HYDROGEOLOGICAL IMPACT ASSESSMENT
HANLEY PARK NORTH DEVELOPMENT
BELLEVILLE, ONTARIO

Prepared for:

Hanley Park Developments Inc.
1058A Albion Road, Suite 207
Toronto, ON M9V 1A7

Prepared by:

BluMetric Environmental Inc.
1682 Woodward Drive
Ottawa, ON K2C 3R8

Project Number: 220384
3 January 2024

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1. INTRODUCTION

BluMetric Environmental Inc. (BluMetric®) was retained by Hanley Park Developments Inc. to conduct a hydrogeological impact assessment for the proposed Hanley Park North residential subdivision in Belleville, Ontario. The subject property covers an area of approximately 35.2 hectares and is located on Part of Lots 14 & 15, Concession 1, Former Thurlow Township, City of Belleville, Hastings County. The site is to the east of Haig Road between Airport Parkway West and Highway 2 in the City of Belleville, Ontario. The proposed residential subdivision will be serviced by the Belleville municipal water supply and sewage systems.

The provincially significant Bell Creek Swamp Complex (Bell Creek Wetland) runs from north to south across the eastern side of the site.

1.1 OBJECTIVES

The objective of the hydrogeological investigation is to satisfy the requirements of the City of Belleville and Quinte Conservation Authority regarding the potential for hydrogeological impacts associated with the proposed residential development and the installation of City services including:

- Assess groundwater elevations and seasonal variability across the site.
- Conduct a limited assessment of terrain conditions based on the hydrogeological drilling program.
- Assess surface water elevations and seasonal variability in the adjacent wetland (the Bell Creek Swamp Complex).
- Determine the potential for hydrogeological impacts during construction and associated with the long-term effects of residential use.
- Conduct a detailed water balance assessment to determine the effects of residential construction and long-term use on the volume of infiltration at the site and assess any potential impacts to the adjacent wetland.
- Conduct one year of groundwater and surface water monitoring and integrate results into a revised report.

1.2 SITE DESCRIPTION

The subject property is located to the immediate east of the City of Belleville, Ontario (Figure 1) and is within the urban area of the City. The site is within the boundaries of the Quinte Conservation Authority (QCA). The Quinte Conservation Authority (QCA) online GIS (QCA, 2023) indicates that most of the site is subject to Ontario Regulation 319/09 (Quinte Conservation Authority, Interference with Wetlands and Alterations to Shorelines and Watercourses).

The subject property is relatively flat and is mostly forest covered with some access trails. The provincially significant Bell Creek Swamp Complex (Bell Creek Wetland) occurs on the eastern side of the site.

1.3 SURROUNDING LAND USE

Surrounding land uses within 500 m of the subject site are described below:

- North:
  - Forested undeveloped land (unused)
  - Wetland (Bell Creek Wetland)
  - Railway lines (CNR)
  - Roads (Airport Parkway West, Haig Road)
  - Industrial land north of Airport Parkway West including an engineered lagoon
- East:
  - Forested undeveloped land (unused)
  - Wetland
  - Agricultural land (pasture)
  - Rural residential (farmhouses and outbuildings) 383 A Airport Parkway West and 385 Airport Parkway West
  - Roads (Antrim)
- West:
  - Urban Residential development
  - Roads (Spruce Gardens, Haig, Hickory, Linden, Sumac, Tessa, Mercedes, Oak Ridge, Briarwood, Victoria. Joyce, Richmond, Freemont, Cambridge, Flint, Diamond, Kingsway, Edgehill)
  - Industrial land adjacent to railway lines (with trucking / distribution / storage)
  - Agricultural land (crop and pasture)
  - Wetland and parkland (Stanley Park)
  - Stormwater retention pond
  - Walking trial (former hydro line)
- South:
  - Undeveloped partially cleared land
  - Wetland (Bell Creek Wetland)
  - Railway line (former CPR)
  - Roads (Bridge, Janlyn, Whalen)
  - Parkland (Haig Park)

Most of the existing development in the area is connected to the Belleville municipal water supply and sewage systems.

1.4 TOPOGRAPHY AND HYDROLOGY

The topography at the site is flat with gentle slopes to the southeast towards the provincially significant Bell Creek Swamp Complex (Bell Creek Wetland). The highest elevation occurs at the northern end of the site (approximately 89 m above sea level (asl)). The elevation at the onsite wetland varies from approximately 86 m asl (upstream end at north end of site) to 83 m asl (downstream end at south end of site). Topographic contours are included on Figure 2.

Surface water drainage at the site is by infiltration with some overland flow towards the wetland. The overburden is generally topsoil and clay/gravel, so infiltration is expected to be the dominant component of onsite drainage. Flow within the wetland is to the south towards the Bay of Quinte (Lake Ontario), immediately west of Telegraph Narrows. The site occurs within the Bell Creek Watershed which is part of the Telegraph Narrows Watershed (Ontario Ministry of Natural Resources and Forestry, 2023). The Bell Creek Watershed drains an area of approximately 23 square kilometres.

Channels within the Bell Creek Wetland in the vicinity of the site are shown on Figure 2 and include:

- Two northern channels (North Channel West and North Channel East) that flow towards the site from the north. These channels run through culverts beneath Airport Parkway West and the CNR railway lines. These channels join at the northern end of the site to form the Main Channel.
- A Main Channel that that runs through the eastern side of the site and exits the site at the eastern site boundary.
- A West Side Channel that runs eastwards towards the eastern side of site through drains beneath existing residential development. This side channel then runs to the south immediately adjacent to the proposed Hanley Park North subdivision then exits the site at the eastern site boundary and joins with the main channel at a point that is southeast of the south-eastern corner of the site.
- An East Side Channel that enters the Main Channel / wetland to the west of the site.
- A Southwest Side Channel that flows from a wetland to the west of Haig Road, through a culvert beneath Haig Road, then along a channel that runs parallel to the abandoned walking trail near the western site boundary.
- The West Side Channel and the Southwest Side Channel join the main channel to the southeast of the eastern corner of the site. From there the Main Channel flow south through a culvert beneath the CPR railway line.

The Bell Creek Wetland is considered to be a 'warm water' system meaning that it does not derive most of its water from cold groundwater inputs. The water in the system mostly comes from runoff with some component of shallow groundwater input from overburden water tables. Details of vegetation, wildlife, species at risk and fish habitat are included in an environmental impact study by Michalski Nielson (2020).

1.5 PROPOSED SUBDIVISION

The proposed development involves the creation of 74 lots for detached family homes and 29 townhouse lots on 8 hectares of the 35.16-hectare parcel. The 74 detached home lots cover an area of 3.9 hectares (average size = 534 square metres), and the 29 townhouse lots cover an area of 0.7 hectares (average size = 236 square metres). There are two areas of development. The 'Northern Development Area' at the northwestern corner of the site includes six detached home lots. The 'Southern Development Area' includes the remainder of the development (68 detached home lots, 29 townhouse lots, and a stormwater pond.

A large portion of the site (27.14 hectares) will be reserved for parkland and wetland features. Of this, 15.1 hectares of the land is Bell Creek Wetland, 8.9 hectares is wetland buffer (woodland), 2.5 hectares is significant woodland, and 0.7 hectares is woodland buffer. For reference information refer to the unsigned Draft Plan of Subdivision (Watson Land Surveyors, 2018) which is included in Appendix A.

The proposed residential subdivision will be serviced by the Belleville municipal water supply and sewage systems. This form of servicing is consistent with the established hierarchy prescribed in the Ontario Provincial Policy Statement and is consistent with servicing of the established neighbouring urban residential developments to the west.

2. METHODOLOGY

2.1 BACKGROUND INFORMATION REVIEW

A review of available background information was conducted including:

- MECP water well records (see Figure 3)
- MECP permit to take water (PTTW) database
- Topographic databases
- QCA online GIS
- Property information

- Ontario Geological Survey (OGS) online geology mapping databases
- A hydrogeological investigation and terrain analysis report for the Mercedes Meadows residential development (Lissom Earth Sciences, 2008).

2.2 Drilling Program

BluMetric obtained public utility clearances and underground service location documentation was finalized prior to drilling.

A total of eight (8) boreholes (BH1 to BH8) were drilled at the site on July 4 and July 12, 2022 by Canadian Environmental Drilling and Contractors Inc. (CED) of Inverary Ontario (Well Contractor License No. 7323). All of the eight boreholes were instrumented as monitoring wells (MW1 to MW8). Drilling supervision was provided by BluMetric.

The boreholes were advanced using a track mounted drilling rig equipped with solid stem augers. Soil samples were collected from the augers for logging and sample collection. Table 1 includes a summary of borehole depths and monitoring well configurations. Borehole logs are provided in Appendix B and borehole/monitoring well locations are indicated on Figure 4.

2.3 Well Installation and Groundwater Monitoring

The monitoring wells (MW1 to MW8) were constructed using new 44 mm and 50 mm inside diameter flush threaded schedule 40 PVC standpipe and well screen. All wells were assembled on site. Silica sand was placed as a filter pack around the well screen and extending approximately 0.3 m above the well screen. Bentonite clay was used to install a seal in the annular space above the sand pack interval. Each monitoring well was completed as a stickup configuration at surface and is protected by a locked steel monument casing. All monitoring wells were constructed in compliance with O. Reg. 903, as amended. A water well record is included with Appendix C.

Table 1: Borehole Depths / Monitoring Well Nests and Configurations

Well Nest Groups		Borehole/Monitoring Well ID	Ground Surface Elevation (m asl)	Stickup (m)	Top of Riser Elevation (m asl)	Depth to Bedrock (m)	Borehole Depth bgs (m)	Well Screen Position / Configuration
Nest A	Shallow	MW1	85.20	0.94	86.14	1.45	1.45	0.6 m well screen in overburden unit / to top of bedrock
	Deep	MW4	85.16	0.76	85.92	1.22	3.96	1.5 m screen in bedrock unit
Nest B	Shallow	MW2	86.76	0.92	87.68	2.41	2.41	1.5 m well screen in overburden unit / to top of bedrock
	Deep	MW3	86.72	0.94	87.67	2.39	5.03	1.5 m screen in bedrock unit
Nest C	Shallow	MW5	86.02	0.92	86.94	2.59	2.59	1.5 m screen in overburden unit / to top of bedrock
	Deep	MW6	85.96	0.85	86.81	2.59	4.27	0.6 m screen in bedrock unit
Nest D	Shallow	MW8	86.26	1.02	87.28	3.66	3.66	1.5 m well screen in overburden unit / to top of bedrock
	Deep	MW7	86.19	0.90	87.09	3.66	5.79	1.5 m screen in bedrock unit

2.4 Surface Water Piezometer Installation and Monitoring

Two surface water piezometers (P1 and P2) were installed at the onsite Bell Creek Wetland. The piezometers were constructed using new 50 mm inside diameter schedule 40 PVC well screen with drive point and protective cap. At each location the well screen was attached to a steel post that was driven into the wetland substrata. The piezometer locations are indicated on Figure 4. A summary of surface water piezometer configurations is provided in Table 2.

Table 2: Piezometer Summary

Piezometer ID	Ground Surface Elevation (m asl)	Stickup (m)	Top of Riser Elevation (m asl)
P1	85.49	1.61	87.10
P2	83.79	1.36	85.15

2.5 Elevation / Location Survey

Proposed borehole locations were laid out in the field on June 8, 2022 by BluMetric prior to drilling. The locations were reviewed with the planning consultant (Macaulay Shiomi Howson Ltd.) and were laid out in the field using RTK (real-time kinematic) global positioning system (GPS) technology.

An elevation/location survey for the completed monitoring wells was carried out by BluMetric on August 16, 2022. GPS survey points (ground control points, site features, etc.) were surveyed using an RTK-GPS system.

2.6 Quality Assurance and Quality Control

A quality assurance/quality control (QAQC) program was implemented according to BluMetric protocols. The QAQC program included the following elements:

- Field staff were suitably qualified and trained to carry out the work and have extensive experience with drilling, installation of wells, management of dataloggers and RTK-GPS field survey methods.
- The field investigation was completed according to BluMetric standard operating procedures for hydrogeological studies. Any deviations were recorded along with an explanatory rationale.
- Field notes and data collection sheets were checked for accuracy and completeness.
- Hard copies including field notes and chain of custody forms were collated, cross-referenced, and filed for future reference if required.
- Survey data was processed by a senior geomatics professional with expertise in RTK-GPS surveying techniques.

3. GEOLOGY AND HYDROGEOLOGY

3.1 SURFICIAL GEOLOGY

Surficial geology information from the Ontario Geological Survey (OGS) was obtained from the OGS Earth website (OGS, 2023). The data shows that most of the site has Paleozoic bedrock near the surface (including undifferentiated carbonate and clastic sedimentary rock, exposed at surface or covered by a discontinuous, thin layer of drift), and some of the site (approximately corresponding to the wetland areas) has "modern alluvial deposits" (clay, silt, sand, gravel, which may contain organic material). The physiography is described as "beveled till plains".

These descriptions are generally consistent with the information identified in water well records in the area (overburden thickness from 0 m to 7 m with an average thickness of 2.9 m) and is generally consistent with the findings of the drilling program.

3.1.1 Terrain Analysis

The drilling program that was completed as part of this investigation identified the following terrain elements (see Figure 4 for borehole locations):

- Well Nest A
  - BH1
    - 0.0 to 1.37 m — SANDY GRAVEL with some boulders
    - 1.37 m — Refusal at top of bedrock
  - BH4
    - 0.0 to 1.22 m — SANDY GRAVEL with some boulders
    - 1.22 m — Top of bedrock (hole extended into bedrock)
- Well Nest B
  - BH2
    - 0.0 to 0.10 m — TOPSOIL
    - 0.10 to 2.39 m — SANDY GRAVEL with some boulders
    - 2.39 m — Refusal at top of bedrock
  - BH3
    - 0.0 to 0.10 m — TOPSOIL
    - 0.10 to 2.39 m — SANDY GRAVEL with some boulders
    - 2.39 m — Top of bedrock (hole extended into bedrock)

- Well Nest C
  - BH5
    - 0.0 to 2.59 m SANDY CLAY with silt and trace gravel/cobbles
    - 2.59 m Refusal at top of bedrock
  - BH6
    - 0.0 to 2.59 m SANDY CLAY with silt and sand, trace gravel/cobbles
    - 2.59 m Top of bedrock (hole extended into bedrock)
- Well Nest D
  - BH7
    - 0.0 to 0.10 m TOPSOIL
    - 0.10 to 2.40 m SAND
    - 2.40 to 3.66 m SAND and GRAVEL increasing gravel towards base
    - 3.66 m Top of bedrock (hole extended into bedrock)
  - BH8
    - 0.0 to 0.10 m TOPSOIL
    - 0.10 to 2.40 m SAND
    - 2.40 to 3.66 m SAND and GRAVEL increasing gravel towards base
    - 3.66 m Refusal at top of bedrock

The thickness of the overburden unit decreases from north to south at the site. At the Northern Development Area the depth to bedrock is 3.7 m and the predominant material is sand and gravel. At the north end of the Southern Development Area the depth to bedrock is 2.6 m and the predominant material is sandy clay. At the eastern side of the Southern Development Area, near the wetland, the depth to bedrock is 2.4 m and the predominant material is sandy gravel. At the south end of the Southern Development Area the depth to bedrock is 1.2 to 1.4 m and the predominant material is sandy gravel.

3.2 Bedrock Geology

Geological mapping information from the OGS Earth website (OGS, 2023) shows that the site is in an area where the Middle Ordovician Verulam Formation is the uppermost bedrock unit. The Verulam Formation occurs within the Simcoe Group. The bedrock is described as limestone and shale. The site is not in an area of inferred karst, but an area of known and inferred karst occurs 440 m to the south of the site in the area including Old Kingston Road to the shoreline of the Bay of Quinte (Lake Ontario).

3.3 HYDROGEOLOGY

A discontinuous shallow unconfined water table exists in parts of the overburden unit. Observations made during drilling in late July 2022 show that the overburden groundwater is typically encountered at depths of 0.9 to 1.3 m below ground surface (bgs). The direction of groundwater flow in the overburden unit is interpreted to be to the south.

In the Belleville area, a water supply aquifer occurs within the horizontally bedded Palaeozoic carbonate sedimentary bedrock. Permeability within these strata is controlled by fractures. The primary porosity (i.e. the 'primary fracture network') is associated with horizontal bedding plane fractures. A secondary porosity is associated with subvertical fracturing. The direction of groundwater flow in the bedrock aquifer is interpreted to be to the south, towards the Bay of Quinte.

A review of information from the Ontario Source Water Protection Atlis online GIS (MECP, 2023) was conducted. The site is not within a 'Source Water Protection Zone'. The bedrock aquifer beneath the site is characterized as a highly vulnerable aquifer.

3.3.1 Water Well Records

A total of 23 water well records from the MECP Water Well Information System (MECP, 2023) were reviewed (individual well records for the wells containing useful information are provided in Appendix C). The well record locations are shown on Figure 3. Please note that the well record locations used are based on the MECP database coordinates and may be subject to varying degrees of error. A summary of relevant information from the water well records is provided in Table 3.

Of the 23 well records identified, ten appear to correspond to water supply wells and the rest are associated with monitoring wells and/or are well abandonment records. Eight of the ten water supply well records are for wells drilled into bedrock. Two water supply wells were completed in the overburden layer only. Nine records indicate freshwater conditions, two well records indicate sulphur for kind of water. One of the wells with sulphur also has salty water indicated.

Static water levels in the well records range from 0.3 m bgs to 6.1 m beg, with an average of 3.1 m bgs. Well yields were generally moderate to high (18 to 114 L/min) with only one well record showing signs of a relatively low yield (5 L/min).

Water-bearing fractures in bedrock that are mentioned in the water well records all occur at depths of less than 10 m bgs.

Table 3: Water Well Records Summary

MECP WATER WELL RECORDS SUMMARY											
Well Record ID	Year Drilled	Depth to BR (m)	Overburden material	Total depth (m)	Casing depth (m)	Depth to water bearing fractures (m)	Static Water Level (m)	Drawdown after Drillers Pumping Test (m)	Recommended pumping rate (GPM)	Recommended pumping rate (L/min)	Comments
2902643	1954	0.0	Bedrock at surface	9.8	1.5	8.5	1.8	2.7	18	82	Sulphur + salt
2902820	1954	3.7	Clay	11.0	4.0	9.1	6.1	?	1	5	Fresh
2902822	1955	1.5	Clay	9.1	2.4	8.5	2.4	0.0	17	77	Fresh
2906319	1974	3.0	Clay	11.6	3.0	8.5	3.0	7.6	8	36	Fresh
2910595	1984	4.3	Clay	9.1	6.1	6.1, 7.9	0.3	7.3	5	23	Fresh
2910818	1985	0.9	Clay	10.7	3.7	5.5	2.7	2.7	15	68	Fresh
2912290	1988	0.6	Topsoil + shale	10.1	3.0	4.3	2.7	6.4	15	68	Sulphur
2916144	1994	Abandonment of dug well									
2916831	1995	6.7	Sand + clay	6.7	6.7	2.7, 6.7	12.0	6.0	4	18	OB well / fresh
2917263	1996	7.0	Sand + clay	7.0	7.0	7.0	1.2	4.0	7	32	OB well / fresh
2917344	1996	4.9	Sand + clay	12.2	5.8	5.5	4.0	10.7	5	23	Fresh
2917345	1996	Well previously drilled to 13.1 m was then extended		20.7	?	?	4.6	16.2	25	114	Fresh
7044014	2007	Well abandonment to 13.7 m									
7135960	2009	1.1	Clay	1.1	0.8	1.1	nm	nt	PVC monitoring well		Untested
7135961	2009	0.9	Clay	0.9	0.6	0.9	nm	nt	PVC monitoring well		Untested
7150194	2010	Well abandonment to 4.27 m									
7150254	2010	Well upgraded, casing extended					4.1	5.2	5	23	
7172233	2011	Well abandonment to 9.1 m							PVC monitoring well		Fresh
7180030	2012	?	Silt	6.0	3.0		nm	nt	PVC monitoring well		
7184581	2012	Well abandonment to 6 m									
7188292	2012	Well abandonment to 4.13 m									
7315465	2018	Well abandonment to 3.27 m									
7315466	2018	Well abandonment to 1.84 m									

A review of the MECP Permit to Take Water (PTTW) database was carried out for a 3 km radius of the site. PTTW information was obtained directly from the MECP interactive GIS system (MECP, 2023). No PTTWs were identified within the 3 km search area. The closest PTTWs are approximately 4 km southeast of the site for industrial takings by Lafarge Canada Inc. of up to 10,712,506 L/day of surface water and groundwater at their Pointe Anne Quarry.

3.3.2 Groundwater Elevations

Groundwater monitoring events were carried out immediately after drilling on July 12 and July 27, 2022, then on August 16, 2022, January 11, April 13, August 31 and November 16, 2023. A summary of groundwater elevation data is provided in Table 4. Groundwater elevation data for the overburden unit is shown on Figure 5. Groundwater elevation data for the bedrock unit is shown on Figure 6, and is shown graphically on Figure 7.

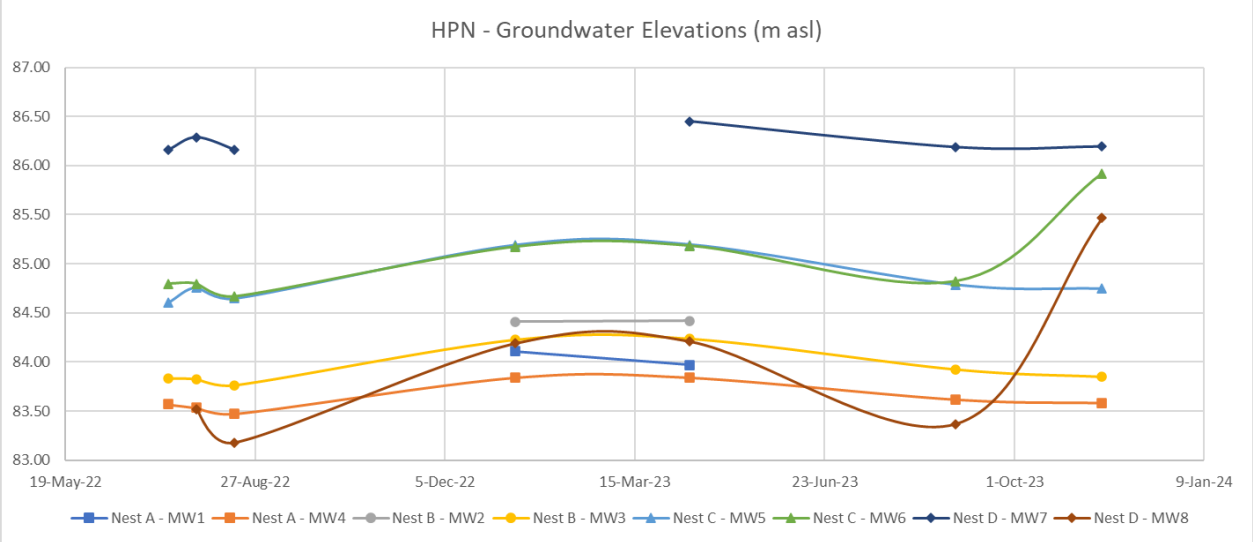
Table 4: Groundwater Elevation Summary

Well Nest Groups	Borehole/Monitoring Well ID	Ground Surface Elevation (m asl)	Stickup (m)	Top of Riser Elevation (m asl)	Depth to Bedrock (m)	Borehole Depth bgs (m)	Bottom of Borehole Elevation (m asl)	12-Jul-22		27-Jul-22		16-Aug-22	
								Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)
Nest A - overburden	MW1	85.20	0.94	86.14	1.45	1.45	83.8	Dry		Dry		Dry	
Nest A - bedrock	MW4	85.16	0.76	85.92	1.22	3.96	81.2	2.35	83.57	2.39	83.53	2.45	83.47
Nest B = overburden	MW2	86.76	0.92	87.68	2.41	2.41	84.4	Dry		Dry		Dry	
Nest B - bedrock	MW3	86.72	0.94	87.67	2.39	5.03	81.7	3.83	83.84	3.84	83.83	3.90	83.77
Nest C - overburden	MW5	86.02	0.92	86.94	2.59	2.59	83.4	2.34	84.60	2.18	84.76	2.29	84.65
Nest C - bedrock	MW6	85.96	0.85	86.81	2.59	4.27	81.7	2.02	84.80	3.03	83.78	2.15	84.67
Nest D - bedrock	MW7	86.19	0.90	87.09	3.66	5.79	80.4	0.93	86.16	0.80	86.29	0.93	86.16
Nest D - overburden	MW8	87.10	-1.63	85.47	3.66	3.66	83.4	Dry		1.95	83.52	2.29	83.18

Well Nest Groups	Borehole/Monitoring Well ID	Ground Surface Elevation (m asl)	Stickup (m)	Top of Riser Elevation (m asl)	Depth to Bedrock (m)	Borehole Depth bgs (m)	Bottom of Borehole Elevation (m asl)	11-Jan-23		13-Apr-23		31-Aug-23		16-Nov-23	
								Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)
Nest A - overburden	MW1	85.20	0.94	86.14	1.45	1.45	83.8	2.04	83.17	2.17	83.97	Dry		Dry	
Nest A - bedrock	MW4	85.16	0.76	85.92	1.22	3.96	81.2	2.08	83.08	2.08	83.84	2.30	83.62	2.34	83.58
Nest B = overburden	MW2	86.76	0.92	87.68	2.41	2.41	84.4	3.27	83.49	3.26	84.42	Dry		Dry	
Nest B - bedrock	MW3	86.72	0.94	87.67	2.39	5.03	81.7	3.44	83.28	3.43	84.24	3.74	83.93	3.82	83.85
Nest C - overburden	MW5	86.02	0.92	86.94	2.59	2.59	83.4	1.75	84.27	1.75	85.19	2.15	84.79	2.19	84.75
Nest C - bedrock	MW6	85.96	0.85	86.81	2.59	4.27	81.7	1.64	84.32	1.63	85.18	1.99	84.82	2.04	85.92
Nest D - bedrock	MW7	86.19	0.90	87.09	3.66	5.79	80.4	Frozen		0.64	86.45	0.90	86.19	0.90	86.19
Nest D - overburden	MW8	87.10	-1.63	85.47	3.66	3.66	83.4	1.28	85.82	1.26	84.21	2.10	83.37	2.16	85.47

bgs = below ground surface
m asl = metres above sea level

Figure 7: Groundwater Elevations



The results show that an overburden water table exists across the northern part of the site including the northern part of the Southern Development Zone. The following observations are noted:

- Overburden groundwater was absent at times (typically in the summer and fall) at MW1, MW2 and MW8.
- A slight downward vertical gradient occurs at the southern-most well nest (MW1 and MW4), and at the well nest (MW2 and MW3) to the east of the Southern Development Area.
- Groundwater elevations at the well nest (MW5 and MW6) near the northwestern corner of the Southern Development Area are often very similar, but the overburden monitoring well appears to be more responsive to periods of recharge.
- Un upward vertical hydraulic gradient occurs at the well nest (MW7 and MW8) at the Northern Development Area.

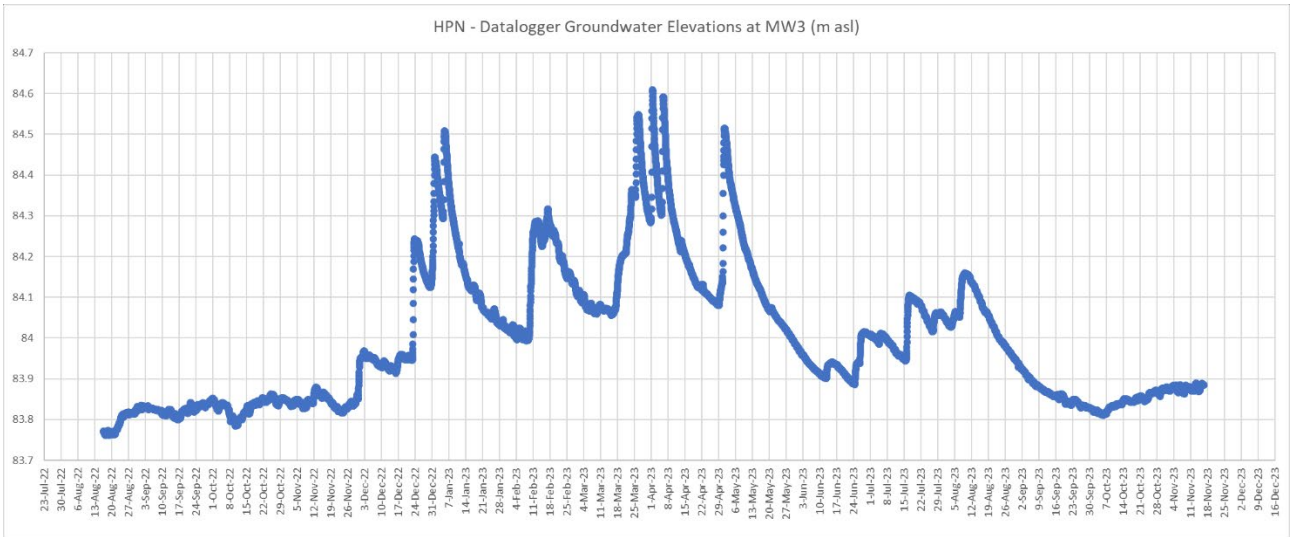
Maximum groundwater elevations occur at well nest D (MW7 and MW8) at the Northern Development Area. The maximum elevation of the unconfined water table in the overburden unit is 85.47 m asl at MW8 in November 2023. The maximum elevation based on measurements made at the bedrock wells was 86.45 m asl measured at MW7 in April 2023 but this represents pressurized groundwater in the upper bedrock hydrostratigraphic unit. For the Southern Development Area, the maximum overburden groundwater elevation was 85.19 m asl at MW5 in April 2023, and the maximum bedrock groundwater elevation was 85.92 m asl at MW6 in November 2023.

An upper bedrock hydro-stratigraphic unit extends across the site and groundwater was encountered at all monitoring well locations. An upward vertical hydraulic gradient is noted within the upper bedrock unit.

A pressure sensing datalogger was installed at MW3 on August 16, 2023. Groundwater elevations measured by the datalogger are presented on Figure 8.

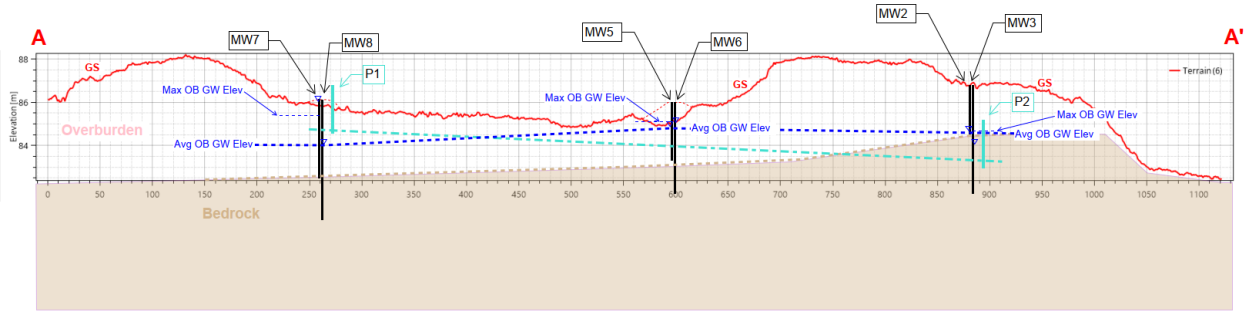
The maximum groundwater elevation at MW3 based on the information from the datalogger was 84.61 m asl which was measured at 4 pm on April 1, 2023. This elevation is 0.37 m higher than the maximum manual water level measurement taken on April 13, 2023.

Figure 8: Datalogger Groundwater Elevations at MW3



The relationships between groundwater and surface water elevations are shown on a conceptual cross-section in Figure 9. The cross-section alignment is indicated on Figure 4.

Figure 9: Cross Section



3.3.3 Conceptual Model

- Overburden (thickness is 1.2 to 3.7 m):
  - Stratigraphy includes sandy gravel, clay and sand.
  - A discontinuous shallow unconfined water table exists across the southern part of the site (overburden groundwater was identified at two of the four overburden monitoring wells).
  - Overburden groundwater is from 0.9 to 1.3 m bgs and occurs as an unconfined water table.
  - Flow within the overburden unit is considered to be within a porous media.
  - Overburden groundwater flows to the south

- Upper Bedrock (nominally to 10 m thickness):
    - Verulam Formation (limestone and shale).
    - The upper bedrock hydro-stratigraphic unit appears to be pressurised, so a confined condition is indicated. Higher pressures are indicated at the north of the site (MW7, MW6).
    - The vertical direction of groundwater flow appears to be upwards between the upper bedrock unit and the overburden unit (i.e. upward hydraulic gradient).
    - Flow is within a fractured bedrock media with primary porosity along bedding plane fractures.
    - The groundwater elevation at the southern bedrock screened monitors is lower (slightly pressurized with groundwater elevations within the bedrock zone).
    - Groundwater flow is to the south towards the Bay of Quinte.

3.3.4 Hydrogeological Sensitivity

The terrain analysis findings show that the overburden thickness varies across the site from 1.2 m to 3.7 m and is an average of 2.5 m thick. Most of the overburden material at the site is expected to be of moderate to high permeability based on the materials encountered (sand and gravel with some clay in one area). The site is not within in area of 'inferred karst' as determined by the OGS Karst mapping layer (OGS, 2023). As mentioned above the OGS database does indicate an area of known and inferred karst to the south of the site. The Bobcaygeon Formation is the uppermost bedrock unit in that area. Based on the summarized findings the site is generally not considered to be hydrogeologically sensitive, but the zone around the well nest at MW1 and MW4 is potentially hydrogeologically sensitive due to thin soils (< 2m thickness).

3.3.5 Potential Sources of Contamination

No potential sources of onsite contamination were identified. The areas of the proposed subdivision are undeveloped. Several walking trails occur within the areas to be developed.

Historical clearing of the land occurred prior to 1948 (as evidenced in an air photo from that year in a report by Palmer, 2021).

Application of road salt along roadways near the western site boundary is expected to have caused some limited impacts to the area immediately bordering the roads and ditches. No onsite impact is expected as a result of road salt application activities.

Industrial land uses to the north of the site have some potential to impact the bedrock aquifer beneath the site. Neighbouring sewage and effluent treatment systems include a treatment lagoon north of Airport Parkway West and any individual septic system associated with the farms at 383-

A Airport Parkway West and 385 Airport Parkway West. These locations are considered far enough away that no specific concerns for adverse environmental impacts were identified. The bedrock aquifer is not used as a source of potable water for the site, so no significant concerns were indicated.

3.4 HYDROLOGY

3.4.1 Surface Water Elevations

Surface water elevations measured at the wetland piezometers are summarized in Table 5. An elevation difference of 1.9 metres between the two points which are 580 m apart is noted. These elevations are consistent with the change in surface elevations on regional topographic maps. Surface water elevation data is shown graphically in Figure 10.

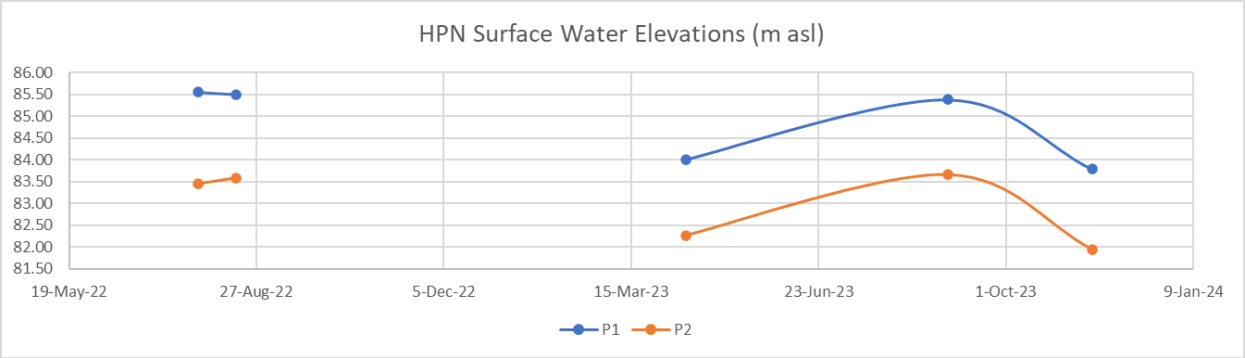
Table 5: Surface Water Elevations Summary

Surface Water Piezometers	Piezometer ID	Ground Surface Elevation (m asl)	Stickup (m)	Top of Riser Elevation (m asl)	27-Jul-22		16-Aug-22		11-Jan-23	
					Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)
	P1	85.49	1.61	87.10	1.55	85.55	1.60	85.50	frozen (1.49)	
	P2	83.79	1.36	85.15	1.70	83.45	1.57	83.59	innaccessible	

Surface Water Piezometers	Piezometer ID	Ground Surface Elevation (m asl)	Stickup (m)	Top of Riser Elevation (m asl)	13-Apr-23		31-Aug-23		16-Nov-23	
					Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)
	P1	85.49	1.61	87.10	1.49	84.01	1.72	85.38	1.77	83.78
	P2	83.79	1.36	85.15	1.32	82.27	1.49	83.66	1.51	81.95

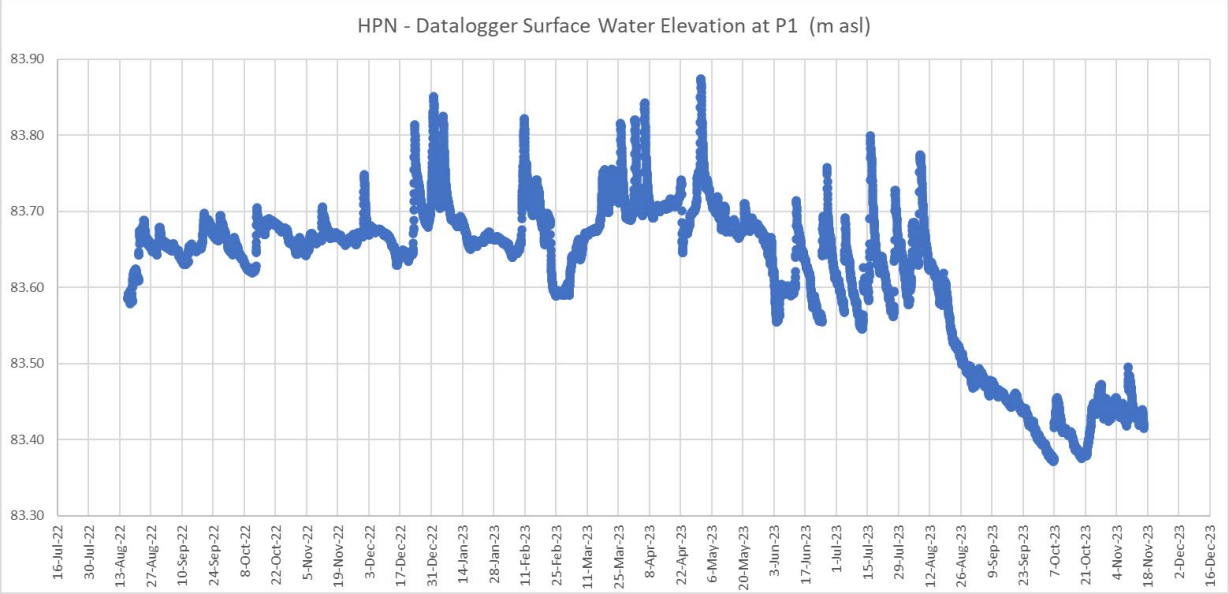
bgs = below ground surface
m asl = metres above sea level

Figure 10: Surface Water Elevations



A pressure sensing datalogger was installed at P1 on August 16, 2023. Surface water elevations measured by the datalogger are presented on Figure 11.

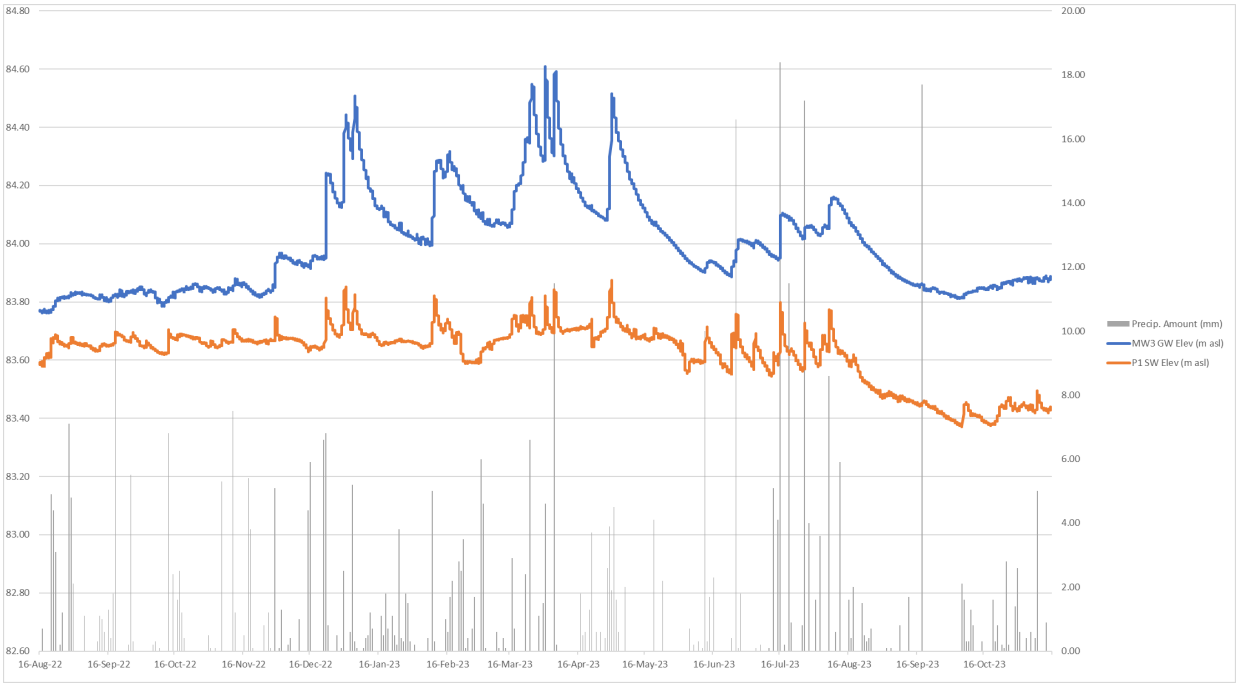
Figure 11: Datalogger Surface Water Elevations at P1



The highest surface water elevation (85.55 m asl) was measured manually at P1 on July 27, 2022. The maximum surface water elevation at P1 based on the information from the datalogger (which was deployed from August 16, 2022 to November 16, 2023) was 83.87 m asl which was measured at 5 am on May 1, 2023.

The relationship between precipitation, surface water elevations, and groundwater elevations was assessed by comparing climate data (Government of Canada, Environment and Natural Resources, Historical Weather, 2022-2023) with the datalogger information from P1 and MW3 as shown in Figure 12.

Figure 12: Precipitation, Surface Water Elevations at P1, and Groundwater Elevations at MW3



The relationships between groundwater and surface water elevations are shown on a conceptual cross-section in Figure 9. The cross-section alignment is indicated on Figure 4.

4. DEVELOPMENT IMPACT ASSESSMENT

Development of the Hanley Park North subdivision has the potential to cause some limited impacts to the local hydrological and hydrogeological systems. Changes such as addition of impervious surfaces can reduce the volume of groundwater recharge from precipitation. Installation of deep service trenches for municipal water supply and sewer piping will impact local groundwater during construction and has the potential to impact groundwater in the long term unless control measures are implemented. The management of storm water at the site could impact the quality and quantity of surface water flow to the adjacent wetland and has the potential to reduce impacts due to the introduction of impervious surfaces and trenching.

4.1 ENGINEERING DESIGN

An unsigned draft plan of subdivision (Watson Land Surveyors, 2018) is included as Attachment A. No detailed plans for building construction were available for review. A detailed engineering design for the site including residential structure plans will be developed after draft plan approval. Building design for the site should take the following items into account:

- The maximum depth of basements must be above the overburden water table (i.e. the overburden water table in all areas to the north of MW1 and MW2) and the top of bedrock in the southern areas.
- The maximum depth of sumps in any basement or subgrade structure must be above the established maximum elevation of overburden groundwater.

PLEASE NOTE: The grading plan and landscape design for the site should incorporate features that promote re-infiltration of runoff water. Such features should include (but not be limited to):

- Dry swales / bioswales
- Check dams
- Gravel beds

4.2 Impact to Existing Groundwater Uses

The water well records that were reviewed in Section 3.3.1 show that there were ten water supply wells in the area. Six of those records are plotted on one location which suggests that the location information was inadequate at the time of data entry into the system and a centroid location was used, so some of those wells probably occur more than 500 m from the site boundaries. Most of the wells that plot within developed areas that are now serviced by the Belleville municipal water supply system have probably been abandoned or are not used. If any of the wells are still in use, they are probably associated with the farms at 383-A Airport Parkway West and 385 Airport Parkway West. Well record 7150254 (extension of an existing well) may be still in use in this area. The well was extended in 2010 but there is no indication of the well depth. Table 6 provides a summary of water supply well information.

Table 6: Water Supply Wells Summary

MECP WATER WELL RECORDS SUMMARY											
Well Record ID	Year Drilled	Depth to BR (m)	Overburden material	Total depth (m)	Casing depth (m)	Depth to water bearing fractures (m)	Static Water Level (m)	Drawdown after Drillers Pumping Test (m)	Recommended pumping rate (GPM)	Recommended pumping rate (L/min)	Comments
2902643	1954	0.0	Bedrock at surface	9.8	1.5	8.5	1.8	2.7	18	82	Sulphur + salt
2902820	1954	3.7	Clay	11.0	4.0	9.1	6.1	?	1	5	Fresh
2902822	1955	1.5	Clay	9.1	2.4	8.5	2.4	0.0	17	77	Fresh
2906319	1974	3.0	Clay	11.6	3.0	8.5	3.0	7.6	8	36	Fresh
2910595	1984	4.3	Clay	9.1	6.1	6.1, 7.9	0.3	7.3	5	23	Fresh
2910818	1985	0.9	Clay	10.7	3.7	5.5	2.7	2.7	15	68	Fresh
2912290	1988	0.6	Topsoil + shale	10.1	3.0	4.3	2.7	6.4	15	68	Sulphur
2916831	1995	6.7	Sand + clay	6.7	6.7	2.7, 6.7	12.0	6.0	4	18	OB well / fresh
2917263	1996	7.0	Sand + clay	7.0	7.0	7.0	1.2	4.0	7	32	OB well / fresh
2917344	1996	4.9	Sand + clay	12.2	5.8	5.5	4.0	10.7	5	23	Fresh
2917345	1996	Well previously drilled to 13.1 m was then extended		20.7	?	?	4.6	16.2	25	114	Fresh
7150254	2010	Well upgraded, casing extended					4.1	5.2	5	23	

The closest well that may be in use (well record #7150254) is approximately 430 m away to the northeast of the proposed subdivision, and the well is upgradient / side-gradient relative to the proposed subdivision. No impacts to existing well users are anticipated. The closest permits to take water (PTTWs) are approximately 4 km southeast of the site at the Pointe Anne Quarry. No impacts to these uses are anticipated.

4.3 Construction Dewatering

Construction dewatering will be required to ensure that excavations remain dry to allow safe access for workers and equipment. It is anticipated that the deepest excavations that will be made during construction of the proposed residential subdivision will be the service trenches for municipal sewer and water. The maximum depth of excavation is expected to be approximately 5 m. Since groundwater in the overburden at the northern end of the site is typically encountered from 0.9 to 1.3 m below ground surface, excavation dewatering is expected, and the excavations will need to be dewatered during construction. The vertical hydraulic gradient in the upper bedrock unit appears to be upwards, so the bedrock excavations will probably continue to make water after initial pumping. Water taking from the overburden unit is not expected to have any significant impact on the bedrock aquifer as the hydraulic gradient is upwards.

Construction dewatering will probably be carried out using standard construction practices. As each excavation is opened to the required depth, water will be pumped out. If contaminated water is encountered, the discharge water should be directed to treatment control measures before it is discharged. The pumped water will probably be of good quality once the excavation is opened and initially pumped out. In the event of major precipitation events there may be anomalous volumes of water to be pumped if the excavations are open and fill with water. After initial dewatering of overburden excavations, the rate of water influx is expected to slow considerably. It is expected that pumping will be relatively continuous if the excavation extends into the shallow bedrock. The construction plans should include erosion and sedimentation control measures for controlling surface water runoff to the excavation and any nearby watercourses.

Discharge of water associated with construction dewatering will require approvals/permits (i.e. municipal sewer use, OWRA Section 53 sewage works). Measures must be taken to minimize erosion, sedimentation, flooding or water quality impacts. MECP approvals may not required for the discharge of water during the construction phase as the work may be conducted according to an agreement with the City of Belleville for discharge to the nearest down-gradient storm sewers (subject to the City of Kingston Sewer Use By-law).

Please Note: Water takings in excess of 50,000 L/day must be registered with the MECP. Water takings from 50,000 to 400,000 L/day must be registered under the 'Environmental Activity and Sector Registry' (EASR) process. Water taking greater than 400,000 L/day would require a 'permit to take water' (PTTW).

4.4 Services Trenches

Ainley Graham & Associates has prepared a 'preliminary watermain design brief' for the proposed Hanley Park North Development (Ainley 2021). The report includes the following information:

- 738 linear metres of 200 mm diameter PVC watermain will be installed.
- All of the watermain piping will be installed at a minimum depth 1.8 bgs.

Trenching for installation of sanitary and storm sewer piping is also expected to be below 1.8 m bgs. The requirement for gravity drainage along sewer lines result in greater depths in most areas. No detailed sewer design drawings were available to determine maximum depths of excavation. Since bedrock was encountered at a depth of 1.2 m at BH4 it is anticipated that some excavations into bedrock will be required in this area, so groundwater will probably be encountered. Trenching of overburden material at the Northern Development Area and at the northern end of the Southern Development area is expected to encounter groundwater.

PLEASE NOTE: The detailed engineering design for the site should include the implementation of vertical impermeable cut-off barriers (clay plugs) as part of the trench backfilling specifications and drawings. Cut-off barriers prevent/inhibit the movement of groundwater along backfilled trenches as engineered backfill is typically of a granular nature and has a high hydraulic conductivity. Low permeability clay plugs act to inhibit the flow of groundwater along backfilled trenches, thus reducing the possibility of groundwater drainage from the area.

4.5 Construction Related Contamination

Construction related activities which have a potential to impact groundwater at the site include:

- Storage and handling of liquid fuels (refuelling of construction equipment).
- Handling and disposal of construction related chemicals (adhesives, sealants, paints, etc.) and associated waste materials.
- Sanitary waste and chemicals associated with portable toilets.

These potential concerns can be mitigated by adhering to 'best management practices' regarding the storage and handling of fuels and other potentially hazardous chemicals. The requirement for best management practices should be included in the detailed design drawings for the development. The site should be kept free of construction waste and all waste should be contained and removed on a regular short-term basis.

4.6 Stormwater Management

Stormwater runoff from construction sites can have high concentrations of total suspended solids (TSS). The use of stormwater and erosion controls during construction will minimize impacts associated with stormwater runoff. The potential for impacts to the bedrock aquifer are considered to be extremely low due to the thick and confining nature of the overburden unit and the upward hydraulic gradient within the bedrock unit.

It is expected that construction plans and tender documents / specifications will include erosion and sedimentation control (ESC) measures. These measures must be designed to be effective in controlling surface water runoff to excavations and any nearby watercourses (special care must be taken with surface water flow to the adjacent wetland.

Ainley Graham & Associates has prepared a preliminary stormwater management plan for the site (Hanley Park North Residential Subdivision, Stormwater Management Report, Part of Lots 14 & 15, Concession 1, Former Thurlow Township, City of Belleville, Hastings County. November 2021). The report indicates the following:

- Drainage will be conveyed through the Northern Development Area toward the park block.
- Drainage from the Southern Development Area will generally be conveyed toward the southeast to the proposed stormwater management (SWM) facility.
- Backyard run-off from most of the lots will be directed toward the Bell Creek Wetland.
- Drainage within developed areas will be handled by curbs, gutters, and storm sewers which will be designed in accordance with City of Belleville design standards.
- A Master Drainage Plan (1996) referenced in the Ainley report (The Stormwater Management Report, Stanley Park West Subdivisions by G.M. Sernas, June 1996) indicates the Stanley Park facility (located upstream to the west of Haig Road on the West Side Channel) was designed to overcontrol discharge allowing for proposed developments to the east (i.e. Mercedes Meadows, Hanley Park North) so that stormwater can be directed to the Bell Creek System via overland flow routes.
- The uncontrolled release of rear yard runoff is not expected to cause an adverse effect to the Bell Creek Wetland.

- Surface water quality control for the Northern Development Area will involve a level spreader berm within the proposed parkland block to the immediate south of the Northern Development Area.
- Surface water quality control for the Southern Development Area will be managed by an 'extended detention wet pond'.
- An erosion and sediment control strategy will be included in the detailed engineering design for the site, to minimize the transfer of sediment during construction. Various measures should be incorporated into the strategy as required, including:
    - Geotextile barriers, straw bales, rock check dams, etc.
    - Routine inspection and maintenance of the erosion and sediment control devices
    - All exposed earth to be re-vegetated (tree, shrub and groundcover species native to the area).
    - Removal and disposal of the erosion and sediment control devices after construction and at a point where the sediment load to drainage water has reduced to an acceptable level.

PLEASE NOTE: The maximum depth of the pond is expected to be 2.5 m. The pond is close to BH1 and BH4 where the overburden thickness is 1.2 to 1.4 m. Grading in the area will need to be adjusted to accommodate the pond as excavation of bedrock is not recommended.

4.7 Ongoing Residential Use

Following construction of the residential subdivision any potential impacts to groundwater will be minimal (e.g. storage and handling of liquid fuels in small quantities, storage and handling of household chemicals in small quantities, application of garden fertilizer, application of pesticides, spills, etc.). The potential for any adverse impacts associated with these items is considered to be low.

Future use of salt on roads within the proposed subdivision is expected to have a minimal impact which will be localized and confined to the overburden unit.
The environmental impact study for the site (Michalski Nielson, 2020) suggests that the applicant should prepare a "Stewardship/Homeowner's Manual" for inclusion as a schedule in the subdivision agreement that will information regarding the significance and sensitivity of the Bell Creek Wetland and the conservation role/actions of landowners.

4.8 Impact to Surface Water and Natural Function of the Ecosystem

Since construction related dewatering work is of a short-term nature and there will be no ongoing taking of groundwater at the site, there will be no significant impact on surface water and the natural function of the associated ecosystems. During construction, all pumped water will be

discharged to storm sewers with due regard for quality and flow as per an agreement between the City of Belleville and the contractor. After construction runoff and stormwater will mostly re-infiltrate. Any other runoff will flow to the Bell Creek Wetland. There will be no net loss of water to the wetland.

4.9 Water Balance

Determination of a water balance for the site involved quantification of the following key parameters, according to the relationship that is provided:

- Precipitation
- Evapotranspiration
- Infiltration (or recharge)
- Runoff

$$P\downarrow = E\uparrow + I\downarrow + R\rightarrow$$

Precipitation can be directly measured. Data was obtained from Environment and Climate Change Canada (ECCC, Canadian Climate Normals, 2023) for the closest climate station (Belleville Station). The total annual precipitation (911.6 mm/year based on data from 1981 to 2010) multiplied by the entire area of the site (350,610 square metres) results in a volume of precipitation over the site of 320,442 cubic metres per year.

Evapotranspiration was calculated using the empirical formulas of Thornthwaite (Thornthwaite and Mather, 1957) with temperature and precipitation data from ECCC (Canadian Climate Normals, 2023). The methodology of Gupta (2017) was used to calculate a daylight adjusted evapotranspiration rate of approximately 0.638 m/year, which results in a volume of evapotranspiration over the entire site of 224,210 cubic metres per year. The calculations are provided in Appendix D. This value assumes that evapotranspiration is equal over the entire site including wetland and treed area, which is reasonable since the wetland is mostly vegetated except for some small areas of open water. The evapotranspiration calculations result is a value for 'surplus water' (precipitation minus evapotranspiration) which includes infiltration and runoff.

Infiltration was calculated using the infiltration factors from MECP's 'Storm Water Management. Planning and Design Manual' (MOE, 2003). These infiltration factors are also listed in 'Hydrogeological Technical Information Requirements for Land Development Applications (MOEE, 1995). Infiltration components were calculated using the following information:

- Topography
  - Undeveloped land areas are 'flat to rolling' (average slope between 0.6 m and 2.8 m per km). This includes future park areas.
  - Developed lots will be flat (slopes less than 0.6m per km).
  - Wetland areas are assumed to have an infiltration factor of 1 (i.e. all surplus water infiltrates).
- Soil
  - Three of the four locations investigated has coarse grained materials (sand and gravel). One location has sandy clay.
  - In order to reflect a portion of the Southern Development area having "medium clay loam" soil, the townhouses portion of calculation was assigned an infiltration factor of 0.2. All other areas were assigned and infiltration factor of 0.4.
- Cover
  - Treed areas (including future park land) were assigned an infiltration factor of 0.2 (woodland).
  - Developed lots (lawns and garden beds) were assigned and infiltration factor of 0.1 (cultivated)
  - Wetland areas are assumed to have an infiltration factor of 1 (i.e. all water infiltrates).

Runoff was calculated by subtracting evapotranspiration and infiltration from precipitation. A water balance assessment was conducted by comparing pre and post development conditions in a quantitative model. Development of the site will include construction of impervious surfaces (rooftops, driveways, roadways and walkways). The areas of impervious features were estimated using typical sizes of similar items in surrounding development areas. Changes to the volumes of infiltration and runoff resulting from the proposed development were calculated. A summary is provided in Table 7.

A simplified water balance model was developed using the site boundaries as limits. Groundwater flow through the upper bedrock (based on a 10 m thick upper bedrock zone, hydraulic conductivity of 1×10^{-5} m/sec and a 380 m wide block) is estimated (using Darcy's Law) to be approximately 13 cubic metres per day. The hydraulic conductivity of the upper bedrock unit is based on the high end of the typical range for fractured limestone (Freeze and Cherry, 1979).

The volume of groundwater flow through the overburden was estimated for the northern portion of the site where the overburden water table has been identified using an estimated hydraulic conductivity of 1×10^{-3} m/sec and a 200 m wide block (since the overburden unit is absent where the wetland exists). A flow from north to south of approximately 60 cubic metres a day was estimated on this basis. The hydraulic conductivity for the overburden unit is based on the typical range for sand/gravel (Freeze and Cherry, 1979).

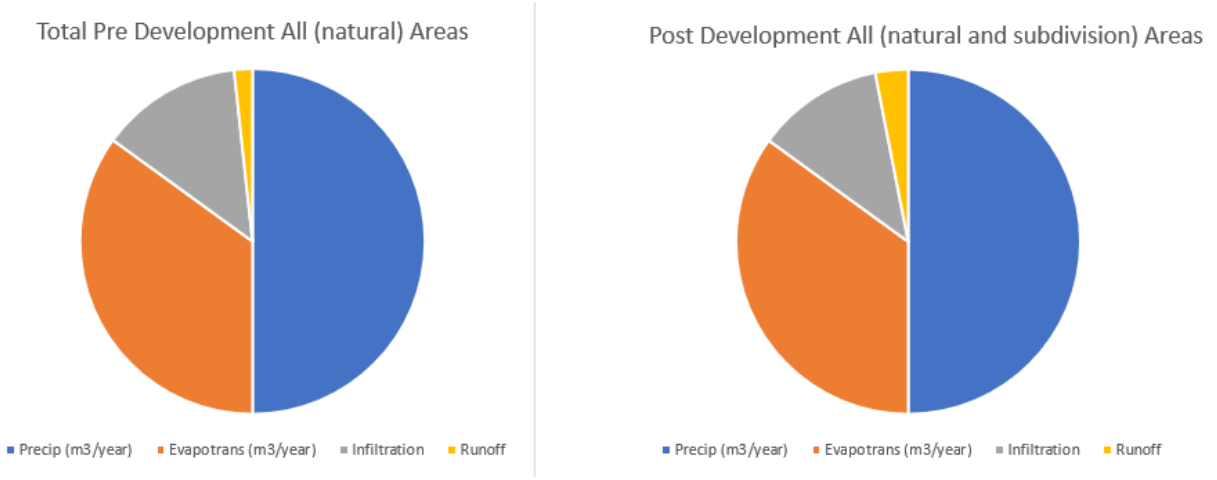
No recent information was available to estimate the volume of flow through the wetland. The flow rate is expected to vary considerably due to seasonal fluctuations. Ongoing monitoring of the piezometer locations will provide some insight into seasonal variability. Flow into and out of the system could potentially be estimated by attempting to measure flows at railway line culvert locations to the north and south of the site. A floodplain report by Ecos Garatech Associates Limited (1989) indicates peak flow rates at the mouth of Bell Creek of 17 cubic metres per second for a 5-year flood. The report includes an analysis if flow dynamics at various railway culverts and road crossings within the catchment area. Although it is beyond the scope of the current investigation to provide a detailed analysis of this data, the information that was reviewed shows that the flow rate within Bell Creek is substantially greater than any of the other parameters that have been discussed as part of the water balance model.

Table 7: Water Balance Summary

PRE DEVELOPMENT CONDITIONS						
	Area (m2)	Precip (m3/year)	Evapotrans (m3/year)	Precip - Evapotrans (m3/year)	Infiltration	Runoff
Total Pre Development Natural Areas	351,610	320,422	224,210	96,212	85,236	10,977
		100%	70.0%		26.6%	3.4%
POST DEVELOPMENT CONDITIONS						
Post Development Natural Area Total	271,370	247,299	173,044	74,256	67,670	6,585
		100%	70.0%		27.4%	2.7%
Percentage of total		*77%*	*77%*		*88%*	*33%*
Total Subdivision Permeable Area	39,470	35,969	25,169	10,800	8,814	1,987
		100%	70.0%		24.5%	5.5%
Percentage of total		*11%*	*11%*		*12%*	*10%*
Total Subdivision Impermeable Area	40,780	37,163	26,004	11,159	0	11,159
		100%	70.0%		0.0%	30.0%
Percentage of total		*12%*	*12%*		*0%*	*57%*

Development is expected to result in a reduction in the amount of infiltration across the site of approximately 8,750 cubic metres per year (24 cubic metres per day) and an increase in runoff of approximately the same volume.

	Precip (m3/year)	Evapotrans (m3/year)	Infiltration	Runoff
Total Pre Development Natural Areas	320,422	224,210	85,236	10,977
Post Development All Areas	320,431	224,217	76,484	19,731



The pre-development scenario indicates infiltration of 27 % of the water is infiltrated, and in the post -development scenario the infiltration component is reduced to 24%.

The volume of flow through the wetland is orders of magnitude greater than the differences in runoff and infiltration that are indicated by the water balance model, so the subtle variation in return flow to the wetland from development (less from overburden groundwater and more from runoff) is expected to have no significant impact to water levels within the wetland. Since the wetland is a warm water system, the small change (3% less) affecting the volume of infiltration compared to runoff is not expected to have a significant impact to the natural function of wetland and local ecosystems.

4.10 Catchment Analysis

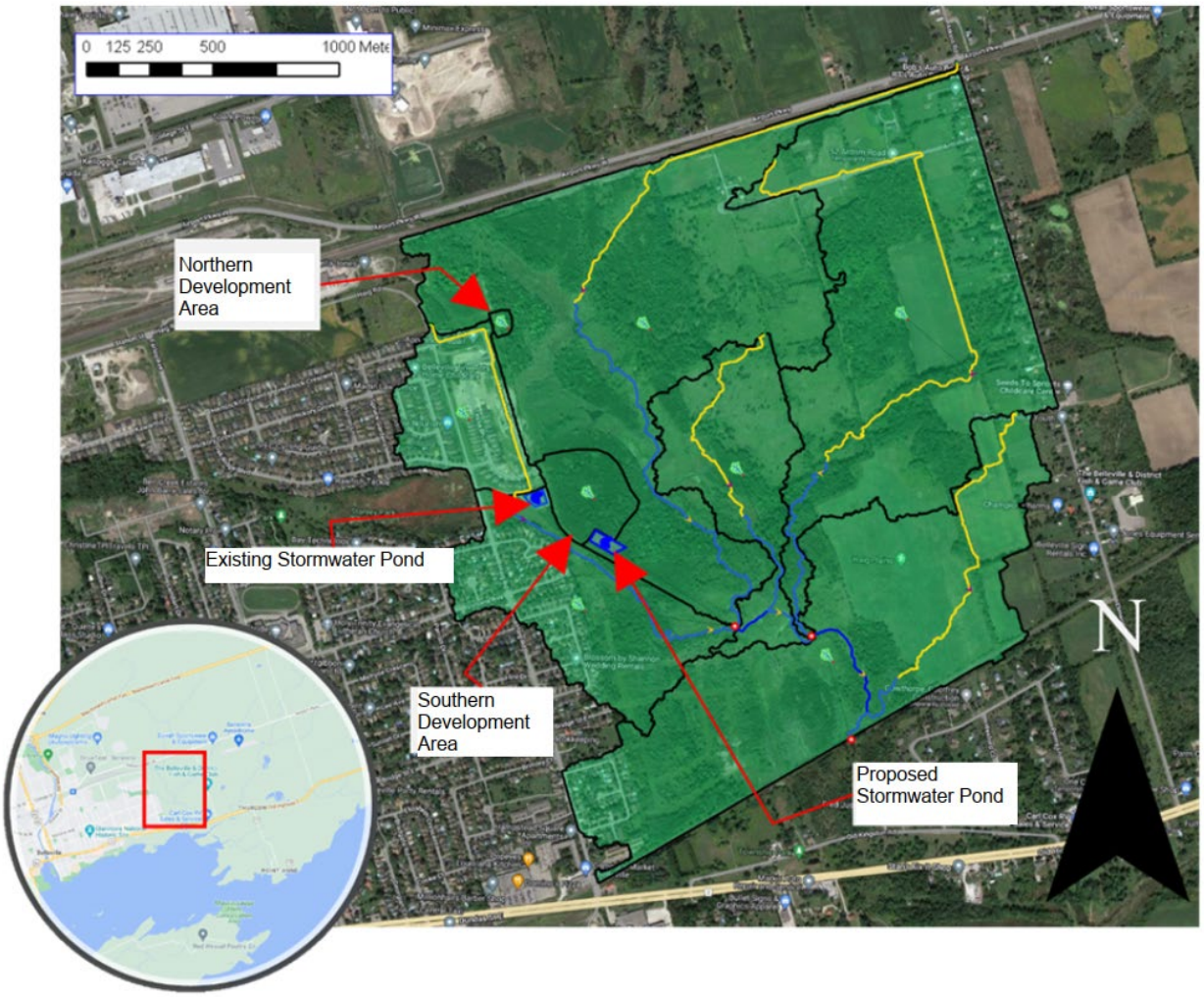
A catchment analysis was conducted by BluMetric's hydrology engineering group using Geo HEC-Hydrologic Modeling System (HMS) software, and US Soil Conservations Service (SCS) methodology for estimating design peak flows in small watersheds (i.e. SCS curve number infiltration 'loss' method and SCS unit hydrograph 'transform' method for stormwater runoff). Kinematic wave routing was used to model stormwater. The hydrological models were run with 10-year and 100-year type II SCS design storms (rainfall associated with a 10-year storm is 84 mm, and rainfall associated with a 100-year storm is 120 mm). The SCS storm information was retrieved from an Ontario Ministry of Transportation (MTO) database by the GeoHEC-HMS software.

The catchment analysis included pre- and post-development scenarios. Figure 13 shows:

- The Northen Development Area and the Southern Development Area.
- The existing stormwater pond to the immediate west of the Southern Development Area.

- The proposed stormwater pond to the immediate south of the Southern Development Area.
- Sub-basin areas.

Figure 13: Development Area and Sub-basin Delineation



The modeling framework incorporates seven sub-basin areas with corresponding lag time flow paths, five routing reaches, three connecting junctions, and two storage areas (i.e. the existing and proposed stormwater ponds). The development areas are situated within a larger sub-basin which is designated as 'Sub-05-EX'. In the post-development scenario, the Southern Development Area is treated as a distinct sub-basin and designated 'Sub-07-EX'. This distinction takes into account the changing dynamics in study area hydrological characteristics associated with the proposed development. A separate simulation was performed for the Northen Development Area, which assumes that stormwater will be diverted to the existing stormwater pond.

Tables 8 and 9 provide an overview of the delineated sub-basins and simulated runoff during the modelled storm events. The results show that runoff for the pre-development scenario (for Sub-05-EX and Sub-07-EX) will be lower compared to the post-development scenario.

Table 8: Sub-basin Summary for Pre-Development Scenario

Sub-basin ID	Drainage Area (ha)	Initial Abstraction (mm)	Curve Number	Impervious Surface (%)	Lag Time (minutes)	Peak 10-Year Storm Discharge (cms)	Peak 100-Year Storm Discharge (cms)
Sub-01-EX	74.975	16.49	75.2	0.02	53.38	2.43	4.88
Sub-02-EX	21.717	19.73	71.74	0	28.61	0.86	1.86
Sub-03-EX	14.368	11.17	90.1	35.84	22.36	1.8	2.79
Sub-04-EX	68.048	14.67	77.29	2.19	31.55	3.7	7.05
Sub-05-EX	87.645	17.4	75.15	0.57	63.71	2.08	4.35
Sub-06-EX	27.435	9.92	83.34	15.09	38.11	1.92	3.21
Sub-07-EX	5.771	7.93	91.91	43.92	20	0.61	0.97

Table 9: Sub-basin Summary for Post-Development Scenario

Sub-basin ID	Drainage Area (ha)	Initial Abstraction (mm)	Curve Number	Impervious Surface (%)	Lag Time (minutes)	Peak 10-Year Storm Discharge (cms)	Peak 100-Year Storm Discharge (cms)
Sub-01-EX	74.975	16.49	75.2	0.02	53.38	2.43	4.88
Sub-02-EX	21.717	19.73	71.74	0	28.61	0.86	1.86
Sub-03-EX	14.368	11.17	90.1	35.84	22.36	1.8	2.79
Sub-04-EX	68.048	14.67	77.29	2.19	31.55	3.7	7.05
Sub-05-EX	87.645	17.4	75.15	0.57	63.71	2.44	4.96
Sub-06-EX	27.435	9.92	83.34	15.09	38.11	1.92	3.21
Sub-07-EX	5.771	7.93	91.91	43.92	20	0.83	1.24

Figures 14 and 15 show the differences between pre- and post-development scenarios for 10-year and 100-year storms in Sub-05-EX and Sub-07-EX. The modelled storm events indicate a 15 to 20% increase in runoff from pre- to post-development conditions. The extra runoff will be directed to the stormwater system associated with the new development and will be directed back to the wetland.

The redirection of water from the Northen Development Area to the existing stormwater pond results in an approximate 3% reduction in overall runoff. This diversion is indicated in Figure 16 and shows that it has a negligible impact on the volume of water that will reach the wetland to the south of Sub-05-EX.

Figure 14: Pre- and Post Development Scenarios for 10-year and 100-year Storms (Sub-05-EX)

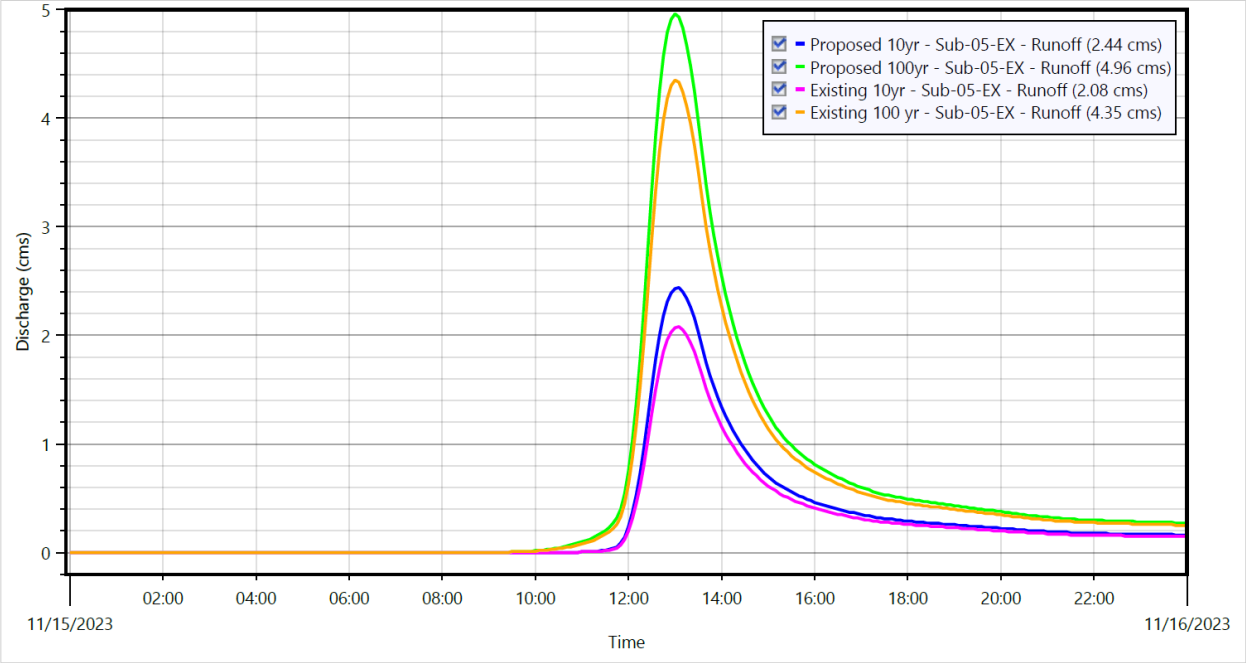


Figure 15: Pre- and Post Development Scenarios for 10-year and 100-year Storms (Sub-07-EX)

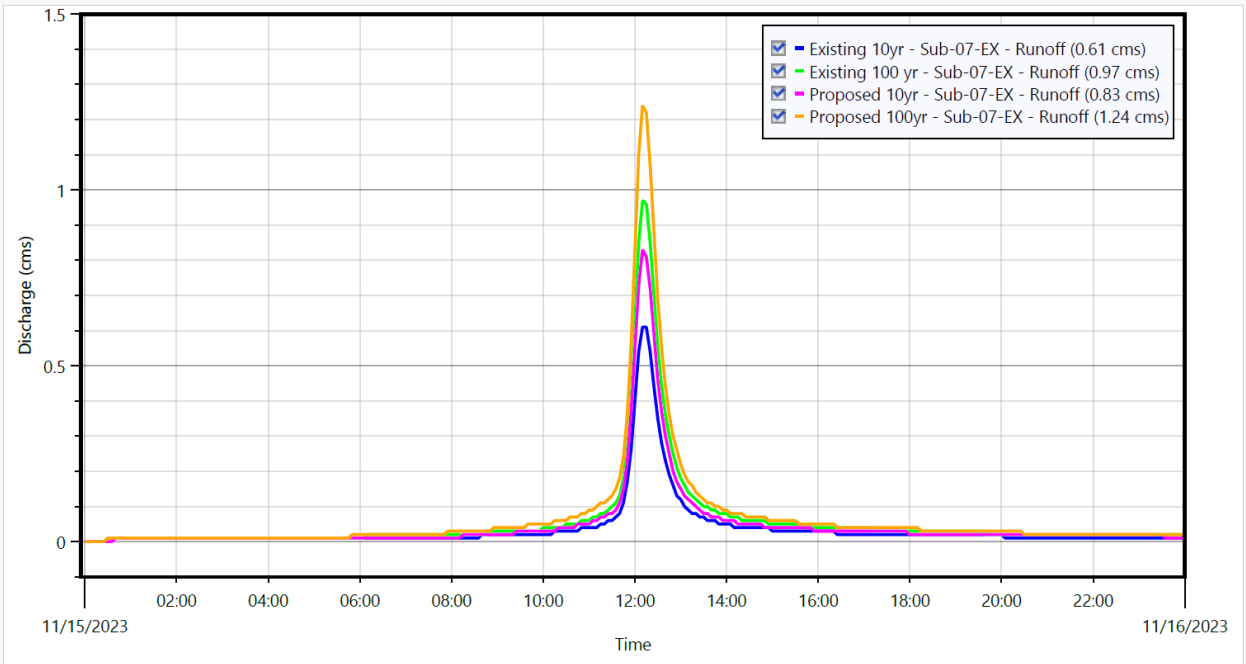
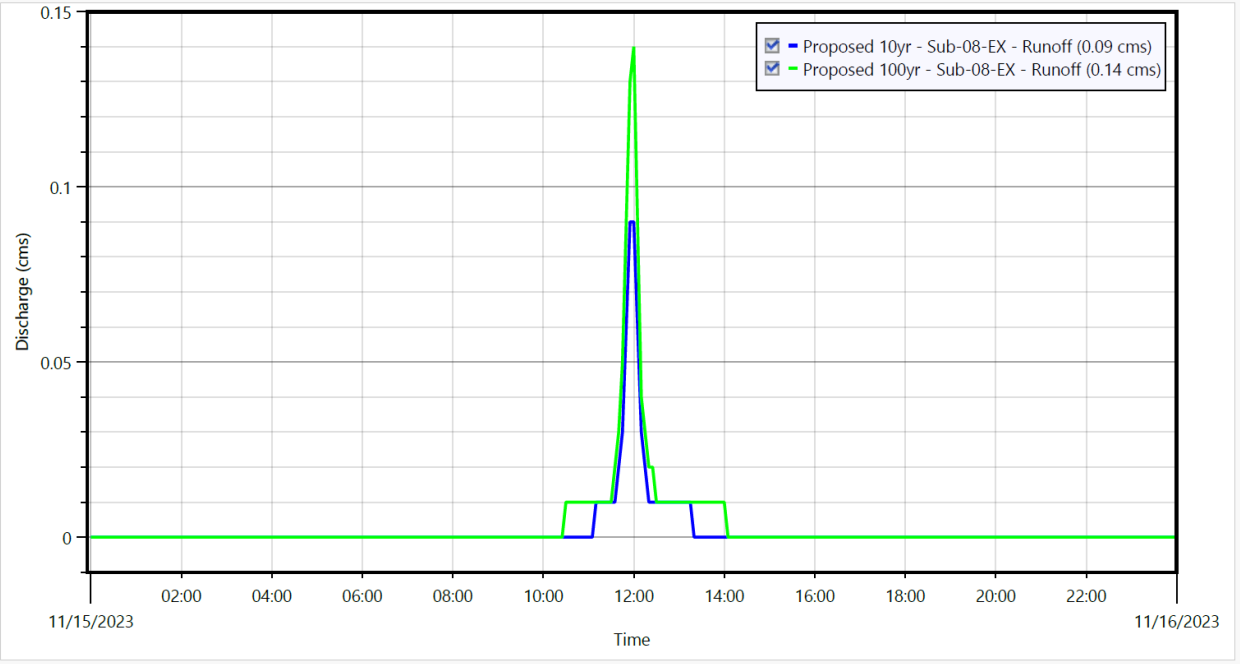


Figure 16: Northern Development Area As Separate Sub-basin (Sub-08-EX) Diverted to Existing Storage



5. CONCLUSIONS

The following statements and conclusions are based on the investigation and analysis contained within this report:

- An unconfined overburden water was identified across the northern portion of the site. The maximum elevation of the unconfined water table in the overburden unit is 85.3 m asl at MW8 measured on July 27, 2022. The water table was absent across the southern portion of the site (MW1 and MW2).
- The maximum elevation of the unconfined water table in the overburden unit is 85.47 m asl at MW8 (measured in November 2023). For the Southern Development Area. the maximum overburden groundwater elevation was 85.19 m asl at MW5 in April 2023.
- An upper bedrock hydro-stratigraphic unit was identified. The upper bedrock unit is confined and appear to be slightly pressurized. Groundwater elevation data indicates an upward vertical hydraulic gradient between the overburden and bedrock units.
- The maximum groundwater elevations based on measurements made at the bedrock wells was 86.45 m asl measured at MW7 in April 2023, and 85.92 m asl at MW6 in November 2023, but it should be noted that these measurements represent pressurized groundwater in the upper bedrock hydrostratigraphic unit.

- The thickness of the overburden unit decreases from north to south at the site. At the Northern Development Area (BH7 and BH8) a maximum depth to bedrock of approximately 3.7 m was identified where the material is sand and gravel. At the north of the Southern Development Area the depth to bedrock is 2.6 m where the material is sandy clay. At the eastern side of the Southern Development Area, near the wetland, the depth to bedrock is 2.4 m where the material is sandy gravel. At the south of the Southern Development Area the minimum depth to bedrock was identified at BH4 (1.2) where the material is sandy gravel.
- The site is not hydrogeologically sensitive and potential sources of contamination from historical and surrounding land uses are not considered to of any significant concern for development of the site as a residential subdivision on City services.
- Surface water elevations at two piezometers installed in the Bell Creek Wetland vary from an average of 84.8 m asl at the upstream piezometer (P1) to an average of 83.0 m asl at the downstream piezometer (P2). The highest surface water elevation (85.55 m asl) was measured manually at P1 on July 27, 2022.
- An assessment of hydrogeological impacts associated with construction at the proposed development areas indicates:
    - No impacts to surrounding groundwater users.
    - Short term impacts associated with construction dewatering.
    - No long-term impacts associated with service trenching as long as precautions are implemented.
    - No long-term impacts associated with sub-grade construction as long as all items are above the maximum elevation of the unconfined water table and precautions are implemented.
    - Potential contamination from construction activities can be mitigated.
- A stormwater management plan for the site indicates:
    - Drainage from the Northern Development Area will be controlled by a level spreader berm and conveyed to the park block.
    - Drainage from the Southern Development Area will be conveyed to a stormwater pond.
    - An erosion and sediment control strategy will be provided as part of the detailed engineering design for the site.
- Potential impacts associated with ongoing residential use of the site can be mitigated. The grading plan and landscape design for the site should incorporate features that promote re-infiltration of runoff water (including, but not be limited to, dry swales / bioswales / check dams / gravel beds).

- There will be no significant impact to surface water (including the Bell Creek Wetland) or the natural function of the ecosystem. A water balance analysis shows that there will be a slight change in the proportions of infiltration and runoff due to development within the subdivision areas (increased runoff is indicated). A catchment analysis indicates a 15 to 20% increase in runoff from pre- to post-development conditions.
- A reduction in infiltration is not expected to cause an adverse effect because runoff will be directed to stormwater ponds or to parkland areas between the subdivision and the wetland. Some of the extra runoff water will reinfiltrate before it reaches the wetland so the impact will be mitigated. The wetland is part of a warm water system so the changes to infiltration and runoff will not have a significant adverse effect.

In summary, it is our professional opinion that this site is suitable for development as a residential subdivision at the proposed lot density. The hydrogeological recommendations contained within this report, if followed, will ensure that the development takes place in an effective manner, with a minimal impact to the natural environment.

6. LIMITATIONS

The conclusions presented in the above captioned report represent our professional opinion, in light of the terms of reference, scope of work, and the limiting conditions noted herein.

The findings presented in this report are based on conditions observed at the specified dates and locations, the analysis of samples for the specified parameters, and information obtained for this project. Unless otherwise stated, the findings cannot be extended to previous or future site conditions, locations that were not investigated directly, or types of analysis not performed.

BluMetric makes no warranty as to the accuracy or completeness of the information provided by others, or of conclusions and recommendations predicated on the accuracy of that information. Nothing in this report is intended to constitute or provide a legal opinion.

This report describes the site conditions and observations made by the BluMetric team at the time of the site investigation and have been prepared solely for the use of the client. No other party may use or rely upon the above-captioned report or portion thereof without the express written consent of BluMetric. BluMetric will consent to any reasonable request to approve the use of this report by other parties as “Approved Users”.

Please do not hesitate to contact the undersigned if you have any questions regarding this information.

Respectfully submitted,
BluMetric Environmental Inc.,

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Senior Hydrogeologist

Michael Melany, M.Sc.Eng., P.Eng.
Senior Engineer

7. REFERENCES

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FIGURES

LEGEND

Subdivision Concept Layout

Property Boundary

REV.	DESCRIPTION	YY/MM/DD	BY	CHK
1				

REFERENCES

DO NOT SCALE DRAWING.
THIS DRAWING MAY HAVE BEEN REDUCED. ALL SCALE NOTATIONS INDICATED ARE BASED ON 11"x17" FORMAT DRAWINGS.

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CLIENT

Hanley Park Development Inc

PROJECT

Hanley Park North
Hydrogeological Impact Assessment

TITLE

Site Layout

The Tower - The Woolen Mill,
4 Cataraqui St.,
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TEL: (613) 531-2725
FAX: (613) 531-1852
Email: info@blumetric.ca
Web: http://www.blumetric.ca

PROJECT #	DATE
220384	**September 06, 2022**

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LEGEND

- Inferred Direction of Groundwater Flow
- Watercourse
- Contour (5m, OBM)
- Subdivision Concept Layout
- Railway
- Bell Creet Wetland - Provincially Significant Wetland (PSW)
- Property Boundary

NOTES:
Bells Creek Wetland is a provincially significant wetland

REV.	DESCRIPTION	YY/MM/DD	BY	CHK
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REFERENCES

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Hanley Park Development Inc

PROJECT

Hanley Park North
Hydrogeological Impact Assessment

TITLE

Hydrology and Topography

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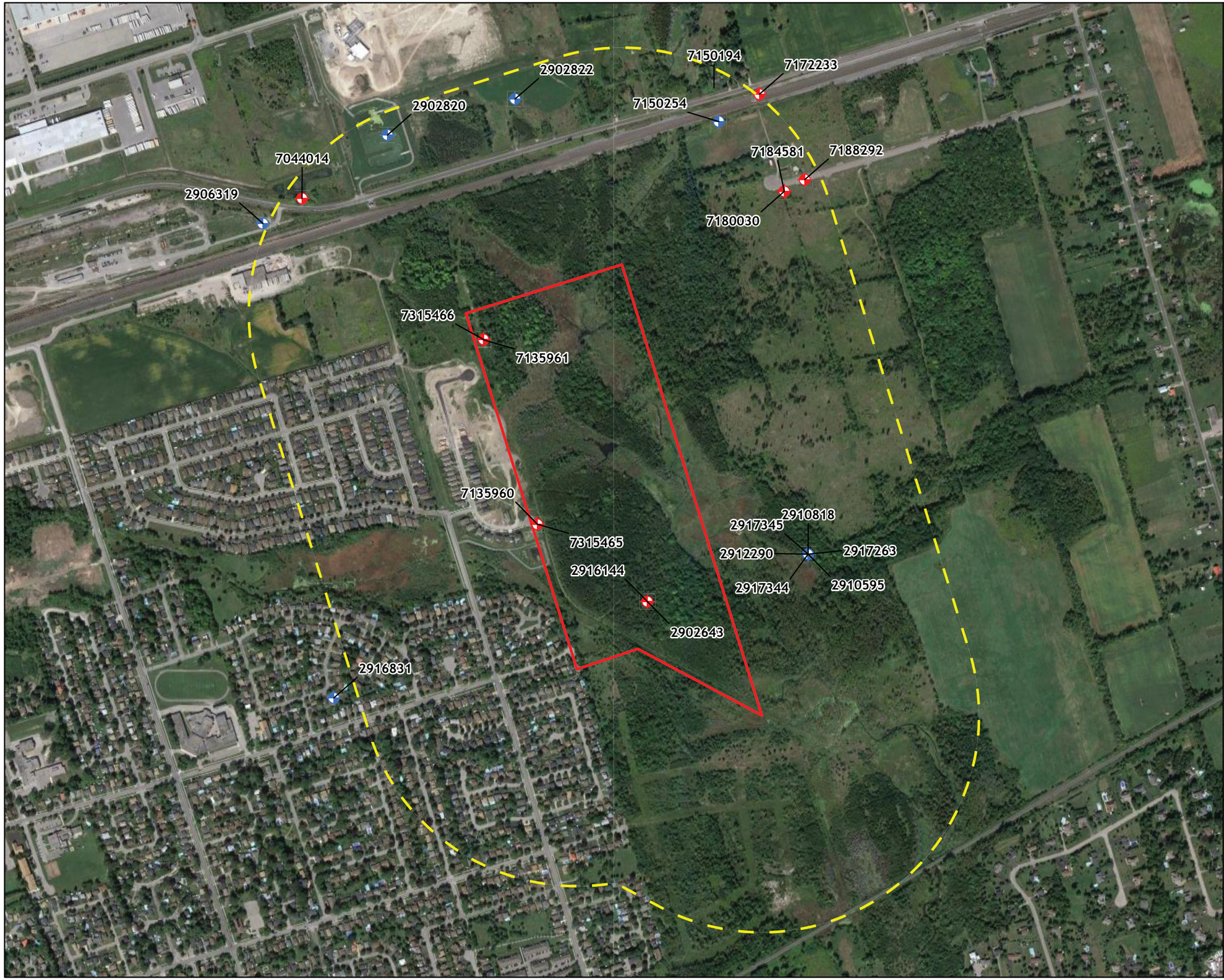

LEGEND

Property Boundary

Subdivision 500 m Boundary

WWIS Well Record (MECP)

Potable Water or Agricultural Supply Well

Well of Other Status

REV.	DESCRIPTION	YY/MM/DD	BY	CHK
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REFERENCES

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Hanley Park Development Inc

PROJECT

Hanley Park North
Hydrogeological Impact Assessment

TITLE

Water Well Records

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LEGEND

- Monitoring Well (BluMetric, 2022)
- Piezometer (BluMetric, 2022)
- Subdivision Concept Layout
- Cross-Section Alignment
- Property Boundary
- 3.7 Depth to Bedrock (m)

REV.	DESCRIPTION	YY/MM/DD	BY	CHK
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REFERENCES

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Well Nest Groups		Borehole / Monitoring Well ID
Nest A	Overburden	MW1
	Bedrock	MW4
Nest B	Overburden	MW2
	Bedrock	MW3
Nest C	Overburden	MW5
	Bedrock	MW6
Nest D	Overburden	MW8
	Bedrock	MW7

CLIENT

Hanley Park Development Inc

PROJECT

Hanley Park North
Hydrogeological Impact Assessment

TITLE

Boreholes/Monitoring Wells/Piezometers

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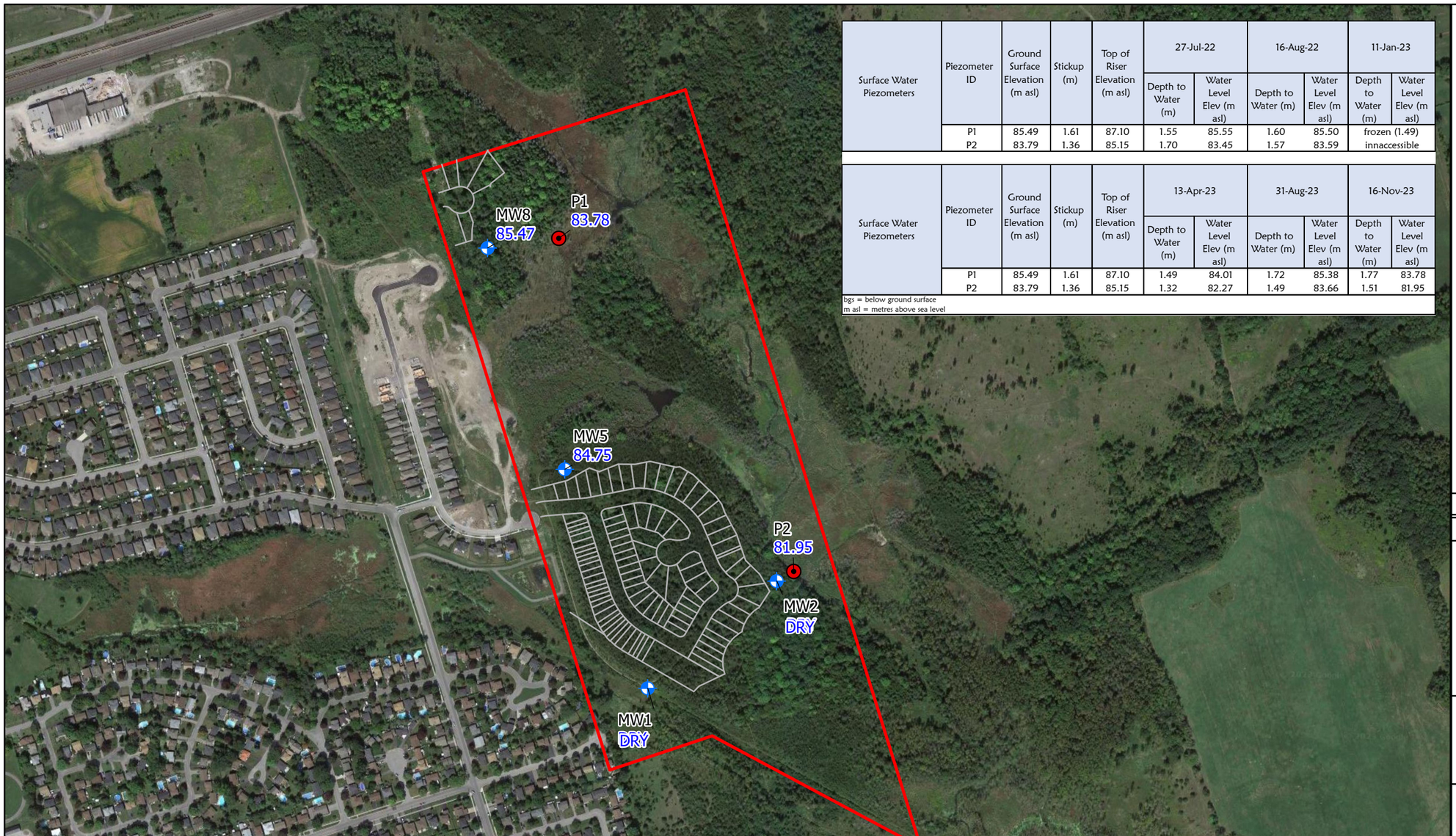

Surface Water Piezometers	Piezometer ID	Ground Surface Elevation (m asl)	Stickup (m)	Top of Riser Elevation (m asl)	27-Jul-22		16-Aug-22		11-Jan-23	
					Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)
	P1	85.49	1.61	87.10	1.55	85.55	1.60	85.50	frozen (1.49)	
	P2	83.79	1.36	85.15	1.70	83.45	1.57	83.59	innaccessible	

Surface Water Piezometers	Piezometer ID	Ground Surface Elevation (m asl)	Stickup (m)	Top of Riser Elevation (m asl)	13-Apr-23		31-Aug-23		16-Nov-23	
					Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)
	P1	85.49	1.61	87.10	1.49	84.01	1.72	85.38	1.77	83.78
	P2	83.79	1.36	85.15	1.32	82.27	1.49	83.66	1.51	81.95

bgs = below ground surface
m asl = metres above sea level

Well Nest Groups	Borehole/Monitoring Well ID	Ground Surface Elevation (m asl)	Stickup (m)	Top of Riser Elevation (m asl)	Depth to Bedrock (m)	Borehole Depth bgs (m)	Bottom of Borehole Elevation (m asl)	12-Jul-22		27-Jul-22		16-Aug-22		11-Jan-23		13-Apr-23		31-Aug-23		16-Nov-23	
								Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)
Nest A - overburden	MW1	85.20	0.94	86.14	1.45	1.45	83.8	Dry		Dry		Dry		2.04	84.11	2.17	83.97	Dry		Dry	
Nest A - bedrock	MW4	85.16	0.76	85.92	1.22	3.96	81.2	2.35	83.57	2.39	83.53	2.45	83.47	2.08	83.84	2.08	83.84	2.30	83.62	2.34	83.58
Nest B = overburden	MW2	86.76	0.92	87.68	2.41	2.41	84.4	Dry		Dry		Dry		3.27	84.41	3.26	84.42	Dry		Dry	
Nest B - bedrock	MW3	86.72	0.94	87.67	2.39	5.03	81.7	3.83	83.84	3.84	83.83	3.90	83.77	3.44	84.23	3.43	84.24	3.74	83.93	3.82	83.85
Nest C - overburden	MW5	86.02	0.92	86.94	2.59	2.59	83.4	2.34	84.60	2.18	84.76	2.29	84.65	1.75	85.19	1.75	85.19	2.15	84.79	2.19	84.75
Nest C - bedrock	MW6	85.96	0.85	86.81	2.59	4.27	81.7	2.02	84.80	2.02	84.80	2.15	84.67	1.64	85.17	1.63	85.18	1.99	84.82	2.04	85.92
Nest D - bedrock	MW7	86.19	0.90	87.09	3.66	5.79	80.4	0.93	86.16	0.80	86.29	0.93	86.16	Frozen		0.64	86.45	0.90	86.19	0.90	86.19
Nest D - overburden	MW8	87.10	-1.63	85.47	3.66	3.66	83.4	Dry		1.95	83.52	2.29	83.18	1.28	84.19	1.26	84.21	2.10	83.37	2.16	85.47

LEGEND

- Monitoring Well (BluMetric, 2022)
- Piezometers (BluMetric, 2022)
- Subdivision Concept Layout
- Property Boundary
- 83.78 Water Level Elevation (m asl) (16-Nov-2023)

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REFERENCES

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Hanley Park Development Inc

PROJECT

Hanley Park North
Hydrogeological Impact Assessment

TITLE

Overburden Groundwater Elevations (November 16, 2023)

BluMetric™ Environmental

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PROJECT #	DATE
220384	November 21, 2023

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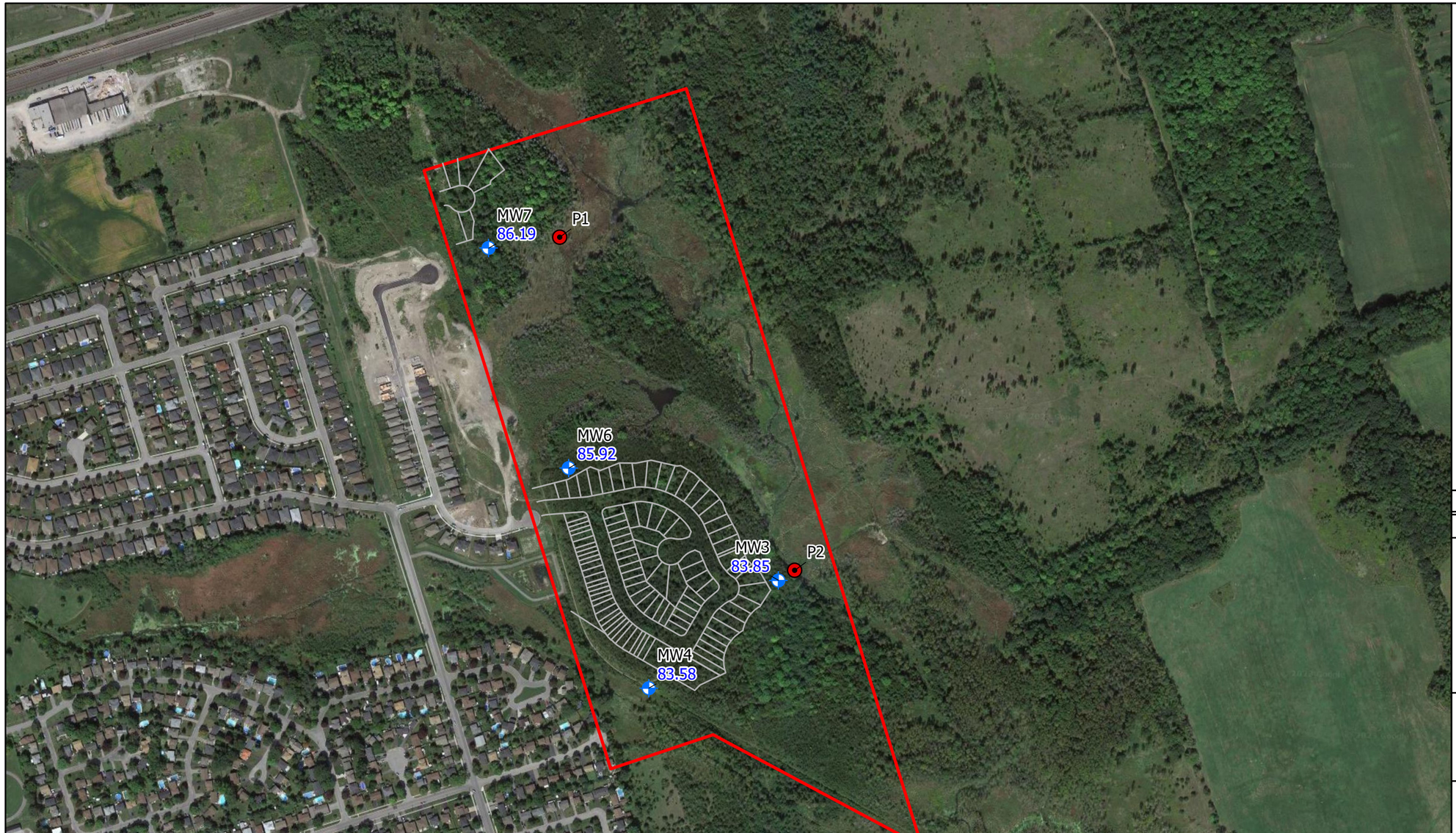


Well Nest Groups	Borehole/Monitoring Well ID	Ground Surface Elevation (m asl)	Stickup (m)	Top of Riser Elevation (m asl)	Depth to Bedrock (m)	Borehole Depth bgs (m)	Bottom of Borehole Elevation (m asl)	12-Jul-22		27-Jul-22		16-Aug-22		11-Jan-23		13-Apr-23		31-Aug-23		16-Nov-23	
								Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)	Depth to Water (m)	Water Level Elev (m asl)
Nest A - overburden	MW1	85.20	0.94	86.14	1.45	1.45	83.8	Dry		Dry		Dry		2.04	84.11	2.17	83.97	Dry		Dry	
Nest A - bedrock	MW4	85.16	0.76	85.92	1.22	3.96	81.2	2.35	83.57	2.39	83.53	2.45	83.47	2.08	83.84	2.08	83.84	2.30	83.62	2.34	83.58
Nest B = overburden	MW2	86.76	0.92	87.68	2.41	2.41	84.4	Dry		Dry		Dry		3.27	84.41	3.26	84.42	Dry		Dry	
Nest B - bedrock	MW3	86.72	0.94	87.67	2.39	5.03	81.7	3.83	83.84	3.84	83.83	3.90	83.77	3.44	84.23	3.43	84.24	3.74	83.93	3.82	83.85
Nest C - overburden	MW5	86.02	0.92	86.94	2.59	2.59	83.4	2.34	84.60	2.18	84.76	2.29	84.65	1.75	85.19	1.75	85.19	2.15	84.79	2.19	84.75
Nest C - bedrock	MW6	85.96	0.85	86.81	2.59	4.27	81.7	2.02	84.80	2.02	84.80	2.15	84.67	1.64	85.17	1.63	85.18	1.99	84.82	2.04	85.92
Nest D - bedrock	MW7	86.19	0.90	87.09	3.66	5.79	80.4	0.93	86.16	0.80	86.29	0.93	86.16	Frozen		0.64	86.45	0.90	86.19	0.90	86.19
Nest D - overburden	MW8	87.10	-1.63	85.47	3.66	3.66	83.4	Dry		1.95	83.52	2.29	83.18	1.28	84.19	1.26	84.21	2.10	83.37	2.16	85.47

LEGEND

- Monitoring Well (BluMetric, 2022)
- Piezometers (BluMetric, 2022)
- Subdivision Concept Layout
- Property Boundary
- 86.19 Water Level Elevation (m asl) (16-Nov-2023)

REV.	DESCRIPTION	YY/MM/DD	BY	CHK
1				

REFERENCES

N W E S

0 100 200 Metres

1:6,000

CLIENT

Hanley Park Development Inc

PROJECT

Hanley Park North
Hydrogeological Impact Assessment

TITLE

Bedrock Groundwater Elevations (Nov 16, 2023)

BluMetric™ Environmental

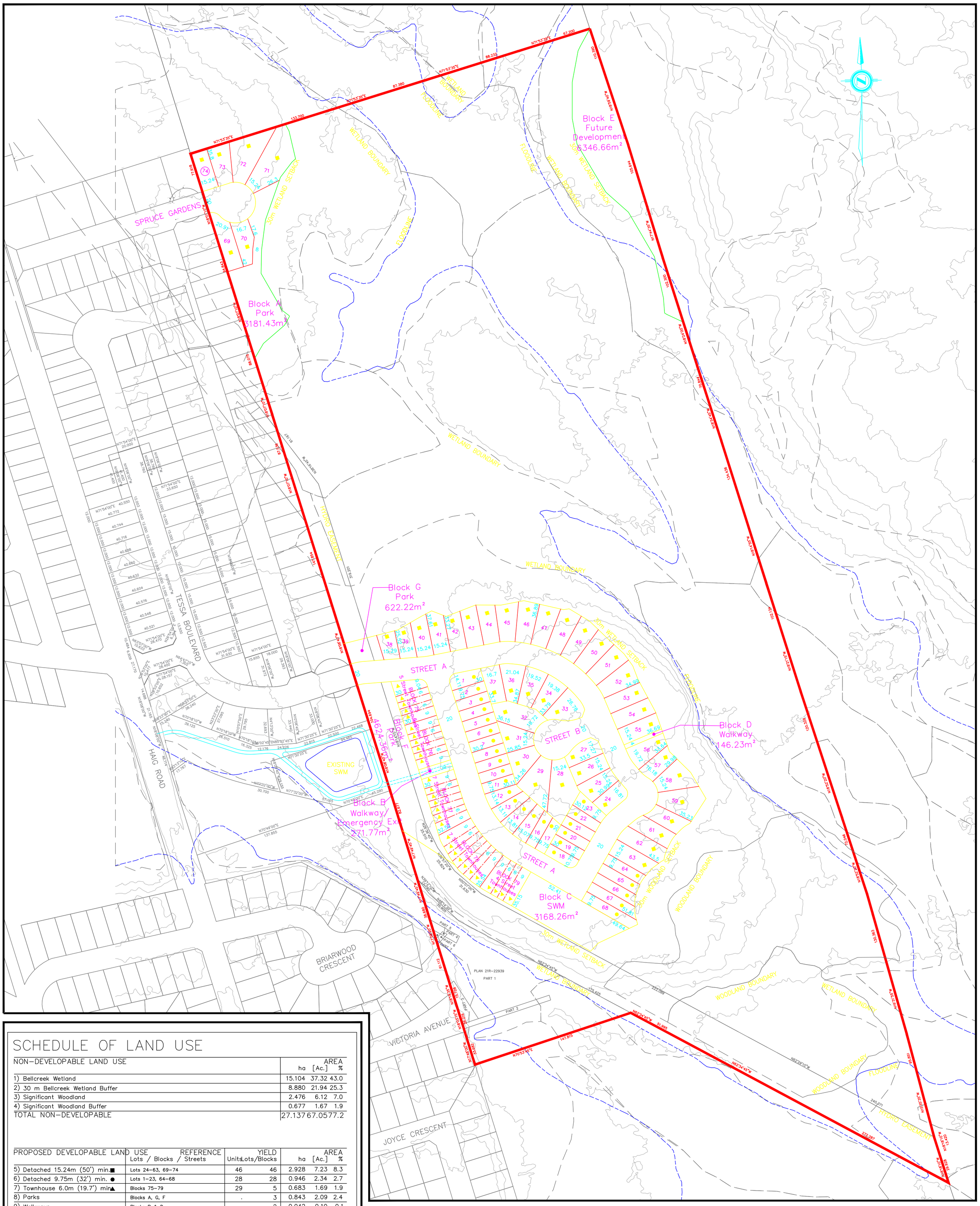
The Tower - The Woolen Mill,
4 Cataraqui St.,
Kingston, Ontario K7K 1Z7
TEL: (613) 531-2725
FAX: (613) 531-1852
Email: info@blumetric.ca
Web: http://www.blumetric.ca

PROJECT #	DATE
220384	November 21, 2023

DRAWN	CHECKED	FIG NO.	REV
MB	RC	06	0

APPENDIX A

Draft Plan of Subdivision



SCHEDULE OF LAND USE

NON–DEVELOPABLE LAND USE	ha	AREA [Ac.]	%
1) Bellcreek Wetland	15.104	37.32	43.0
2) 30 m Bellcreek Wetland Buffer	8.880	21.94	25.3
3) Significant Woodland	2.476	6.12	7.0
4) Significant Woodland Buffer	0.677	1.67	1.9
TOTAL NON–DEVELOPABLE	27.137	67.05	77.2

PROPOSED DEVELOPABLE LAND USE	REFERENCE Lots / Blocks / Streets	YIELD Units	Lots/Blocks	ha	AREA [Ac.]	%
5) Detached 15.24m (50') min.■	Lots 24–63, 69–74	46	46	2.928	7.23	8.3
6) Detached 9.75m (32') min. ●	Lots 1–23, 64–68	28	28	0.946	2.34	2.7
7) Townhouse 6.0m (19.7') min▲	Blocks 75–79	29	5	0.683	1.69	1.9
8) Parks	Blocks A, G, F	.	3	0.843	2.09	2.4
9) Walkways	Blocks B & D	.	2	0.042	0.10	0.1
10)Stormwater Management Facility	Block C	.	1	0.317	0.78	0.9
11)Roads – Public R.O.W.s	Spruce Gardens, Streets A, B	.	.	1.632	4.03	4.6
12)Future Development	Block E	.	1	0.634	1.57	1.8
TOTAL DEVELOPABLE		103	86	8.024	19.83	22.8

TOTALS				35.16	86.88	100

Notes:
Bellcreek Wetland Boundary Surveyed September 13, 2017

No.	REVISION	DATE
4	Revised Draft Plan	October 8, 2021
3	Revised Draft Plan	September 22, 2021
2	Revised Draft Plan based on new Environmental Assessment	August 25, 2021
1	Prepared Draft Plan	December 4, 2019

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0 10 25 50 100
METRES

SCALE 1 : 1500

DATE Nov 8, 2018

PROJECT No. LJ17–1588

File: N:\GIS_PROJECTS\220000\220384 - P07423 - Hanley Park Developments - Hydrog for Subdiv on City Services - Belleville\DWG\2022-06-02\Hanley Park North draft plan_October'2021 SHOWN on Concept Plan.dwg

OWNER'S AUTHORIZATION

I/WE, BEING THE REGISTERED OWNER OF THE SUBJECT LANDS, HEREBY AUTHORIZE MACAULAY SHIOMI HOWSON LTD TO PREPARE AND SUBMIT THIS DRAFT PLAN OF SUBDIVISION FOR APPROVAL.

SIGNED _____ DATE _____

NAME, POSITION

SURVEYOR'S CERTIFICATE

I HEREBY CERTIFY THAT THE BOUNDARIES OF THE SUBJECT LANDS AND THEIR RELATIONSHIP TO THE ADJACENT LANDS ARE ACCURATELY AND CORRECTLY SHOWN ON THIS PLAN.

SIGNED _____ DATE _____

KEITH WATSON, O.L.S.
WATSON LAND SURVEYORS LTD.

ADDITIONAL INFORMATION

REQUIRED UNDER SECTION 51(17) OF THE PLANNING ACT

a SHOWN ON DRAFT PLAN AND SURVEYOR'S CERTIFICATE
b SHOWN ON DRAFT AND KEY PLANS
c SHOWN ON KEY PLAN
d LAND TO BE USED IN ACCORDANCE WITH LAND USE SCHEDULE
e SHOWN ON DRAFT PLAN
f SHOWN ON DRAFT PLAN
g SHOWN ON DRAFT AND KEY PLANS
h FULL MUNICIPAL SERVICES
i SOIL IS LOAM OVERLYING BEDROCK
j SHOWN ON DRAFT PLAN
k ALL MUNICIPAL SERVICES TO BE PROVIDED
l SHOWN ON DRAFT PLAN

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DRAFT PLAN OF SUBDIVISION HANLEY PARK NORTH

PART OF LOT 14, CONCESSION 1
EAST OF HAIG ROAD AND NORTH OF VICTORIA AVENUE
CITY OF BELLEVILLE
FORMER TOWNSHIP OF THURLOW
HASTINGS COUNTY

APPENDIX B

Borehole Logs

Monitoring Well ID: BH1/MW1

Project No.: 220384
Client: Hanley Park Development Inc.
Report: Subdivision Hydrogeology Assessment
Site Address: Part Lot 14, Con. 1, E. of Haig Rd., N. of Victoria Ave. Belleville, On.

Elevation Ground: *85.20 m*
TOP: *86.14 m*

UTM (Zone 18): 4894353.987 N
312926.144 E

Depth (m)	Elevation (m)	Description	Depth (m) / Elev. (m.a.s.l.)
		Ground Surface	0.0 / 85.2
0	85	**SANDY GRAVEL** Sandy gravel, vegetation, roots	
		SANDY GRAVEL Sandy gravel with some boulders	[1.3]
1	84		1.4 / 83.8
		BEDROCK Bedrock refusal at 1.37 m. 0.61 m well screen installed between 0.84 and 1.45 m bgs. Backfilled with silica sand and 3/8" bentonite plug.	
2	83		
3	82		
4	81		
5	80		

SAMPLE: Type, Recovery (%), Blow Counts, Sample ID, Lab Analysis; 1000 ▲ 200 400 600 800

WELL COMPLETION: Construction

Notes:
- J-Plug
- Monument Well Casing
- Concrete Footing
- Bentonite Seal
- Silica Sand Filter
- 50 mm 010 Slot PVC Screen

Drill Date: 2022 July 4
Drilled By: 'Canadian Environmental Drilling and Contractors Inc.
Drilling Method: Hollow Stem Auger
Hole Diameter (OD): 0.23 m
Logged By: MD
Checked By: RLC

AUGER SAMPLE
Perched Groundwater Strike / Unstabilized Groundwater Level
True Groundwater Strike / Stabilized Groundwater Level

Sheet 1 of 1

BH MW OB LOG 220384-AUG 25 BH 4.07.GPJ BLUMETRIC STANDARD.GDT 22-8-26

Monitoring Well ID: BH2/MW2

Project No.: 220384
Client: Hanley Park Development Inc.
Report: Subdivision Hydrogeology Assessment
Site Address: Part Lot 14, Con. 1, E. of Haig Rd., N. of Victoria Ave. Belleville, On.

Elevation Ground: *86.76 m*
TOP: *87.68 m*

UTM (Zone 18): 4894501.045 N
313102.919 E

SUBSURFACE PROFILE					SAMPLE						WELL COMPLETION	
Depth (m)	Elevation (m)	Symbol	Description	Depth (m) / Elev. (m.a.s.l.)	Type	Recovery (%)	Blow Counts	Sample ID	Lab Analysis	1000 ▲ 200 400 600 800	Construction	Notes
-1												J-Plug
	87											Monument Well Casing
			Ground Surface	0.0 86.8								
0			**TOPSOIL** Organic topsoil, vegetation, roots									Concrete Footing
			SANDY GRAVEL Sandy gravel, vegetation, roots									Bentonite Seal
			SANDY GRAVEL Sandy gravel with some boulders									
	86											
1				[2.3]								Silica Sand Filter
												50 mm 010 Slot PVC Screen
	85											
2				2.4 84.3								
			BEDROCK Bedrock refusal at 2.39 m 1.52 m well screen installed between 0.89 and 2.41 m bgs. Backfilled with silica sand and 3/8" bentonite plug.									
	84											
3												
	83											
4												
	82											
5												

Drill Date: 2022 July 4
Drilled By: 'Canadian Environmental Drilling and Contractors Inc.
Drilling Method: Hollow Stem Auger
Hole Diameter (OD): 0.23 m
Logged By: MD
Checked By: RLC

AUGER SAMPLE
Perched Groundwater Strike / Unstabilized Groundwater Level
True Groundwater Strike / Stabilized Groundwater Level

Sheet 1 of 1

220384-AUG 25 BH 4.07.GPJ BLUMETRIC STANDARD.GDT 22-8-26
BH MW OB LOG

Monitoring Well ID: BH3/MW3

Project No.: 220384
Client: Hanley Park Development Inc.
Report: Subdivision Hydrogeology Assessment
Site Address: Part Lot 14, Con. 1, E. of Haig Rd., N. of Victoria Ave. Belleville, On.

Elevation Ground: *86.72 m*
TOP: *87.67 m*

UTM (Zone 18): 4894500.413 N
313104.047 E

SUBSURFACE PROFILE					SAMPLE						WELL COMPLETION	
Depth (m)	Elevation (m)	Symbol	Description	Depth (m) / Elev. (m.a.s.l.)	Type	Recovery (%)	Blow Counts	Sample ID	Lab Analysis	1000 ▲ 200 400 600 800	Construction	Notes
-1	87		Ground Surface	0.0 86.7								J-Plug
												Monument Well Casing
0			**TOPSOIL** Organic topsoil, vegetation, roots									Concrete Footing
			SANDY GRAVEL Sandy Ggravel, vegetation, roots									
	86		**SANDY GRAVEL** Sandy gravel with some boulders									
1				[2.3]								Cuttings Backfill
	85											
2				2.4 84.3								Bentonite Seal
	84		**BEDROCK** Limestone bedrock									
3												2022-Aug-16: 2.96 m bgs (83.77 m)
	83			[2.6]								
4												Silica Sand Filter
	82											50 mm 010 Slot PVC Screen
5				5.0 81.7								
			1.52 m well screen installed between 3.51 and 5.03 m bgs. Backfilled with silica sand and 3/8" bentonite plug.									

Drill Date: 2022 July 12
Drilled By: 'Canadian Environmental Drilling and Contractors Inc.
Drilling Method: Hollow Stem Auger/ Air Hammer
Hole Diameter (OD): 0.23 m
Logged By: MD
Checked By: RLC

AUGER SAMPLE
CYCLONE RETURN (HAMMER)
Perched Groundwater Strike / Unstabilized Groundwater Level
True Groundwater Strike / Stabilized Groundwater Level

Sheet 1 of 1

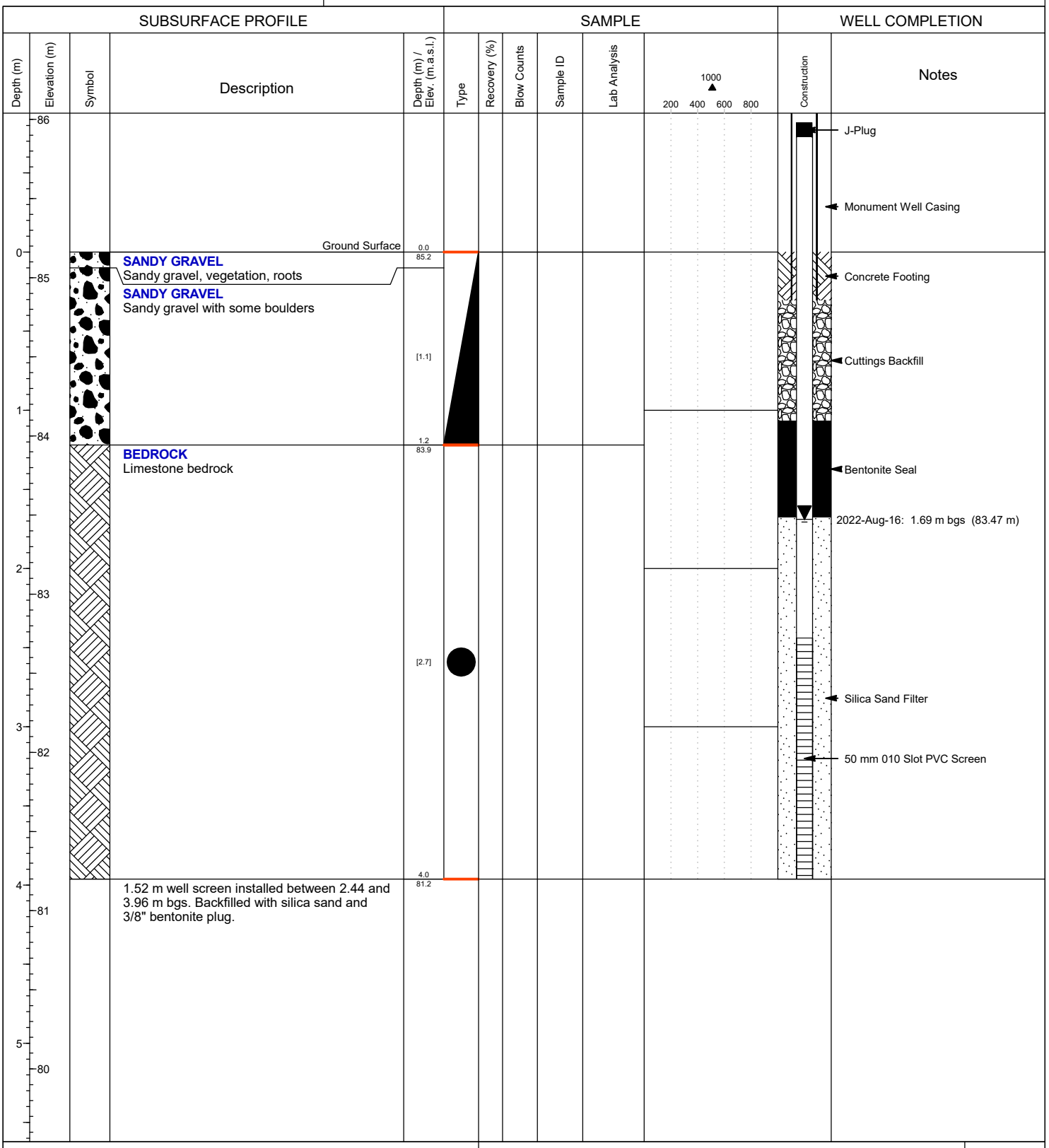
BH MW OB LOG 220384-AUG 25 BH 4.07.GPJ BLUMETRIC STANDARD.GDT 22-8-26

Monitoring Well ID: BH4/MW4

Project No.: 220384
Client: Hanley Park Development Inc.
Report: Subdivision Hydrogeology Assessment
Site Address: Part Lot 14, Con. 1, E. of Haig Rd., N. of Victoria Ave. Belleville, On.

Elevation Ground: *85.16 m*
TOP: *85.92 m*

UTM (Zone 18): 4894352.652 N
312926.459 E



Drill Date: 2022 July 12
Drilled By: 'Canadian Environmental Drilling and Contractors Inc.
Drilling Method: Hollow Stem Auger/ Air Hammer
Hole Diameter (OD): 0.23 m
Logged By: MD
Checked By: RLC

AUGER SAMPLE
CYCLONE RETURN (HAMMER)
Perched Groundwater Strike / Unstabilized Groundwater Level
True Groundwater Strike / Stabilized Groundwater Level

Sheet 1 of 1

BH MW OB LOG 220384-AUG 25 BH 4.07.GPJ BLUMETRIC STANDARD.GDT 22-8-26

Monitoring Well ID: BH5/MW5

Project No.: 220384
Client: Hanley Park Development Inc.
Report: Subdivision Hydrogeology Assessment
Site Address: Part Lot 14, Con. 1, E. of Haig Rd., N. of Victoria Ave. Belleville, On.

Elevation Ground: *86.02 m*
TOP: *86.94 m*

UTM (Zone 18): 4894654.213 N
312812.464 E

Depth (m)	Elevation (m)	Symbol	Description	Depth (m) / Elev. (m.a.s.l.)
			Ground Surface	0.0 / 86.0
0	86		**SANDY CLAY** Silty sandy clay, vegetation, roots	
			SANDY CLAY Silty sandy clay with trace gravel and cobble	[2.5]
2	84			2.6 / 83.4
			BEDROCK Bedrock refusal at 2.59 m ▼ 2.6 m: 1.52 m well screen installed between 1.07 and 2.59 m bgs. Backfilled with silica sand and 3/8" bentonite plug.	

SAMPLE: Type, Recovery (%), Blow Counts, Sample ID, Lab Analysis; 1000 ▲ 200 400 600 800

WELL COMPLETION: Construction; Notes

- J-Plug
- Monument Well Casing
- Concrete Footing
- Bentonite Seal
- 2022-Aug-16: 1.37 m bgs (84.65 m)
- Silica Sand Filter
- 50 mm 010 Slot PVC Screen

Drill Date: 2022 July 12
Drilled By: 'Canadian Environmental Drilling and Contractors Inc.
Drilling Method: Hollow Stem Auger
Hole Diameter (OD): 0.23 m
Logged By: MD
Checked By: RLC

AUGER SAMPLE
Perched Groundwater Strike / Unstabilized Groundwater Level
True Groundwater Strike / Stabilized Groundwater Level

Sheet 1 of 1

BH MW OB LOG 220384-AUG 25 BH 4.07.GPJ BLUMETRIC STANDARD.GDT 22-8-26

Monitoring Well ID: BH6/MW6

Project No.: 220384
Client: Hanley Park Development Inc.
Report: Subdivision Hydrogeology Assessment
Site Address: Part Lot 14, Con. 1, E. of Haig Rd., N. of Victoria Ave. Belleville, On.

Elevation Ground: *85.96 m*
TOP: *86.81 m*

UTM (Zone 18): 4894654.097 N
312816.714 E

Depth (m)	Elevation (m)	Symbol	Description	Depth (m) / Elev. (m.a.s.l.)	Type	Recovery (%)	Blow Counts	Sample ID	Lab Analysis	1000 ▲ 200 400 600 800	Construction	Notes
0	86		Ground Surface	0.0 / 86.0								J-Plug; Monument Well Casing
			SANDY CLAY Silty sandy clay, vegetation, roots									Concrete Footing
			SANDY CLAY Silty sandy clay with trace gravel and cobble									
1	85			[2.5]								Cuttings Backfill 2022-Aug-16: 1.29 m bgs (84.67 m); Bentonite Seal
2	84			2.6 / 83.4								
			BEDROCK Limestone bedrock									
3	83			[1.7]								Silica Sand Filter
4	82			4.3 / 81.7								50 mm 010 Slot PVC Screen
			0.91 m well screen installed between 3.39 and 4.27 m bgs. Backfilled with silica sand and 3/8" bentonite plug.									
5	81											

Drill Date: 2022 July 12
Drilled By: 'Canadian Environmental Drilling and Contractors Inc.
Drilling Method: Hollow Stem Auger/ Air Hammer
Hole Diameter (OD): 0.23 m
Logged By: MD
Checked By: RLC

AUGER SAMPLE
CYCLONE RETURN (HAMMER)
Perched Groundwater Strike / Unstabilized Groundwater Level
True Groundwater Strike / Stabilized Groundwater Level

Sheet 1 of 1

BH MW OB LOG 220384-AUG 25 BH 4.07.GPJ BLUMETRIC STANDARD.GDT 22-8-26

Monitoring Well ID: BH7/MW7

Project No.: 220384
Client: Hanley Park Development Inc.
Report: Subdivision Hydrogeology Assessment
Site Address: Part Lot 14, Con. 1, E. of Haig Rd., N. of Victoria Ave. Belleville, On.

Elevation Ground: *86.19 m*
TOP: *87.09 m*

UTM (Zone 18): 4894955.510 N
312706.788 E

SUBSURFACE PROFILE					SAMPLE						WELL COMPLETION	
Depth (m)	Elevation (m)	Symbol	Description	Depth (m) / Elev. (m.a.s.l.)	Type	Recovery (%)	Blow Counts	Sample ID	Lab Analysis	1000 ▲ 200 400 600 800	Construction	Notes
0	87		Ground Surface	0.0 86.2								J-Plug
												Monument Well Casing
			TOPSOIL Organic topsoil, vegetation, roots									2022-Aug-16: 0.02 m bgs (86.16 m)
			SAND Sand									Concrete Footing
1	86											
	85			[2.4]								Cuttings Backfill
2	84											
			SAND & GRAVEL Sand, increasing gravel	2.4 83.7								
3	83			[1.2]								Bentonite Seal
			BEDROCK Limestone bedrock	3.7 82.5								
4	82			[2.1]								
												Silica Sand Filter
5	81											50 mm 010 Slot PVC Screen

Drill Date: 2022 July 12
Drilled By: 'Canadian Environmental Drilling and Contractors Inc.
Drilling Method: Hollow Stem Auger/ Air Hammer
Hole Diameter (OD): 0.23 m
Logged By: MD
Checked By: RLC

AUGER SAMPLE
CYCLONE RETURN (HAMMER)
Perched Groundwater Strike / Unstabilized Groundwater Level
True Groundwater Strike / Stabilized Groundwater Level

Monitoring Well ID: BH7/MW7

Project No.: 220384
Client: Hanley Park Development Inc.
Report: Subdivision Hydrogeology Assessment
Site Address: Part Lot 14, Con. 1, E. of Haig Rd., N. of Victoria Ave. Belleville, On.

Elevation Ground: *86.19 m*
TOP: *87.09 m*

UTM (Zone 18): 4894955.510 N
312706.788 E

SUBSURFACE PROFILE					SAMPLE						WELL COMPLETION	
Depth (m)	Elevation (m)	Symbol	Description	Depth (m) / Elev. (m.a.s.l.)	Type	Recovery (%)	Blow Counts	Sample ID	Lab Analysis	1000 ▲ 200 400 600 800	Construction	Notes
				[2.1]								
				5.8 80.4								
			1.52 m well screen installed between 4.27 and 5.79 m bgs. Backfilled with silica sand and 3/8" bentonite plug.									
6	80											
7	79											
8	78											
9	77											
10	76											
11	75											

Drill Date: 2022 July 12
Drilled By: 'Canadian Environmental Drilling and Contractors Inc.
Drilling Method: Hollow Stem Auger/ Air Hammer
Hole Diameter (OD): 0.23 m
Logged By: MD
Checked By: RLC

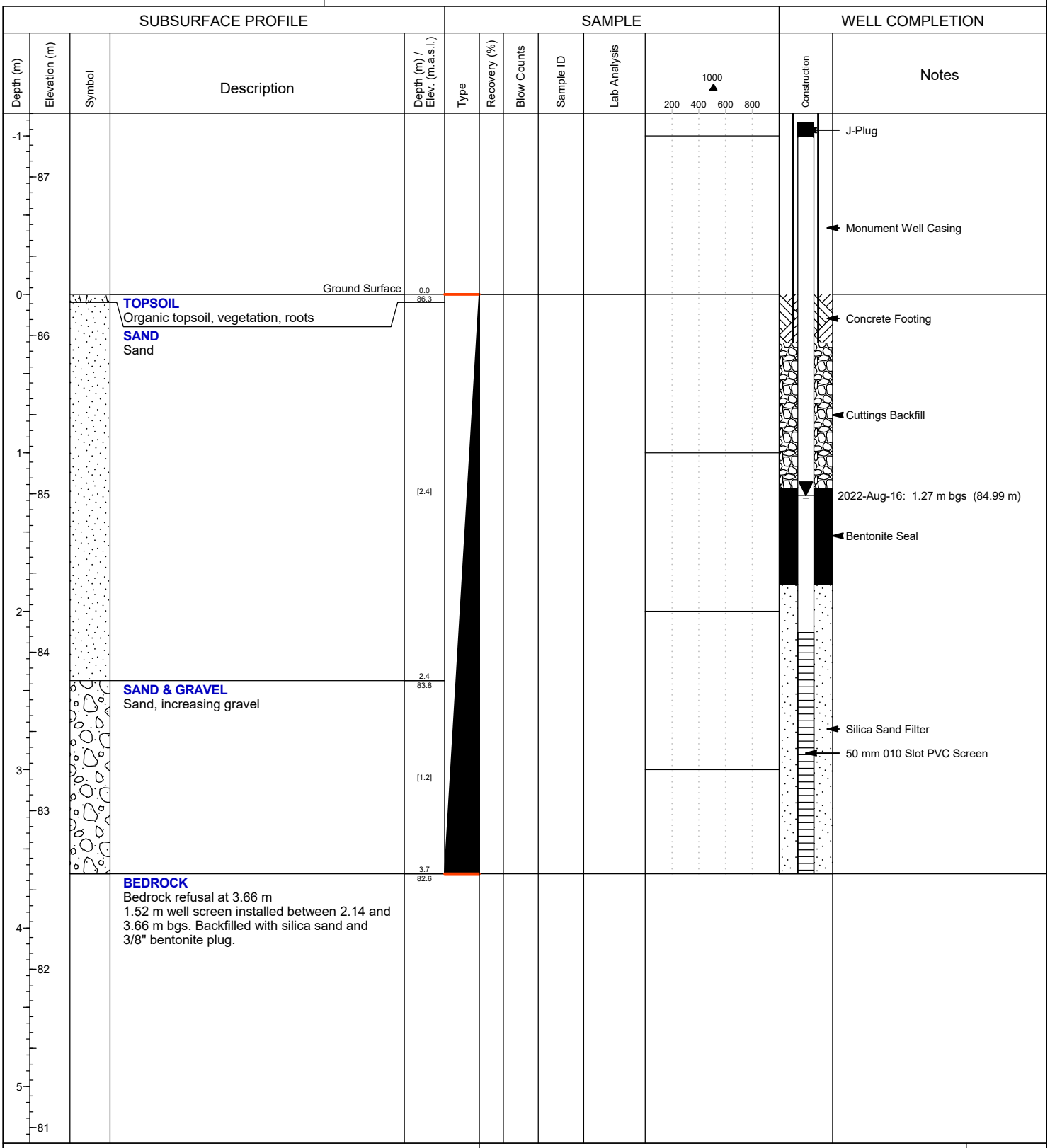
AUGER SAMPLE
CYCLONE RETURN (HAMMER)
Perched Groundwater Strike / Unstabilized Groundwater Level
True Groundwater Strike / Stabilized Groundwater Level

Monitoring Well ID: BH8/MW8

Project No.: 220384
Client: Hanley Park Development Inc.
Report: Subdivision Hydrogeology Assessment
Site Address: Part Lot 14, Con. 1, E. of Haig Rd., N. of Victoria Ave. Belleville, On.

Elevation Ground: *86.26 m*
TOP: *87.28 m*

UTM (Zone 18): 4894957.488 N
312706.591 E



Drill Date: 2022 July 12
Drilled By: 'Canadian Environmental Drilling and Contractors Inc.
Drilling Method: Hollow Stem Auger
Hole Diameter (OD): 0.23 m
Logged By: MD
Checked By: RLC

AUGER SAMPLE
Perched Groundwater Strike / Unstabilized Groundwater Level
True Groundwater Strike / Stabilized Groundwater Level

Sheet 1 of 1

BH MW OB LOG 220384-AUG 25 BH 4.07.GPJ BLUMETRIC STANDARD.GDT 22-8-26

APPENDIX C

Water Well Records

Ontario — Ministry of the Environment, Conservation and Parks

Measurements recorded in: ☐ Metric ☑ Imperial

Well Tag No. (Place Sticker and/or Print Below) **Tag#:A331759**

Well Record

Regulation 903 Ontario Water Resources Act

Page 1 of 1

Well Owner's Information

First Name	Last Name/Organization	E-mail Address	☐ Well Constructed by Well Owner
	Hanley Park Development Inc		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
1055A Albion Rd, Suite 207	Toronto	ON	M9V1A7	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
	City of Belleville	14 & 15	1

County/District/Municipality	City/Town/Village	Province	Postal Code
Hastings	Belleville	Ontario	K8N5B6

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 8 3	18	327114	4894948		

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

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
brown	silt	clay	loose	0	2'
tan	till	gravel	light/dry	2'	12'
grey	limestone		bedrock	12'	19'
	8 MW's set on site in cluster				

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m^3/ft^3)
0	13.5'	3/8 bentonite plug	
13.5'	19'	#2 silica sand	

Results of Well Yield Testing

After test of well yield, water was: ☐ Clear and sand free ☐ Other, specify

If pumping discontinued, give reason:

Pump intake set at (m/ft)

Pumping rate (l/min / GPM)

Duration of pumping ____ hrs + ____ min

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

	Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level				
1			1	
2			2	
3			3	
4			4	
5			5	
10			10	
15			15	
20			20	
25			25	
30			30	
40			40	
50			50	
60			60	

Method of Construction

☐ Cable Tool ☐ Diamond
☑ Rotary (Conventional) ☐ Jetting
☐ Rotary (Reverse) ☐ Driving
☐ Boring ☐ Digging
☑ Air percussion
☐ Other, specify

Well Use

☐ Public ☐ Commercial ☐ Not used
☐ Domestic ☐ Municipal ☐ Dewatering
☐ Livestock ☑ Test Hole ☑ Monitoring
☐ Irrigation ☐ Cooling & Air Conditioning
☐ Industrial
☐ Other, specify

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
1.5"	PVC	.25"	0	14'

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To
1.75"	PVC	.10	14'	19'

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
☐ Other, specify

Water Details

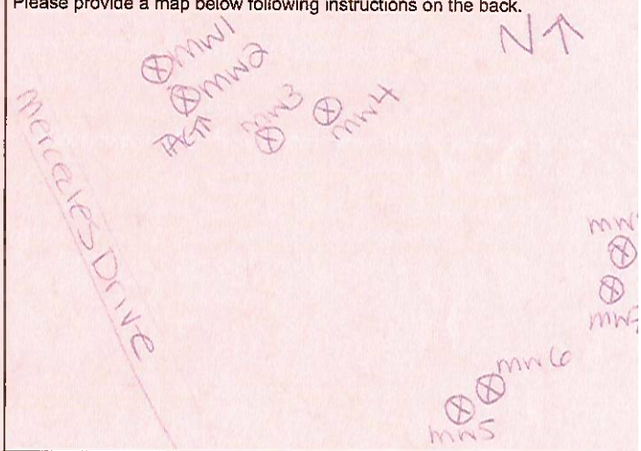
Water found at Depth (m/ft)	Gas	Kind of Water: ☐ Fresh ☐ Untested ☐ Other, specify
	☐	
	☐	
	☐	

Hole Diameter

Depth (m/ft) From	Depth (m/ft) To	Diameter (cm/in)
0	12'	9"
12'	19'	4"

Map of Well Location

Please provide a map below following instructions on the back.



Comments:

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Canadian Environmental Drilling Contractors	7123

Business Address (Street Number/Name)	Municipality	Province	Postal Code	Business E-mail Address
4112 Perth Rd, Inverary	Frontenac	ON	K0H1X0	info@cedc.com

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)	Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
613 351 3291	Fillion, Jonathan	3115		2022/07/15

Well owner's information package delivered ☐ Yes ☐ No

Date Package Delivered: ____

Date Work Completed: 2022/07/12

Ministry Use Only

Audit No. Z388957

Received

0506E (2020/06) © Queen's Printer for Ontario, 2020

Well Owner's Copy

M | Z | Not Plotted | E

| 9 | R | | N

Elev. | 9 | R | |

Basin | 24 | | |

ONTARIO

29 No. 2643

The Well Drillers Act

Department of Mines, Province of Ontario

Water Well Record

[redacted], Village, Town or City Thurlow

[redacted] own or City) Belleville

[redacted] Belleville R.R.

Date Completed 5 (day) Aug (month) 54 (year) Cost of Well (excluding pump)

Pipe and Casing Record

Casing diameter(s) 6"

Length(s) of casing(s) 5 ft.

Type of screen —

Length of screen —

Distance from top of screen to ground level —

Is well a gravel-wall type? —

Pumping Test

Date Aug. 5/54

Static level 6 ft.

Pumping level 15 ft.

Pumping rate 18 g.p.m.

Duration of test 1 hrs.

Distance from cylinder or bowls to ground level —

Water Record

Kind (fresh or mineral) mineral

Quality (hard, soft, contains iron, sulphur, etc.) hard - sulphur & salt

Appearance (clear, cloudy, coloured) cloudy

For what purpose(s) is the water to be used? domestic

How far is well from possible source of contamination? 150 ft.

What is the source of contamination? barnyard

Enclose a copy of any mineral analysis that has been made of water —

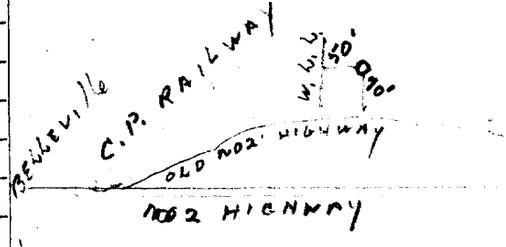
Depth(s) to Water Horizon(s)	Kind of Water	No. of Feet Water Rises
38 ft.	mineral	32 ft.

Well Log

Overburden and Bedrock Record	From	To
grey limestone	0 ft.	32 ft.

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



Situation: Is well on upland, in valley, or on hillside? upland

Drilling Firm George H. Chalk Jr.

Address R.R. #6 Napanee Ont.

Name of Driller George H. Chalk Jr. Address R.R. #6 Napanee Ont.

Date Aug. 15/54 Licence Number 410

George H. Chalk Jr.
Signature of Licensee

FORM 5

CSS.S8

UTM Z E
5 R N
Elev. 4 R 0 2 9 4
Basin 2 4

The Ontario Water Resources Commission Act, 1957

GROUND WATER BRANCH
JUL 20 1959
ONTARIO WATER RESOURCES COMMISSION

29 No 2820
C

WATER WELL RECORD

County or District HASTINGS Township Village, Town or City THURLOW

Date completed 3 (day) 6 (month) 59 (year)

[redacted] ress RR 6 BELLEVILLE

Casing and Screen Record

Inside diameter of casing 6 1/4"
Total length of casing 13'
Type of screen none
Length of screen none
Depth to top of screen none
Diameter of finished hole 6 1/4"

Pumping Test

Static level 20'
Test-pumping rate 2 G.P.M.
Pumping level CAN BE PUMPED DRY
Duration of test pumping 1 hr
Water clear or cloudy at end of test CLEAR
Recommended pumping rate 1 G.P.M.
with pumping level of DRY

Well Log

Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	No. of feet water rises	Kind of water (fresh, salty, sulphur)
CLAY	0'	12'			
SOFT LIMESTONE	12'	36'	30'	16'	Fresh

Water Record

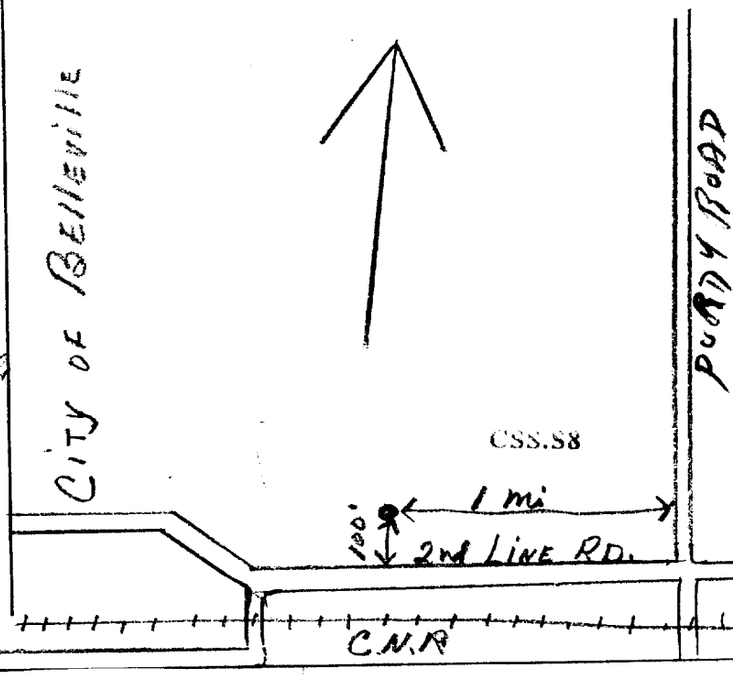
For what purpose(s) is the water to be used?
DOMESTIC

Is well on upland, in valley, or on hillside?
VALLEY

Drilling Firm Thos Donaldson & Son
Address 56 Holmes Rd
RR 3 Belleville Ont
Licence Number 76
Name of Driller Marcel Donaldson
Address 31 Wilkins St Belleville
Date July 9/59
Thos Donaldson
(Signature of Licensed Drilling Contractor)

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



Form 5
15M-58-4149

UTM Z E
R N

Elev. R

Basin

ONTARIO

The Water-well Drillers Act, 1954
Department of Mines

RECEIVED
SEP 13 1955
GEOLOGICAL BRANCH
DEPARTMENT of MINES

29 No 2822

Water-Well Record

County or Territorial District Hastings Township, Village, Town or City Thurlow

Con. 2 Lot Pt 14 Street and Number (if in Village, Town or City)

Owner School S.S. # 4 Address Belleville R.R.

Date completed 12 (day) May (month) 1955 (year)

Pipe and Casing Record

Casing diameter(s) 6"
Length(s) 8'
Type of screen —
Length of screen —

Pumping Test

Static level 8'
Pumping rate 1000 G.P.H. flow
Pumping level 8'
Duration of test 1 hr.

Well Log

Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	No. of feet water rises	Kind of water (fresh, salty, or sulphur)
Clay	0	5			fresh
Grey limestone	5	30	28'	20'	

Water Record

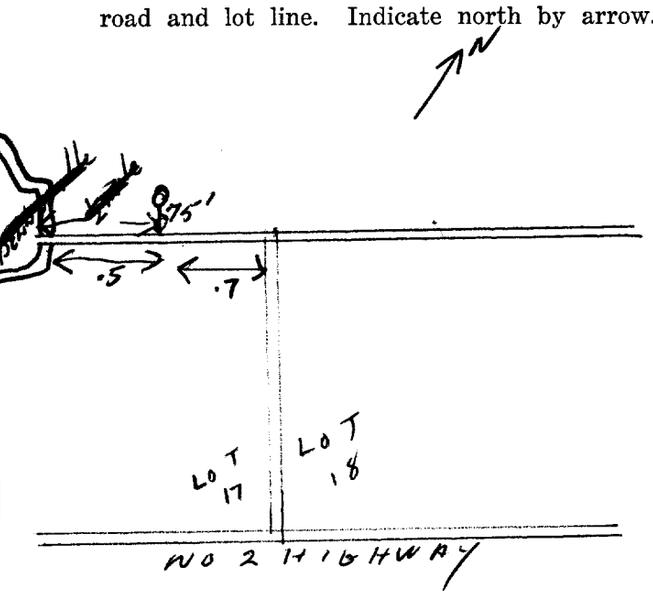
For what purpose(s) is the water to be used?
Domestic
Is water clear or cloudy? Clear
Is well on upland, in valley, or on hillside?
Hillside
Drilling firm George H. Chalk Jr.
Address R.R. # 6
Napanee Ont.
Name of Driller George H. Chalk Jr.
Address R.R. # 6
Napanee, Ont.
Licence Number 410

I certify that the foregoing statements of fact are true.

Date May 12/55 George H. Chalk Jr.
Signature of Licensee

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



Form 5

MINISTRY OF THE ENVIRONMENT MAP 31C-3F

The Ontario Water Resources Act

WATER WELL RECORD

Ontario

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 2906319 | MUNICIP. 29020 | CON. CON 02

COUNTY OR DISTRICT: Hastings | TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE: Thurlow | CON., BLOCK, TRACT, SURVEY, ETC.: Conn. 2 | LOT: 012

[redacted] R.R.6 Belleville Ont. | DATE COMPLETED: DAY 12 MO. 03 YR. 74

UTM: 195048 | RC: 4 | ELEVATION: 0300 | RC: 4 | BASIN CODE: 24

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
Grey	Clay	Stones	Dense	0	10
Grey	Limestone		Layered	10	38

31: 0010205/2 | 0038215

32:

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0028	1 ☒ FRESH 3 ☐ SULPHUR; 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR; 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR; 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR; 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR; 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
06	1 ☒ STEEL; 2 ☐ GALVANIZED; 3 ☐ CONCRETE; 4 ☒ OPEN HOLE	1/4	0	0010
06	4 ☒ OPEN HOLE		10	0038

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET
MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN FEET	

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	DEPTH SET AT - FEET TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☐ PUMP 2 ☒ BAILER | PUMPING RATE: 0003 GPM | DURATION OF PUMPING: 02 HOURS 00 MINS

STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING: 1 ☐ PUMPING 2 ☐ RECOVERY	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
010 FEET	036 FEET		FEET	FEET	FEET	FEET

IF FLOWING, GIVE RATE	PUMP INTAKE SET AT	WATER AT END OF TEST
GPM	FEET	1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE	RECOMMENDED PUMP SETTING	RECOMMENDED PUMPING RATE
☐ SHALLOW ☒ DEEP	036 FEET	0003 GPM

50-53: 0001 GPM./FT. SPECIFIC CAPACITY

LOCATION OF WELL 1295

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.

DRILLERS REMARKS:

FINAL STATUS OF WELL 54: 1
1 ☒ WATER SUPPLY; 2 ☐ OBSERVATION WELL; 3 ☐ TEST HOLE; 4 ☐ RECHARGE WELL; 5 ☐ ABANDONED, INSUFFICIENT SUPPLY; 6 ☐ ABANDONED POOR QUALITY; 7 ☐ UNFINISHED

WATER USE 55-56: 01
1 ☒ DOMESTIC; 2 ☐ STOCK; 3 ☐ IRRIGATION; 4 ☐ INDUSTRIAL; ☐ OTHER; 5 ☐ COMMERCIAL; 6 ☐ MUNICIPAL; 7 ☐ PUBLIC SUPPLY; 8 ☐ COOLING OR AIR CONDITIONING; 9 ☐ NOT USED

METHOD OF DRILLING 57: 1
1 ☒ CABLE TOOL; 2 ☐ ROTARY (CONVENTIONAL); 3 ☐ ROTARY (REVERSE); 4 ☐ ROTARY (AIR); 5 ☐ AIR PERCUSSION; 6 ☐ BORING; 7 ☐ DIAMOND; 8 ☐ JETTING; 9 ☐ DRIVING

CONTRACTOR

NAME OF WELL CONTRACTOR: H.R.Gobel | LICENCE NUMBER: 2334

ADDRESS: R.R.1 [illegible] Ont.

NAME OF DRILLER OR BORER: H.R.Gobel | LICENCE NUMBER:

SIGNATURE OF CONTRACTOR: [signature] | SUBMISSION DATE: DAY 6 MO. 4 YR. 74

OFFICE USE ONLY

DATA SOURCE 58: 1 | CONTRACTOR 59-62: 2334 | DATE RECEIVED 63-68: 100474

DATE OF INSPECTION | INSPECTOR: K

REMARKS: CSS.SS | P DG | WI

MINISTRY OF THE ENVIRONMENT COPY

FORM 7 07-091

Ministry of the Environment
Ontario

The Ontario Water Resources Act 31C3f

WATER WELL RECORD

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 (1 2) 2910595 MUNICIP 29020 (10 14) CON CON (15) 01 (22 23 24)

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT 25-27
Hastings	Thurlow	1	15

[redacted] R.R. 1 Picton

DATE COMPLETED 48-53: DAY 1 MO 5 YR 84

(24) RC (25) ELEVATION (26) RC (30) BASIN CODE (31) I II III IV (47)

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
	Clay			0	14
	Limestone			14	30

31

32 (1 2 10 14 15 21 32 43 54 65 75 80)

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
10-13: 20	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL (14)
15-18: 26	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL (19)
20-23	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL (24)
25-28	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL (29)
30-33	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL (34 80)

51 CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
10-11: 6 1/4	1 ☒ STEEL (12) 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	188	0	13-16: 20
17-18	1 ☐ STEEL (19) 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			20-23
24-25	1 ☐ STEEL (26) 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			27-30

SCREEN

SIZE(S) OF OPENING (SLOT NO.) 31-33	DIAMETER 34-38 INCHES	LENGTH 39-40 FEET
MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN 41-44 FEET	(30)

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	DEPTH SET AT - FEET TO	MATERIAL AND TYPE (CEMENT GROUT LEAD PACKER ETC.)
10-13	14-17	
18-21	22-25	
26-29	30-33 (80)	

71 PUMPING TEST

PUMPING TEST METHOD (10)	PUMPING RATE (11-14)	DURATION OF PUMPING (15-16 HOURS, 17-18 MINS)
1 ☐ PUMP 2 ☒ BAILER	10 GPM	1 HOURS

STATIC LEVEL (19-21)	WATER LEVEL END OF PUMPING (22-24)	WATER LEVELS DURING (25)	15 MINUTES (26-28)	30 MINUTES (29-31)	45 MINUTES (32-34)	60 MINUTES (35-37)
1 FEET	25 FEET	1 ☐ PUMPING 2 ☐ RECOVERY	4 FEET	1 FEET	1 FEET	1 FEET

IF FLOWING, GIVE RATE (38-41)	PUMP INTAKE SET AT	WATER AT END OF TEST (42)
GPM	FEET	1 ☐ CLEAR 2 ☐ CLOUDY

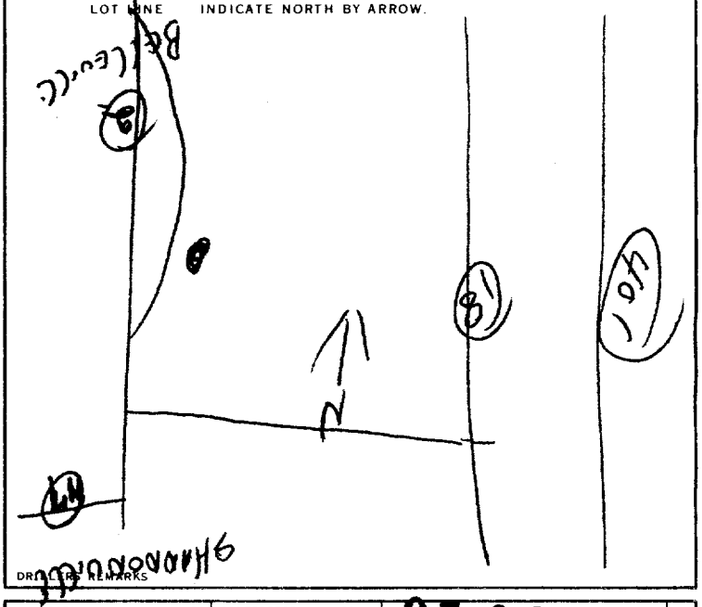
RECOMMENDED PUMP TYPE	RECOMMENDED PUMP SETTING (43-45)	RECOMMENDED PUMPING RATE (46-49)
☒ SHALLOW ☐ DEEP	25 FEET	5 GPM

(50-53)

LOCATION OF WELL

2917

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



FINAL STATUS OF WELL (54)

1 ☐ WATER SUPPLY 2 ☒ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED

WATER USE (55-56)

1 ☒ DOMESTIC 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL ☐ OTHER 5 ☐ COMMERCIAL 6 ☐ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED

METHOD OF DRILLING (57)

1 ☒ CABLE TOOL 2 ☐ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☐ ROTARY (AIR) 5 ☐ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING

CONTRACTOR

NAME OF WELL CONTRACTOR: Florn Donaldson — LICENCE NUMBER: 1831

ADDRESS: R.R. 5 Cloverleaf Dr. Belleville

NAME OF DRILLER OR BORER — LICENCE NUMBER

SIGNATURE OF CONTRACTOR: Florn Donaldson — SUBMISSION DATE: DAY 1 MO 5 84

MINISTRY OF THE ENVIRONMENT COPY

OFFICE USE ONLY

DATA SOURCE (58) — CONTRACTOR (59-62): 1831 — DATE RECEIVED (63-68): 01 06 84 (80)

DATE OF INSPECTION — INSPECTOR

REMARKS

WDE

CSS.ES

FORM NO. 0506—4—77 FORM 7

Ministry of the Environment
Ontario

The Ontario Water Resources Act

WATER WELL RECORD

31 C 3 f

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 2910818 | MUNICIP. 29020 | CON. CON 01

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
HASTINGS	THURLOW	CON 1	15

[redacted] #1 FOXBORO ONT

DATE COMPLETED: DAY 2 MO 1 YR 85

G | RC | ELEVATION | RC | BASIN CODE (I, II, III, IV)

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
BROWN	TOPSOIL			0	1
BROWN	CLAY			1	3
GREY	LIMESTONE			3	35

31

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
18	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
6 1/4	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	.188	0	12
6	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE		12	35
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER (INCHES)	LENGTH (FEET)

MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN (FEET)

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD	PUMPING RATE	DURATION OF PUMPING
1 ☐ PUMP 2 ☒ BAILER	20 GPM	1 HOURS 00 MINS

STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
9 FEET	18 FEET	1 ☐ PUMPING 2 ☐ RECOVERY	FEET	FEET	FEET	FEET

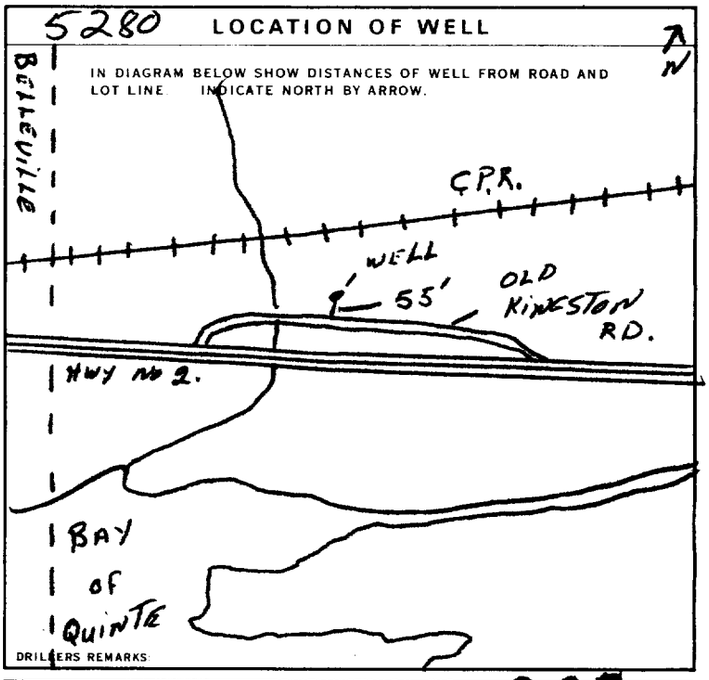
IF FLOWING, GIVE RATE	PUMP INTAKE SET AT	WATER AT END OF TEST
GPM	30 FEET	1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE	RECOMMENDED PUMP SETTING	RECOMMENDED PUMPING RATE
☒ SHALLOW ☐ DEEP	30 FEET	15 GPM

LOCATION OF WELL

5280

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS:

FINAL STATUS OF WELL

1 ☒ WATER SUPPLY 2 ☐ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED

WATER USE

1 ☒ DOMESTIC 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL ☐ OTHER 5 ☐ COMMERCIAL 6 ☐ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED

METHOD OF DRILLING

1 ☒ CABLE TOOL 2 ☐ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☐ ROTARY (AIR) 5 ☐ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING

CONTRACTOR

NAME OF WELL CONTRACTOR: MANSE DONALDSON WELL DRILLING — LICENCE NUMBER: 1805.

ADDRESS: 274 MAIN ST. FOXBORO

NAME OF DRILLER OR BORER: KEN DONALDSON — LICENCE NUMBER: 1841

SIGNATURE OF CONTRACTOR: Ken Donaldson — SUBMISSION DATE: DAY 2 MO. 1 YR. 85

OFFICE USE ONLY

DATA SOURCE | CONTRACTOR: 1805 | DATE RECEIVED: 07 02 85

DATE OF INSPECTION | INSPECTOR

REMARKS

WDE

CSS.ES

MINISTRY OF THE ENVIRONMENT COPY

FORM NO. 0506—4—77 FORM 7

Ministry of the Environment
Ontario

The Ontario Water Resources Act

WATER WELL RECORD

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 2912290 MUNICIP 29020 CON.

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
[redacted]	[redacted] FLOW	CON 1	16

[redacted] #4 BELLEVILLE ONT.

DATE COMPLETED: DAY 15 MO 09 YR 86

ELEVATION RC ELEVATION RC BASIN CODE

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
BROWN	TOPSOIL	STONES		0	1
GREY	SHALE		BROKEN	1	2
GREY	LIMESTONE			2	33

31

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
14	1 ☐ FRESH 2 ☐ SALTY 3 ☒ SULPHUR 4 ☐ MINERALS 6 ☐ GAS
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS

51 CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
6¼	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC	.188	0	10
6	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE 5 ☐ PLASTIC		10	33
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET
MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN FEET	

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	DEPTH SET AT - FEET TO	MATERIAL AND TYPE (CEMENT GROUT LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD	PUMPING RATE	DURATION OF PUMPING
1 ☐ AIR 2 ☐ BAILER	20 GPM	1 HOURS 00 MINS

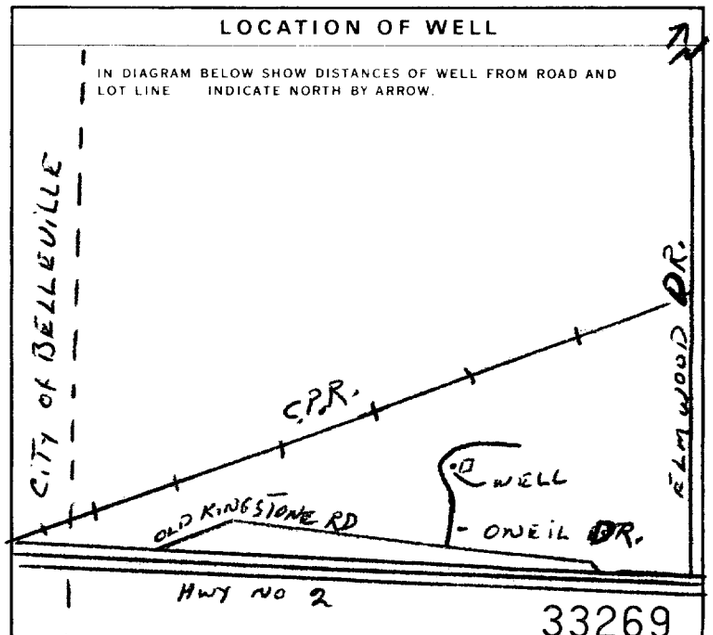
STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
9 FEET	30 FEET	1 ☐ PUMPING 2 ☐ RECOVERY	FEET	FEET	FEET	FEET

IF FLOWING, GIVE RATE	PUMP INTAKE SET AT	WATER AT END OF TEST
GPM	30 FEET	1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE	RECOMMENDED PUMP SETTING	RECOMMENDED PUMPING RATE
☐ SHALLOW ☒ DEEP	30 FEET	15 GPM

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



33269

DRILLERS REMARKS

54 FINAL STATUS OF WELL

1 ☒ WATER SUPPLY 2 ☐ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED 9 ☐ DEWATERING

55-56 WATER USE

1 ☒ DOMESTIC 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL ☐ OTHER 5 ☐ COMMERCIAL 6 ☐ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED

57 METHOD OF CONSTRUCTION

1 ☐ CABLE TOOL 2 ☐ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☒ ROTARY (AIR) 5 ☒ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING ☐ DIGGING ☐ OTHER

CONTRACTOR

NAME OF WELL CONTRACTOR: MANSE DONALDSON WELL DRILLING — WELL CONTRACTOR'S LICENCE NUMBER: 1805

ADDRESS: RR#5 BELLEVILLE ONT.

NAME OF WELL TECHNICIAN: KEN DONALDSON — WELL TECHNICIAN'S LICENCE NUMBER: T-0019

SIGNATURE OF TECHNICIAN/CONTRACTOR: Ken Donaldson — SUBMISSION DATE: DAY 15 MO 09 YR 88

MINISTRY OF THE ENVIRONMENT COPY

OFFICE USE ONLY

DATA SOURCE 58 — CONTRACTOR 59-62: 1805 — DATE RECEIVED 63-66: OCT 19 1988

DATE OF INSPECTION — INSPECTOR

REMARKS

CSS.ES

FORM NO. 0506 (11/86) FORM 9

Ministry of the Environment
Ontario

ENVIRONMENT & ENERGY
AUG 30 1995
KINGSTON -- ONTARIO

The Ontario Water Resources Act

WATER WELL RECORD

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK [X] CORRECT BOX WHERE APPLICABLE

11 — 2916831 — MUNICIP. 29020 — CON. CON | LOT 10,11

COUNTY OR DISTRICT [redacted] — TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE [redacted] Thurlow — CON, BLOCK, TRACT, SURVEY, ETC. Con 1 Lot 17 — LOT 12. — DATE COMPLETED 8 MO 8 YR 95

[redacted] P.O. Box 20151

RNG — RC. — ELEVATION — RC. — BASIN CODE

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
Black	Top Soil			0	2.
Red	Sand			2	6.5
Blue	Clay			6.5	22
	Flat Rock				

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
9	1 ☑ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS
22	1 ☑ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS

51 CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
36"	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC	1½"	0	22
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC			
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET
MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN FEET	

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	DEPTH SET AT - FEET TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)
0	8½ FT	Volclay Sealing Clay

71 PUMPING TEST

PUMPING TEST METHOD	PUMPING RATE	DURATION OF PUMPING
1 ☑ PUMP 2 ☐ BAILER	15 GPM	4/5 HOURS MIN

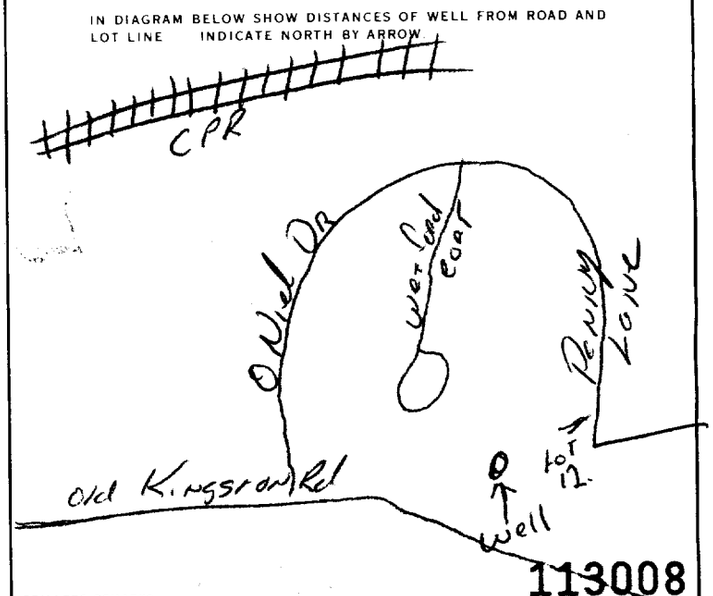
STATIC LEVEL	WATER LEVEL END OF PUMPING	25 WATER LEVELS DURING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
12 FEET	18 FEET	1 ☐ PUMPING 2 ☐ RECOVERY	FEET	FEET	FEET	FEET

IF FLOWING, GIVE RATE	PUMP INTAKE SET AT	WATER AT END OF TEST
GPM	FEET	1 ☑ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE	RECOMMENDED PUMP SETTING	RECOMMENDED PUMPING RATE
☐ SHALLOW ☐ DEEP	FEET	4 GPM

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



113008

DRILLERS REMARKS

FINAL STATUS OF WELL 54
1 ☑ WATER SUPPLY 2 ☐ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED ☐ DEWATERING

WATER USE 55-56
1 ☑ DOMESTIC 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL ☐ OTHER 5 ☐ COMMERCIAL 6 ☐ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED

METHOD OF CONSTRUCTION 57
1 ☐ CABLE TOOL 2 ☐ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☐ ROTARY (AIR) 5 ☐ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING ☑ DIGGING ☐ OTHER

CONTRACTOR

NAME OF WELL CONTRACTOR: Van Soelen Landscaping — WELL CONTRACTOR'S LICENCE NUMBER: 6534
ADDRESS: RR#7 Belleville
NAME OF WELL TECHNICIAN: Bill Van Soelen — WELL TECHNICIAN'S LICENCE NUMBER: T 1871
SIGNATURE OF TECHNICIAN/CONTRACTOR: [signature] — SUBMISSION DATE: DAY 22 MO. 8 YR. 95

OFFICE USE ONLY

DATA SOURCE 58 — CONTRACTOR 59-62: 6534 — DATE RECEIVED 63-68: SEP 01 1995
DATE OF INSPECTION — INSPECTOR
REMARKS: CSS.ES

MINISTRY OF THE ENVIRONMENT COPY

FORM NO. 0506 (11/86) FORM 9

Ministry of the Environment
Ontario

The Ontario Water Resources Act

WATER WELL RECORD

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 — 2917263 — MUNICIP 29020 — CON. CON 01

COUNTY OR DISTRICT: [redacted] — TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE: THURLOW — CON., BLOCK, TRACT, SURVEY, ETC: CON 1 LOT 17 — LOT: 15

[redacted] 20151 BELLEVILLE — DATE COMPLETED: DAY 15 MO 10 YR 96

21 — RC. — ELEVATION — RC. — BASIN CODE

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
BLACK	TOPSOIL			0	2'
BROWN	SAND			2	8'
GRAY	CLAY			8'	23'
ROCK					

MINISTRY OF ENVIRONMENT & ENERGY
NOV 15 1996
KINGSTON ONTARIO
REGIONAL OFFICE

31
32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
23	1 ☑ FRESH 2 ☐ SALTY — 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS
	1 ☐ FRESH 2 ☐ SALTY — 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS
	1 ☐ FRESH 2 ☐ SALTY — 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS
	1 ☐ FRESH 2 ☐ SALTY — 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS
	1 ☐ FRESH 2 ☐ SALTY — 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS

51 CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
36"	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☑ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC	1½"	0	26'
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC			
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET
MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN FEET	

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	DEPTH SET AT - FEET TO	MATERIAL AND TYPE (CEMENT GROUT LEAD PACKER, ETC.)
0	8½	VAULT SEAL & GRAVEL

71 PUMPING TEST

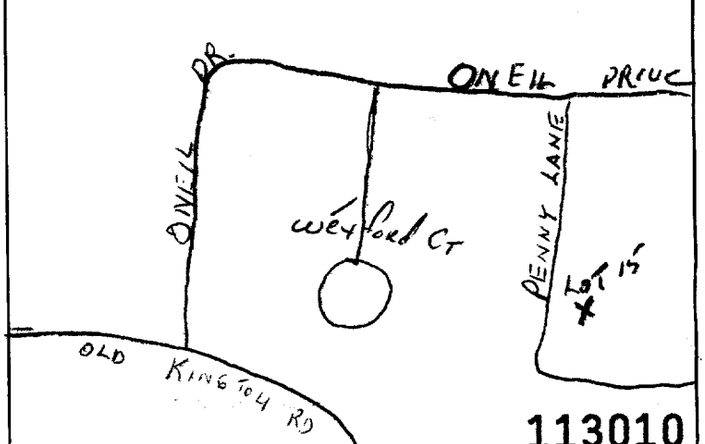
PUMPING TEST METHOD	PUMPING RATE GPM	DURATION OF PUMPING HOURS	MINS
1 ☐ PUMP 2 ☐ BAILER	15	2	30

STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING 1 ☐ PUMPING 2 ☐ RECOVERY	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
4.0 FEET	17 FEET		FEET	FEET	FEET	FEET

IF FLOWING, GIVE RATE	PUMP INTAKE SET AT	WATER AT END OF TEST	RECOMMENDED PUMP TYPE	RECOMMENDED PUMP SETTING	RECOMMENDED PUMPING RATE
GPM	21 FEET	1 ☑ CLEAR 2 ☐ CLOUDY	☐ SHALLOW ☐ DEEP	FEET	7 GPM

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS

113010

FINAL STATUS OF WELL

1 ☑ WATER SUPPLY 2 ☐ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED ☐ DEWATERING

WATER USE

1 ☑ DOMESTIC 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL ☐ OTHER 5 ☐ COMMERCIAL 6 ☐ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED

METHOD OF CONSTRUCTION

1 ☐ CABLE TOOL 2 ☐ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☐ ROTARY (AIR) 5 ☐ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING ☑ DIGGING ☐ OTHER

CONTRACTOR

NAME OF WELL CONTRACTOR: VAN SOELEN LANDSCAPING — WELL CONTRACTOR'S LICENCE NUMBER: 6534

ADDRESS: BILL VAN SOELEN

NAME OF WELL TECHNICIAN: [redacted] — WELL TECHNICIAN'S LICENCE NUMBER: T1871

SIGNATURE OF TECHNICIAN/CONTRACTOR: RR#7 Belleville — SUBMISSION DATE: DAY 5 MO 11 YR 96

OFFICE USE ONLY

DATA SOURCE — CONTRACTOR: 6534 — DATE RECEIVED: NOV 18 1996

DATE OF INSPECTION — INSPECTOR

REMARKS: CSS.ES

MINISTRY OF THE ENVIRONMENT COPY

FORM NO. 0506 (11/86) FORM 9

Ministry of Environment and Energy
Ontario

The Ontario Water Resources Act
WATER WELL RECORD

Print only in spaces provided.
Mark correct box with a checkmark, where applicable.

11 | 2917344 | Municipality 29020 | Con. CON | 01

County or District	Township/Borough/City/Town/Village	Con block tract survey, etc.	Lot
[redacted]	Thurlow	I	15
	Address: R. R. # 4, Belleville Ontario	Date completed: 10 day 07 month 96 year	

21 | Northing | RC | Elevation | RC | Basin Code | ii | iii | iv

LOG OF OVERBURDEN AND BEDROCK MATERIALS (see instructions)

General colour	Most common material	Other materials	General description	Depth – feet From	Depth – feet To
Brown	Sand		Loose	0	2
Brown	Clay	Sand	Packed	2	9
Brown	Clay Hardpan	Smallstone	Packed	9	16
Grey	Limestone		Hard	16	40

31
32

41 WATER RECORD

Water found at – feet	Kind of water
18	1 ☑ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 5 ☐ Gas
	1 ☐ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 5 ☐ Gas
	1 ☐ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 5 ☐ Gas
	1 ☐ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 5 ☐ Gas
	1 ☐ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 5 ☐ Gas

51 CASING & OPEN HOLE RECORD

Inside diam inches	Material	Wall thickness inches	Depth – feet From	Depth – feet To
6¼"	1 ☑ Steel 2 ☐ Galvanized 3 ☐ Concrete 4 ☐ Open hole 5 ☐ Plastic	.188	0	19
6"	1 ☐ Steel 2 ☐ Galvanized 3 ☑ Concrete 4 ☐ Open hole 5 ☐ Plastic		19	40
	1 ☐ Steel 2 ☐ Galvanized 3 ☐ Concrete 4 ☐ Open hole 5 ☐ Plastic			

SCREEN

Sizes of opening (Slot No.)	Diameter inches	Length feet
Material and type	Depth at top of screen feet	

61 PLUGGING & SEALING RECORD

☐ Annular space ☐ Abandonment

Depth set at – feet From	Depth set at – feet To	Material and type (Cement grout, bentonite, etc.)
0	6	Cuttings
6	17	Cement

71 PUMPING TEST

Pumping test method: 1 ☐ Pump 2 ☑ Bailer | Pumping rate: 5 GPM | Duration of pumping: 2 Hours 0 Mins

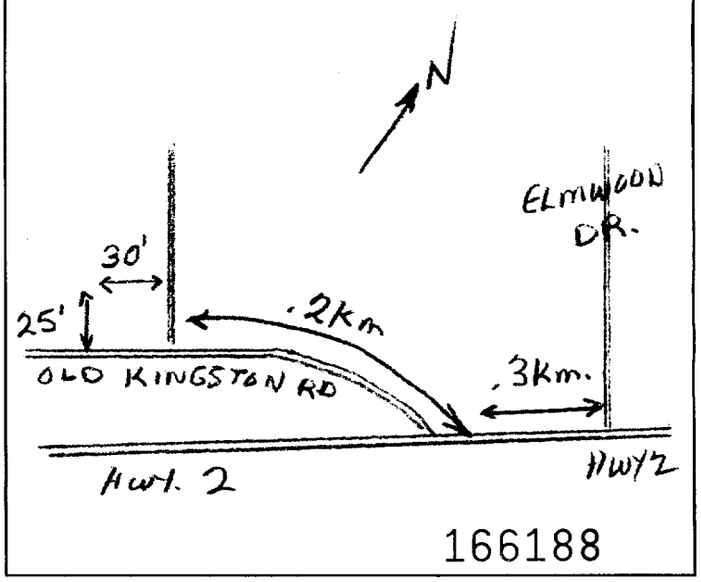
Static level	Water level end of pumping	Water levels during: 1 ☐ Pumping 2 ☑ Recovery			
		15 minutes	30 minutes	45 minutes	60 minutes
13 feet	48 feet	17 feet	13 feet	13 feet	13 feet

If flowing give rate	Pump intake set at	Water at end of test
GPM	feet	☑ Clear ☐ Cloudy

Recommended pump type	Recommended pump setting	Recommended pump rate
☐ Shallow ☑ Deep	37 feet	5 GPM

LOCATION OF WELL

In diagram below show distances of well from road and lot line.
Indicate north by arrow.



166188

FINAL STATUS OF WELL

1 ☑ Water supply 2 ☐ Observation well 3 ☐ Test hole 4 ☐ Recharge well 5 ☐ Abandoned, insufficient supply 6 ☐ Abandoned, poor quality 7 ☐ Abandoned (Other) 8 ☐ Dewatering 9 ☐ Unfinished 10 ☐ Replacement well

WATER USE

1 ☑ Domestic 2 ☐ Stock 3 ☐ Irrigation 4 ☐ Industrial 5 ☐ Commercial 6 ☐ Municipal 7 ☐ Public supply 8 ☐ Cooling & air conditioning 9 ☐ Not used 10 ☐ Other

METHOD OF CONSTRUCTION

1 ☑ Cable tool 2 ☐ Rotary (conventional) 3 ☐ Rotary (reverse) 4 ☐ Rotary (air) 5 ☐ Air percussion 6 ☐ Boring 7 ☐ Diamond 8 ☐ Jetting 9 ☐ Driving 10 ☐ Digging 11 ☐ Other

Name of Well Contractor	Well Contractor's Licence No.
CHALK WELL DRILLING LTD.	1507
Address: R. R. # 6, Napanee, Ontario	
Name of Well Technician: R. Ian Chalk	Well Technician's Licence No.: T-0047
Signature of Technician/Contractor: CHALK WELL DRILLING LTD.	Submission date: 10 day 07 mo 96

MINISTRY USE ONLY

Data source	Contractor	Date received
	1507	FEB 14 1997
Date of inspection	Inspector	
Remarks		

CSS. S

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Ontario

The Ontario Water Resources Act
WATER WELL RECORD

Print only in spaces provided.
Mark correct box with a checkmark, where applicable.

11 — 2917345 — Municipality 29020 — Con CON — 91

County or District	Township/Borough/City/Town/Village	Con	block	tract	survey, etc.	Lot
[redacted]	Thurlow		I			15

Address: R. R. # 4, Belleville, Ontario — Date completed: 10 (day) 07 (month) 96 (year)

21 — Northing — RC — Elevation — RC — Basin Code — ii — iii — iv

LOG OF OVERBURDEN AND BEDROCK MATERIALS (see instructions)

General colour	Most common material	Other materials	General description	Depth – feet From	Depth – feet To
	Well previously drilled			0	43
Grey	Limestone		Hard	43	68

31
32

41 WATER RECORD

Water found at – feet	Kind of water					
unk.	1 ☑ Fresh	2 ☐ Salty	3 ☐ Sulphur	4 ☐ Minerals	5 ☐ Gas	6
	1 ☐ Fresh	2 ☐ Salty	3 ☐ Sulphur	4 ☐ Minerals	5 ☐ Gas	6
	1 ☐ Fresh	2 ☐ Salty	3 ☐ Sulphur	4 ☐ Minerals	5 ☐ Gas	6
	1 ☐ Fresh	2 ☐ Salty	3 ☐ Sulphur	4 ☐ Minerals	5 ☐ Gas	6
	1 ☐ Fresh	2 ☐ Salty	3 ☐ Sulphur	4 ☐ Minerals	5 ☐ Gas	6

51 CASING & OPEN HOLE RECORD

Inside diam inches	Material	Wall thickness inches	Depth – feet From	Depth – feet To
6"	1 ☐ Steel 2 ☐ Galvanized 3 ☐ Concrete 4 ☑ Open hole 5 ☐ Plastic		43	68
	1 ☐ Steel 2 ☐ Galvanized 3 ☐ Concrete 4 ☐ Open hole 5 ☐ Plastic			
	1 ☐ Steel 2 ☐ Galvanized 3 ☐ Concrete 4 ☐ Open hole 5 ☐ Plastic			

SCREEN

Sizes of opening (Slot No.)	Diameter inches	Length feet

Material and type: — Depth at top of screen feet: —

61 PLUGGING & SEALING RECORD

☐ Annular space ☐ Abandonment

Depth set at – feet From	Depth set at – feet To	Material and type (Cement grout, bentonite, etc.)

71 PUMPING TEST

Pumping test method: 1 ☐ Pump 2 ☑ Bailer — Pumping rate: 25 g.p.h. GPM — Duration of pumping: 2 Hours 0 Mins

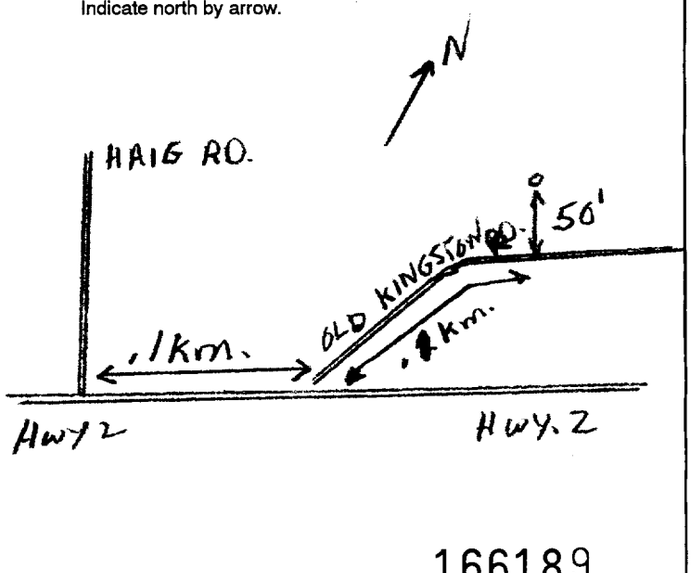
Static level	Water level end of pumping	Water levels during: 1 ☐ Pumping 2 ☑ Recovery			
		15 minutes	30 minutes	45 minutes	60 minutes
15 feet	68 feet	62 feet	57 feet	52 feet	46 feet

If flowing give rate	Pump intake set at	Water at end of test
GPM	feet	☑ Clear ☐ Cloudy

Recommended pump type	Recommended pump setting	Recommended pump rate
☐ Shallow ☐ Deep	65 feet	25 g.p.h. GPM

LOCATION OF WELL

In diagram below show distances of well from road and lot line. Indicate north by arrow.



166189

FINAL STATUS OF WELL

1 ☑ Water supply; 2 ☐ Observation well; 3 ☐ Test hole; 4 ☐ Recharge well; 5 ☐ Abandoned, insufficient supply; 6 ☐ Abandoned, poor quality; 7 ☐ Abandoned (Other); 8 ☐ Dewatering; 9 ☐ Unfinished; 10 ☐ Replacement well

WATER USE

1 ☑ Domestic; 2 ☐ Stock; 3 ☐ Irrigation; 4 ☐ Industrial; 5 ☐ Commercial; 6 ☐ Municipal; 7 ☐ Public supply; 8 ☐ Cooling & air conditioning; 9 ☐ Not used; 10 ☐ Other

METHOD OF CONSTRUCTION

1 ☑ Cable tool; 2 ☐ Rotary (conventional); 3 ☐ Rotary (reverse); 4 ☐ Rotary (air); 5 ☐ Air percussion; 6 ☐ Boring; 7 ☐ Diamond; 8 ☐ Jetting; 9 ☐ Driving; 10 ☐ Digging; 11 ☐ Other

Name of Well Contractor	Well Contractor's Licence No.
CHALK WELL DRILLING LTD.	1507

Address: R. R. # 6, Napanee, Ontario

Name of Well Technician	Well Technician's Licence No.
R. Ian Chalk	T-0047

Signature of Technician/Contractor	Submission date
CHALK WELL DRILLING LTD.	10 (day) 07 (mo) 96 (yr)

MINISTRY USE ONLY

Data source	Contractor	Date received
	1507	FEB 14 1997

Date of inspection: — Inspector: — Remarks: CSS. S

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0506 (07/94) Front Form 9

APPENDIX D

Calculations

Thornthwaite Calculation

Thornthwaite Method (1957) **Potential Evapotranspiration**

'Hydrology and Hydraulic Systems' 4th edition by Ram S. Gupta, 2017

Et month = 1.62 (10*Tm)/I) ^ a

where:

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

I_i = sum (Tm/5) ^ 1.514

Canada Climate Normals Environment Canada Climate Normals: BELLEVILLE STATION Ontario **Month**	Temp C	I_i	Et (cm) unadjusted	Daylight Factor	Et (mm) adjusted
January	-6.7	frozen			
Feb	-5.1	frozen			
March	-0.4	frozen			
April	7	1.6643	2.9857	1.13	0.0337
May	13.7	4.6000	6.4313	1.28	0.0823
June	19	7.5473	9.3455	1.29	0.1206
July	21.8	9.2936	10.9353	1.31	0.1433
Aug	20.8	8.6558	10.3640	1.21	0.1254
Sept	16.3	5.9843	7.8440	1.04	0.0816
Oct	9.5	2.6426	4.2325	0.94	0.0398
Nov	3.6	0.6081	1.3964	0.79	0.0110
Dec	-2.6	frozen			
		40.996	53.535		0.638
	a =	1.1428			metres

Note: Daylight Factor is an adjustment factor for possible hours of sunshine based on latitude.
Monthly temperature from Environment Canada Climate Normals website at:
https://climate.weather.gc.ca/climate_normals/index_e.html

1981 to 2010 Canadian Climate Normals station data

Temperature

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Code
Daily Average (°C)	-6.7	-5.1	-0.4	7.0	13.7	19.0	21.8	20.8	16.3	9.5	3.6	-2.6	8.1	A

<- UPDATE

▼ Precipitation

1981 to 2010 Canadian Climate Normals station data

Precipitation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Code
Rainfall (mm)	30.6	29.4	40.3	69.2	81.2	74.5	65.1	75.5	91.9	84.9	84.7	44.6	771.9	A
Snowfall (cm)	36.8	28.6	22.1	6.5	0.0	0.0	0.0	0.0	0.0	0.2	11.0	34.5	139.7	A
Precipitation (mm)	67.3	58.1	62.4	75.8	81.3	74.5	65.1	75.5	91.9	85.2	95.7	79.1	911.6	A

<- UPDATE

Environment Canada Climate Normals: BELLEVILLE STATION Ontario	911.3	mm
Potential Evapotranspiration (PE)	638	mm
Surplus Water (Precipitation - PE)	274	mm

Darcy Calculations

Groundwater Flow Through (Overburden)

Hydraulic Conductivity (k) =	1E-03	m/s
Horizontal Gradient (i) =	0.0013	
Length (L) =	200	m
Aquifer Thickness (t) =	2.7	m
Groundwater Flow (Q_b) =	60	m^3/day
	21,833	m3/year

Groundwater Flow Through (Bedrock)

Hydraulic Conductivity (k) =	1E-05	m/s
Horizontal Gradient (i) =	0.0038	
Length (L) =	380	m
Aquifer Thickness (t) =	10	m
Groundwater Flow (Q_b) =	13	m^3/day
	4,580	m3/year

PRE DEVELOPMENT CONDITIONS										
	Area (m2)	Precip (m3/year)	Evapotrans (m3/year)	Precip - Evapotrans (m3/year)	Topo factor	Soil factor	Cover factor	Infiltration Factor	Infiltration	Runoff
Natural Areas										
Wetland Area	151,040	137,643	96,313	41,330				1	41,330	0
Treed Area	200,570	182,779	127,897	54,883	0.25	0.4	0.2	0.85	46,650	8,232
Total Pre Development Natural Areas	351,610	320,422	224,210	96,212					87,980	8,232
		100%	70.0%						27.5%	2.6%
POST DEVELOPMENT CONDITIONS										
Natural Areas										
Wetland Area	151,040	137,643	96,313	41,330				1	41,330	0
Treed Area	120,330	109,657	76,730	32,926	0.25	0.4	0.2	0.85	27,987	4,939
Post Development Natural Area Total	271,370	247,299	173,044	74,256					69,317	4,939
		100%	70.0%						28.0%	2.0%
Percentage of total		*77%*	*77%*						*89%*	*27%*
Subvivison Areas - Permeable										
Parks	8,420	7,673	5,369	2,304	0.25	0.4	0.2	0.85	1,958	346
Stormwater Pond	3,170	2,889	2,021	867				1	867	-
Future Development (remains treed for now)	6,340	5,778	4,043	1,735	0.25	0.4	0.2	0.85	1,475	260
Detached lots (minus bldg footprints and driveways)	18,760	17,096	11,963	5,133	0.3	0.4	0.1	0.8	4,107	1,027
Townhouse lots (minus bldg footprints and driveways)	2,770	2,524	1,766	758	0.3	0.2	0.1	0.6	455	303
Total Subdivision Permeable Area	39,460	35,960	25,162	10,798					8,862	1,936
		100%	70.0%						24.6%	5.4%
Percentage of total		*11%*	*11%*						*11%*	*11%*
Subvivison Areas - Impermeable										
Bldg footprints	18,280	16,659	11,657	5,002						5,002
Paved Driveways	5,760	5,249	3,673	1,576						1,576
Roadways	16,320	14,872	10,407	4,466						4,466
Walkways	420	383	268	115						115
Total Subdivision Impermeable Area	40,780	37,163	26,004	11,159						11,159
		100%	70.0%						0.0%	30.0%
Percentage of total		*12%*	*12%*						*0%*	*62%*

	Precip (m3/year)	Evapotrans (m3/year)	Infiltration (m3/year)	Runoff (m3/year)	Infiltration %
Total Pre Development Natural Areas	320,422	224,210	85,236	10,977	27%
Post Development All Areas	320,422	224,217	76,484	19,731	24%

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