samples (TW1_1 and TW1_2) were collected for the 'subdivision supply' suite of parameters, in addition to a select suite of metals.

During the pumping test, turbidity was observed to decrease from 7.36 FNU to 0.0 FNU within the first hour of the test. Initial high turbidity measurements are considered to be a result of drilling the well.

All groundwater samples were collected unfiltered and unchlorinated, directly into clean bottles supplied by the analytical laboratories (Paracel Laboratories Ltd., Ottawa, ON). Chlorine indicator strips were used to ensure no chlorine residual remained in the sampled water. The samples were kept on ice and shipped directly to Paracel under strict chain of custody procedures. All of the samples were received by the laboratory within 12 hours of collection.

Paracel is fully accredited by SCC/CALA, and has accreditation for Ontario Safe Drinking Water Act (OSDWA) testing.

During the pumping test, water level monitoring consisted of manual readings of drawdown and recovery made with an electronic water level tape. Following pump shutoff, water levels were measured in TW1 until approximately 100% recovery was achieved (approximately 10 min post-shutoff).

Drawdown and recovery data from the pumping test were plotted and analyzed using the Cooper-Jacob and Theis Recovery methods, respectively. The hydraulic conductivity (K , m/s) and transmissivity (T , m²/d) of the aquifer were estimated. Storativity cannot be assessed properly without the use of an additional observation well, which was not available at the time of the test.

4.0 RESULTS

A drawdown curve and tabular data from the pumping test at TW1 are available in Appendix D and Table 1, respectively. A summary of recorded groundwater field parameter data and the official Laboratory Certificates of Analysis are available in Tables 2 and 3 and Appendix D, respectively.

4.1 Static Conditions

Prior to the initiation of pumping, water levels were measured in TW1. The static groundwater level was recorded at 4.365 m below top of casing (btoc) at the beginning of the pumping test ($t=0$). Assigning an arbitrary site benchmark of 100.00 m to the top of the casing, the static water elevation in the well was 95.635 m (local).

No evidence of groundwater discharge was observed in the development area at the time of the pumping test.

4.2 Pumping Test

The pumping test was conducted at TW 1 under the supervision of McIntosh Perry personnel. Water was pumped directly from the test well using a pump and tubing supplied by Air Rock Drilling. The water discharge was directed away from the well, and was allowed to flow overland across the Site. At the time of the pumping test, the weather was approximately 25°C and clear.

All water level measurement data are presented in Table 4, appended to this report.

Based on a short-term pumping test completed by Air Rock Drilling upon completion of the well, it was estimated that a pumping rate exceeding 90 L/min would be sustainable at the well.

On July 13, 2018, following installation of the pumping equipment by Air Rock Drilling, a static water level of 4.365 m btoc was measured in the well. At approximately 08:07, the pump was turned on and the flow rate adjusted to approximately 92 L/min. This pumping rate was maintained with minimal variation for the duration of the test (360 minutes total).

The water level ranged between 95.217 m to 95.625 m local (4.375 to 4.783 m btoc), with a maximum drawdown of 0.418 m observed. 100% recovery was achieved in the well within 10 minutes of pump shut down.

4.3 Well Yield

The pumping test undertaken by McIntosh Perry provides a reasonable indication of the yield of TW1. During this test, approximately 33,120 L of water was pumped from the well, at a rate (92 L/min) that exceeds the estimated peak hourly demand for the development (17.4 L/min).

4.4 Transmissivity

A summary of the well and hydrogeological properties determined during the testing work at the Site are presented in Appendix E. A transmissivity of approximately 734.56 m²/d was calculated using the Cooper-Jacob method. Assuming an aquifer thickness of 54.3 m (corresponding to the interval between the bottom of the casing and the bottom of the well) and fully horizontal groundwater flow, a hydraulic conductivity of 1.57 x 10⁻⁴ m/s was calculated using the Transmissivity equation (T=Kb).

Storativity (S) could not be calculated as other wells for observation purposes were not available for measurement at the time of the pumping test.

4.5 Long Term Yield

The long-term yield (maximum recommended pumping rate) of TW1 was estimated based on the following factors:

- Observations during six-hour pumping test
- Calculated properties
- Details of proposed development

By extrapolating the drawdown data on a semi-logarithmic scale, it is estimated that a conservatively maximum pumping rate of 92 L/min could be sustained for over 100,000 minutes (69 days) of continuous pumping with a maximum drawdown of under 1 m (see Appendix E). It is noted that this situation is inherently conservative, as the pump will cycle on and off on a much shorter time scale, allowing the well to recharge.

The long-term yield (Q20) was also calculated using the Farvolden and the Moell Methods. Based on this analysis the calculated Q20 values are 6,352 L/min and 2,945 L/min, respectively (see Appendix E).

Based on the available information, a long-term sustainable pumping rate of 92 L/min is considered appropriate for the well. This yield is sufficient to supply water to the proposed development at this Site, given that the peak hourly demand is currently estimated at 17.4 L/min.

4.6 Water Quality

Laboratory Certificates of Analysis for on-site groundwater testing are presented in Appendix D. A summary of field and laboratory results from TW1 is presented in Tables 2 and 3. Samples were taken twice during the six-hour test on July 13, 2018. Pre- and post-test samples (TW1_1 and TW1_2, respectively) were taken directly from the on-site pump tubing. Analytical results were compared to the Ontario Drinking Water Standards, Objectives, and Guidelines (ODWS).

Based on the analytical results from July 13, 2018, there are no exceedances of ODWS, including maximum acceptable concentration (MAC) parameters, in TW1_1 or TW1_2.

5.0 WATER TREATMENT

The use of disinfection such as an ultraviolet (UV) system, although not required, may be desired. Based on the observed water quality there should not be any hindrances to UV disinfection.

For aesthetic reasons, water treatment such as softening may be desired. Softening of water can be achieved through reverse osmosis or ion exchange. It is noted that depending on which resin is used in the treatment system, softening with ion exchange will increase the concentrations of sodium or potassium relative to those noted in Table 3.

The Langelier Saturation Index (LSI) and Ryznar Stability Index (RSI) were calculated for TW1 (Appendix F). These results indicate that scale formation is possible, though not likely at the tested temperature. This is to be expected in areas of carbonate bedrock.

6.0 SEPTIC ASSESSMENT

As part of this investigation, an assessment with respect to the Site's ability to be serviced by a private on-site septic system was undertaken. Typically, for individual sites the septic assessment will follow the provision outlined within the MOECP document Procedure D-5-4 Technical Guideline for Individual On-Site Sewage System: Water Quality Risk Assessment (August 1996); however, as it is understood that the proposed development will be serviced by a septic system with a Daily Design Flow that will be greater than 10,000 litres per day(L/d), Procedure D-5-4 is not applicable.

Notwithstanding, the following concerns were considered: Lot Size, System Isolation and Contaminant Attenuation.

Lot Size

The total area for the site is 39.89 ha, with approximately 2.71 ha slated for development. Accordingly, McIntosh Perry is of the opinion that sufficient spatial area exists on the property to accommodate a septic system designed for DDF exceeding 10,000 litres.

System Isolation

As previously outlined McIntosh Perry conducted a hand auger and borehole program to determine overburden depth and soil characterization. Based on this investigation, it was determined that the on-site overburden was 4 m in depth or greater. Static water level at monitoring locations was noted to be in the order of 0.2 to 0.3 m bgs; note the supply aquifer for the area is located in the underlying bedrock.

Referencing MOECP Water Well Records for down gradient users (Pinestrand Crescent) reveals that these users are over 700 m away from the proposed development with supply wells completed into the underlying bedrock. Accordingly, McIntosh Perry is of the opinion that sufficient spatial separation exists between the proposed development and the down gradient users.

Contaminant Attenuation

As the Site is proposed to be serviced with a septic system having a DDF greater than 10,000 L/d, attenuation will be governed through application of Reasonable Use Policies to the satisfaction of the MOECP. By following Guideline B-7: Incorporation of the Reasonable Use Concept into MOEE Groundwater Management, it has been determined that the proposed septic system and current lot size are sufficient to meet the target nitrate concentration. Refer to Appendix H for further details.

7.0 CONCLUSIONS

Based on the investigation undertaken, the following are noted:

- Groundwater users within the area typically utilize aquifer sources contained within the underlying bedrock formation and not the groundwater found within the overburden.
- The groundwater tested for the Site is suitable for potable purposes, as no exceedances of ODWS, including maximum acceptable concentration (MAC) parameters as well as aesthetic objectives (AO) and operational guidelines (OG) were detected through analytical testing.
- The aquifer into which the test well was completed can adequately supply water at the pumping test flow rate (92 L/min) based on observed and extrapolated drawdown and calculations to confirm safe well yield (Farvolden and Moell Methods).
- Langelier Saturation Index (LSI) and Ryznar Stability Index (RSI) calculations indicate that scale formation is possible, though not likely at the tested temperature. This is to be expected in areas of carbonate bedrock.
- The use of disinfection such as an ultraviolet (UV) system, although not required, may be desired. Based on the observed water quality there should not be any hindrances to UV disinfection.
- Overburden for the Site is of suitable characteristics to support an on-site septic system.
- Spatial separation vertically and horizontally is adequate to provide isolation from septic effluent for the bedrock supply aquifer as well as downgradient users.
- The proposed septic system and current lot size are sufficient to meet the target nitrate concentration as per Reasonable Use concept.

8.0 RECOMMENDATIONS

8.1 Water Supply

Well Construction

- Any newly installed wells should have at least 6.1 m of casing and adhere to all other requirements of O.Reg. 903, as amended.
- Any newly installed test wells should be appropriately developed and tested prior to domestic use.

Water Quality and Treatment

- Water from Test Well 1 meets all applicable health related standards at the present time.
- Field measurements of turbidity ranged from 7.36 to 0.0 FNU within the pumping test period.
- If water softening is desired, this can be achieved through reverse osmosis or ion exchange. It is noted that softening with ion exchange will increase the concentration of sodium or potassium depending on which resin is used in the treatment system.

8.2 Wastewater Treatment

Potential Septic Systems

- Approval for on-site septic treatment will be governed by the MOECP as it is understood that the Daily Design Flow proposed system will be greater than 10,000 litres per day.
- Based on the general characterization of overburden in the vicinity of the proposed septic leaching bed, imported fill materials will likely be necessary to provide the required vertical separation from groundwater. Further investigation of soil will likely be required to support the MOECP Sewage Works application process.
- Any septic systems must be constructed with all appropriate setbacks, treatment units and stipulations as per applicable Ontario Regulations.

Potential Lot Layout

- This hydrogeological assessment is in support of the proposed development described herein; this assessment does not address the potential for more than one water well or septic system at the Site. However, this report does address a sustained peak hourly demand for all proposed on-site structures associated with the development at the time of writing.

9.0 LIMITATIONS

This report has been prepared and the work referred to in this report has been undertaken by McIntosh Perry Consulting Engineers Ltd. for Bing Professional Engineering Inc. (Bing Professional Engineering). It is intended for the sole and exclusive use of Bing Professional Engineering, their affiliated companies and partners and their respective insurers, agents, employees, advisors, and reviewers. The report may not be relied upon by any other person or entity without the express written consent (Reliance Letter) of McIntosh Perry Consulting Engineers Ltd.

Any use which a third party makes of this report, or any reliance on decisions made based on it, without a reliance letter are the responsibility of such third parties. McIntosh Perry Consulting Engineers Ltd. accept no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

The investigation undertaken by McIntosh Perry Consulting Engineers Ltd. with respect to this report and any conclusions or recommendations made in this report reflect McIntosh Perry Consulting Engineers Ltd. judgment based on the Site conditions observed at the time of the site inspection on the date(s) set out in this report and on information available at the time of the preparation of this report.

This report has been prepared for specific application to this site and it is based, in part, upon visual observation of the Site, subsurface investigation at discrete locations and depths, and specific analysis of specific chemical parameters and materials during a specific time interval, all as described in this report. Unless otherwise stated, the findings cannot be extended to previous or future Site conditions, portions of the Site which were unavailable for direct investigation, subsurface locations which were not investigated directly, or chemical parameters, materials or analysis which were not addressed. Substances other than those addressed by the investigation described in this report may exist within the Site, substances addressed by the investigation may exist in areas of the Site not investigated and concentrations of substances addressed which are different than those reported may exist in areas other than the locations from which samples were taken.

If site conditions or applicable standards change or if any additional information becomes available at a future date, modifications to the findings, conclusions and recommendations in this report may be necessary.

We trust that this information is satisfactory for your present requirements. Should you have any questions or require additional information, please do not hesitate to contact the undersigned.

Respectfully submitted,

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10.0 REFERENCES

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OGS Earth, 2018. Ontario Ministry of Northern Development, Mines and Forestry, - Ontario Geological Survey Earth – for Google Earth. Bedrock classification data for Eastern Ontario.

Theis, C.V., 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage, Trans. Amer. Geophys. Union, Vol. 16, pp. 519-524.

MOE, 1996. Procedure D-5-5 Technical Guideline for Private Wells: Water Supply Assessment.

TABLES

Table 1
Summary of Hand Auger Data
New Development 6688 Franktown Road, Ottawa, Ontario

Hand Auger ID	Soil Description	Depth (m bgs)	Refusal (Y/N)	Depth to Water (m bgs)
HA1	Topsoil	0.0 - 0.1	N	0.0
	Clay	0.1 - 1.1		
HA2	Topsoil	0.0 - 0.2	N	0.0
	Medium Br. Sand	0.2 - 0.5		
	Clay	0.5 - 1.1		
HA3	Topsoil	0.0 - 0.1	N	0.0
	Medium Br. Sand	0.1 - 0.9		
	Clay	0.9 - 1.0		
HA4	Topsoil	0.0 - 0.2	N	0.2
	Medium Br. Sand	0.2 - 1.2		
HA5	Topsoil	0.0 - 0.2	N	0.3
	Medium Br. Sand	0.2 - 1.2		
HA6	Topsoil	0.0 - 0.2	N	0.2
	Fine Br. Sand	0.2 - 1.2		
HA7	Topsoil	0.0 - 0.2	N	0.2
	Medium Br. Sand	0.2 - 0.8		

NOTES:

m bgs

Metres below ground surface

Table 2
Summary of Field Parameters
New Development 6688 Franktown Road, Ottawa, Ontario

Test Well 1

Pumping Test at:		TW1	Date:	13-Jul-18		
Time Elapsed (min)	Turbidity (NTU)	pH	Conductivity (us/cm)	Temperature (°C)	DO (mg/L)	Flow Rate (L/min)
Pump On						92
1	236	7.58	614	12.18	5.74	
2						
3						
4						
5						
9	9.3	7.49	577	8.97	3.83	92
15						
21	2.5	7.02	613	9.04	3.83	
30	1.8	6.92	631	9.06	4.06	
60	1.7	6.80	686	9.14	5.29	
120	2.1	6.77	728	9.16	6.26	
180	0.2	6.77	747	9.22	3.87	
240	0	6.72	727	9.20	3.87	
300	1.8	6.76	762	9.16	3.86	
360	0	6.76	765	9.17	3.85	
Notes:	<i>Flow rate measured with stopwatch and bucket</i>					

NOTES:

min Minutes
 FTU Formazin Nephelometric Units
 ms/cm Millisiemens per centimeter
 (°C) Degrees celsius
 mg/L Milligrams per litre
 L/min Litres per minute

Table 3
Summary of Laboratory Results
New Development, 6688 Franktown Road, Ottawa, ON

Test Well 1

Sample ID	Units	MDL	ODWSOG	Limit Type	TW 1_1	TW 1_2
Sample Date					13-Jul-18	13-Jul-18
Location					Test Well 1	
Parameter:						
Microbiological Parameters						
E Coli	CFU/ 100 mL	1	0	MAC	<1	<1
Fecal Coliforms	CFU/ 100 mL	1	-		<1	<1
Total Coliforms	CFU/ 100 mL	1	0	MAC	<1	<1
Heterotrophic Plate Count	CFU/mL	10	-		-	-
General Inorganics						
Alkalinity, total	mg/L	5	500	OG	325	328
Ammonia as N	mg/L	0.01	-		0.12	0.12
Dissolved Organic Carbon	mg/L	0.5	5	AO	2.9	3.2
Colour*	TCU	2	5	AO	3	4
Conductivity	uS/cm	5	-		697	834
Hardness	mg/L		-		259	327
pH	pH Units	0.1	-		7.7	7.6
Phenolics	mg/L	0.001	-		<0.001	<0.001
Total Dissolved Solids	mg/L	10	500	AO	380	486
Sulphide	mg/L	0.02	0.05	AO	<0.02	<0.02
Tannin & Lignin	mg/L	0.1	-		0.1	0.1
Total Kjeldahl Nitrogen	mg/L	0.1	-		0.2	0.2
Turbidity*	NTU	0.1	5	AO	1.5	1.4
Anions						
Chloride	mg/L	1	250	AO	24	65
Fluoride	mg/L	0.1	1.5	MAC	0.4	0.4
Nitrate as N	mg/L	0.1	10	MAC	<0.1	<0.1
Nitrite as N	mg/L	0.05	1	MAC	<0.05	<0.05
Sulphate	mg/L	1	500	AO	38	41
Metals						
Calcium	ug/L	0.1	-		55.7	75.4
Iron	ug/L	0.1	300	AO	0.1	0.1
Magnesium	ug/L	0.2	-		29.2	33.7
Manganese	ug/L	0.005	50	AO	0.006	0.006
Potassium	ug/L	0.1	-		4.6	4.8
Sodium	ug/L	0.2	200000	AO	17.6	21.6

NOTES:

- * These parameters were analyzed outside of the accepted holding time
- MDL Method Detection Limit
- ODWSOG Ontario Drinking Water Standards, Objectives, and Guidelines (MOECC, 2003 rev. 2006; PIBs 4449e01)
- AO Aesthetic Objective
- MAC Maximum Allowable Concentration (Health-Related Parameter)
- OG Operational Guideline
- ND Non detectable (below MDL)
- mg/L Milligrams per litre
- TCU True Colour Units
- uS/cm Microsemens per centimeter
- NTU Nephelometric Turbidity Units
- ct/ 100 mL Number of bacteria-forming colonies per 100 mL

Table 4
Summary of Water Level Data
Pumping Test - TW1 - 13-Jul-2018

TOC Elevation (assumed)	100.000 m
Static Water Level	4.365 m BTOC
Static Water Elevation	95.635 m
95% Recovery Level	4.386 m BTOC
95% Recovery Elevation	95.614 m

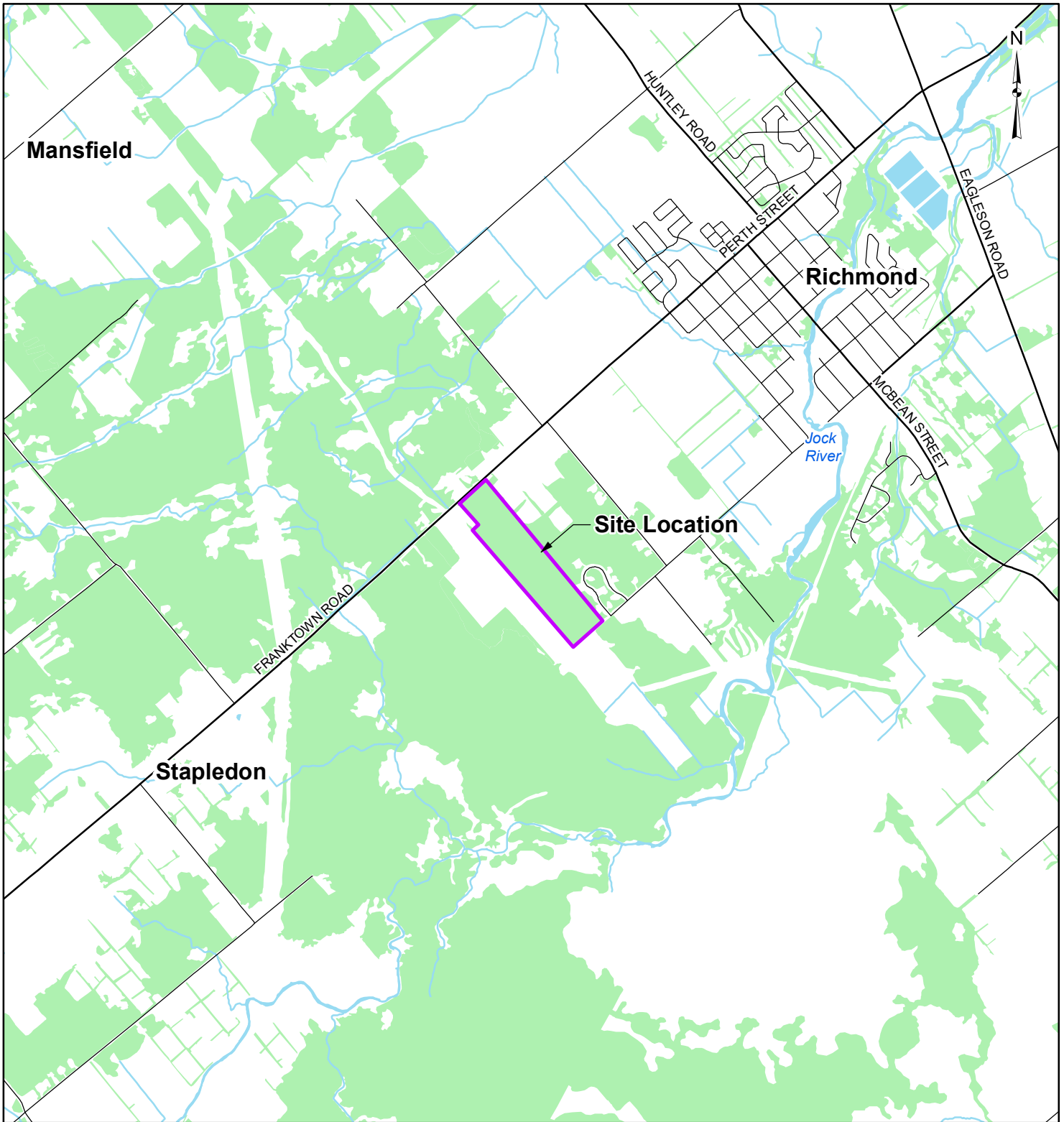
Elapsed Time (minutes)	24-Hr Time	Water Level (m BTOC)	Water Level (m ASL)	Drawdown (m)	Notes
0		4.365	95.635	0	
1	08:07	4.709	95.291	0.344	PUMP ON
2		4.716	95.284	0.351	
3		4.726	95.274	0.361	
4		4.733	95.267	0.368	92L/minute at 8:10 am
5		4.737	95.263	0.372	
6		4.740	95.26	0.375	
7		4.740	95.26	0.375	
8		4.744	95.256	0.379	
9		4.745	95.255	0.38	
10		4.745	95.255	0.38	
20		4.758	95.242	0.393	
30		4.761	95.239	0.396	
45		4.765	95.235	0.4	
60		4.769	95.231	0.404	
120		4.779	95.221	0.414	
180		4.783	95.217	0.418	
240		4.780	95.22	0.415	
300		4.748	95.252	0.383	
360	14:07	4.746	95.254	0.381	PUMP OFF
361		4.416	95.584	0.051	
362		4.406	95.594	0.041	
363		4.403	95.597	0.038	
364		4.399	95.601	0.034	
365		4.397	95.603	0.032	
366		4.395	95.605	0.03	
367		4.385	95.615	0.02	
368		4.382	95.618	0.017	
369		4.379	95.621	0.014	
370		4.375	95.625	0.01	

NOTES

TOC: Top of Casing

m BTOC: metres below top of casing

FIGURES



LEGEND

- Approximate Property Boundary
- Local Road
- Major Road
- Watercourse
- Waterbody
- Wooded Area

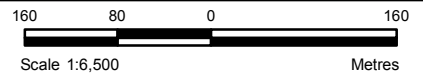
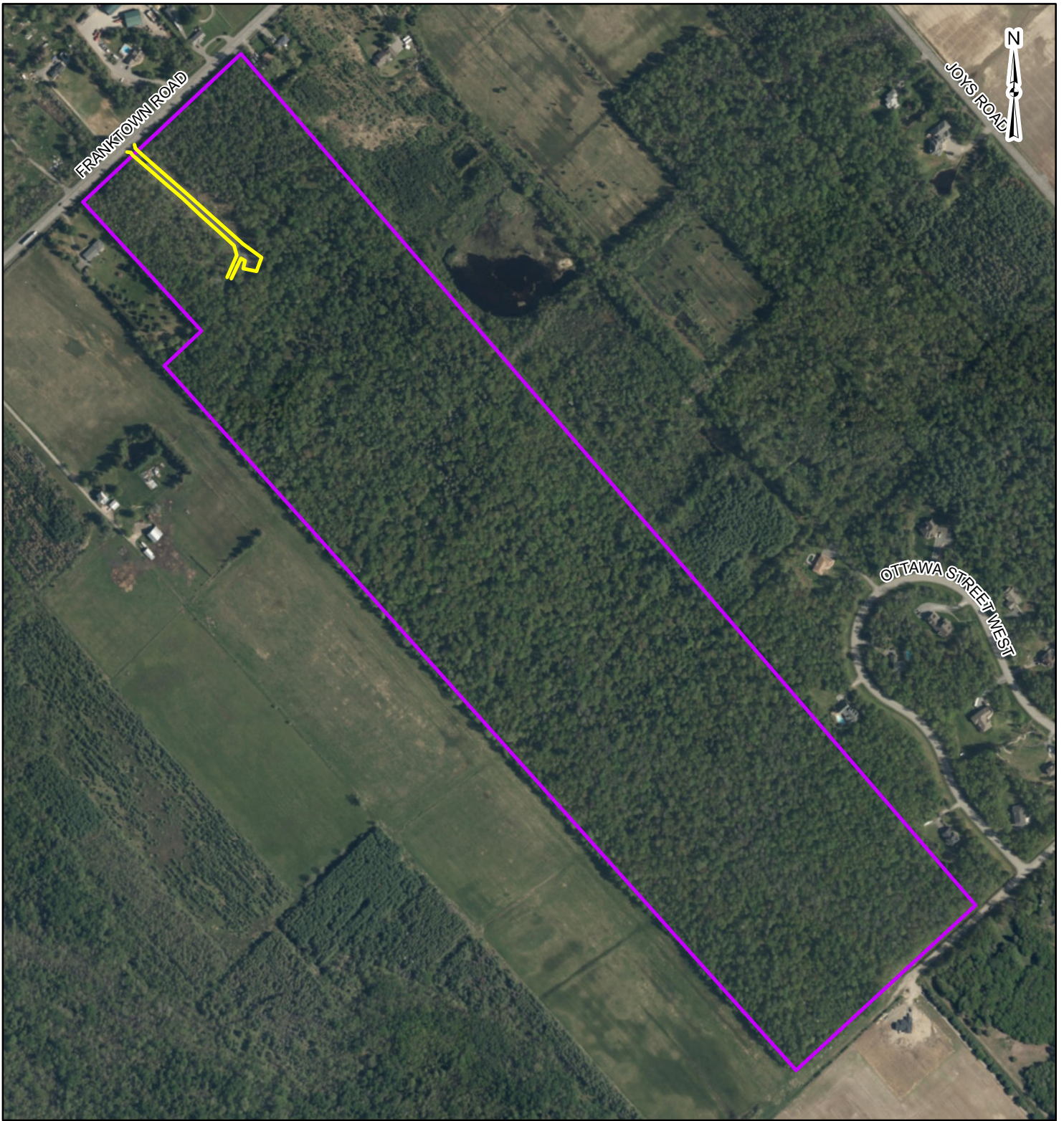


REFERENCE

GIS data provided by the Ontario Ministry of Natural Resources and Forestry, 2018.

CLIENT:		BING PROFESSIONAL ENGINEERING	
PROJECT:		HYDROGEOLOGICAL STUDY 6688 FRANKTOWN ROAD	
TITLE:		SITE LOCATION	
PROJECT NO: CP-17-0503		FIGURE:	
Date	Jul., 17, 2018	1	
GIS	JD		
Checked By	JB		

McINTOSH PERRY
 115 Walgreen Road, RR3, Carp, ON K0A1L0
 Tel: 613-836-2184 Fax: 613-836-3742
 www.mcintoshperry.com



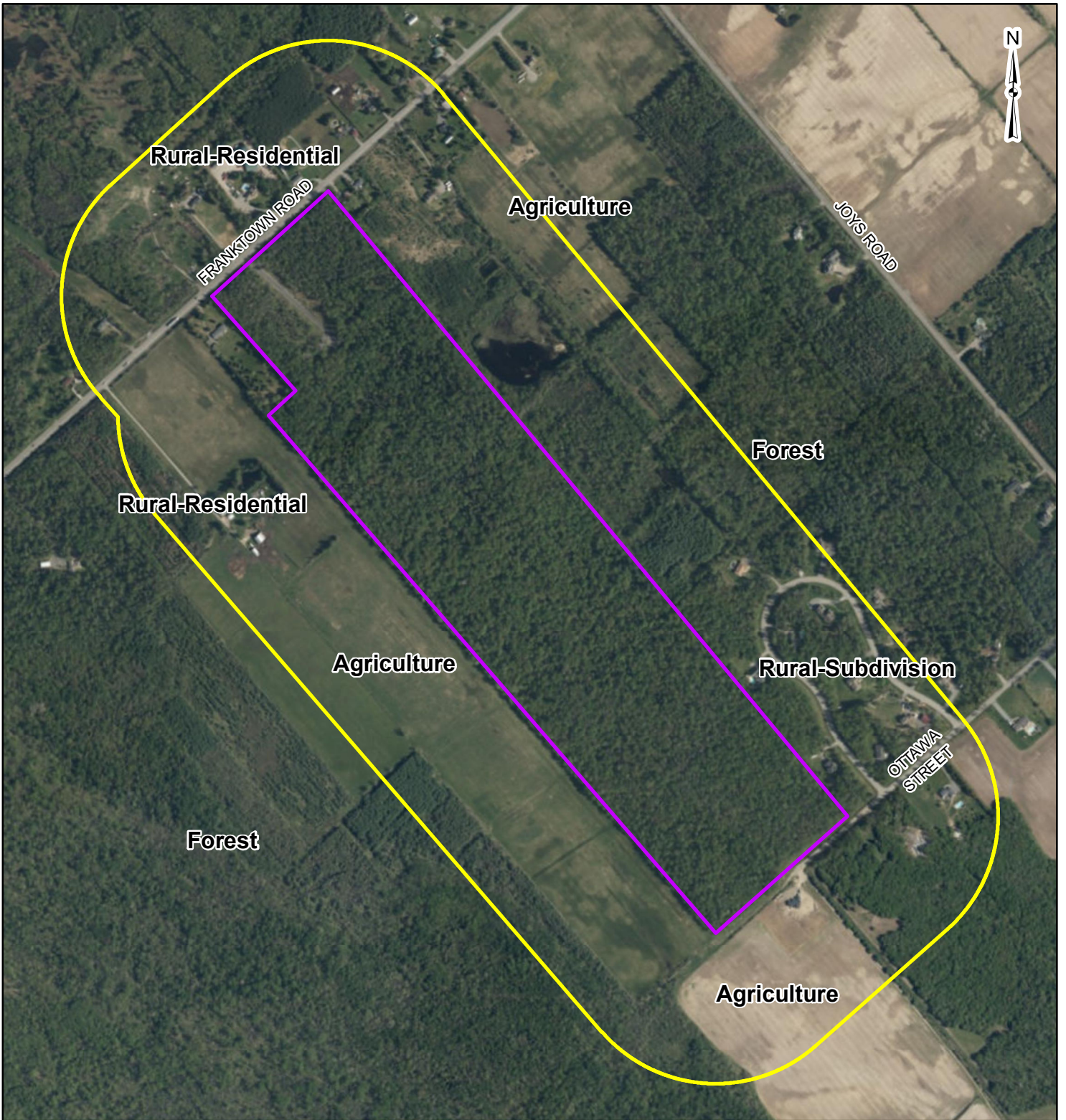
LEGEND

- Approximate Property Boundary
- Proposed Development

REFERENCE

GIS data provided by the Ontario Ministry of Natural Resources and Forestry, 2018.

CLIENT:		BING PROFESSIONAL ENGINEERING	
PROJECT:		HYDROGEOLOGICAL STUDY 6688 FRANKTOWN ROAD	
TITLE:		SITE LAYOUT	
McINTOSH PERRY <small>115 Walgreen Road, RR3, Carp, ON K0A1L0 Tel: 613-836-2184 Fax: 613-836-3742 www.mcintoshperry.com</small>	PROJECT NO: CP-17-0503	FIGURE:	2
	Date	Jul., 19, 2018	
	GIS	JD	
	Checked By	JB	



LEGEND

- Approximate Site Boundary
- 250m Buffer

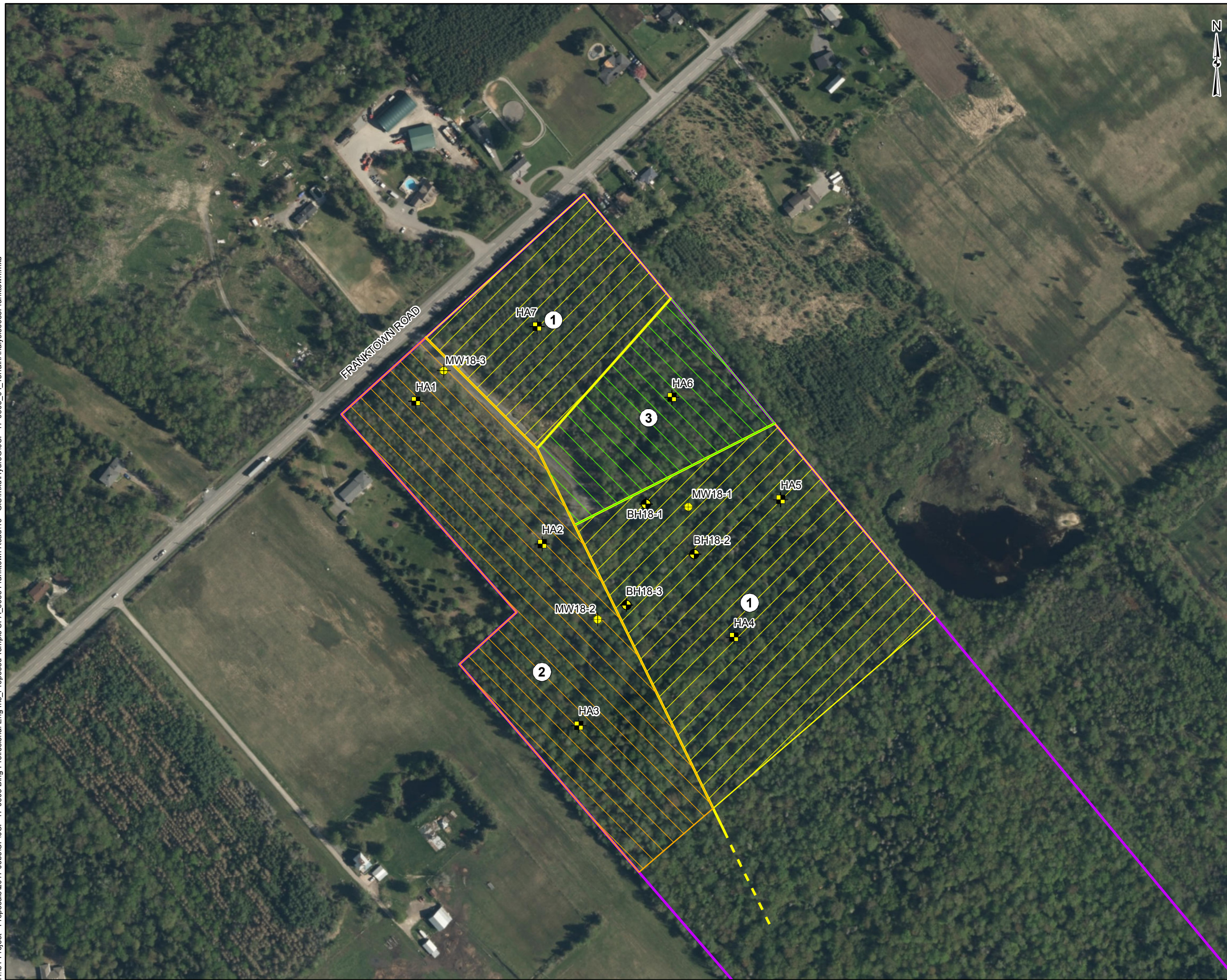
REFERENCE

GIS data provided by the Ontario Ministry of Natural Resources and Forestry, 2018.



CLIENT:		BING PROFESSIONAL ENGINEERING	
PROJECT:		HYDROGEOLOGICAL STUDY 6688 FRANKTOWN ROAD	
TITLE:		STUDY AREA AND SURROUNDING LAND USE	
McINTOSH PERRY <small>115 Walgreen Road, RR3, Carp, ON K0A1L0 Tel: 613-836-2184 Fax: 613-836-3742 www.mcintoshperry.com</small>	PROJECT NO: CP-17-0503	FIGURE:	3
	Date	Jul., 17, 2018	
	Checked By	JD	

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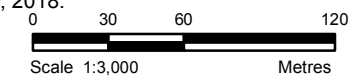


LEGEND

- Hand Auger
- Borehole
- Monitoring Well
- Site Boundary
- Zone 1 - MEDIUM SAND, some to trace fines
- Zone 2 - SILT and CLAY, trace sand
- Zone 3 - Silty FINE SAND

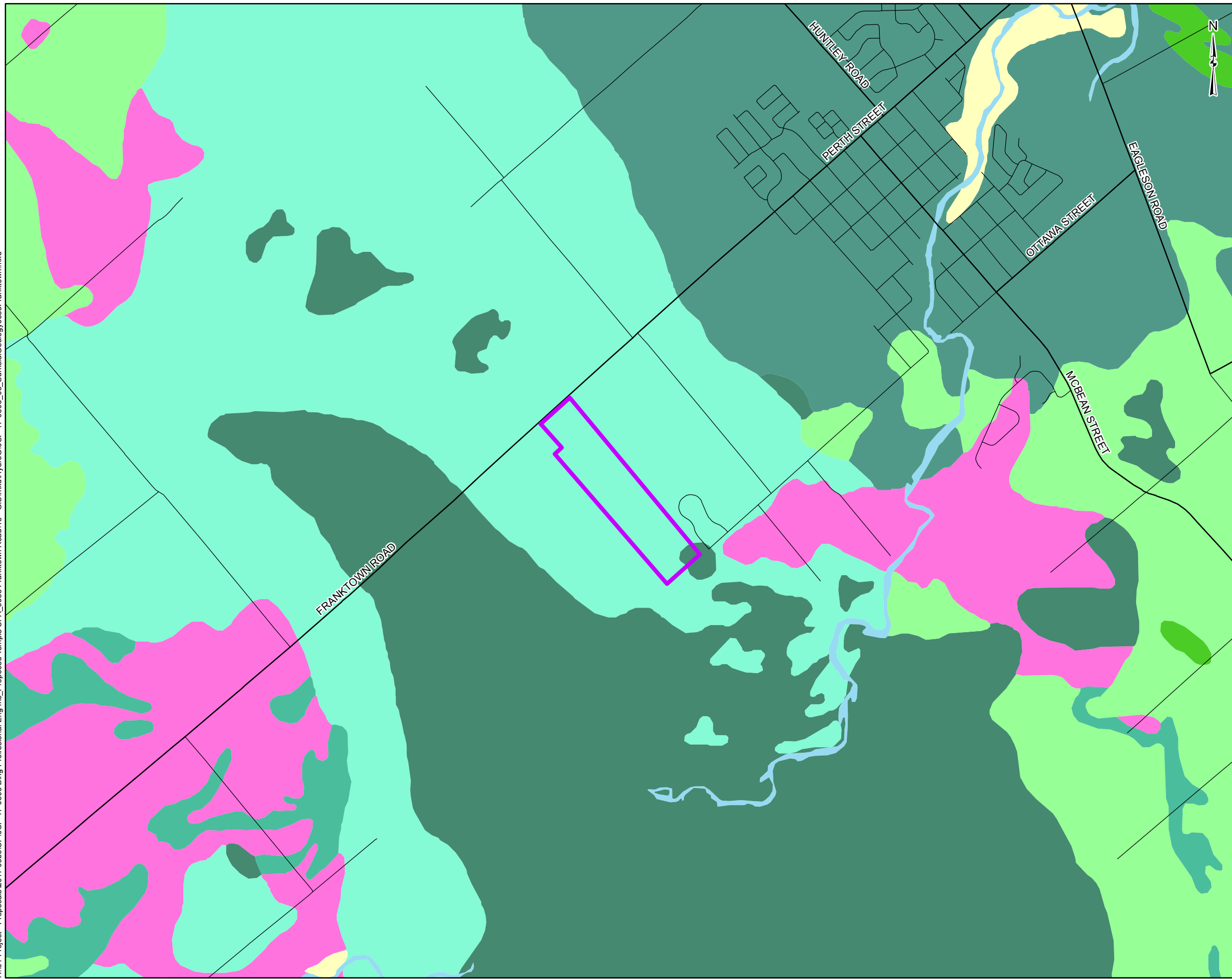
REFERENCE

GIS data provided by the Ontario Ministry of Natural Resources and Forestry, 2018.



CLIENT: BING PROFESSIONAL ENGINEERING		
PROJECT: HYDROGEOLOGICAL STUDY 6688 FRANKTOWN ROAD		
TITLE: TERRAIN ANALYSIS		
McINTOSH PERRY <small>115 Walgreen Road, RR3, Carp, ON K0A1L0 Tel: 613-836-2184 Fax: 613-836-3742 www.mcintoshperry.com</small>	PROJECT NO: CP-17-0503	FIGURE:
	Date: Jul., 19, 2018	4
	GIS: JD	
	Checked By: JB	

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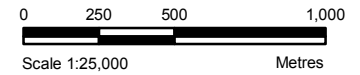


LEGEND

- Property Boundary
 - Local Road
 - Major Road
- Surficial geology**
- Description**
- Organic Deposits
 - Sand Dunes
 - Floodplains, sand, silt, clay
 - Fluvial Terraces, sand, silt
 - Reworked Marine Sediments
 - Beach Formations
 - Sand, reworked glaciofluvial
 - Deltaic and Estuarine Deposits
 - Marine Deposits, clay, silt
 - Erosional Terraces
 - Glaciofluvial Deposits
 - Till, plain
 - Till, drumlinized
 - Till, hummocky to rolling
 - Paleozoic Bedrock
 - Precambrian Bedrock
 - Water

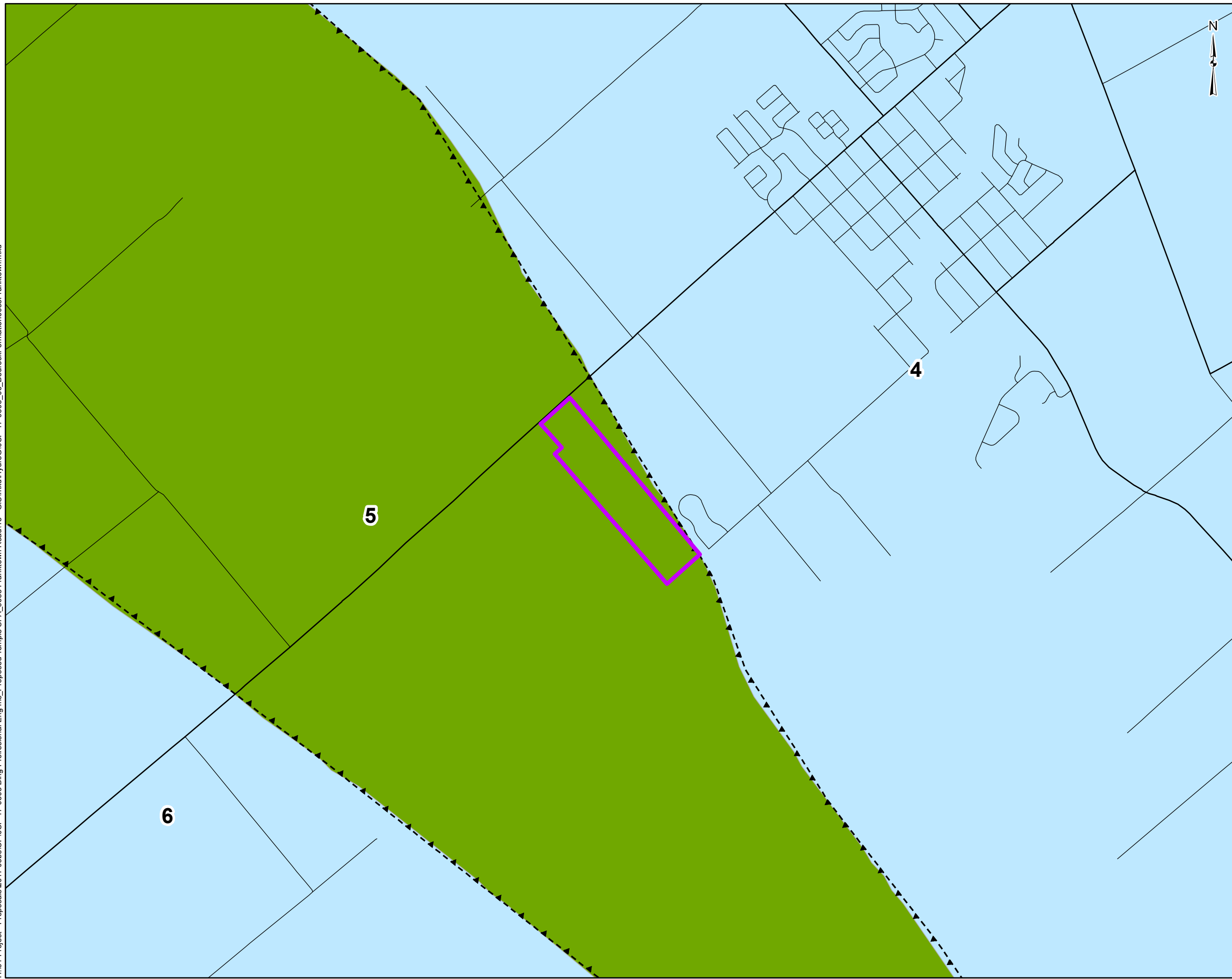
REFERENCE

GIS data provided by the Ontario Ministry of Natural Resources and Forestry, 2018.
 Surficial Geology of Southern Ontario provided by the Ontario Geological Survey, Miscellaneous Release - Data 128 - Revised










CLIENT:		BING PROFESSIONAL ENGINEERING	
PROJECT:		HYDROGEOLOGICAL STUDY 6688 FRANKTOWN ROAD	
TITLE:		SURFICIAL GEOLOGY	
McINTOSH PERRY <small>115 Walgreen Road, RR3, Carp, ON K0A1L0 Tel: 613-836-2184 Fax: 613-836-3742 www.mcintoshperry.com</small>	PROJECT NO: CP-17-0503	FIGURE:	5
	Date	Jul., 19, 2018	
	GIS	JD	
	Checked By	JB	

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LEGEND

-  Property Boundary
 -  Local Road
 -  Major Road
 -  Fault
- Bedrock Geology**
-  6 Gull River Formation: Interbedded silty dolomite, lithographic to fine crystalline limestone, oolitic limestone, shale, and fine-grained calcareous quartz sandstone
 -  5 Rockliffe Formation: Interbedded fine-grained light greenish grey quartz sandstone, shaley limestone and shale, locally conglomerate at base, interbeds of calcarenite and silty dolostone in upper part
 -  4 Oxford Formation: Sublithographic to fine crystalline dolostone

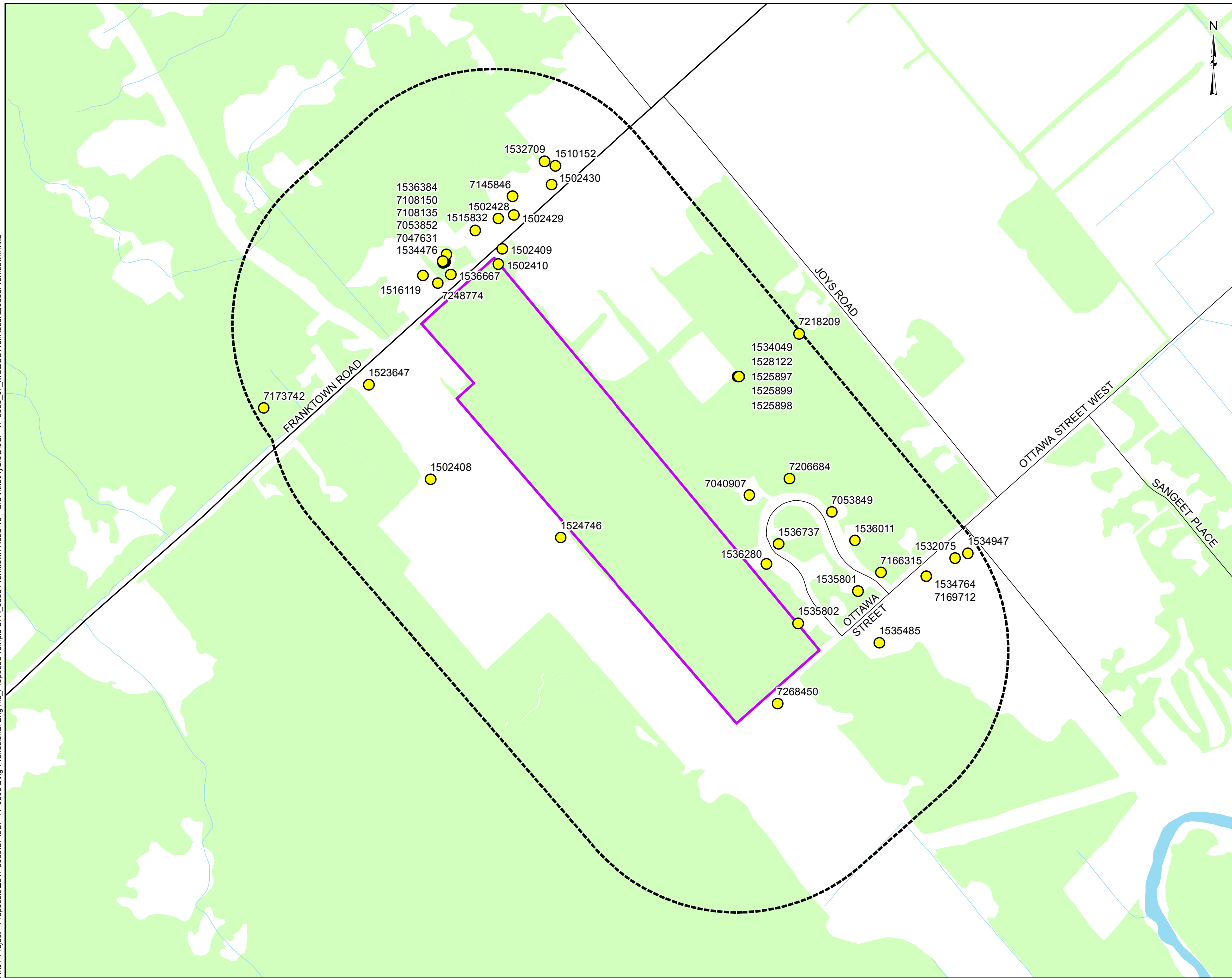
REFERENCE

GIS data provided by the Ontario Ministry of Natural Resources and Forestry, 2018.
 Urban Geology of the National Capital Area, Bélanger, R; Geological Survey of Canada, Open File 5311, 2008



CLIENT: BING PROFESSIONAL ENGINEERING						
PROJECT: HYDROGEOLOGICAL STUDY 6688 FRANKTOWN ROAD						
TITLE: BEDROCK FORMATION						
McINTOSH PERRY <small>115 Walgreen Road, RR3, Carp, ON K0A1L0 Tel: 613-836-2184 Fax: 613-836-3742 www.mcintoshperry.com</small>	PROJECT NO: CP-17-0503					
	FIGURE: 6					
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Date	Jul., 19, 2018					
GIS	JD					
Checked By	JB					

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LEGEND

- MOECC Well Record
- Site Boundary
- 500m Radius
- Local Road
- Major Road
- Watercourse
- Waterbody
- Wooded Area

REFERENCE

GIS data provided by the Ontario Ministry of Natural Resources and Forestry, 2018.

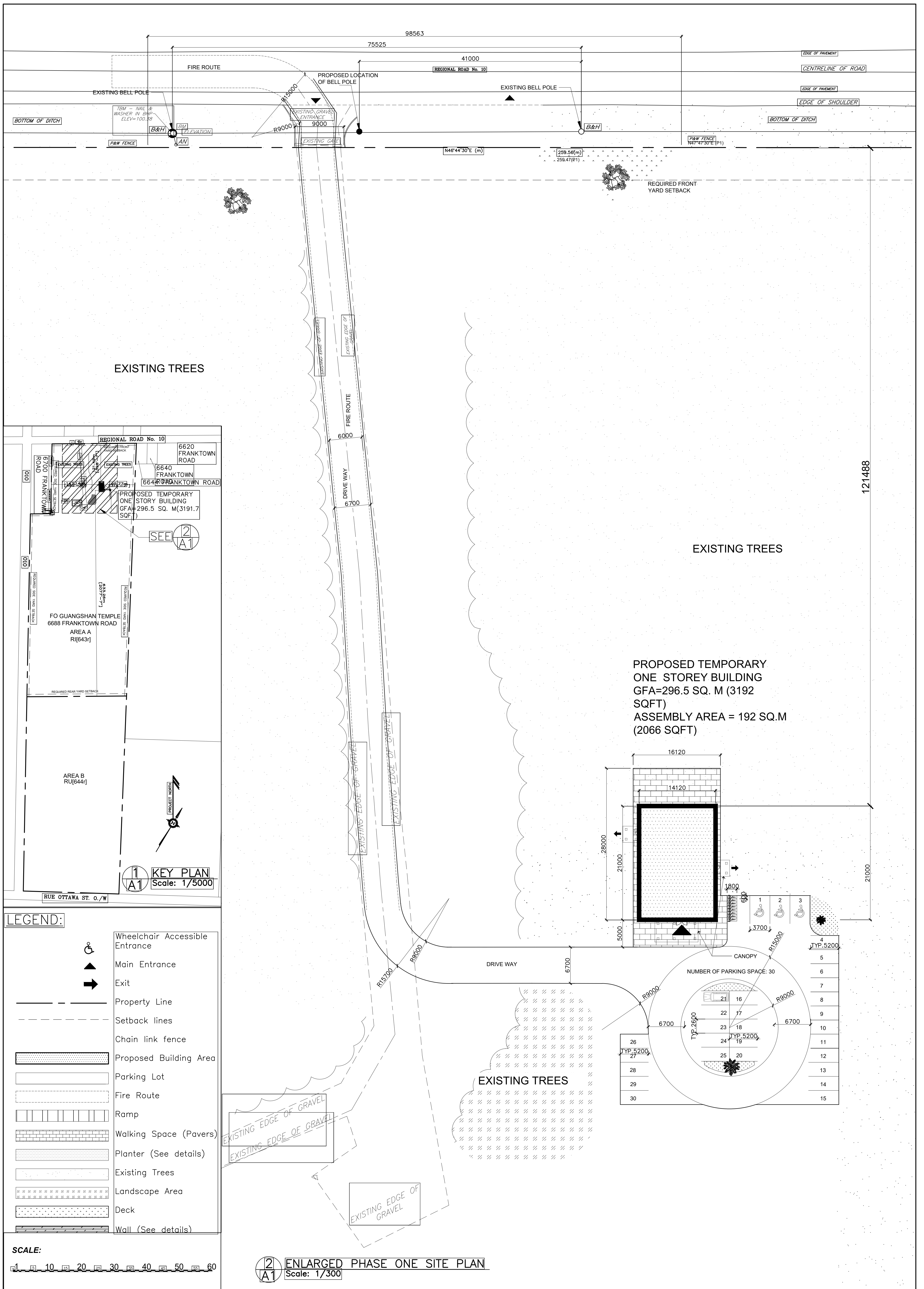
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CLIENT:		BING PROFESSIONAL ENGINEERING	
PROJECT:		HYDROGEOLOGICAL STUDY 6688 FRANKTOWN ROAD	
TITLE:		MOECC WWIS SUMMARY	
McINTOSH PERRY <small>115 Walgreen Road, RR3, Carp, ON K0A1L0 Tel: 613-836-2184 Fax: 613-836-3742 www.mcintoshperry.com</small>	PROJECT NO:	CP-17-0613	FIGURE:
	Date	Jul., 19, 2018	7
	Checked By	JB	

APPENDICES

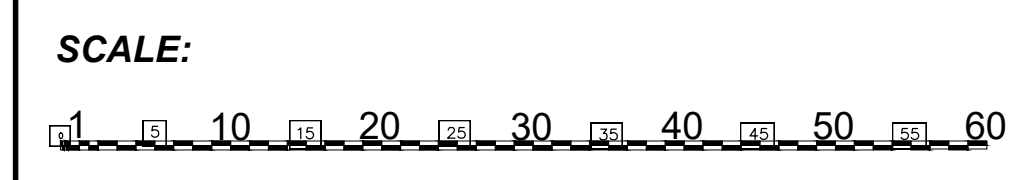
APPENDIX A

SITE PLAN



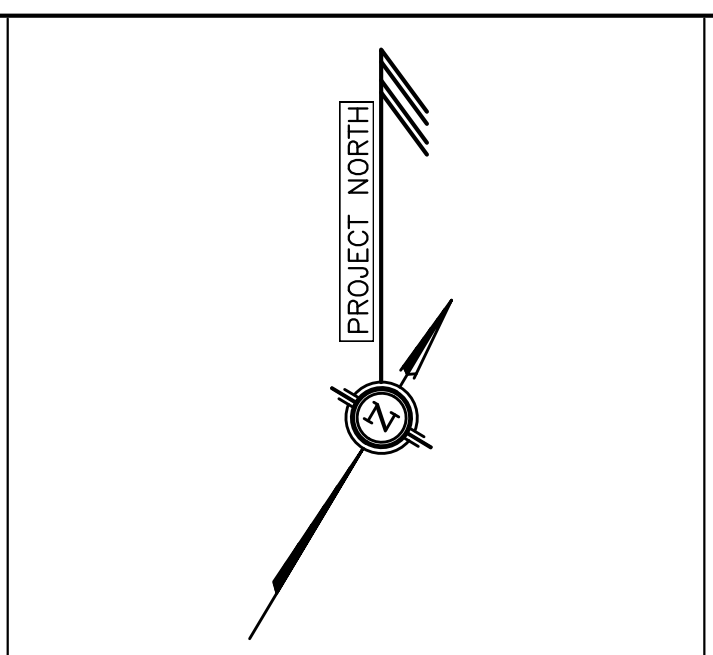
LEGEND:

	Wheelchair Accessible Entrance
	Main Entrance
	Exit
	Property Line
	Setback lines
	Chain link fence
	Proposed Building Area
	Parking Lot
	Fire Route
	Ramp
	Walking Space (Pavers)
	Planter (See details)
	Existing Trees
	Landscape Area
	Deck
	Wall (See details)



(2) ENLARGED PHASE ONE SITE PLAN
Scale: 1/300

**PROPOSED
FOGUANGSHAN TEMPLE
NEW BUILDING AT
6688 FRANKTOWN RD.
OTTAWA, ON**



SUSAN D. SMITH ARCHITECT

941 MERIVALE ROAD
OTTAWA, ONTARIO
K1Z 6A1
613-722-5327
s.smith@sdsarch.ca

SITE PLAN

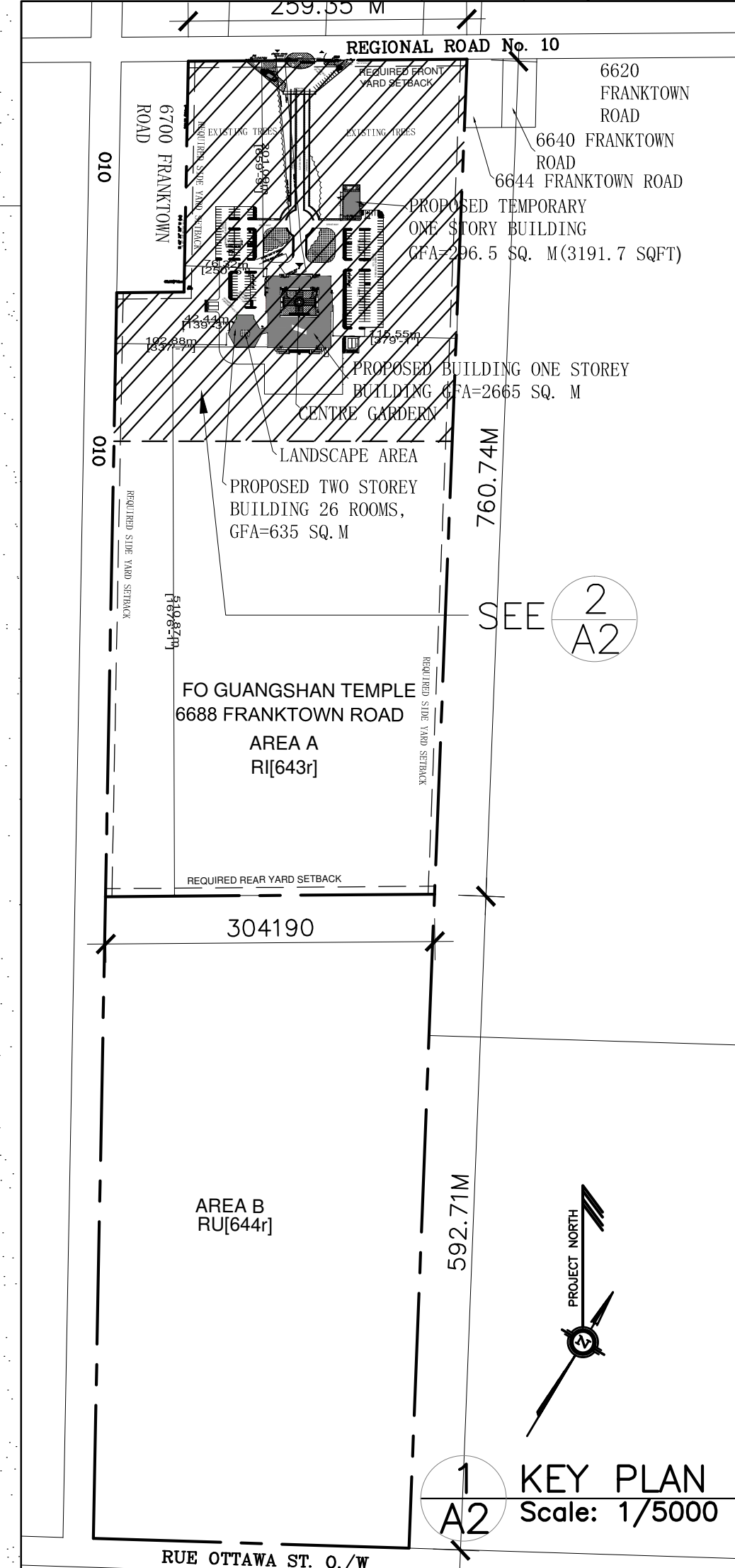
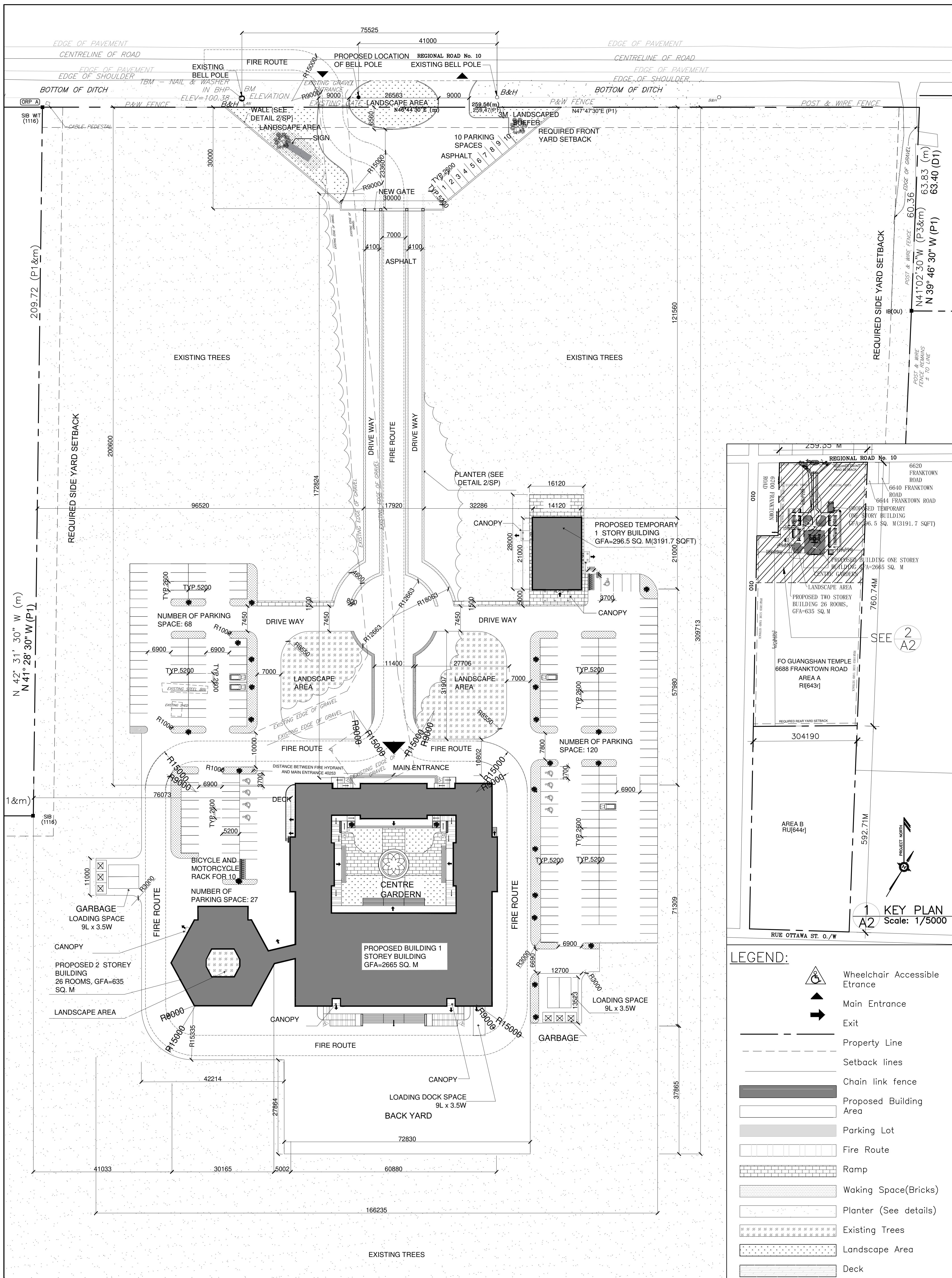
NOTES:

- All dimensions are to be checked on site. Discrepancies or ambiguities should be reported prior to work on site or ordering of materials.
- All work to be in accordance with the Ontario Building Code, latest edition.

PRELIMINARY SITE PLAN

SCALE	AS NOTES
Drawn	
Checked	
Date	MAR/2018
JOB #	

A1



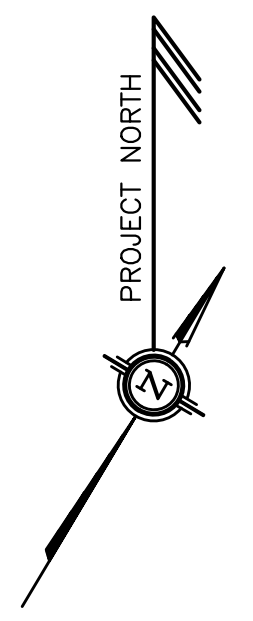
LEGEND:

- Wheelchair Accessible Entrance
- Main Entrance
- Exit
- Property Line
- Setback lines
- Chain link fence
- Proposed Building Area
- Parking Lot
- Fire Route
- Ramp
- Waking Space (Bricks)
- Planter (See details)
- Existing Trees
- Landscape Area
- Deck

SCALE:
 1 10 20 30 40 50 60

2 PRELIMINARY SITE PLAN
 A2 Scale: 1/500

**PROPOSED
 FOGUANGSHAN TEMPLE
 NEW BUILDING AT
 6688 FRANKTOWN RD.
 OTTAWA, ON**



SUSAN D. SMITH ARCHITECT
 1114 GLADSTONE AVE
 OTTAWA, ONTARIO
 K1Y 3H5
 613-722-5327
 sds@magma.ca

SITE PLAN

NOTES:
 1. All dimensions are to be checked on site. Discrepancies or ambiguities should be reported prior to work on site or ordering of materials.
 2. All work to be in accordance with the Ontario Building Code, latest edition.

PRELIMINARY SITE PLAN

SCALE	AS NOTES
Drawn	
Checked	
Date	MAR/2018
JOB #	

A2

APPENDIX B

MOECC WWIS DATA SUMMARY

MOECC WWIS DATA SUMMARY

Well ID	Depth (m)	Depth to Bedrock (m)	Static WL	Status
1534764	36.9	7.9	3.8	Water Supply
1536667	26.2	0	0	Abandoned-Other
7248774	42.7	0	4.3	<Null>
1535485	22.3	8.2	2.3	Water Supply
1502410	6.7	0	2.4	Water Supply
1510152	15.5	3.7	0	Water Supply
1532709	67.1	4.9	1.8	Water Supply
1524746	27.4	4.9	3	Water Supply
7145846	71.9	0	2	Water Supply
1502409	19.8	2.4	1.2	Water Supply
1536384	50	8.2	1.3	Water Supply
7108135	30.5	0	7.3	Water Supply
7040907	18.6	3.4	0.8	Water Supply
7169712	61	0	0	Other Status
1528122	19.2	4.6	1.8	Water Supply
1525897	30.5	11	3.4	Test Hole
1502428	18.3	9.1	4.6	Water Supply
7166315	61.3	0	5.2	Water Supply
1536737	24.7	3	2.3	Water Supply
1534049	55.2	8.2	15.2	Water Supply
1536280	21.3	4.3	2.3	Water Supply
7218209	67	0	2.8	<Null>
1523647	22.9	15.2	1.8	Water Supply
7053852	18.3	0	0.4	Water Supply
7047631	43.3	0	8.6	Water Supply
1535801	18.3	8.2	3.3	Water Supply
1502430	18.3	5.2	4.6	Water Supply
7268450	48.8	0	2.6	<Null>
7053849	18.3	0	2.8	Water Supply
1502408	18.3	7.9	2.4	Water Supply
1534947	37.5	1.5	3.8	Water Supply
1515832	19.5	3.7	0	Water Supply
1534476	54.9	1.8	3.8	Water Supply
7206684	54.9	0	1.5	<Null>
1502429	27.7	2.7	0	Water Supply
1535802	18.9	7.3	4.8	Water Supply
1525899	19.2	1.2	3.7	Test Hole
1536011	18.9	4	3.7	Water Supply
1516119	32	4.6	1.8	Water Supply
1525898	31.4	4.6	3.7	Test Hole
7173742	85.3	0	3.7	Water Supply
7108150	54.9	0	6.9	Water Supply
1532075	36.6	2.7	3	Water Supply

APPENDIX C

MOECC WELL RECORD – TW1



CERTIFICATE OF WELL COMPLIANCE

I, Ken Desaulniers DO HEREBY CERTIFY that I am licensed to drill wells in the Province of Ontario, and that I have supervised the drilling of a well on the

property of International Buddhist Progress Society of Ottawa located at # 6688 FRANKTOWN ROAD, Richmond

Lot/Plan No.) in the City of Ottawa (Geographical Township of Goulbourn Part LOT 19 CONC 3 PLAN # RP-4R-7040 S/L # Part 1

CERTIFY FURTHER that, I am aware of the well drilling requirements, the guidelines, recommendations and regulations of the Ministry of the Environment governing well installations in the Province of Ontario, and the standards specified in any subdivision agreement and hydrogeological report applicable to this site and City Standards.

AND DO HEREBY CERTIFY THAT the said well has been drilled, cased, grouted (cement or bentonite) as applicable and constructed in strict conformity with the standards required.

Signed this 11TH day of JULY 2015
Kenny [Signature] Air Rock Drilling Co. Ltd.
Well Driller/Company

The Engineer on behalf of the landowner set out above Certifies that he/she has inspected the well and it was constructed in accordance with the specifications in O.Reg.903, this report and the Hydrogeological Report with regards to casing length and grouting requirements.

SIGNED this _____ day of _____,

Engineer

2018372
TAGA252856





Measurements recorded in: Metric Imperial

Page of

Well Owner's Information

First Name, Last Name / Organization, E-mail Address, Mailing Address (Street Number/Name), Municipality, Province, Postal Code, Telephone No. (inc. area code)

Well Location

Address of Well Location (Street Number/Name), Township, Lot, Concession, County/District/Municipality, City/Town/Village, Province, Postal Code, UTM Coordinates Zone, Easting, Northing, Municipal Plan and Sublot Number, Other

Overburden and Bedrock Materials/Abandonment/Sealing Record (see instructions on the back of this form)

Table with columns: General Colour, Most Common Material, Other Materials, General Description, Depth (m/ft) From, To

Annular Space: Depth Set at (m/ft) From, To; Type of Sealant Used (Material and Type); Volume Placed (m³/G)

Method of Construction: Cable Tool, Rotary (Conventional), Rotary (Reverse), Boring, Air percussion, Other; Well Use: Public, Commercial, Not used, Domestic, Municipal, Dewatering, Livestock, Test Hole, Monitoring, Irrigation, Cooling & Air Conditioning, Industrial, Other

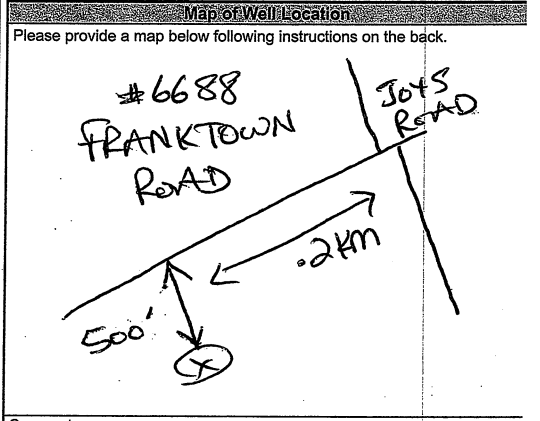
Construction Record - Casing: Inside Diameter (cm/ft), Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel), Wall Thickness (cm/ft), Depth (m/ft) From, To; Status of Well: Water Supply, Replacement Well, Test Hole, Recharge Well, Dewatering Well, Observation and/or Monitoring Hole, Alteration (Construction), Abandoned, Insufficient Supply, Abandoned, Poor Water Quality, Abandoned, other, specify

Construction Record - Screen: Outside Diameter (cm/in), Material (Plastic, Galvanized, Steel), Slot No., Depth (m/ft) From, To

Water Details: Water found at Depth (m/ft), Kind of Water: Fresh, Untested, Gas, Other; Hole Diameter: Depth (m/ft) From, To, Diameter (cm/in)

Well Contractor and Well Technician Information: Business Name of Well Contractor, Well Contractor's Licence No., Business Address (Street Number/Name), Municipality, Province, Postal Code, Business E-mail Address, Name of Well Technician (Last Name, First Name), Well Technician's Licence No., Signature of Technician and/or Contractor, Date Submitted

Results of Well Yield Testing: After test of well yield, water was: Clear and sand free, Other, specify; Draw Down: Time (min), Water Level (m/ft), Recovery: Time (min), Water Level (m/ft); Pumping rate (l/min / GPM); Duration of pumping; Final water level end of pumping (m/ft); If flowing give rate (l/min / GPM); Recommended pump depth (m/ft); Recommended pump rate (l/min / GPM); Well production (l/min / GPM); Disinfected? Yes, No



Comments: 1 HP - 20 GPM SET @ 100 FT; Well owner's information package delivered: Yes, No; Date Package Delivered: 2018 07 13; Date Work Completed: 2018 07 11; Ministry Use Only: Audit No. 7276984

APPENDIX D

LABORATORY CERTIFICATES OF ANALYSES

Certificate of Analysis

McIntosh Perry Consulting Eng. (Carp)

115 Walgreen Rd.
Carp, ON K0A 1L0
Attn: Justin Cameron

Client PO:
Project: 17-0503
Custody: 42032

Report Date: 19-Jun-2018
Order Date: 15-Jun-2018

Order #: 1824668

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
1824668-01	Hydro G-BH18-3
1824668-02	Hydro G-BH-1R
1824668-03	Hydro G-BH-2R

Approved By:



Mark Foto, M.Sc.
Lab Supervisor

Certificate of Analysis
Client: McIntosh Perry Consulting Eng. (Carp)
Client PO:

Report Date: 19-Jun-2018
Order Date: 15-Jun-2018
Project Description: 17-0503

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC	18-Jun-18	18-Jun-18

Certificate of Analysis

Report Date: 19-Jun-2018

Client: McIntosh Perry Consulting Eng. (Carp)

Order Date: 15-Jun-2018

Client PO:

Project Description: 17-0503

Client ID:	Hydro G-BH18-3	Hydro G-BH-1R	Hydro G-BH-2R	-
Sample Date:	06/15/2018 13:53	06/15/2018 14:08	06/15/2018 14:20	-
Sample ID:	1824668-01	1824668-02	1824668-03	-
MDL/Units	Water	Water	Water	-

Anions

Nitrate as N	0.1 mg/L	<0.1	<0.1	<0.1	-
Nitrite as N	0.05 mg/L	<0.05	<0.05	<0.05	-

Certificate of Analysis
 Client: McIntosh Perry Consulting Eng. (Carp)
 Client PO:

Report Date: 19-Jun-2018
 Order Date: 15-Jun-2018
 Project Description: 17-0503

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Nitrate as N	ND	0.1	mg/L						
Nitrite as N	ND	0.05	mg/L						

Certificate of Analysis
 Client: McIntosh Perry Consulting Eng. (Carp)
 Client PO:

Report Date: 19-Jun-2018
 Order Date: 15-Jun-2018
 Project Description: 17-0503

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Nitrate as N	ND	0.1	mg/L	ND				20	
Nitrite as N	ND	0.05	mg/L	ND				20	

Certificate of Analysis
 Client: McIntosh Perry Consulting Eng. (Carp)
 Client PO:

Report Date: 19-Jun-2018

Order Date: 15-Jun-2018

Project Description: 17-0503

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Nitrate as N	1.04	0.1	mg/L	ND	104	81-112			
Nitrite as N	0.903	0.05	mg/L	ND	90.3	76-117			

Certificate of Analysis
Client: McIntosh Perry Consulting Eng. (Carp)
Client PO:

Report Date: 19-Jun-2018
Order Date: 15-Jun-2018
Project Description: 17-0503

Qualifier Notes:

None

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.

Parcel ID: 1824668



TRUSTED
RESPONS
RELIABLE



Chain of Custody
(Lab Use Only)
No 42032

Page 1 of 1

Client Name: <u>APCE</u>	Project Reference: <u>17-0503</u>	Turnaround Time: <input type="checkbox"/> 1 Day <input type="checkbox"/> 3 Day <input type="checkbox"/> 2 Day <input checked="" type="checkbox"/> Regular Date Required: _____
Contact Name: <u>Justin Cameron</u>	Quote # <u>S/O</u>	
Address: <u>115 Walgreen Road, Covington, LA 70014</u>	PO # _____	
Telephone: <u>63-915-3752</u>	Email Address: <u>j.cameron@mcintoshperry.com</u>	

Criteria: O. Reg. 153/04 (As Amended) Table __ RSC Filing O. Reg. 558/00 PWQO CCME SUB (Storm) SUB (Sanitary) Municipality: _____ Other: _____

Matrix Type: S (Soil Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)				Required Analyses												
Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken		Nitrate (NO3)	Nitrite (NO2)									
				Date	Time											
1824668																
1 HydroG-BH1B-3	GW	-	1	15 Jun 2018	1:53	-	-									
2 HydroG-BH-1R	GW	-	1	↓	2:08	-	-									
3 HydroG-BH-2R	GW	-	1		2:20	-	-									
4																
5																
6																
7																
8																
9																
10																

Comments: _____ Method of Delivery: Walkin

Relinquished By (Sign): <u>S. Holik</u>	Received by Driver/Depot:	Received at Lab:	Verified By:
Relinquished By (Print): <u>Stefan Holik</u>	Date/Time: _____	Date/Time: <u>15 Jun 2018 4:03</u>	Date/Time: <u>15 Jun 2018 4:30 pm</u>
Date/Time: <u>15 Jun 18 4:00 pm</u>	Temperature: _____ °C	Temperature: <u>20</u> °C	pH Verified By: _____

Certificate of Analysis

McIntosh Perry Consulting Eng. (Carp)

115 Walgreen Rd.
RR# 3 Carp, ON K0A 1L0
Attn: Jordan Bowman

Client PO:
Project: 17-0503
Custody: 6644

Report Date: 16-Jul-2018
Order Date: 13-Jul-2018

Order #: 1828639

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Parcel ID	Client ID
1828639-01	TW1-1
1828639-02	TW1-2

Approved By:



Dale Robertson, BSc
Laboratory Director

Certificate of Analysis
Client: McIntosh Perry Consulting Eng. (Carp)
Client PO:

Report Date: 16-Jul-2018

Order Date: 13-Jul-2018

Project Description: 17-0503

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Alkalinity, total to pH 4.5	EPA 310.1 - Titration to pH 4.5	16-Jul-18	16-Jul-18
Ammonia, as N	EPA 351.2 - Auto Colour	16-Jul-18	16-Jul-18
Anions	EPA 300.1 - IC	16-Jul-18	16-Jul-18
Colour	SM2120 - Spectrophotometric	16-Jul-18	16-Jul-18
Conductivity	EPA 9050A- probe @25 °C	16-Jul-18	16-Jul-18
Dissolved Organic Carbon	MOE E3247B - Combustion IR, filtration	16-Jul-18	16-Jul-18
E. coli	MOE E3407	13-Jul-18	14-Jul-18
Fecal Coliform	SM 9222D	13-Jul-18	14-Jul-18
Metals, ICP-MS	EPA 200.8 - ICP-MS	16-Jul-18	16-Jul-18
pH	EPA 150.1 - pH probe @25 °C	16-Jul-18	16-Jul-18
Phenolics	EPA 420.2 - Auto Colour, 4AAP	16-Jul-18	16-Jul-18
Subdivision Package	Hardness as CaCO ₃	16-Jul-18	16-Jul-18
Sulphide	SM 4500SE - Colourimetric	16-Jul-18	16-Jul-18
Tannin/Lignin	SM 5550B - Colourimetric	16-Jul-18	16-Jul-18
Total Coliform	MOE E3407	13-Jul-18	14-Jul-18
Total Dissolved Solids	SM 2540C - gravimetric, filtration	13-Jul-18	16-Jul-18
Total Kjeldahl Nitrogen	EPA 351.2 - Auto Colour, digestion	16-Jul-18	16-Jul-18
Turbidity	SM 2130B - Turbidity meter	16-Jul-18	16-Jul-18

Certificate of Analysis
 Client: McIntosh Perry Consulting Eng. (Carp)
 Client PO:

Report Date: 16-Jul-2018

Order Date: 13-Jul-2018

Project Description: 17-0503

Client ID:	TW1-1	TW1-2	-	-
Sample Date:	07/13/2018 08:20	07/13/2018 14:12	-	-
Sample ID:	1828639-01	1828639-02	-	-
MDL/Units	Drinking Water	Drinking Water	-	-

Microbiological Parameters

E. coli	1 CFU/100 mL	ND	ND	-	-
Fecal Coliforms	1 CFU/100 mL	ND	ND	-	-
Total Coliforms	1 CFU/100 mL	ND	ND	-	-

General Inorganics

Alkalinity, total	5 mg/L	325	328	-	-
Ammonia as N	0.01 mg/L	0.12	0.12	-	-
Dissolved Organic Carbon	0.5 mg/L	2.9	3.2	-	-
Colour	2 TCU	3 [1]	4 [1]	-	-
Conductivity	5 uS/cm	697	834	-	-
Hardness	mg/L	259	327	-	-
pH	0.1 pH Units	7.7	7.6	-	-
Phenolics	0.001 mg/L	<0.001	<0.001	-	-
Total Dissolved Solids	10 mg/L	380	486	-	-
Sulphide	0.02 mg/L	<0.02	<0.02	-	-
Tannin & Lignin	0.1 mg/L	0.1	0.1	-	-
Total Kjeldahl Nitrogen	0.1 mg/L	0.2	0.2	-	-
Turbidity	0.1 NTU	1.5 [1]	1.4 [1]	-	-

Anions

Chloride	1 mg/L	24	65	-	-
Fluoride	0.1 mg/L	0.4	0.4	-	-
Nitrate as N	0.1 mg/L	<0.1	<0.1	-	-
Nitrite as N	0.05 mg/L	<0.05	<0.05	-	-
Sulphate	1 mg/L	38	41	-	-

Metals

Calcium	0.1 mg/L	55.7	75.4	-	-
Iron	0.1 mg/L	0.1	0.1	-	-
Magnesium	0.2 mg/L	29.2	33.7	-	-
Manganese	0.005 mg/L	0.006	0.006	-	-
Potassium	0.1 mg/L	4.6	4.8	-	-
Sodium	0.2 mg/L	17.6	21.6	-	-

Certificate of Analysis
Client: McIntosh Perry Consulting Eng. (Carp)
Client PO:

Report Date: 16-Jul-2018

Order Date: 13-Jul-2018

Project Description: 17-0503

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	ND	1	mg/L						
Fluoride	ND	0.1	mg/L						
Nitrate as N	ND	0.1	mg/L						
Nitrite as N	ND	0.05	mg/L						
Sulphate	ND	1	mg/L						
General Inorganics									
Alkalinity, total	ND	5	mg/L						
Ammonia as N	ND	0.01	mg/L						
Dissolved Organic Carbon	ND	0.5	mg/L						
Colour	ND	2	TCU						
Conductivity	ND	5	uS/cm						
Phenolics	ND	0.001	mg/L						
Total Dissolved Solids	ND	10	mg/L						
Sulphide	ND	0.02	mg/L						
Tannin & Lignin	ND	0.1	mg/L						
Total Kjeldahl Nitrogen	ND	0.1	mg/L						
Turbidity	ND	0.1	NTU						
Metals									
Calcium	ND	0.1	mg/L						
Iron	ND	0.1	mg/L						
Magnesium	ND	0.2	mg/L						
Manganese	ND	0.005	mg/L						
Potassium	ND	0.1	mg/L						
Sodium	ND	0.2	mg/L						
Microbiological Parameters									
E. coli	ND	1	CFU/100 mL						
Fecal Coliforms	ND	1	CFU/100 mL						
Total Coliforms	ND	1	CFU/100 mL						

Certificate of Analysis
 Client: McIntosh Perry Consulting Eng. (Carp)
 Client PO:

Report Date: 16-Jul-2018

Order Date: 13-Jul-2018

Project Description: 17-0503

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	23.9	1	mg/L	23.8			0.4	10	
Fluoride	0.44	0.1	mg/L	0.44			1.1	10	
Nitrate as N	ND	0.1	mg/L	ND			0.0	20	
Nitrite as N	ND	0.05	mg/L	ND				20	
Sulphate	38.7	1	mg/L	38.3			0.9	10	
General Inorganics									
Alkalinity, total	319	5	mg/L	325			1.9	14	
Ammonia as N	0.103	0.01	mg/L	0.120			14.7	17.7	
Dissolved Organic Carbon	2.8	0.5	mg/L	2.9			4.8	37	
Colour	3	2	TCU	3			0.0	12	
Conductivity	691	5	uS/cm	697			0.9	11	
pH	7.8	0.1	pH Units	7.7			0.6	10	
Phenolics	ND	0.001	mg/L	ND				10	
Total Dissolved Solids	54.0	10	mg/L	54.0			0.0	10	
Sulphide	1.16	0.04	mg/L	1.18			1.5	10	
Tannin & Lignin	ND	0.1	mg/L	ND			0.0	11	
Total Kjeldahl Nitrogen	0.16	0.1	mg/L	0.17			4.4	10	
Turbidity	1.5	0.1	NTU	1.5			0.7	10	
Metals									
Iron	0.1	0.1	mg/L	0.1			9.6	20	
Magnesium	30.4	0.2	mg/L	29.2			3.9	20	
Manganese	0.007	0.005	mg/L	0.006			3.1	20	
Potassium	4.8	0.1	mg/L	4.6			2.5	20	
Sodium	17.8	0.2	mg/L	17.6			1.3	20	
Microbiological Parameters									
E. coli	ND	1	CFU/100 mL	ND				30	
Fecal Coliforms	ND	1	CFU/100 mL	ND				30	
Total Coliforms	ND	1	CFU/100 mL	ND				30	

Certificate of Analysis
 Client: McIntosh Perry Consulting Eng. (Carp)
 Client PO:

Report Date: 16-Jul-2018

Order Date: 13-Jul-2018

Project Description: 17-0503

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	33.1	1	mg/L	23.8	92.6	78-112			
Fluoride	1.37	0.1	mg/L	0.44	92.3	73-113			
Nitrate as N	0.97	0.1	mg/L	ND	96.6	81-112			
Nitrite as N	0.911	0.05	mg/L	ND	91.1	76-107			
Sulphate	46.8	1	mg/L	38.3	84.3	75-111			
General Inorganics									
Ammonia as N	0.370	0.01	mg/L	0.120	100	81-124			
Dissolved Organic Carbon	12.6	0.5	mg/L	2.9	97.5	60-133			
Phenolics	0.022	0.001	mg/L	ND	89.9	69-132			
Total Dissolved Solids	106	10	mg/L		106	75-125			
Sulphide	0.50	0.02	mg/L		99.6	79-115			
Tannin & Lignin	1.1	0.1	mg/L	ND	111	71-113			
Total Kjeldahl Nitrogen	2.22	0.1	mg/L	0.17	103	81-126			
Metals									
Calcium	832		ug/L		83.2	80-120			
Iron	872		ug/L		87.2	80-120			
Magnesium	1050		ug/L		105	80-120			
Manganese	49.2		ug/L		98.3	80-120			
Potassium	1160		ug/L		116	80-120			
Sodium	1040		ug/L		104	80-120			

Certificate of Analysis
Client: McIntosh Perry Consulting Eng. (Carp)
Client PO:

Report Date: 16-Jul-2018

Order Date: 13-Jul-2018

Project Description: 17-0503

Qualifier Notes:

Login Qualifiers :

Samples received submerged in water, possibly melted ice. This condition can compromise sample integrity.

Applies to samples: TW1-1, TW1-2

Sample Qualifiers :

1 : This analysis was conducted after the accepted holding time had been exceeded.

QC Qualifiers :

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable

ND: Not Detected

MDL: Method Detection Limit

Source Result: Data used as source for matrix and duplicate samples

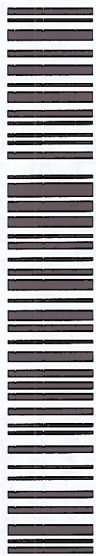
%REC: Percent recovery.

RPD: Relative percent difference.

PARACCE

LABORATORIES

Parcel ID: 1828639



Bldg. 4J8
js.com

Parcel Order Number

1828639

Chain Of Custody
Ontario Drinking Water Samples

No 6644

Client Name:	McLachlan Perry	Project Ref:	17-0503	Waterworks Name:	
Contact Name:	S. Bowman	Quote #:	S/D	Waterworks Number:	
Address:	115 Walsgreen Rd	PO #:	17-0503	Address:	
After Hours Contact:		E-mail:	j.bowman@mcclachlanperry.com	Public Health Unit:	
Telephone:	613 229 9528	Fax:			

Samples Submitted Under: (Indicate ONLY one)

ON REG 170/03 ON REG 318/08 Private Well

ON REG 243/07 ON REG 319/08 Other: *OWS*

Have LSN forms been submitted to MOE/MOHLTC?: Yes No N/A

Are these samples for human consumption?: Yes No

All information must be completed before samples will be processed.

LOCATION NAME	SAMPLE ID	Sample Type: R/T/D/P	Source Type: G/S	Reportable: Y/N	Resample	SAMPLE COLLECTED		# of Containers	Free/Combined Chlorine Residual mg/L	Standing / Flushed: S/O (REG 243)	Total Coliform/E. Coli	Required Analyses						
						DATE	TIME					HPC	Lead	THM	Subdiv.			
	1	TW 1	TW 1-1	P	G	N	17-Jul-18	0820	8	No	F							
	2	TW 1	TW 1-2	P	G	N	13-Jul-19	See Bottles	8	No	F							
	3							2:12										
	4																	
	5																	
	6																	
	7																	
	8																	
	9																	
	10																	

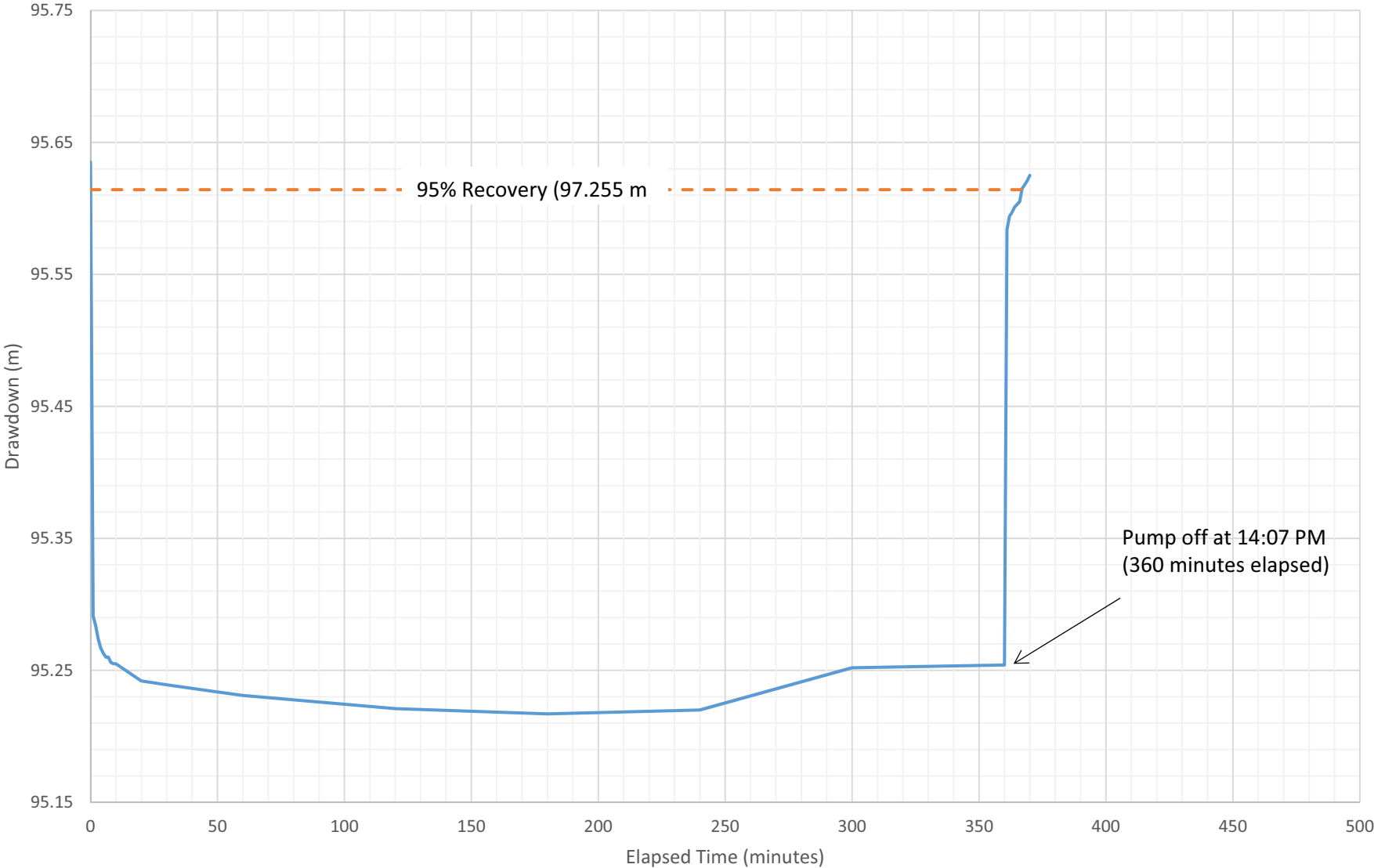
Comments: Please Rush Results. *Sample submerged in the water, water in container for 24 hrs.*

Relinquished By (Sign):	Received By Driver/Depot:	Relinquished at Lab:	Verified By:
<i>S. Bowman</i>		<i>W. D. S. 2</i>	<i>W. D. S. 2</i>
Date/Time: 13-Jul-2018 / 15:00	Temperature: °C	Date/Time: July 18/18 4pm	Date/Time: 13/7/18
		Temperature: 40.1 °C	By: <i>W. D. S. 2</i>

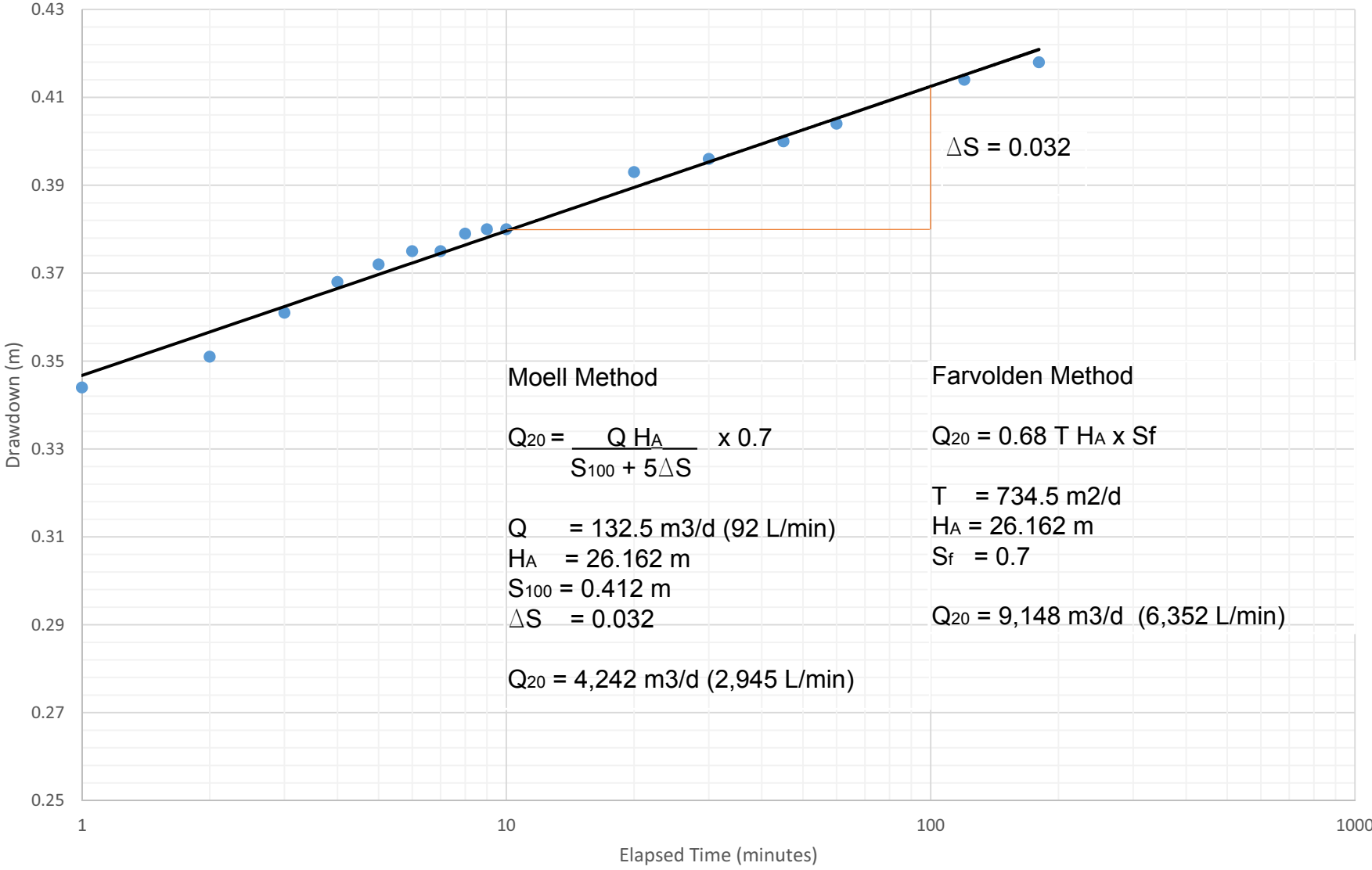
APPENDIX E

WATER LEVEL DATA AND ASSOCIATED ANALYSES

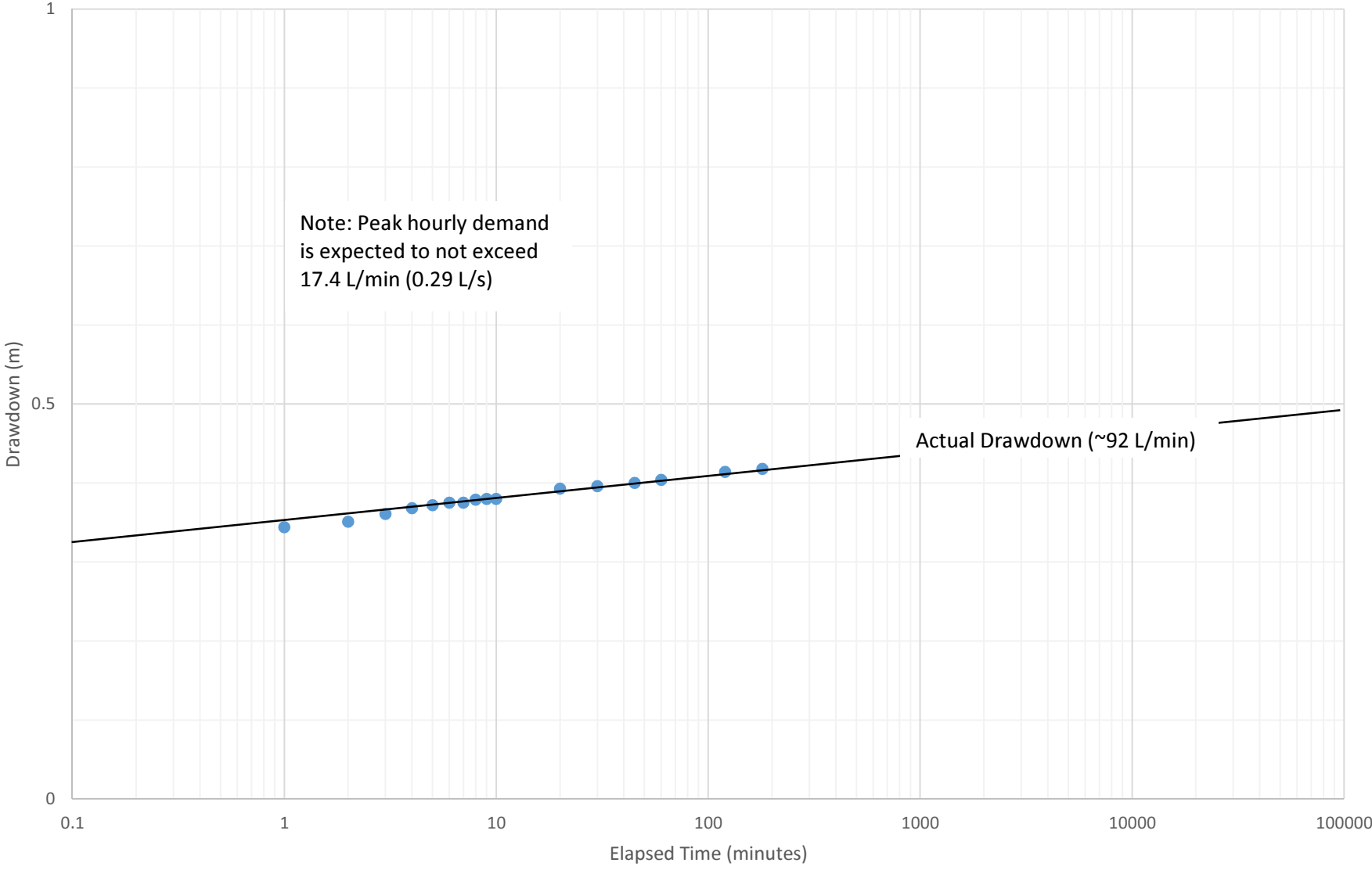
Drawdown vs Time
TW1 Pumping Test (Drawdown), July 13, 2018
6688 Franktown Road, Ottawa, ON



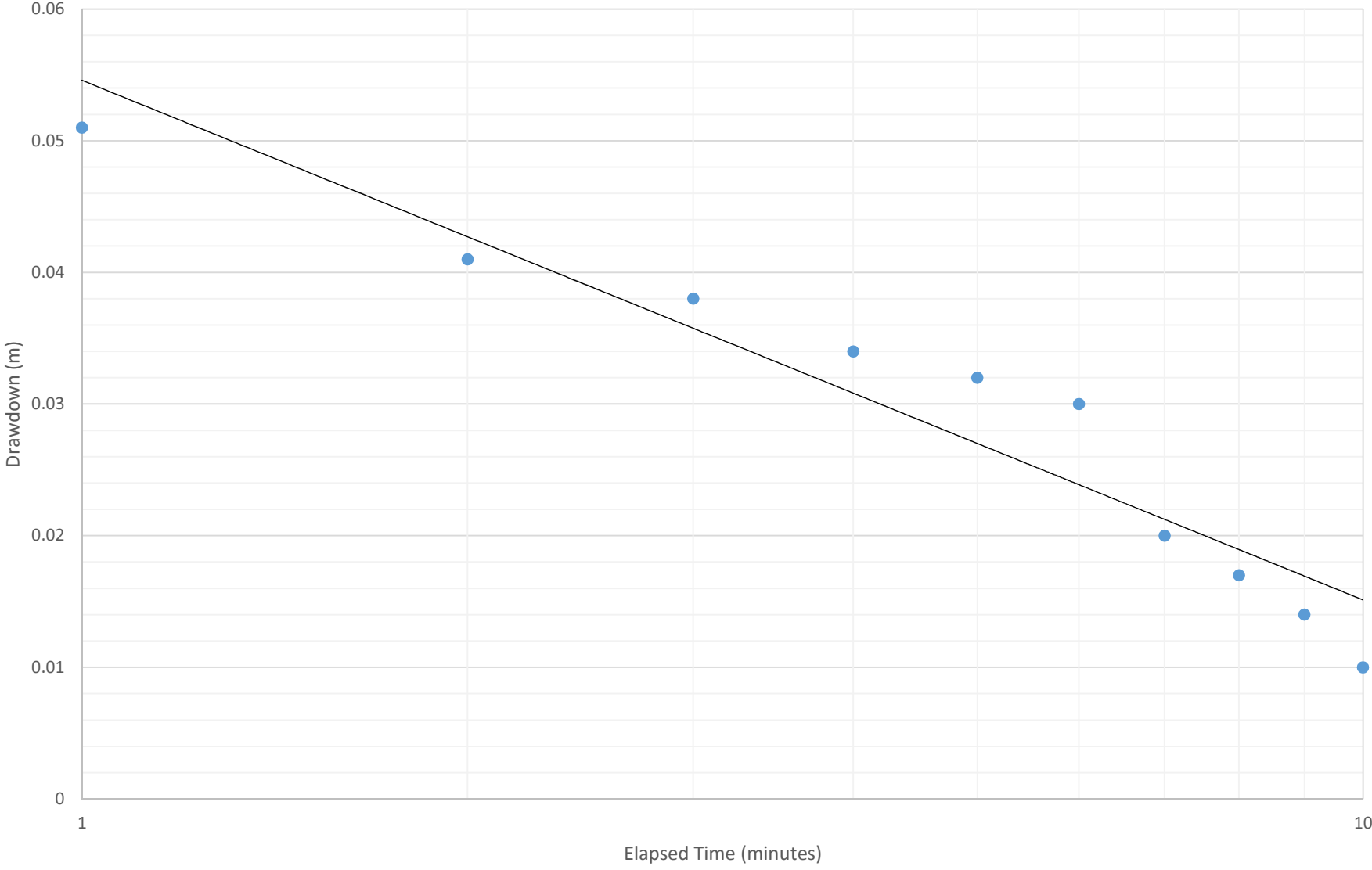
Drawdown vs Log Time
TW1 Pumping Test (Drawdown), July 13, 2018
6688 Franktown Road, Ottawa, ON



Drawdown vs Log Time
TW1 Pumping Test (Drawdown), July 13, 2018
6688 Franktown Road, Ottawa, ON



Drawdown (Recovery) vs Log Time
TW1 Pumping Test (Drawdown), July 13, 2018
6688 Franktown Road, Ottawa, ON



APPENDIX F

LANGELIER SATURATION INDEX (LSI) AND RYZNAR STABILITY INDEX (RSI) CALCULATIONS

Langelier Saturation Index (LSI)

If LSI is negative: No potential to scale, the water will dissolve CaCO₃

If LSI is positive: Scale can form and CaCO₃ precipitation may occur

If LSI is close to zero: Borderline scale potential. Water quality or changes in temperature, or evaporation could change the index.

The LSI is probably the most widely used indicator of cooling water scale potential. It is purely an equilibrium index and deals only with the thermodynamic driving force for calcium carbonate scale formation and growth.

$$LSI = pH - pH_s$$

Where:

pH is the measured water pH

pH_s is the pH at saturation in calcite or calcium carbonate and is defined as:

$$pH_s = (9.3 + A + B) - (C + D)$$

Where:

$$A = (\text{Log}_{10} [\text{TDS}] - 1) / 10$$

$$B = -13.12 \times \text{Log}_{10} (^{\circ}\text{C} + 273) + 34.55$$

$$C = \text{Log}_{10} [\text{Ca}^{2+} \text{ as CaCO}_3] - 0.4$$

$$D = \text{Log}_{10} [\text{alkalinity as CaCO}_3]$$

TW1_2					
pH	6.76			A	0.168664
TDS	486			B	2.399298
Hardness	327			C	2.114548
Alkalinity	328			D	2.515874
Temp.	9.17				
pH _s =					7.23754
LSI =					-0.47754
RSI =					7.71508

Ryznar Stability Index (RSI)

$$RSI = 2(pH_s) - pH$$

Where:

pH is the measured water pH

pH_s is the pH at saturation in calcite or calcium carbonate

The empirical correlation of the Ryznar stability index can be summarized as follows:

RSI << 6 the scale tendency increases as the index decreases

RSI >> 7 the calcium carbonate formation probably does not lead to a protective corrosion inhibitor film

RSI >> 8 mild steel corrosion becomes an increasing problem.

APPENDIX G

PHOTOGRAPHIC LOG



Photo 1: Site entrance, view of Franktown Road from MW18-3



Photo 2: On-site construction laneway, view from Franktown Road



Photo 3: On-site cleared area in vicinity of proposed

APPENDIX H

REASONABLE USE ASSESSMENT

MEMORANDUM

To: Bing Professional Engineering Inc.
From: McIntosh Perry Consulting Engineers Ltd.
Date: July 30, 2018
Re: 6688 Franktown Road Reasonable Use Assessment

McIntosh Perry Consulting Engineers Ltd. (McIntosh Perry) was retained by Mr. Bingfeng Li of Bing Professional Engineering Inc. (Bing Professional Engineering) to conduct a Reasonable Use Assessment on a parcel of land located at 6688 Franktown Road in Ottawa, Ontario (the Site). The Site currently consists of forested land, with a cleared portion that will be utilized for future development of a place of worship. The total area of the Site is approximately 39.89 hectares (ha), while the proposed development will have a footprint of approximately 2.71 ha.

Ground surface at the Site is relatively flat. Drainage in the area of the proposed development is interpreted to reflect surface topography, and is likely controlled by ditches along Jinkinson Road. Other areas of the site likely drain to the south, toward the Richmond Fen. The regional groundwater is interpreted to flow to the south, and slightly east, toward the Jock River.

As part of the hydrogeological assessment at the site, two samples (TW1_1 and TW1_2) were collected from a newly drilled on-site water supply well (Test Well 1, TW1). The well, TW1, is located slightly south of the proposed driveway location, roughly 100 m east of Franktown Road. The samples were analyzed for the 'subdivision supply' suite of parameters, which includes nitrate, as well as a suite of metals. The nitrate concentration was below the laboratory detection limit (<0.1 mg/L) (**see laboratory results attached**) in both of the samples collected. The well extends approximately 61.0 m below ground surface, with bedrock detected from 3.05 m below ground surface to 61.0 m below ground surface. The well is believed to be representative of the hydrogeological conditions across the proposed development area.

A concern with rural development is the potential contamination of shallow aquifers with nitrates. As part of the terrain analysis conducted by McIntosh Perry, three monitoring wells (MW18-1, MW18-2, MW18-3) were advanced and sampled at the Site. Note that samples from MW18-1, MW18-2, and MW18-3 are referred to on the Chain of Custody as samples HydroG-BH18-1R, HydroG-BH18-2R, and HydroG-BH18-3, respectively. Each monitoring well was sampled for nitrates and nitrites (**see laboratory results attached**). The present background concentrations of nitrate on site is less than the laboratory method detection limit (<0.1 mg/L) (**see lab results attached**). For the purposes of calculating the nitrate dilution, half of the laboratory method detection limit of 0.05 mg/L was used as the background nitrate concentration. There appears to be limited upgradient sources of nitrate to groundwater in the area as most of the surrounding land is forested, and there are no large developments in the surround area on septic systems. Therefore, the potential nitrate contaminant increase from other sources has been determined to be 0 mg/L.

Large subsurface sewage disposal systems (systems with daily design flows greater than 10,000 L/day) are bound by the Ministry of the Environment, Conservation and Parks (MOECP) *Guideline B-7: Incorporation of the Reasonable Use Concept into MOEE Groundwater Management*. The maximum allowable boundary nitrate concentration is a fraction of the relevant drinking water standards. As per Guideline B-7, in this case, the maximum concentration of nitrate in groundwater is a correlation between one quarter of the health-related Ontario Drinking Water Quality Standards (ODWQS) limit for nitrate of 10 mg/L, and the background nitrate concentration. The maximum concentration of nitrate at the property boundary is calculated as follows:

$$C_m = C_b + x (C_r - C_b)$$

Where,

- C_m is the maximum concentration of nitrate that would be acceptable in the groundwater beneath the adjacent property;
- C_b is the background concentration of nitrate in the groundwater before it has been affected by human activity;
- x is 0.25 for health-related parameters, and
- C_r is the maximum concentration of nitrate in accordance with the Ontario water management guideline (ODWQS in this case), as per Guideline B-7.

Therefore,

$$C_m = 0.05 \text{ mg/L} + (0.25)(10 \text{ mg/L} - 0.05 \text{ mg/L})$$

$$C_m = 2.54 \text{ mg/L}$$

The lot size downgradient of the septic system distribution header (approximately 39.67 ha) is sufficiently large enough to accommodate the proposed septic system without increasing the nitrate concentrations above the property boundary nitrate concentration limit of 2.54 mg/L.

The nitrate concentration calculations are as follows (see nitrate concentration calculations attached for further details):

Land Area:

Approximate Land Area Downgradient of the Septic System Distribution Header (A) = 39.67 ha = 396,649.7 m²

Water Surplus:

$$\text{Water Surplus (Ws)} = \text{Precipitation} - \text{Evapotranspiration}$$

Where,

- Precipitation = 943.4 mm/year (Based off of Environment Canada's average yearly precipitation from 1981 to 2010 for the Ottawa MacDonald-Cartier International Airport), and
- Evapotranspiration = 609.52 mm/year (Based off of Thornthwaite Method, "Hydrology & Hydraulic Systems", Gupta).

Therefore,

$$Ws = 943.4 \text{ mm/year} - 609.52 \text{ mm/year}$$

$$Ws = 333.88 \text{ mm/year}$$

Infiltration Factor:

$$\text{Infiltration Factor } (If) = \sum \text{Topographic } If + \text{Soil } If + \text{Cover } If$$

Where,

- Topographic Infiltration Factor for Flat & Rolling Terrain= 0.275;
- Soil Infiltration Factor for Sand and Silt= 0.4, and
- Cover Infiltration Factor for Woodland / Meadow= 0.15 (MOEE Hydrogeological Technical Information Requirements for Land Development Applications, 1995).

Therefore,

$$If = \sum 0.275 + 0.4 + 0.15$$

$$If = 0.825$$

Infiltration:

$$\text{Infiltration } (I) = Ws * If$$

$$I = (333.88) * (0.825)$$

$$I = 275.45 \text{ mm/year} = 0.275 \text{ m/year}$$

Dilution Water Available:

$$\text{Dilution Water Available } (Dw) = A * I$$

$$Dw = (396,649.7 \text{ m}^2) * (0.275 \text{ m/year})$$

$$Dw = 109,256.3 \text{ m}^3/\text{year} \left| \frac{1000 \text{ L}}{1 \text{ m}^3} \right| \left| \frac{1 \text{ year}}{365 \text{ day}} \right| = 299,332.3 \text{ L/day}$$

Nitrate Concentrations:

$$Cw = Cm - Cp - Co$$

Where,

- Cw is the maximum nitrate concentration originating in the disposal site that can be permitted to reach the adjacent property and not cause Cm to be exceeded;

- C_m is the maximum concentration of nitrate that would be acceptable in the groundwater beneath the adjacent property (2.54 mg/L);
- C_p is the background concentration of nitrate in the groundwater (0.05 mg/L), and
- C_o is the potential contaminant increase from other sources (0 mg/L).

Therefore,

$$C_w = 2.54 \text{ mg/L} - 0.05 \text{ mg/L} - 0 \text{ mg/L}$$

$$C_w = 2.49 \text{ mg/L}$$

Effluent Nitrate Concentration

$$\text{Effluent Nitrate Concentration } (C_e) = \frac{(C_w * D_w) + (C_w * Q_e)}{Q_e}$$

Where,

- Q_e = Effluent Loading = 40,320 L/day/lot (Sewage daily design flow)

Using the above equation, the effluent nitrate concentration (C_e) is calculated to be 20.95 mg/L. The typical nitrate concentration in domestic wastewater effluent without tertiary treatment (i.e. treated with a septic tank and leaching bed only) is 40 mg/L. The proposed septic system will consist of Waterloo Biofilters, which are Level IV treatment units which include a recirculation loop. Waterloo Biofilters typically can achieve a nitrate reduction of 50 % to 65 %. A 20.95 mg/L effluent nitrate concentration represents a 47.62 % reduction in nitrate from standard domestic wastewater effluent, which means that a minimum of 47.62 % reduction in nitrate concentration is required to achieve the required nitrate dilution to meet the target nitrate concentration (C_w). Therefore, the nitrate reduction of 50 % to 65% for Waterloo Biofilters is sufficient to meet the required nitrate concentrations.

Conclusions

- The minimum reduction of nitrate is 47.62 % to meet an effluent nitrate concentration of 20.95 mg/L;
- The Waterloo Biofilters typically have a nitrate reduction of 50 % to 65 %, which exceeds the 47.62 % reduction requirement, and
- The current lot is a sufficient size to dilute the nitrogen to the required target nitrate concentration.

We trust that this information is acceptable and meets the current requirements for your project. Should you have any questions or require additional information, please do not hesitate to contact the undersigned.

Respectively submitted,



Eliza Walker, EIT
McIntosh Perry Consulting Engineers Ltd.
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Patrick Leblanc, P.Eng., Project Engineer
McIntosh Perry Consulting Engineers Ltd.
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h:\01 project - proposals\2017 jobs\cp\0cp-17-0503 bing proffesional eng inc_proposed temple spa_6688 franktown road\09 - septic & sewage design\cp-17-0503 reasonable use assessment_memo_july 30, 2018.docx

Certificate of Analysis

McIntosh Perry Consulting Eng. (Carp)

115 Walgreen Rd.
RR# 3 Carp, ON K0A 1L0
Attn: Jordan Bowman

Client PO:
Project: 17-0503
Custody: 6644

Report Date: 16-Jul-2018
Order Date: 13-Jul-2018

Order #: 1828639

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Parcel ID	Client ID
1828639-01	TW1-1
1828639-02	TW1-2

Approved By:



Dale Robertson, BSc
Laboratory Director

Certificate of Analysis
Client: McIntosh Perry Consulting Eng. (Carp)
Client PO:

Report Date: 16-Jul-2018

Order Date: 13-Jul-2018

Project Description: 17-0503

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Alkalinity, total to pH 4.5	EPA 310.1 - Titration to pH 4.5	16-Jul-18	16-Jul-18
Ammonia, as N	EPA 351.2 - Auto Colour	16-Jul-18	16-Jul-18
Anions	EPA 300.1 - IC	16-Jul-18	16-Jul-18
Colour	SM2120 - Spectrophotometric	16-Jul-18	16-Jul-18
Conductivity	EPA 9050A- probe @25 °C	16-Jul-18	16-Jul-18
Dissolved Organic Carbon	MOE E3247B - Combustion IR, filtration	16-Jul-18	16-Jul-18
E. coli	MOE E3407	13-Jul-18	14-Jul-18
Fecal Coliform	SM 9222D	13-Jul-18	14-Jul-18
Metals, ICP-MS	EPA 200.8 - ICP-MS	16-Jul-18	16-Jul-18
pH	EPA 150.1 - pH probe @25 °C	16-Jul-18	16-Jul-18
Phenolics	EPA 420.2 - Auto Colour, 4AAP	16-Jul-18	16-Jul-18
Subdivision Package	Hardness as CaCO ₃	16-Jul-18	16-Jul-18
Sulphide	SM 4500SE - Colourimetric	16-Jul-18	16-Jul-18
Tannin/Lignin	SM 5550B - Colourimetric	16-Jul-18	16-Jul-18
Total Coliform	MOE E3407	13-Jul-18	14-Jul-18
Total Dissolved Solids	SM 2540C - gravimetric, filtration	13-Jul-18	16-Jul-18
Total Kjeldahl Nitrogen	EPA 351.2 - Auto Colour, digestion	16-Jul-18	16-Jul-18
Turbidity	SM 2130B - Turbidity meter	16-Jul-18	16-Jul-18

Certificate of Analysis
 Client: McIntosh Perry Consulting Eng. (Carp)
 Client PO:

Report Date: 16-Jul-2018

Order Date: 13-Jul-2018

Project Description: 17-0503

Client ID:	TW1-1	TW1-2	-	-
Sample Date:	07/13/2018 08:20	07/13/2018 14:12	-	-
Sample ID:	1828639-01	1828639-02	-	-
MDL/Units	Drinking Water	Drinking Water	-	-

Microbiological Parameters

E. coli	1 CFU/100 mL	ND	ND	-	-
Fecal Coliforms	1 CFU/100 mL	ND	ND	-	-
Total Coliforms	1 CFU/100 mL	ND	ND	-	-

General Inorganics

Alkalinity, total	5 mg/L	325	328	-	-
Ammonia as N	0.01 mg/L	0.12	0.12	-	-
Dissolved Organic Carbon	0.5 mg/L	2.9	3.2	-	-
Colour	2 TCU	3 [1]	4 [1]	-	-
Conductivity	5 uS/cm	697	834	-	-
Hardness	mg/L	259	327	-	-
pH	0.1 pH Units	7.7	7.6	-	-
Phenolics	0.001 mg/L	<0.001	<0.001	-	-
Total Dissolved Solids	10 mg/L	380	486	-	-
Sulphide	0.02 mg/L	<0.02	<0.02	-	-
Tannin & Lignin	0.1 mg/L	0.1	0.1	-	-
Total Kjeldahl Nitrogen	0.1 mg/L	0.2	0.2	-	-
Turbidity	0.1 NTU	1.5 [1]	1.4 [1]	-	-

Anions

Chloride	1 mg/L	24	65	-	-
Fluoride	0.1 mg/L	0.4	0.4	-	-
Nitrate as N	0.1 mg/L	<0.1	<0.1	-	-
Nitrite as N	0.05 mg/L	<0.05	<0.05	-	-
Sulphate	1 mg/L	38	41	-	-

Metals

Calcium	0.1 mg/L	55.7	75.4	-	-
Iron	0.1 mg/L	0.1	0.1	-	-
Magnesium	0.2 mg/L	29.2	33.7	-	-
Manganese	0.005 mg/L	0.006	0.006	-	-
Potassium	0.1 mg/L	4.6	4.8	-	-
Sodium	0.2 mg/L	17.6	21.6	-	-

Certificate of Analysis
Client: McIntosh Perry Consulting Eng. (Carp)
Client PO:

Report Date: 16-Jul-2018

Order Date: 13-Jul-2018

Project Description: 17-0503

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	ND	1	mg/L						
Fluoride	ND	0.1	mg/L						
Nitrate as N	ND	0.1	mg/L						
Nitrite as N	ND	0.05	mg/L						
Sulphate	ND	1	mg/L						
General Inorganics									
Alkalinity, total	ND	5	mg/L						
Ammonia as N	ND	0.01	mg/L						
Dissolved Organic Carbon	ND	0.5	mg/L						
Colour	ND	2	TCU						
Conductivity	ND	5	uS/cm						
Phenolics	ND	0.001	mg/L						
Total Dissolved Solids	ND	10	mg/L						
Sulphide	ND	0.02	mg/L						
Tannin & Lignin	ND	0.1	mg/L						
Total Kjeldahl Nitrogen	ND	0.1	mg/L						
Turbidity	ND	0.1	NTU						
Metals									
Calcium	ND	0.1	mg/L						
Iron	ND	0.1	mg/L						
Magnesium	ND	0.2	mg/L						
Manganese	ND	0.005	mg/L						
Potassium	ND	0.1	mg/L						
Sodium	ND	0.2	mg/L						
Microbiological Parameters									
E. coli	ND	1	CFU/100 mL						
Fecal Coliforms	ND	1	CFU/100 mL						
Total Coliforms	ND	1	CFU/100 mL						

Certificate of Analysis
 Client: McIntosh Perry Consulting Eng. (Carp)
 Client PO:

Report Date: 16-Jul-2018

Order Date: 13-Jul-2018

Project Description: 17-0503

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	23.9	1	mg/L	23.8			0.4	10	
Fluoride	0.44	0.1	mg/L	0.44			1.1	10	
Nitrate as N	ND	0.1	mg/L	ND			0.0	20	
Nitrite as N	ND	0.05	mg/L	ND				20	
Sulphate	38.7	1	mg/L	38.3			0.9	10	
General Inorganics									
Alkalinity, total	319	5	mg/L	325			1.9	14	
Ammonia as N	0.103	0.01	mg/L	0.120			14.7	17.7	
Dissolved Organic Carbon	2.8	0.5	mg/L	2.9			4.8	37	
Colour	3	2	TCU	3			0.0	12	
Conductivity	691	5	uS/cm	697			0.9	11	
pH	7.8	0.1	pH Units	7.7			0.6	10	
Phenolics	ND	0.001	mg/L	ND				10	
Total Dissolved Solids	54.0	10	mg/L	54.0			0.0	10	
Sulphide	1.16	0.04	mg/L	1.18			1.5	10	
Tannin & Lignin	ND	0.1	mg/L	ND			0.0	11	
Total Kjeldahl Nitrogen	0.16	0.1	mg/L	0.17			4.4	10	
Turbidity	1.5	0.1	NTU	1.5			0.7	10	
Metals									
Iron	0.1	0.1	mg/L	0.1			9.6	20	
Magnesium	30.4	0.2	mg/L	29.2			3.9	20	
Manganese	0.007	0.005	mg/L	0.006			3.1	20	
Potassium	4.8	0.1	mg/L	4.6			2.5	20	
Sodium	17.8	0.2	mg/L	17.6			1.3	20	
Microbiological Parameters									
E. coli	ND	1	CFU/100 mL	ND				30	
Fecal Coliforms	ND	1	CFU/100 mL	ND				30	
Total Coliforms	ND	1	CFU/100 mL	ND				30	

Certificate of Analysis
 Client: McIntosh Perry Consulting Eng. (Carp)
 Client PO:

Report Date: 16-Jul-2018

Order Date: 13-Jul-2018

Project Description: 17-0503
Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	33.1	1	mg/L	23.8	92.6	78-112			
Fluoride	1.37	0.1	mg/L	0.44	92.3	73-113			
Nitrate as N	0.97	0.1	mg/L	ND	96.6	81-112			
Nitrite as N	0.911	0.05	mg/L	ND	91.1	76-107			
Sulphate	46.8	1	mg/L	38.3	84.3	75-111			
General Inorganics									
Ammonia as N	0.370	0.01	mg/L	0.120	100	81-124			
Dissolved Organic Carbon	12.6	0.5	mg/L	2.9	97.5	60-133			
Phenolics	0.022	0.001	mg/L	ND	89.9	69-132			
Total Dissolved Solids	106	10	mg/L		106	75-125			
Sulphide	0.50	0.02	mg/L		99.6	79-115			
Tannin & Lignin	1.1	0.1	mg/L	ND	111	71-113			
Total Kjeldahl Nitrogen	2.22	0.1	mg/L	0.17	103	81-126			
Metals									
Calcium	832		ug/L		83.2	80-120			
Iron	872		ug/L		87.2	80-120			
Magnesium	1050		ug/L		105	80-120			
Manganese	49.2		ug/L		98.3	80-120			
Potassium	1160		ug/L		116	80-120			
Sodium	1040		ug/L		104	80-120			

Certificate of Analysis
Client: McIntosh Perry Consulting Eng. (Carp)
Client PO:

Report Date: 16-Jul-2018

Order Date: 13-Jul-2018

Project Description: 17-0503

Qualifier Notes:

Login Qualifiers :

Samples received submerged in water, possibly melted ice. This condition can compromise sample integrity.

Applies to samples: TW1-1, TW1-2

Sample Qualifiers :

1 : This analysis was conducted after the accepted holding time had been exceeded.

QC Qualifiers :

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable

ND: Not Detected

MDL: Method Detection Limit

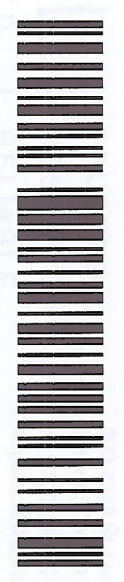
Source Result: Data used as source for matrix and duplicate samples

%REC: Percent recovery.

RPD: Relative percent difference.



Parcel ID: 1828639



Bld. 4J8
js.com

Parcel Order Number
1828639

Chain Of Custody
Ontario Drinking Water Samples
No 6644

Client Name: Melanok Perry Project Ref: 17-0503 Waterworks Name: _____
 Contact Name: S. Bowman Quote #: S/O Waterworks Number: _____
 Address: 115 Walsgreen Rd PO #: 17-0503 Address: _____
 After Hours Contact: _____ E-mail: j.bowman@melanokperry.com
 Telephone: 615 229 9528 Fax: _____ Public Health Unit: _____

Samples Taken By: S.H.
 Signature: _____
 Page 1 of 1
 Turn Around Time Required: 1 day 2 day 3 day 4 day

Samples Submitted Under: (Indicate ONLY one)
 ON REG 170/03 ON REG 318/08 Private Well
 ON REG 243/07 ON REG 319/08 Other: OWS
 Have LSN forms been submitted to MOE/MOHLTC?: Yes No N/A
 Are these samples for human consumption?: Yes No
All information must be completed before samples will be processed.

Sample Type: R = Raw ; T = Treated ; D = Distribution ; P = Plumbing
 Source Type: G = Ground Water; S = Surface Water
 Reportable: Requires AWQI reporting as per Regulation - Y = Yes; N = No

LOCATION NAME	SAMPLE ID	Sample Type: R/T/D/P	Source Type: G/S	Reportable: Y/N	Resample	SAMPLE COLLECTED		# of Containers	Free/Combined Chlorine Residual mg/L	Standing / Flushed: S/O (REG 243)	Total Coliform/E. Coli	Required Analyses		
						DATE	TIME					HPC	Lead	THM
<u>TW 1</u>	<u>TW 1-1</u>	<u>P</u>	<u>G</u>	<u>N</u>	<u>17-Jul-18</u>	<u>0820</u>	<u>8</u>	<u>No</u>	<u>F</u>	<u>Subdiv.</u>	<u>EC-TC</u>			
<u>TW 1</u>	<u>TW 1-2</u>	<u>P</u>	<u>G</u>	<u>N</u>	<u>13-Jul-18</u>	<u>See Bottles</u>	<u>8</u>	<u>No</u>	<u>F</u>					

Comments: Please Rush Results **:- Sample submerged in the water, water in container for 15 min.**

Relinquished By (Sign): _____ Received By Driver/Depot: _____
 Relinquished By (Print): S. Bowman Date/Time: _____
 Date/Time: 13-Jul-2018 / 15:00 Temperature: _____
 Date/Time: _____ Temperature: _____
 Date/Time: _____ Temperature: _____
 Date/Time: July 18/18 4pm Temperature: 4.1
 Date/Time: 13/7/18 pH Verified: By: _____

Certificate of Analysis

McIntosh Perry Consulting Eng. (Carp)

115 Walgreen Rd.
Carp, ON K0A 1L0
Attn: Justin Cameron

Client PO:
Project: 17-0503
Custody: 42032

Report Date: 19-Jun-2018
Order Date: 15-Jun-2018

Order #: 1824668

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Parcel ID	Client ID
1824668-01	Hydro G-BH18-3
1824668-02	Hydro G-BH-1R
1824668-03	Hydro G-BH-2R

Approved By:



Mark Foto, M.Sc.
Lab Supervisor

Certificate of Analysis
Client: **McIntosh Perry Consulting Eng. (Carp)**
Client PO:

Report Date: 19-Jun-2018
Order Date: 15-Jun-2018
Project Description: 17-0503

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC	18-Jun-18	18-Jun-18

Certificate of Analysis

Report Date: 19-Jun-2018

Client: McIntosh Perry Consulting Eng. (Carp)

Order Date: 15-Jun-2018

Client PO:

Project Description: 17-0503

Client ID:	Hydro G-BH18-3	Hydro G-BH-1R	Hydro G-BH-2R	-
Sample Date:	06/15/2018 13:53	06/15/2018 14:08	06/15/2018 14:20	-
Sample ID:	1824668-01	1824668-02	1824668-03	-
MDL/Units	Water	Water	Water	-

Anions

Nitrate as N	0.1 mg/L	<0.1	<0.1	<0.1	-
Nitrite as N	0.05 mg/L	<0.05	<0.05	<0.05	-

Certificate of Analysis
 Client: McIntosh Perry Consulting Eng. (Carp)
 Client PO:

Report Date: 19-Jun-2018

Order Date: 15-Jun-2018

Project Description: 17-0503

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Nitrate as N	ND	0.1	mg/L						
Nitrite as N	ND	0.05	mg/L						

Certificate of Analysis
 Client: McIntosh Perry Consulting Eng. (Carp)
 Client PO:

Report Date: 19-Jun-2018

Order Date: 15-Jun-2018

Project Description: 17-0503

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Nitrate as N	ND	0.1	mg/L	ND				20	
Nitrite as N	ND	0.05	mg/L	ND				20	

Certificate of Analysis
 Client: McIntosh Perry Consulting Eng. (Carp)
 Client PO:

Report Date: 19-Jun-2018
 Order Date: 15-Jun-2018
 Project Description: 17-0503

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Nitrate as N	1.04	0.1	mg/L	ND	104	81-112			
Nitrite as N	0.903	0.05	mg/L	ND	90.3	76-117			

Certificate of Analysis
Client: McIntosh Perry Consulting Eng. (Carp)
Client PO:

Report Date: 19-Jun-2018
Order Date: 15-Jun-2018
Project Description: 17-0503

Qualifier Notes:

None

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.

Parcel ID: 1824668



TRUSTED
RESPONS
RELIABLE



Chain of Custody
(Lab Use Only)
No 42032

Client Name: <u>APCE</u>	Project Reference: <u>17-0503</u>	Turnaround Time: <input type="checkbox"/> 1 Day <input type="checkbox"/> 3 Day <input type="checkbox"/> 2 Day <input checked="" type="checkbox"/> Regular Date Required: _____
Contact Name: <u>Justin Cameron</u>	Quote # <u>S/O.</u>	
Address: <u>115 Walgreen Road, Covington, LA 70010</u>	PO # _____	
Telephone: <u>63-915-3752</u>	Email Address: <u>j.cameron@mcintoshperry.com</u>	

Criteria: O. Reg. 153/04 (As Amended) Table __ RSC Filing O. Reg. 558/00 PWQO CCME SUB (Storm) SUB (Sanitary) Municipality: _____ Other: _____

Matrix Type: S (Soil Sed.) GW (Ground Water) SW (Surface Water) SS (Storm Sanitary Sewer) P (Paint) A (Air) O (Other)

Parcel Order Number: <u>1824668</u>	Matrix	Air Volume	# of Containers	Sample Taken		Required Analyses															
				Date	Time	Nitrate (NO3)	Nitrite (NO2)														
1	GW	✓	1	15 Jun 2018	1:53	✓	✓														
2	GW	✓	1	↓	2:08	✓	✓														
3	GW	✓	1	↓	2:20	✓	✓														
4																					
5																					
6																					
7																					
8																					
9																					
10																					

Comments: _____ Method of Delivery: Walkin

Relinquished By (Sign): <u>S. Holt</u>	Received by Driver/Depot:	Received at Lab: <u>[Signature]</u>	Verified By: <u>[Signature]</u>
Relinquished By (Print): <u>Stefan Holt</u>	Date/Time: _____	Date/Time: <u>15 JUN 2018 4:03</u>	Date/Time: <u>15 JUN 2018 4:30 pm</u>
Date/Time: <u>15 Jun 18 / 4:00 pm</u>	Temperature: _____ °C	Temperature: <u>20</u> °C	pH Verified By: _____

OCP-17-0503
 6688 Franktown Road, Ottawa Ontario
 Nitrate Loading Calculations

Land Area 39.66497 ha (downgradient)
 396649.7 m²

Water Surplus (Ws)
 Ws = Precipitation - Evapotranspiration

Precipitation 943.4 mm/yr
 Evapotranspiration 609.5239 mm/yr

Ws = 333.8761 mm/yr
 0.333876 m/yr

Infiltration Factor (If) per MOEE 1995

Topo Flat & Rolling 0.275
 Soil Sand and Silt 0.4
 Cover Woodland / Meadow 0.15

If = 0.825

Infiltration (I)

I = Ws * If
 I = 0.275448 m/yr

Dilution Water Available (Dw)

Dw = A * I
 Dw = 109256.3 m³/yr
 299332.3 L/day

Background Nitrate Concentration (Cb) Cb = 0.05 mg/L
 Boundary Nitrate Concentration (Cm) Cm = 2.5375 mg/L
 Target Nitrate Concentration (Ow) Ow = 2.4875 mg/L

Effluent Nitrate Concentration (Ce)

$$Ce = (Ow * Dw) + (Ow * Qe) / Qe$$

Effluent Loading (Qe) Qe = 40320 L/day/Lot
 Effluent Nitrate Concentration (Ce) Ce = 20.95507 mg/L

Potential Evapotranspiration

Thornthwaite Method, "Hydrology & Hydraulic Systems", Gupta

$$E_{t\text{month}} = 1.62 (10^* T_m / I)^a$$

where:

$$a = 675 * 10^{-9} * I^3 - 771 * 10^{-7} * I^2 + 179 * 10^{-4} * I + 492 * 10^{-3}$$

$$I = \sum (T_m / 5)^{1.514}$$

Stn: **Ottawa, Ontario (YOW)**

Month	Temp C	I	ET (cm) unadjusted	Daylight Factor	ET (cm) adjusted
January	-10.3				
Feb	-8.1				
March	-2.3				
April	6.3	1.4189	2.8610	1.13	3.2330
May	13.3	4.3982	6.4518	1.28	8.2583
June	18.5	7.2487	9.2396	1.29	11.9191
July	21	8.7821	10.6062	1.31	13.8942
Aug	19.8	8.0336	9.9484	1.21	12.0375
Sept	15	5.2767	7.3542	1.04	7.6483
Oct	8	2.0372	3.7105	0.94	3.4879
Nov	1.5	0.1616	0.6001	0.79	0.4741
Dec	-6.2				
I		37.35695	50.7719		60.9524
thus a =		1.0883			

Note: Daylight Factor is an adjustment factor for possible hours of sunshine based on latitude.

Monthly temperature from Environment Canada

Input data from user
Set value
Calculated by worksheet