LRL

ENGINEERING | INGÉNIERIE

December 17, 2024, (Revised March 6, 2025)

Our File Ref.: 220487

Entrepreneur Holding Corporation
363 Entrepreneur Crescent
Ottawa (Navan), Ontario K4B 1T8

Attention: Dustin Wilson

Subject: Hydrogeological Assessment & Terrain Analysis –
Proposed Warehouse Development
363 Entrepreneur Crescent, Ottawa, Ontario

Dear Mr. Wilson,

LRL Engineering (LRL) was retained by Entrepreneur Holding Corporation (the 'Client') to complete a Hydrogeological Assessment & Terrain Analysis for the property located at 363 Entrepreneur Crescent in Ottawa (Navan), Ontario in support of the proposed site development. It is anticipated that one (1) approximately 592 m² warehouse will be developed on the subject property, in addition to corresponding gravel parking and circulation area and related components. The proposed development will be serviced by a private water supply well and sewage disposal system.

The assessment was carried out to determine if the proposed development can be adequately and safely supplied with potable water according to the Ontario Drinking Water Standards (ODWS) and *Procedure D-5-5 Technical Guideline for Private Wells: Water Supply Assessment (August 1996)*; and that the proposed development can be serviced with a private septic system. The assessment was also intended to confirm that the construction of the supply well, and proposed construction activities, will be such as to minimize impairment to the regional aquifer and that it meets the current Ontario Regulation 903 requirements.

The assessment was conducted according to Ontario Ministry of the Environment, Conservation and Parks (MECP) "Hydrogeological Technical Information Requirements for Land Development Applications" (April 1995), which include the following guidelines and procedures:

- Guideline D-5 Planning for Sewage and Water Services (August 1996);
- Procedure D-5-4 Technical Guideline for Individual On-site Sewage Systems: Water Quality Impact Risk Assessment (August 1996); and
- Procedure D-5-5 Technical Guideline for Private Wells: Water Supply Assessment (August 1996).

The City of Ottawa Hydrogeological and Terrain Analysis Guidelines, March 2021, was also referenced to support the completion of this study.

The assessment involved a desktop review of available information on the geology and hydrogeology of the site and adjacent lands in addition to intrusive investigative work, supply aquifer demand evaluations and water quality sampling and analysis. Based on our review of available information, and results of our field investigations, it is determined that the proposed development can be supplied with a sufficient quantity of water as well as that the site conditions are suitable for an on-site sewage disposal system. The water supply will not be permitted for consumption, although through readily available water treatment technologies, the supply is considered suitable for other facility necessities such as water closet fixture distribution.

The aquifer conditions of the proposed supply well (A379014) are considered to be mineralized as per Ontario Regulation 903 Wells Regulation. When mineralized water is encountered, the well owner shall:

- Immediately abandon the well; or
- Request formal Ontario Ministry of the Environment, Conservation and Parks approval.

A formal request for consent to maintain the well constructed on the site for future demand supply use was made to the Ontario Ministry of the Environment, Conservation and Parks (MECP) Director and formal consent to maintain the well was issued by the MECP for the proposed on-site supply well A379014.

1 Scope of Investigation

LRL was retained by Entrepreneur Holding Corporation to complete a Hydrogeological Assessment & Terrain Analysis for the property located at 363 Entrepreneur Crescent in Ottawa (Navan), Ontario (herein referred to as the 'Site'). This assessment was requested in support of the proposed development of the Site, and associated application submission to the City of Ottawa. It is understood that one (1) approximately 592 m² warehouse will be constructed on the Site. Further details pertaining to the anticipated development are included in Section 3.

LRLs scope for this investigation was in general accordance with current applicable provincial guidelines, in addition to the City of Ottawa Hydrogeological and Terrain Analysis Guideline, dated March 2021. Prior to the initiation of the scope of this investigation, a virtual pre-consultation meeting was held with the Hydrogeologist of the City of Ottawa on November 28, 2022. The meeting was requested by LRL to review the project with the technical review from the City of Ottawa, discuss the possible concerns related to the natural features of the area, and how this can be addressed through the pumping test of the supply well and neighbouring aquifer supply sampling. LRLs scope for this Hydrogeological Assessment & Terrain Analysis was generally as follows:

- Conduct a search of available well information for neighbouring properties through the MECP water well records database;
- Perform a desk top review of available geological maps and local well records to obtain information pertaining to the quantity supply aquifer of the subject Site;
- Collect a water sample, representative of pre- and post-treatment supply aquifer conditions, from the neighbouring property to the west (357 Entrepreneur Cres.) to obtain information of the respective aquifer characteristics;
- Provide support during the construction of the test well, including a grouting inspection to verify the installation corresponds to applicable requirements and regulations (Ontario Regulation 903);

- Conduct one (1) – eight (8) hour pumping test on the newly constructed test well on the Site by using a submersible pump, powered by a portable generator.
  - Manual water levels were collected from the supply well during the pumping test to analyse the hydrogeological characteristics of the aquifer on-Site;
  - Collect and submit water samples from the supply well periodically during the pumping test, four (4)-hours and eight (8)-hours of pumping, for laboratory analysis under the subdivision package, and volatile organic compounds; and
  - Following the pumping test, record water levels for up to 24 hours or until 95% recovery has occurred.
- Collect and compile relevant sub-surface details related to the underlying subsurface conditions through collaboration with additional sub-surface investigation field work (i.e. Phase Two Environmental Site Assessment, and Geotechnical Investigation);
- Compare the laboratory analysis results, from the supply well, to the applicable Ontario Drinking Water Standard (ODWS) and MECP D-5-5 Maximum Concentration Considered Reasonably Treatable (MCCRT); and
- Prepare a summary regarding the quality and the quantity of the supply aquifer and comparison to D-5-5 compliance requirements set forth by the City of Ottawa Technical Authority. Summarize the findings to confirm that the property size and soil conditions are suitable to attenuate the impacts of the septic system effluent.

2 SITE AND AREA DESCRIPTION

The Site is generally undeveloped with exception to a granular base applied across the majority of the surface of the Site and is used as a storage yard for the adjacent YSB Hoisting Equipment & YSB Carpentry facility. The Site is set within a rural, low-density commercial and light industrial area of Ottawa, Ontario, southeast of the City's urban extents. The Site is legally described as Part of Block 3 Plan 50M136 Part 3 ON Plan 50R6694; Subject to an Easement in Gross Over Part 9 ON Plan 4R-27830 As in OC1627867; City of Ottawa.

The Site is located approximately 310 m northeast of the Boundary Road and Entrepreneur Crescent intersection, as presented in **Figure 1**. The Site is a rectangular shape, with a total area of approximately 3,000 m² or 0.75 acre as shown in **Figure 2**. Historically, the Site was used as agricultural lands, since at least the mid-1960's (1965). Thereafter, the Site remained undeveloped and densely wooded until approximately 2017, when the vegetation was cleared. Neighbouring lands include commercial and light industrial developments since at least the early 1990's. The Site is zoned as Rural General Industrial Zone (RG2), according to the City of Ottawa interactive mapping system (geoOttawa).

Municipal water supply and sanitary services are not available for the Site. Select neighbouring lands are equipped with private water supply wells, and sewage disposal systems. The potable groundwater is found in the gravel/shale bedrock layer, at depths between 21.0 m and 30.3 m below ground surface (bgs).

2.1 Topography

The topography of the Site and vicinity are generally flat. The subject Site and the neighbouring lands have a common topographic elevation of 78 m above mean sea level (amsl) according to *The Atlas of Canada – Toporama*. More specifically, the Site has a slight slope to the southern and western perimeters with elevations ranging between 76.74 and 77.22 m amsl. A ditch boarders the northern extent of the Site with bank height of approximately 1.0 m. Elevations along the southern extent of the Site range between 103.7 and 102.5 m amsl.

These detailed elevations are presented in the Annis, O'Sullivan, Vollebekk Ltd. Topographic Survey plan, dated December 14, 2022, and included in **Attachment A**.

2.2 Existing Development Features

The Site is generally undeveloped with exception to a granular base applied across the majority of the surface and is used as a storage yard for the adjacent YSB Hoisting Equipment & YSB Carpentry facility.

2.3 Aerial Imagery

Aerial imagery was access through the City of Ottawa on-line interactive mapping portal, geoOttawa. The available historical imagery for the Site dates back to the mid 1960's (1965) when the Site and neighbouring lands appear to be used for agriculture purposes (fields or pastures). An agricultural related development is present approximately 170 m west of the Site. No significant changes were observed in the subsequent aerial imagery until the early 1990's (1991) when the Site appears to be un-developed and forested, with a clearing at the southern portion of the property, and the neighbouring lands were observed to include low-density commercial developments to the south, east and west of the Site.

In the available 2014 aerial imagery, the neighbouring lands to the east, north and south are developed. North of the Site appears to be operated as a mineral extraction facility. As of the 2021 aerial imagery, the Site appears to be occupied for it's current use as a storage yard for the adjacent land to the east.

2.4 Neighbouring Properties and Land Uses

According to the City of Ottawa's Zoning information, available through the City of Ottawa's on-line interactive mapping portal, geoOttawa, the neighbouring lands are zoned as follows:

- The neighbouring lands to the east and west are zoned as Rural General Industrial Zone (RG2); and
- The neighbouring lands to the north and the south are zoned as Rural Heavy Industrial (RH).

The neighbouring land uses generally include the following:

- North: Mineral-Aggregate extraction facility and seasonal snow dump;
- South: Entrepreneur Crescent followed by an un-known commercial/light industrial operation with various storage containers and vehicles;
- East: Industrial - YSB Hoisting Equipment & YSB Carpentry facility (carpentry company and hoist equipment rentals facility), followed by vacant; and
- West Construction company yard (Galaxy Construction) followed by vehicle storage yard.

2.5 Hydrology

The Site is generally flat with a gentle slope south and west. Using the available features of the interactive mapping tool, *The Atlas of Canada – Toporama*, it appears that the local groundwater flow direction varies on either side of the neighbouring Boundary Road. West of Boundary Road is inferred to flow in a northerly to northwesterly direction towards the Bear Brook, approximately 2.2 km to the northwest of the Site. Surface water features to the east of Boundary Road, where the Site is located, are shown to flow easterly towards the Shaws Creek, approximately 3.3 km east of the Site. Therefore, the groundwater flow direction across the Site in inferred to be towards the east.

A ditch is present along the northern perimeter of Site; however, the flow direction was not confirmed at the time of this assessment. According to an Environmental Impact Statement[1] dated June 23, 2023, and prepared by others, the ditch was also observed to have '*lack of any flows observed*' at the time of their June 12, 2023, Site visit.

The ditch was described in the Environmental Impact Statement as having high water chemistry measurements related to salt, likely associated with the adjacent snow dumping facility. The Environmental Impact Statement indicated that these conditions would likely result in fish, which could enter the ditch during high seasonal water level conditions from neighbouring sources, to perish. The Environmental Impact Statement concluded that the ditch has no natural heritage values. However, it was recommended that to prevent surface runoff from the Site into the ditch, a 'raised berm' would be constructed to the north of the proposed warehouse development, which would divert runoff into the Sites strategic stormwater management system. A formal stormwater management plan has been prepared to support the development of the Site. The plan will be submitted to the City under a separate cover.

A Phase Two Environmental Site Assessment was completed for the Site to address potential environmental concerns raised with respect to adjacent or neighbouring land uses, and on-Site activities. As part of this assessment, a total of four (4) groundwater monitoring wells were constructed on the property to facilitate groundwater sample collection, and to further address the hydrogeological characteristics of the upper / shallow overburden groundwater. Groundwater was measured in each monitoring well at depths of between 0.20 and 0.55 m below grade. Based on these measurements, in conjunction with groundsurface elevations, the upper / shallow overburden groundwater flow direction is found to be towards the southeast.

The variance between locally inferred groundwater flow directions, and measured groundwater elevations may be attributed to infrastructure including utility trenches, structures, and ditches or swales. A municipal ditch is presented along the southern extent of the Site.

2.6 Natural Heritage Features

Based on available databases and records reviewed, the following with respect to Natural Heritage Features, are revealed for the Site:

- The Site is not part of a provincial park or conservation area;
- The Site is not within any Areas of Natural and Scientific Interest (ANSI) identified by the Ministry of Natural Resources (MNR) as having provincial significance;
- The Site does not include any area identified as Provincial Significance Wetland (PSW) by MNR,
- The Site does not include any area designated as environmental significant in municipal official plans;
- The Site does not include any area designated as an escarpment natural area by Niagara Escarpment Plan;
- The Site does not include any area which is a habitat of endangered species;
- The Site does not include any Oak Ridges Moraine Conservation area; and,

[1] Environmental Impact Statement – Zoning By-Law Amendment for 363 Entrepreneur Crescent, prepared by Kilgour & Associates Ltd., June 23, 2023.

- The Site does not include any area designated as a wilderness area.

As discussed above in Section 2.5, a ditch is present along the northern perimeter of Site. According to Kilgour & Associates Ltd., at the time of their June 12, 2023 Site visit, the flow direction was not confirmed. The report states that the watercourse identified acts more so like a trough which is supported by the lack of any flow encountered, even during the spring freshet (June 12, 2023).

According to an Environmental Impact Statement prepared by others, the ditch was also observed to have '*lack of any flows observed*' at the time of their Site visit. The Environmental Impact Statement concluded that the ditch has no natural heritage values. It is understood that the findings of this Environmental Impact Statement report were confirmed by the Ontario Ministry of the Environment, Parks and Conservations as being accurate and reliable.

2.7 Geology & Hydrogeology

2.7.1 Geological Mapping

Surficial soil deposit mapping[2] indicates that the surficial geology is Offshore Marine Deposits: clay, silty clay, and silt, commonly calcareous and fossiliferous; locally overlain by thin sand. Bedrock mapping[3] indicates that the bedrock is described as the Carlsbad Formation: grey shale, sandy shale, and some dolomitic layers.

According to the Brunton, F.R. and Dodge, J.E.P. Karst map of Southern Ontario, including Manitoulin Island; Ontario Geological Survey, Groundwater Resource Study 5, 2008, known areas to potential areas of karst geology is present in the vicinity of the Site, namely to the south. The Site and adjacent land to the east and west are identified as "Unknown or no observed evidence of karstification due to the character of bedrock, lack of outcrop and/or relative thickness of overburden."

2.7.2 Hydrogeologically Sensitive Areas

The Site is considered Hydrogeologically Sensitive by using the associated trigger parameters, summarized as follows:

<u>Shallow Soil Conditions or Bedrock Outcrops</u>

- In regard to shallow soils or bedrock outcrops, a review of geological mapping and additional supporting documents, including MECP water well records, have revealed a deposit of overburden greater than 2.0 m in thickness. This was further confirmed through the advancement of boreholes across the Site at the time of additional sub-surface investigation fieldwork completed by LRL, in support of the proposed development application, and outlined below in Sections 2.7.3 and 2.7.4, respectively. These additional investigations included a Geotechnical Investigation and a Phase Two Environmental Site Assessment. No bedrock outcrops were encountered at the time of LRLs Site visits associated with the corresponding investigations and assessments.

  Subsurface conditions encountered during these studies are summarized as follows, although greater detail is available in the corresponding reporting documents completed for the respective investigations. Copies of the borehole logs from the Phase Two Environmental Site Assessment and Geotechnical Investigation are included in

---

[2] St-Onge, D.A., Surficial Geology, Lower Ottawa Valley, Ontario, Map 2140A, Geological Survey of Canada, 2009.
[3] Harrison, J.E., 1976, Generalized Bedrock Geology, Ottawa-Hull, Ontario and Quebec, Geological Survey of Canada, Map 1508A, Scale 1:125,000.

Attachment B, and further detail pertaining to each summary, including chemical analysis and conclusions are provided in Section 4.1.

Potential Karst Topography

- According to the Ontario Geological Survey, Karst study for Southern Ontario, issued in 2008, the subject area is identified to be within a region identified as:
    - Unknown or no observed evidence of karstification due to the character of bedrock, lack of outcrop and/or relative thickness of overburden; or
    - Potential Karst - areas of carbonate rock units identified as most susceptible to karst processes.

  Based on the borehole advancement completed across the property in November 2022, and March 2023, overburden was found to extend beyond 2.0 m in depth. A penetration test was completed as part of the geotechnical investigation which revealed that bedrock is present at greater depths then 24.5 m, where the test was terminated. The Karts potential on the Site is unlikely due to the in-field results and observations collected.

High Permeable Soils

- Subsurface conditions across the Site encountered during the Phase II ESA drilling program generally included a layer of sand and gravel fill extending from surface to 0.85 m bgs. Underlying the fill material was a layer of brown silty sand which extended from the bottom of the fill layer to 1.2 m bgs followed by silty clay to a depth of 6.0 m bgs where the boreholes were terminated.

  Surficial soil deposit mapping indicates that the surficial geology is Offshore Marine Deposits: clay, silty clay, and silt, commonly calcareous and fossiliferous; locally overlain by thin sand.

  Therefore, the underlying soils on the Site are not considered to be high-permeable.

Within 30 m of Surface Water

- The ditch located along the northern perimeter of the Site, has been identified by the City of Ottawa as a watercourse. As discussed in Section 2.6, the ditch acts more as a trough which is supported by the lack of any flow encountered and is not considered to have natural heritage value. Since a property within 30 m of a water feature is considered hydrogeologically sensitive, therefore, based on the presence of the watercourse, the Site will be considered hydrogeologically sensitive.

2.7.3 Geotechnical Investigation (February 2023, Revised: December 2024):

Fill material consisting of a crushed stone granular material was encountered at the surface of all boring locations and extended to depths ranging between 0.60 and 1.07 m bgs. The recorded SPT “N” values of this deposit varied from 30 to 36, indicating the deposit is dense. The natural moisture contents were found to be 9 and 11%. Underlying the fill material at all boring locations, a layer of brown silty sand was encountered and extended to a depth of 1.45 m bgs. The recorded SPT “N” values of this deposit varied from 14 to 19, indicating the deposit is compact. The natural moisture contents were found to be 22 and 24%.

Below the silty sand in all boring locations, a layer of clayey silty was encountered and extended to a depth of 4.12 m bgs. This material contained trace sand, grey and wet. The SPT “N” values were found to range between 0 (weight of hammer (WH)) and 4, indicating the material is soft to very soft. The natural moisture contents were determined to range between 37 and 87%.

Refusal using the DCP test was encountered on the Site at a depth of 24.50 m bgs. This was encountered over a large boulder within till material or over possible bedrock. As part of the investigation, select soil samples were submitted for laboratory gradation analyses. The results of these analysis are summarized in the following **Table A**.

Table A: Gradation Analysis Summary

Sample Location	Depth (m)	Percent for Each Soil Gradation					Estimated Hydraulic Conductivity K (m/s)
		Sand			Silt (%)	Clay (%)	
		Coarse (%)	Medium (%)	Fine (%)			
BH1	1.52 – 2.13	0.4	0.8	4.1	59.3	35.4	5×10^{-8}
BH2	6.10 – 6.71	0.0	0.0	0.6	31.0	68.4	5×10^{-8}

Atterberg limits and moisture contents were conducted on two (2) split spoon soil samples. A summary of these values is provided below in **Table B**.

Table B: Summary of Atterberg Limits and Water Contents

Sample Location	Parameter					
	Depth (m)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Water Content (%)	USCS Group Symbol
BH3	4.57 – 5.18	61	23	38	90	CH
BH4	1.52 – 2.13	67	25	42	77	CH

The laboratory reports can be found in **Attachment C** of this report.

A piezometer was installed in one (1) borehole location to measure the static groundwater level. The piezometer consisted of a 19 mm diameter PVC pipe with a slotted bottom to allow for groundwater infiltration, backfilled with silica sand, and sealed with bentonite. The water was measured on December 6, 2022, and found to be at 0.5 m bgs.

The locations of the boreholes are presented in **Figure 3**.

2.7.4 Phase Two Environmental Site Assessment (December 2024)

Subsurface conditions across the Site generally included a layer of sand and gravel fill extending from surface to 0.85 m bgs. Underlying the fill material was a layer of brown silty sand which extended from the bottom of the fill layer to 1.2 m bgs followed by silty clay to a depth of 6.0 m bgs where the boreholes were terminated. Refusal over inferred bedrock was not encountered in any of the boreholes.

The locations of the borehole are presented in **Figure 3**.

2.7.5 Potential Sources of Contamination

To support the proposed development application, a Phase One Environmental Site Assessment was completed for the Site. This assessment was conducted to identify potential environmental concerns or liabilities related to the past and present operations conducted on the property and the adjacent lands. A historical records review of the Site was conducted, as well as contact with relevant regulatory agencies, a walk-through Site inspection of the property and interviews with those knowledgeable of the Site.

This review was completed with general reference to Ontario Regulation 153/04, which is the provincial regulation which is most often referenced when considering the environmental conditions of a Site. The regulation outlines possible Potential Contaminating Activities (PCA) which can be associated with impairment or impacts to the quality of the subject property conditions. The review revealed the following potential sources of contamination, and the corresponding PCA as set out by Ontario Regulation 153/04.

O. Reg 153/04 Schedule D PCA	Location of PCA	Description and Source Information	Contribution to an APEC
PCA 32: Iron and Steel Manufacturing and Processing	On-Site	The adjacent property hoist equipment manufacturing and rental company (YSB Hoisting equipment facility), is identified as an industrial use which involves assembling, processing, storing, warehousing, or distributing hoisting equipment. Associated material and equipment are stored on the Site. This was observed through aerial photography and Site visit.	The PCA is located on the Site and is therefore automatically considered to contribute to an on-Site APEC.
PCA 30: Importation of Fill Materials of Unknown Quality	On-Site	Identified through aerial imagery and confirmed by the interview with the Site owner.	The PCA is located on the Site and is therefore automatically considered to contribute to an on-site APEC.
PCA 32: Iron and Steel Manufacturing and Processing	357 Entrepreneur Crescent, immediately east of the Site.	Adjacent property immediately east of the Site occupied by a hoist equipment rental company (YSB Hoisting Equipment & YSB Carpentry facility). Industrial use which involves assembling, processing, storing, warehousing, or distributing hoisting equipment. Observed through aerial photography and Site visit.	Due to the type of the activity and location being along the eastern perimeter of the Site, this record is considered to represent an APEC to the eastern portion of the Site.
PCA Other: Construction company workshop and storage yard	371 Entrepreneur Crescent, immediately west of the Site.	Construction company workshop and storage yard. Observed through aerial photography and Site visit	Due to the type of the activity and location being along the western perimeter of the Site, this record is considered to represent an APEC to the western portion of the Site.
PCA 28: Gasoline and Associated Products Storage in Fixed Tanks.	Identified at 5495 Boundary Road, approximately 170 m west of the Site (up-gradient).	Reported to be an abandoned service station, with records of underground liquid fuel storage tanks.	Due to the type of the activity and location being up-gradient of the Site, this record is considered to represent an APEC to the western portion of the Site.

O. Reg 153/04 Schedule D PCA	Location of PCA	Description and Source Information	Contribution to an APEC
PCA 34: Metal Fabrication.	5507 Boundary Road, approximately 170 m west (up-gradient) of the Site.	Listed as Renes Welding Inc., a fabricated metal products facility established in 1982.	Due to the type of the activity and location being up-gradient of the Site, this record is considered to represent an APEC to the western portion of the Site.
PCA 52: Storage, maintenance, fuelling and repair of equipment, vehicles, and material used to maintain transportation systems.	381 Entrepreneur Crescent approximately 40 m to the west of Site used as vehicle storage yard.	Observed through the site visit and Aerial photos	The yard is located generally up-gradient of the Site and therefore presents a potential risk for environmental concern to the Site.
PCA 58: Waste Disposal and Waste Management, including thermal treatment, landfilling and transfer of waste, other than use of biosoils as soil conditioners.	Immediately north of the Site (trans-gradient).	Based on observations at the time of the site reconnaissance, the adjacent land to the north operates as a snow dumping facility.	Due to the up-gradient location from the Site, this record does represent an APEC to the Site.

Based on the findings of the Phase One ESA, it is recommended that a Phase Two ESA be conducted on the Site to confirm the presence/absence of impacts in the areas of potential environmental concern identified. The findings of the Phase Two Environmental Site Assessment are discussed below in Section 4.1.

2.8 Ontario Water Well Records

A search was conducted of the well records from the MECP Water Well Information System (WWIS) department. The search by UTM coordinates covered a 750 m radius from the Site. The search returned 30 water well records, however, several of which did not have any details available related to the construction or subsurface conditions encountered. Nine (9) of the water well records retrieved was for a test well. A copy of those WWRs which included relevant details related to the hydrogeological and subsurface features are included in **Attachment D** and their approximately locations are presented in **Figure 4**.

The records of the wells within 750 m of the Site, where details were available, revealed that the wells include both drilled and shallow overburden wells. The drilled wells, seven (7) of which, were reported to extend to depths of between 28.9 and 61.0 m. Only one (1) shallow overburden/dug supply well was reported, which extended to a depth of between 7.0 m. The remaining overburden well reported were test holes/monitoring wells.

The well records show that that the geological conditions within 750 m are generally similar and consist of clay to depths between 21.0 and 44.8 m followed by a thin layer of gravel, over shale or limestone bedrock. A thin layer of sand was reported in select wells over the clay, and glacial till was reported over bedrock in the supply well located approximately 640 m northwest of the Site. The water type was reported as sulphur in two (2) of the test well locations.

On August 23, 2023, the proposed supply well for the anticipated development was constructed at the northeastern portion of the Site. The well was advanced to a depth of 48.7 m. Clay was reported to be encountered at ground surface to a depth 26.2 m followed by gravel to 28.0 m bgs. The well was extended into shale bedrock to 48.7 m bgs. Water was found at a depth 46.9 m, with a static water level measured at 2.80 m. More than 2.0 m of overburden is indicated, which provides support that the Site is not considered hydraulically sensitive.

Inferred subsurface profiles cross sections are presented in **Figure 5A** through **Figure 5B** and include select wells in the vicinity of the cross-section segments as shown in **Figure 4**. The general overburden conditions encountered in the wells, where details were available, within 750 m of the Site are as follows:

MECP Well Number	Distance and Direction from Site (m)	Depth (m)	Overburden Details			Bedrock Details	Groundwater Encountered (m)	Static Water Level (m)	Type of water
			Sand/Till (m)	Clay (m)	Gravel (m)	Bedrock (m)			
A379014 (Tag)	On-Site	48.7	--	0 – 26.2	26.2 – 28.0	28.0 - 48.7	46.9	2.8	Not Tested
7320860	Directly east	28.9	--	0 – 21.3	21.3 – 22.6	22.6 – 28.9 (Shale)	27	9.6	--
7043396	225 SW	32.4	--	0 – 30.3	30.3 – 31.5	31.5 – 32.4 (Shale)	31.5	2.9	Sulphur
7266180	368 SW	7.0	0 – 0.2 (Topsoil)	0.2 – 7.0	--	--	--	--	Fresh
7201225	*440 E*	*31.4*	--	*0 – 31.4*	--	--	--	--	--
7201224	*500 S*	*44.8*	--	*0 – 44.8*	--	--	--	--	--
7201724	*553 NE*	*1.5*	*0 – 1.5 (Sand)*	--	--	--	--	--	--
7201737	*555 NE*	*6.4*	*0 – 1.5 (Sand)*	*1.5 – 6.4*	--	--	--	--	--
1525164	640 NW	30.5	0 – 0.6 (Sand) 21.3 – 23.5 (Till)	0.6 – 21.3	--	23.5 – 30.5 (Limestone)	29.0	1.8	Sulphur
7212030	*650 SW*	*6.4*	*0.3 – 2.4 (Sand)*	*2.4 – 6.4*	*0 – 0.3*	--	--	--	--
7212029	*652 SW*	*6.4*	*0.3 – 2.4 (Sand)*	*2.4 – 6.4*	*0 – 0.3*	--	--	--	--
7322574	670 NE	42.4	0 – 2.1 (Sand)	2.1 – 24.2	24.2 – 26.1	26.1 – 42.4 (Limestone)	7.9	2.1	Salty
1534876	670 W	33.5	0 – 1.5 (Sand)	1.5 – 29.0	29.0 – 33.2	33.2 – 33.5	33.5	2.6	Salty
7310678	695 NW	61.0	--	0 – 1.8 (Clay Fill with gravel) 1.8 – 21.0	21.0 – 22.3	22.3 – 61.0 (Shale)	27.0 52.0	3.8	--
7200942	*705 S*	*1.5*	*0 – 0.9 (Sand)*	*0.9 – 1.5*	--	--	--	--	--
7201226	*745 SE*	*43.6*	--	*0 – 43.6*	--	--	--	--	--
7200943	*745 SE*	*6.4*	*0 -0.9 (Sand)*	*0.9 – 6.4*	--	--	--	--	--

Notes:

Italics	Test Hole/ Monitoring Well Record
--	Not Data/Not Tested

2.8.1 Water Well Record Summary

Based on the details of the well records obtained in the area (within 750 m of the Site) it is anticipated that the aquifer can yield a sufficient amount to supply the proposed development on the Site in the long term. For example, one (1) hour pumping test results from select neighbouring wells within 750 m of the Site, provide results indicative that the bedrock - Limestone aquifer is able to achieve a rate of 54 L/min over 60 minutes utilizing approximately 0.3% of the available drawdown. The duration of the 60-minute pumping test, with a 0.3% available drawdown, accounted for a volume of 3,240 L being removed. Therefore, assuming a comparable drawdown rate, in less than one (1) hour, the maximum daily demand of 1,910 L/day will be achieved. A pumping rate of 54 L/minute exceeds the maximum hourly demand rate calculated as 19.1 L/minute. The neighbouring property, located immediately east of the Site, was reported to be advanced into the bedrock – shale stratum, which was able to achieve a rate of 13 L/min over 60 minutes utilizing 41.4% of the available drawdown. This accounts for approximately half the proposed development maximum daily demand in the duration of the pumping test (21 – 22 L/minute).

Based on the proposed development and anticipated maximum daily demand of 1,910 L/day, or 15.9 L/minute, over an eight (8) hour period, as described in greater detail in Section 3, these conditions are considered suitable to sustain the anticipated Site development and corresponding activities. A summary of the quantity of water of select neighboring wells within a 750 m radius of the Site is as follows:

MECP Well Number	Distance and Direction from Site	Depth (m)	Pump Test Details					
			Pump Rate (L/min)	Duration (min)	Drawdown (m)	Specific Capacity (L/Sec/m)	Recovery (%)	Recommended Pump Rate (L/min)
7320860	**Directly east**	**28.9**	**13**	**60**	**11.99**	**0.0180**	**100**	**15**
7043396	**225 SW**	**32.4**	**58.5**	**60**	**0.15**	**6.5**	**100**	**45.5**
7266180	*368 SW*	*7.0*	--	--	--	--	--	--
1525164	*640 NW*	*30.5*	*113*	*60*	*11.12*	*0.1693*	*--*	*113*
7322574	*670 NE*	*42.4*	*54*	*60*	*0.13*	*6.9230*	*100*	*56*
1534876	670 W	33.5	42	60	0.17	4.1176	100	50
7310678	**695 NW**	**61.0**	**42**	**60**	**1.92**	**0.3645**	**100**	**66**

Notes:

-- No Data is Available/Not Reported

BOLD Supply well advanced into Shale Bedrock

Italics Supply well advanced into the Limestone Bedrock

xxx Dug/Shallow Supply Well

2.9 Shallow Overburden Groundwater Monitoring Wells

Entrepreneur Holding Corporation retained LRL to complete a Phase Two Environmental Site Assessment on the Site in the context of property redevelopment. The assessment was completed to determine if recognized potential environmental concerns have negatively impacted soil and groundwater quality of the subject Site. The potential environmental concerns identified that requires investigation includes:

- **PCA 32**: Iron and Steel Manufacturing and Processing. The adjacent property hoist equipment manufacturing and rental company (YSB Hoisting equipment facility), is identified as an industrial use which involves assembling, processing, storing, warehousing, or distributing hoisting equipment. Associated material and equipment are stored on the Site since at least mid of 2022;
- **PCA 30**: Importation of Fill Material of Unknown Quality. Based on available information obtained, a layer of granular crushed stone was applied across the surface of the subject property in 2022 (est.). The source and quality of the material is unknown, therefore its conditions, in addition to the underlying materials, should be investigated;
- **PCA 32**: Iron and Steel Manufacturing and Processing. 357 Entrepreneur Crescent, immediately east of the Site, occupied by a hoist equipment rental company (YSB Hoisting Equipment & YSB Carpentry facility), industrial use which involves assembling, processing, storing, warehousing, or distributing hoisting equipment;
- **PCA Other**: Construction company workshop and storage yard. 371 Entrepreneur Crescent, immediately west of the Site, occupied by Galaxy Construction - workshop and storage yard;
- **PCA 56**: Treatment of Sewage equal to or greater than 10,000 litres per day. 954192 Ontario Ltd at 336 Entrepreneur Crescent, approximately 100 m south-east of the Site, issued an environmental compliance approval for industrial sewage works and treatment of Sewage equal to or greater than 10,000 litres per day;
- **PCA 58**: Waste Disposal and Waste Management, including thermal treatment, landfilling and transfer of waste, other than use of biosoils as soil conditioners. 954192 Ontario Ltd at 336 Entrepreneur Crescent, approximately 100 m south-east of the Site, listed as waste disposal site with approval of ECA-Waste Disposal Sites issued in March 2012, November 2012, October 2016, and March 2020;
- **PCA 58**: Waste Disposal and Waste Management, including thermal treatment, landfilling and transfer of waste, other than use of biosoils as soil conditioners. Cumberland Con. 10 Dump, approximately 150 m east of the Site listed as a landfill in 1991;
- **PCA 58**: Waste Disposal and Waste Management, including thermal treatment, landfilling and transfer of waste, other than use of biosoils as soil conditioners. Unnamed Waste Disposal Site, approximately 110 m south of the Site listed as a landfill in 1991.
- **PCA Other**: Spill. 954192 Ontario Ltd at 336 Entrepreneur Crescent, approximately 100 m south-east of the Site, reported a spill incident to the MECP in March 2019. The incident was summarized as non-compliance with FA re-evaluation required.
- **PCA 58**: Waste Disposal and Waste Management, including thermal treatment, landfilling and transfer of waste, other than use of biosoils as soil conditioners. The adjacent land to the north of the Site operates as a snow dumping facility.

To address these concerns, an intrusive investigation was carried out between March 13 and March 16, 2023, by LRL. Further details pertaining to the findings of the Phase Two Environmental Site Assessment, namely concentrations of contaminates encountered, contamination plumes, and recommendations are described below in Section 4.1. This section pertains solely to the geological and hydrogeological characteristics across the Site.

A total of ten (10) boreholes were advanced across the Site. The subsurface soil conditions in the area investigated on the Site generally consist of included a layer of sand and gravel fill extending from surface to 0.85 m bgs. Underlying the fill material was a layer of brown silty sand which extended from the bottom of the fill layer to 1.2 m bgs followed by silty clay to a depth of 6.0 m bgs where the boreholes were terminated. Refusal over inferred bedrock was not encountered in any of the boreholes.

Four (4) boreholes were completed as monitoring wells: BH23-2, BH23-3, BH23-4 and BH23-5 (herein referred to as MW23-2, MW22-3, MW23-4, and MW23-5). Monitoring wells were constructed within the 203 mm diameter boreholes with a 51 mm slotted PVC piezometer. The top of the screen was extended to the ground surface using a solid riser pipe. Annular space around the slotted portion of the piezometer was backfilled with pre-washed and graded silica sand up to 300 mm above the top of the screen. A bentonite seal was placed above the sand pack and bentonite was used to fill the remainder of the hole to the surface. Monitoring wells were finished at the surface with a flush-mount aluminum casing.

The locations of the monitoring wells are described as follows:

Monitoring Well Identification	Location
MW23-2	West-central portion of the Site.
MW23-3	South-central portion of the Site.
MW23-4	Southeastern portion of the Site.
MW23-5	North-central portion of the Site.

The borehole and monitoring well locations are presented in **Figure 3**, and a copy of the borehole logs are included in **Attachment B**. Static groundwater elevations were measured at each monitoring well prior to the respective sampling activities and are summarized as follows.

Monitoring Well	Ground Surface Elevation (m)	Reference Elevation (m)	Depth to Water Table (m)		Groundwater Elevation (m)
			Reference Point	Ground Surface	
MW23-2	99.90	99.83	0.20	0.27	99.63
MW23-3	99.88	99.80	0.39	0.47	99.41
MW23-4	99.87	99.79	0.47	0.55	99.32
MW23-5	99.89	99.78	0.09	0.20	99.69

Groundwater depth measurements were between 0.20 and 0.55 m below grade, which corresponded to elevations between 99.32 and 99.69 m, with respect to an arbitrary benchmark established and assigned an elevation of 100.00 m.

The groundwater elevations and interpreted flow contours are shown in **Figure 6**. Based on these elevations the groundwater flow direction on the Site is towards the southeast. However, based on local surface water features, the overall groundwater flow direction is inferred to be towards the east.

3 PROPOSED DEVELOPMENT

It is anticipated that one (1) approximately 592 m² warehouse will be developed on the subject property, in addition to corresponding gravel (permeable) parking and circulation area and related components. The proposed development will be serviced by a private water supply well and sewage disposal system. The location and dimensions of the proposed features are presented in **Figure 7**.

The warehouse is anticipated to include a slab-on grade level (ground floor), with a partial second-floor mezzanine. The ground floor portion of the building is anticipated to include open warehouse space, meeting and collaboration space, a lunchroom area, washroom facilities and one (1) set of laundry units (washer and dryer). The mezzanine is anticipated to be used for general storage as well as to house mechanical components and equipment related to overall serviceability of the development (i.e. heating components and water treatment system).

To facilitate the development of the Site, excavation of the overburden materials to accommodate the foundation structural components (footings) are anticipated to extend to between 1.5 and 1.8 m below grade. The excavated areas, and underside of footings will be backfilled with non-frost susceptible backfill material, as outlined in the corresponding Geotechnical Investigation report prepared by LRL, dated February 2023.

The septic system will be designed by a competent individual and submitted for approval with the Ottawa Septic System Office (OSSO). A formal submission was made to the OSSO, however it is understood that based on subsequent alterations to the proposed Site layout, a revised application will need to be submitted which depicts the updated proposed location. Once the revised application is approved by the OSSO, a copy of the permit will be submitted to the City for their records. The actual proposed location for the installation of the system will be at the southwestern extent of the Site, between the warehouse and the southern property boundary as presented in **Figure 7**. The proposed septic details are as follows:

- The septic system will be a new construction, encompassing an approximate area of 68 m²;
- The sewage design flow for the Site will be 1,273 L/day;
- The proposed system will be a Class IV 'Eljen' partially raised system with the ability to reduce concentrations of total nitrogen by more than 50%;
- The tank will have a capacity of 5,509 L and will be equipped with a Polytek effluent filter; and
- The total capacity of the system will be 6,903 L.

In support of this hydrogeological assessment, a test well has been constructed on the Site in the location presented in **Figure 7**. The well was advanced to a depth of 48.7 m. Clay was reported to be encountered at ground surface to a depth 26.2 m followed by gravel to 28.0 m bgs. The well was extended into shale bedrock to 48.7 m bgs. Water was found at a depth of 46.9 m, with a static water level measured at 2.80 m. For the purposes of this report, the test well installed will be referred to as the 'Proposed Supply Well' as it is intended to use the well to supply the proposed warehouse development.

4 PREVIOUSLY PREPARED REPORTS

4.1 Phase Two Environmental Site Assessment, 363 Entrepreneur Crescent, Ottawa, Ontario, September 5, 2023

Entrepreneur Holding Corporation has retained LRL Engineering to complete a Phase Two Environmental Site Assessment on the properties located at 363 Entrepreneur Crescent, Ottawa, Ontario. A Phase Two ESA was completed to address the presence or absence of one or more contaminants at the Site as determined in the Phase One ESA and to assess the quality of the soil and ground water. The findings of the corresponding Phase One ESA should be read in conjunction with the Phase Two ESA presented herein. The Phase One ESA identified eight (8) individual potential contaminating activities (PCA). The PCAs that affect the Phase Two ESA are detailed above in Section 0, and are generally summarized as follows:

- **PCA 32**: Iron and Steel Manufacturing and Processing;
- **PCA 30**: Importation of Fill Material of Unknown Quality;
- **PCA Other**: Construction company workshop and storage yard;
- **PCA 56**: Treatment of Sewage equal to or greater than 10,000 litres per day;
- **PCA 58**: Waste Disposal and Waste Management, including thermal treatment, landfilling and transfer of waste, other than use of biosoils as soil conditioners; and
- **PCA Other**: Spill.

The contaminants of potential concern (CPCs) in soil and groundwater for the Site were based on the APECs identified at the Site during Phase One Environmental Site Assessment and observations at the time of the drilling program. The following CPCs for the Site were suspected to be associated with the identified APECs:

- Petroleum Hydrocarbons ranges F1-F4 (PHCs);
- Volatile Organic Compounds (VOCs);
- Polycyclic Aromatic Hydrocarbons (PAHs);
- Polychlorinated Biphenyls (PCBs); and
- Metals, Metal hydrides, and General Inorganics.

An assessment of the CPCs for the Site was completed as part of the Phase Two ESA analytical submission program. Soil and groundwater samples were submitted for a combination of the CPCs dependant on borehole and monitoring well locations with respect to the APECs. Based on the analytical results for the CPCs at the Site, generally the soils were found to meet the applicable provincial site condition standards (SCS) with two (2) exceptions, which included the following:

- Lead was reported above the SCS of 120 µg/g, with a value of 284 µg/g in the borehole advanced at the southwestern extent of the Site (BH23-7), from depths extended between 0.0 and 1.05 m below grade. A secondary soil sample collected from this borehole was submitted for metals analysis, which revealed that lead concentrations at depths between 1.20 and 1.95 m below grade were significantly below the SCS wit ha value of 7.5 µg/g; and
- Conductivity was marginally above the SCS of 1400 µg/g with a value of 1460 µg/g in a sample collected from the north-central portion of the property (BH23-5) at depths between 0 – 1.0 m. A duplicate sample representative of this parent sample was found to

have lower concentrations of conductivity with a value of 1250 µg/g. Therefore, it is possible that the elevated conductivity encountered may be limited or an anomaly.

Groundwater samples collected at the Site on March 16, 2023, revealed that only one (1) of the four (4) sample locations was found to have elevated concentrations of select parameters of concern. Based on the concentration reported, and in comparison, to the applicable SCS, exceedances to select PAH parameters were encountered in monitoring well MW23-3, located at the southeastern portion of the Site (down-gradient location on the Site). More specifically for the following parameters:

- Benzo [a] pyrene;
- Benzo [b] fluoranthene;
- Benzo [k] fluoranthene;
- Chrysene; and
- Fluoranthene.

Vanadium, commonly elevated in clay deposits across the region, was also detected above the appliable SCS in MW23-3.

LRL returned to the Site to confirm if the concentrations of PAH and metals encountered, as since these parameters were found to be notably lower in the soil samples collected from the Site, and no further exceedances were detected on the Site in the groundwater. A re-sample was collected on April 17, 2023, by LRL. The results of the additional sampling returned lower concentrations of all parameters previously reported above the SCS. Of which, Benzo [a] pyrene remained above the appliable SCS with concentrations of 0.07 µg/L.

4.1.1 Additional Consideration

Benzo (a) pyrene is a byproduct of combustion including vehicle exhaust, burning of wood or other petroleum burning activities. Based on the history of the Site, and the location of the exceedances, in addition to the southeasterly shallow groundwater flow direction, the source of this exceedance is un-identified and is unlikely the result of current or previous on-Site activities.

It was recommended in the Phase Two ESA report that remediation work to address the elevated lead concentrations in the soil be completed during the construction efforts. Remediation efforts, when performed using conventional ‘dig-and-dump’ methodology requires confirmatory sampling of excavation limits. This methodology, including additional confirmatory sampling for lead parameters, will be completed to address the impacted soil encountered, and confirm that the conditions of the Site are in accordance with applicable provincial SCS. Impacted soils with contaminates require special attention and handling requirements for disposal.

The impacted groundwater is also anticipated to be addressed at the time of development. As the PAH impacts appear to be limited to the southeastern portion of the Site, it may be attributed by localised impacted soil. The removal of soil in the vicinity of the monitoring well of concern will be completed during construction, and subsequent groundwater sampling will take place (either from the salvaged monitoring well, or a newly constructed monitoring well). If elevated concentrations of parameters of concern, namely PAH, continue to be elevated, numerous effective treatment technologies are available.

The impacted overburden is limited to the upper extents of the Site (upper approximate 1.2 m), and the impacted groundwater encountered was measured at a depth of 0.47 m below grade. The risk to the supply aquifer on the Site, with respect to these exceedances encountered, is considered negligible based on the thick, underlying confining soil conditions. The clay layer encountered is considered to act as a physical boundary between the encountered impacted shallow groundwater, and the supply aquifer for the identified wells in the area. The overburden conditions (clay) are not considered a suitable potential aquifer for possible future development in the vicinity of the Site.

4.2 Geotechnical Investigation, Proposed Warehouse, 363 Entrepreneur Crescent, Ottawa, Ontario, February 2023: Revised Decemebr 2024

LRL was retained by Entrepreneur Holding Corporation to perform a Geotechnical Investigation for a proposed warehouse development on the Site. The purpose of the investigation was to identify the subsurface conditions across the Site by the completion of a limited borehole drilling program. The fieldwork for this investigation was carried out on November 17, 2022, by LRL. A total of four (4) boreholes, labelled BH1 through BH4, as presented in **Figure 3**, were drilled across the Site to get a general understanding of the underlying soil conditions.

Sampling of the overburden materials encountered in the boreholes was carried out at regular depth intervals using a 50.8 mm diameter drive open conventional spoon sampler in conjunction with standard penetration testing (SPT) “N” values. In-situ field vane shear testing using a tapered vane was carried out in the soft to very soft cohesive soils. The boreholes were augered and sampled to a depth of 7.00 m below ground surface (bgs). A Dynamic Cone Penetration (DCP) test was carried out in BH2 until refusal (24.50 m bgs) to determine the overburden thickness. Upon completion, the boreholes were backfilled using the overburden cuttings.

The underlying soil conditions encountered across the Site generally included the following:

- Fill material consisting of a crushed stone granular material was encountered at the surface of all boring locations, and extended to depths ranging between 0.60 and 1.07 m bgs. The recorded SPT “N” values of this deposit varied from 30 to 36, indicating the deposit is dense. The natural moisture contents were found to be 9 and 11%;
- Underlying the fill material at all boring locations, a layer of brown silty sand was encountered and extended to a depth of 1.45 m bgs. The recorded SPT “N” values of this deposit varied from 14 to 19, indicating the deposit is compact. The natural moisture contents were found to be 22 and 24%;
- Below the silty sand in all boring locations, a layer of clayey silty was encountered and extended to a depth of 4.12 m bgs. This material contained trace sand, grey and wet. The SPT “N” values were found to range between 0 (weight of hammer (WH)) and 4, indicating the material is soft to very soft. The natural moisture contents were determined to range between 37 and 87%;
- Underlying the clayey silt in all boring locations, a layer of silty clay was encountered and extended to the end of sampling at a depth of 7.00 m bgs. This was found to be grey, and wet. The SPT “N” values of this layer were WH, indicating the material is very soft. The natural moisture contents were determined to be 76 and 90%; and
- Inferred glacial till was encountered in BH2 by way of the DCP test. This was found to be in a compact to very dense state of packing.

Two (2) soil samples were collected for laboratory gradation analyses. The gradation analyses comprised of sieve and hydrometer. Based on the analytical results collected, the estimated hydraulic conductivity was 5×10^{-8} with a plasticity index range between 38 and 42%, and a liquid limit range of between 61 and 67%.

A piezometer was installed in BH3 to measure the static groundwater level. The piezometer consisted of a 19 mm diameter PVC pipe with a slotted bottom to allow for groundwater infiltration, backfilled with silica sand, and sealed with bentonite. The water was measured on December 6, 2022, and found to be at 0.5 m bgs.

5 WATER QUALITY AND QUANTITY ASSESSMENT

5.1 Initial Water Quality Evaluation – 357 Entrepreneur Cresent

During our initial technical pre-consultation with the City of Ottawa Hydrogeologist, it was indicated that elevated concentrations of various parameters may be encountered in the bedrock aquifer in the area. Therefore, it was anticipated that by verifying the conditions of a neighbouring supply well, pre- ad post- treatment, and interviewing occupants of the building may provide insight on future recommendations for the anticipated development on Site and viable treatment system options for the water supply. LRL was granted permission to collect a representative sample of the neighbouring supply well of 357 Entrepreneur Crescent. A copy of the well record for this property (Well No. 7320860) is included in **Attachment D**.

LRL visited the property immediately east of the Site, on April 7, 2023, to collect two (2) samples of the supply water distribution system. One (1) sample was collected directly from the pressure tank, prior to treatment (pre-), and the second sample was collected from a washroom tap post-treatment (post-). The water samples were collected using laboratory prepared bottles and were submitted to an accredited laboratory (Parcel Laboratories Ltd. of Ottawa, Ontario) for analysis of a standard “subdivision” package. Each location was dis-infected prior to sampling with a distilled water/bleach solution and the fixture was allowed to run for a duration of at least 10-minutes prior to sampling. The aerator on the washroom tap was removed prior to disinfection and sampling. The sample containers were labelled with exclusive identification details and stored in a cooler with pre-chilled ice packs during transportation to the laboratory.

Our interview with the property owner at the time of the sampling revealed the following pertinent information related to the water supply and distribution system:

- The property is serviced by a drilled well located on the west side of the building. The well was installed in 2018 and was initially extended to 115 m. However, the water quality was not considered suitable and well was modified to intercept a shallower aquifer being approximately 28 m in depth;
- The distribution system which supplies the building with water includes a water treatment system. The system includes:
    - A smaller pressure tank is used in conjunction with a submersible pump to direct water into the building. The water is then emptied into a larger pressure tank;
    - From the larger capacity pressure tank, the water is passed through the following sequence of treatment systems:
        - a water softener that uses salt;
        - a series of three (3) carbon filters;
        - Iodine dosage; and
        - Reverse osmosis.
    - The water is then stored in a 1,000 L capacity container available for supply.
- The system is maintained twice annually by a plumbing and treatment specialist which includes sampling to confirm the components are in superior working order;

- At the time of the installation (2018), the system start-up cost was approximately \$25,000. For commercial/light industrial purposes, this is considered feasible to initiate and operate.

The analytical results from the pre- and post- treatment samples are presented in the included **Table 1**. Exceedances to the Ontario Drinking Water Standards (ODWS), and MECP D-5-5 guideline – maximum concentration considered reasonably treatable, were encountered in the pre- treatment sample for the following parameters:

- Alkalinity with a value of 605 mg/L, above the ODWS operation guideline (OG) of between 30 – 500 mg/L;
- Hardness with a value of 1,050 mg/L, above the ODWS OG of between 80 – 100 mg/L;
- Total Dissolved Solids (TDS) aesthetic objective (AO) of 500 mg/L, with a value of 7,640 mg/L;
- Turbidity was elevated with a value of 12 NTU, above the ODWS AO of 5 NTU, and the maximum allowable concentration (MAC) if treatment is required of 1 NTU;
- Chloride was reported with a value of 4,350 mg/L, above the AO of 250 mg/L;
- Iron was above the AO of 0.3 mg/L with a value of 1.3 mg/L; and
- Sodium was reported with a concentration of 2,010 mg/L, above the AO of 200 mg/L.

Post- treatment, the samples were found to improve significantly, however select parameters remain above the ODWS. These parameters include the following:

- Alkalinity with a value of 16 mg/L, below the ODWS OG acceptable range of between 30 and 500 mg/L;
- Hardness with a value of 0.00 mg/L, below the ODWS OG acceptable range of between 80 – 100 mg/L;
- Marginally above the TDS AO of 500 mg/L, with a value of 508 mg/L; and
- Chloride was reported with a value of 302 mg/L, above the AO of 250 mg/L.

Sodium, although was reported below the ODWS AO of 200 mg/L, was above the 20 mg/L limit which the local medical officer should be notified, with a value of 152 mg/L. It is our opinion that these remaining exceedances to the ODWS can be accounted for through adjustments to the existing system including possible media replacement, or dosing adjustments. The water is considered to be treatable with respect to the proposed use and development plan of the Site.

A copy of the laboratory certificate of analysis is included in **Attachment E**.

5.2 Proposed Supply Well – 363 Entrepreneur Cresent

The proposed supply well to facilitate the anticipated warehouse development on the Site was constructed on August 23, 2023, by Air Rock Well Drilling (Richmond, Ontario). The well was advanced at the northeastern portion of the Site, being a minimum of 3.0 m from all property lines, and beyond 15 m from potential sources of contamination, such as septic disposal systems (existing and proposed). The well extended to a depth of 48.7 m. Clay was reported to be encountered at ground surface to a depth 26.2 m followed by gravel to 28.0 m bgs. The well was extended into shale bedrock to 48.7 m bgs. Water was found at a depth 46.9 m, with a static water level measured at 2.80 m. A copy of the well record (Well Tag#A379014) is included in **Attachment D**.

The previously prepared EIS, as mentioned above in Section 2.6, has identified the ditch which traverses along the northern perimeter, as being likely impacted by the adjacent snow dump, and is likely impaired by elevated concentrations of sodium/chloride.

"Development within the site is unlikely to alter the hydrology, riparian functions, or terrestrial or aquatic habitat functions of the ditch adjacent to the site. The HDFA (Appendix C) determined that the Ditch, has extremely high salinity and is acting as a trough instead of water flowing through it. While the Ditch may have marginal connection to downstream features during the spring freshet, which could provide a limited and temporary entry point for fish, any fish entering the feature would certainly perish from the extreme environment. As such, the Ditch does not hold natural heritage value. A setback to protect feature is not required."

It is understood that Regulation 903 indicates that a supply well should not be placed within 15 m of a potential contamination source, and that the ditch is considered a possible contamination source by the City of Ottawa resulting from the neighbouring snow dump. The proposed supply well location is positioned approximately 7 m from the extents of the ditch, and is considered acceptable due to the proposed development details, and general site conditions as rationalized as follows:

- The proposed supply well has been constructed as a drilled well, extending to a depth of approximately 48.7 m below grade, comparable to that of the neighbouring supply well at 357 Entrepreneur Crescent. The clay deposit encountered during well construction was reported to be 26.2 m thick, which a confining layer between potential ditch infiltration and the supply aquifer. In addition to the clay layer, the well was also include a cement grout and bentonite slurry seal of at least 29.8 m, to further prevent surficial infiltration into the supply aquifer;
- The proposed supply well has constructed as per O. Reg. 903 with a minimum casing stickup of 40 cm, water proof cap. The immediate area will be graded such that will divert surface water from the installation. These actions would prevent possible impairment to the groundwater through infiltration into the water well;
- As a conservative approach to further mitigate possible impacts to the Site from the neighbouring land, a 5 m naturalized berm is to be constructed along the norther extent of the site. The berm is intended to prevent surface runoff from the adjacent property on the site, and towards the proposed well;
- After completing an initial water quality analysis of the neighbouring supply well, it was found that chloride and sodium are elevated in the groundwater, likely naturally. Samples were collected from pre- and post- treatment and it was found that through the use of various treatment units, including RO, carbon filtration, water softening and iodine dosing, the quality of the supply aquifer can be improved significantly; and

- The client will be utilizing a comparable treatment system for the development, therefore, the should the bedrock aquifer be impaired (although unlikely) by the neighbouring facility and ditch, adequate treatment will be in place to address the contaminates of concern.

Although the well is constructed so that the casing extends above ground surface, it is further recommended that the casing be extended/confirmed to be at least 400 mm above ground surface following final grading and surfacing.

5.3 Quantity

The proposed development of the Site is anticipated to include an approximate 592 m² warehouse with office space. The required aquifer yield has been derived from the City of Ottawa Design Guidelines – Water Distribution, 2010, as amended, including the August 18, 2021, Technical Bulletin specified alterations, and the MECP's Design Guidelines for Drinking-Water Systems, 2008.

The anticipated average daily flow demands have been evaluated based on the septic design, which is considered the industry standard and has been the means for evaluation on several comparable properties within the City of Ottawa. The daily flow demand is estimated based on the total daily design sanitary sewage flow, calculated as per Table 8,2.1.3. B of the Ontario Building Code, 2012. The calculation is shown in the following table.

Occupancy Type	Column 2 (L/unit)	Column 1 (unit)	Number of units	Daily Design Flow
Office Building	75	Per each 9.3 m2 of office space	21.37 m^2	173
Warehouse	950	Per water closet	1	950
	150	Per loading bay	1	150
Total Daily Demand				**1,273 L**

A peak demand (peaking factor), according to the MECP D-5-5 Guideline occurs over a period of 120 minutes / day. Therefore, using the Total Daily Design Sanitary Sewage Flow (TDDSSF) of 1,273 L/day, divided by the peak demand duration of 120 minutes/day, the anticipated maximum daily demand rate is calculated to be 10.6 L/min. For general consideration, and although not the anticipated volume to be meet at the Site during operations, the maximum daily flow is often estimated based on a multiplier of 1.5 the average daily flow. This is intended to confirm the aquifer can meet this arbitrary value in the event of a possible isolated increase in demand. The maximum daily flow is estimated as 7,632 L/day or 15.9 L/min (1.5 times the average daily flow, over an 8-hour period) and the peak hourly flow is estimated as 19.1 L/min (1.8 times the maximum daily flow). An eight (8) hour period was considered as this is the duration that a typical commercial/industrial operation is in use.

In support of the proposed lot development application, a Stormwater Management and Servicing Report was prepared by LRL. Section 5.1 of this report discusses the water supply servicing design for the Site. The report confirms that the required water supply requirement (the average daily demand) for the proposed industrial building was calculated to be 1,273 L/day following the OBC, 2012 Sewage System Design Flow as detailed above. For additional consideration, the City of Ottawa Design Guidelines – Water Distribution, 2010, is an alternative method for establishing the anticipated daily (over 24-hour) supply demand based on the total surface area of a property. The Site, being 3,000 m^2, is estimated to have an Average Daily Damand of 10,500 L/day; a Maximum Daily Demand of 15,750 L/day; and a Maximum Hour Demand of 28,350 L/day. This equates to 7.32 L/minute; 10.92 L/minute; and 19.68 L/minute, respectively. For further details related to these calculations, the Stormwater Management and

Servicing Report was prepared by LRL should be consulted.

5.3.1 Pumping Test

To establish the hydraulic properties of the proposed supply aquifer, an eight (8)-hr pump test was conducted on the newly constructed supply well on August 30, 2023. The pumping rate exceeded the daily peak demand rate, over a common commercial operation period of eight (8)-hours. The well was pumped at a constant flow rate (±5%) of approximately 22 L/min over eight (8)-hr period using a temporary submersible pump lowered into the well. The pumping test rate was greater than the calculated daily peak demand rate of 19.1 L/minute, in addition to the Maximum Hour Demand discussed above.

Drawdown was measured manually during the pumping and recovery periods using an electronic water level tape. Following the pump's cessation, the supply well water level recovery was measured. Data collected in the field for the pumping test which includes the flow rate, water levels and measurement intervals, are presented in **Attachment F**.

At the time of the pumping test, the initial static water level, with the submersible pump installed, was measured as 2.61 m below top of casing (btc) on August 30. 2024, and test well depth was measured as approximately 49.1 m btc. The submersible pump was set at approximately 45 m btc at the time of the test. The drawdown after eight (8)-hr of pumping was 3.64 m. This represents only approximately 8.1% of the available drawdown in the well, assuming the set pump depth of 45 m is the maximum drawdown which can be reached. The specific capacity of the well after eight (8)-hr of pumping was calculated to be 0.101 L/sec/m with a long-term availability of 82.4 m³ per day (82,400 L/day). This surpasses the calculated maximum daily demand, and the maximum peak hourly flow demand of 7,632 L/day (15.9 L/minutes) and 9,188 L/day (19.1 L/minute), respectively. The long-term availability calculation is presented in **Table 2**.

The recovery was commenced at the end of the eight (8)-hr pumping duration. The submersible pump remained in the well throughout this time so not to alter the recovery test process and measurements. After one (1) hour of recovery, the well returned to 90.1% of the initial water level (2.97 m btc). LRL returned after approximately 16 hours and again after 24 hours of recovery to verify the water level. The well was recorded to have reached 92.8% and 91.7% recovery, respectively. Marginally below the D-5-5 guideline requirement of 95% within 24 hours. As indicated in the D-5-5 guidelines, "*where sufficient recovery does not occur, the issue of the long- term safe yield of the aquifer is especially significant and must be addressed.*"

According to the City of Ottawa's Hydrogeological and Terrain Analysis Guideline, it is recommended that to establish background levels, a test well should be monitored for a period of one (1) week prior to pumping test, and one (1) week post pumping test. The test well was installed approximately one (1) week prior to the pumping test (August 23, 2024). At the time of the corresponding one (1) hour pumping test by the well installer and as included on the well record, a water level of 2.79 m btc was recorded.

LRL returned to the Site on August 30, 2023, to complete the eight (8) – hour pumping test, at which time the static water level was initially recorded to be 2.75 m below top of casing, prior to the pump installation. The pump was installed, and a water level of 2.61 m was recorded. It is suspected, after further review of the available field notes recorded, that the water level did not stabilize sufficiently after the pump being installed. Therefore, the increased displacement of 0.18 m with the pump installed can be considered unlikely and not representative of at the true stabilization level. If the water level with the pump installed was in fact more comparable to that indicated on the water well record (2.79 m), the well would have reached 97.7 % recovery 960 minutes, thus complying with the applicable provincial requirements. And if the water level was closer to the 2.75 m measured prior to the pump being set, the well would have reached 96.6 % recovery 960 minutes.

This is further justified using the *Forward Solution* modeling approach through AQTESOLV software Version 4.5, by HydroSOLVE Inc. *Forward Solution* is a method in AQTESOLV for planning the pumping test or predicting the new drawdown and recovery curves for an existing pumping test. The conceptual model used for the AQTESOLV analysis was of a bounded, leaky confined aquifer. To conduct the *Forward Solution* model, the Huntush-Jacob solution was applied to the aquifer test data with 22 L/min. The displacement-time curve for the anticipated configuration is shown in the included TW1_R2. Using this approach, it was found that it would be expected that the 95% recovery is achieved after 1100 minutes or 0.76 day (18.3 hours), within the 24 hour required duration, and only a 140 minute variable. A copy of the anticipated configuration graph is included in **Appendix L**.

It is our professional opinion that using either of the above rationalizations, it is demonstrated that the recovery of the test well corresponds with the D-5-5 requirements of 95% recovery within 24 hours following end of the pumping.

5.3.2 Aquifer Characteristics

Following the completion of the constant rate pumping test, the data was analysed using the Aquifer Test software package, by Waterloo Hydrogeologic. The data underwent Theis and Agarwal-Theis Recovery analysis, the results of which are shown in the table below. Graphical analyses of the drawdown are provided for reference purposes in **Attachment G**.

Established from the information gathered from the pump test, the wells' transmissivity and coefficient of storage were calculated using the average of the Theis logarithmic approximation for the drawdown and Agarwal/Theis for the recovery. The specific yield of the well was calculated using the information obtained from the pump test, the transmissivity and coefficient of storage. The yield takes into account a minimum safety factor of 3. The characteristics of the well are summarized in the table below. The yield was calculated using the safety factor; therefore, the theoretical yields can be higher.

Parameter	Supply Well *8 Hour Test* Theis
Transmissivity (m^2/sec)	7.59×10^{-5}
Coefficient of Storage	4.51×10^{-3}
Pumping Rate (L/min)	22
Available Drawdown (m) – assuming pump set at 45 m (as per pumping test)	42.4
Maximum Drawdown (m)	3.64
% Drawdown	8.1%
Specific Yield (L/sec/m)	0.101
Maximum Pumping Rate (L/min)	57.2
Long Term Availability (m^3/day)	82.4

Based on the observed drawdown/recovery relationship, it is concluded that the long-term yield of the test well is in excess of maximum daily demand flow of 7,632 L (7.63 m^3/day) with a projected value of 82.4 m^3/day and is found to be able to meet a maximum pumping rate of 57.2 L/minute, more than double the peak hourly demand of 19.1 L/minute, as well as the Maximum Hour Demand of 19.68 L/minute.

5.4 Quality

5.4.1 Field Measurements

Throughout the pumping tests the following field parameters were measured and recorded:

- Turbidity, chlorine and colour using a Lamotte TC-3000 Trimeter; and
- Conductivity, total dissolved solids (TDS) and pH using a portable meter (Hanna Instruments).

A summary of the field measurements collected throughout the duration of the pumping test are included in **Attachment F**.

The machine detection limits of the Lamotte TC-3000 Trimeter are as follows:

- Turbidity of 0.01 NTC, with an accuracy of +/- 0.05 (or 2%, whichever is greater);
- Colour of 0.1 CU, with an accuracy of +/- 0.5 (or 2%, whichever is greater); and
- Chlorine of 0.01 ppm, with an accuracy of +/-0.02 (or 2%, whichever is greater).

For the purposes of this report, values read as less than the corresponding limits will be reported as <0.01, or <0.1.

The following calibration, or zeroing techniques performed as part of this assessment, during the filed investigations is summarized as follows:

Parameter	Equipment Used	Calibration and Zeroing Techniques
Turbidity	Lamotte TC-3000 Trimeter	Prior to use, the equipment was calibrated using the 'two-point' method, following manufacturer instructions. Standard calibration solutions of 0.0 NTU and a 1.0 NTU were used to calibrate the machine. The solutions were pre-made by a supplier.
Colour	Lamotte TC-3000 Trimeter	Prior to the use of the equipment, and periodically during the pumping test, colour measurements were first zeroed by following the manufacturer's instructions and using Deionized Water (prepared and supplied by Hanna Instruments – HI7040-2).
Chlorine	Lamotte TC-3000 Trimeter	Prior to each chlorine reading, a blank sample, including Deionized Water (prepared and supplied by Hanna Instruments – HI7040-2) was screened to zero the machine.
Conductivity	HI98129 Hanna Instruments	Prior to each event, where the meter is used (typically daily), the instrument was calibrated using the Hanna Instrument prepared 1413 µs/cm conductivity solution (HI7031).
pH	HI98129 Hanna Instruments	Prior to each event, where the meter is used (typically daily), the instrument was calibrated using the 'two-point' method, following manufactures specifications. As the pH readings are anticipated to be within the neutral to slightly acid range based on our knowledge of the area and past experience, solutions of 7.01 pH Units (Hanna Instruments HI7007) and 4.01 pH Units (Hanna Instruments HI7004) were used.

5.4.2 Groundwater Sampling

Groundwater samples were collected for laboratory analysis during the pumping tests to assess the quality of the proposed supply aquifer. The water samples were collected after four (4) and eight (8)-hours of pumping. The water samples were collected directly into laboratory prepared bottles. The water samples were submitted to the laboratory for analysis of a “subdivision” package. The eight (8)-hour sample was also submitted to the laboratory for analysis of trace metals and volatile organic compounds (VOCs).

To address the contaminates of concern identified in the Phase One Environmental Site Assessments completed for the Site by LRL (Revised December 2024), LRL returned to the Site on November 22, 2024, to collect additional samples from the test well. The contaminates of concern included Petroleum Hydrocarbons (PHC) F1 through F4, Polycyclic Aromatic Hydrocarbons (PAH), and Polychlorinated Biphenyls (PCB). An additional round of Trace Metals were also analysed from the test well at this time.

The groundwater analytical results are discussed in Section 5.4.3. The laboratory Certificate of Analysis from Paracel Laboratories Ltd. (Ottawa, Ontario) is included in **Attachment H**.

5.4.2.1 Chlorine Residual

Procedure D-5-5 specifies, “T*he chlorine residual must be zero before any bacteriological sample can be taken*.” At the start of the eight (8)-hour pumping test, the chlorine residual was measured at 0.03 mg/L and fluctuated throughout the duration of the test with values of 0.02 mg/L at both the four (4) and eight (8) - hours pumping durations.

Chlorine residual at the time of the sample collection was thought to be a result of seasonal conditions influencing the field equipment and the sample matrix. It has been noted historically that during hot seasonal conditions, the glass vials used for the field measurement becoming cloudy from condensation, which is thought to disrupt the light exchange used for the measurement.

Further research into this matter (“chlorine residual without the well being chlorinated”) has found the following which may be attributed to the residual levels detected:

- In-field measurements can be influenced by sunlight. Sunlight can react with the indicator tablets used for the collecting the measurements, resulting in false positives. It is found that the 3-minute reaction time for the tablets in the sample matrix is needed to be kept outside of sunlight. It is likely that during the sample collection, the vials were exposed to the sunlight which returned false positives; and
- It was also retrieved that most common interferent with chlorine residual reading is oxidized manganese. Manganese was detected in the samples collected therefore this is a possible explanation for the slight detection of chlorine.

According to the equipment manual for the Lamotte TC-3000e, chlorine measurement accuracy is 0.02 ppm (mg/L) or 2%, which ever is greater. Therefore, based on the accuracy of the equipment, the chlorine residual measurements can be in the range of 0.00 and 0.04 mg/L in the four (4) hour and eight (8) hour samples collected. According to this, it is possible that based simply on the machine accuracy range, the samples are likely free of chlorine residual.

5.4.3 Supply Aquifer Quality – Proposed Supply Well (August 30th, 2024)

The groundwater chemistry of the proposed supply aquifer for the development was obtained by collecting water samples from the newly constructed proposed supply well located at the northeastern portion of the Site. The well was installed within the upper bedrock shale formation common of the area.

To represent the long-term water quality of the well, samples were collected during different stages of the pump test and well development (after four (4) and eight (8)-hours of pumping). The water samples were collected using laboratory prepared bottles and were submitted to an accredited laboratory (Parcel Laboratories Ltd. of Ottawa, Ontario) for analysis of a standard “subdivision” package, trace metals and volatile organic compounds (VOCs). The laboratory certificates of analysis are included in **Attachment H**.

Table 3A through **Table 3C** summarizes the water analysis and also includes the relative ODWS (O. Reg. 169/03) for the parameters tested. The water samples were found to be very comparable to that of the initial water sample collected from the neighbouring property as discussed in Section 5.1. The majority of the parameters analysed meet the ODWS parameters tested except for the following:

- Alkalinity was reported to have values of 703 and 705 mg/L at 4- and 8-hour, respectively. These values are above the ODWS OG limit of 500 mg/L. Alkalinity can be reduced through the use of a reverse osmosis treatment system. A water treatment specialist was contacted to obtain details with respect to the best suited treatment options, and provide details on a suitable reverse osmosis system. The details of this correspondence discussed in greater detail in Section 5.5;
- Hardness was found to be 1020 and 1030 mg/L at 4- and 8-hours, respectively, above the ODWS OG limit of 100 mg/L. High levels of hardness can lead to scale deposits and excessive utilization of regular soaps. Hardness can be reduced through the use of a water softener. However, the reported sodium (as discussed lower in this section) is elevated and the introduction of such a unit is not considered suitable. Rather, to reduce hardness levels, a treatment system specialist contacted proposed the use of a reverse osmosis system. The treatability of Hardness in the proposed water distribution supply for the Site is discussed in greater detail in Section 5.5;
    - The Langelier Saturation Index (LSI) is used to determine the calcium carbonate stability of water and the pH at which water is saturated with calcium carbonate (pHs). The LSI calculation is used to establish the level of saturation. The Ryznar Stability Index (RI) is used to determine the aggressiveness of water which can indicate the scale and corrosion potential. The calculations for RI and LSI are shown in **Table 4**. Using a water temperature of 10°C (typical of an interior distribution system circulating through a building), the LSI was calculated for the 8-hour sample of 1.78 which indicates the water is scale forming but non-corrosive. The RI was calculated to be 4.72 at the 8-hour sample which indicates heavy scaling.
- TDS values were found to be 7950 and 7880 mg/L in the 4- and 8-hour samples, respectively, above the AO of 500 mg/L. Where TDS levels exceed the ODWS AO, it is required that a professional comment regarding treatment include “***written rationale that corrosion, encrustation or taste problems will not occur***”, according to the MECP D-5-5 Guideline. As indicated in the ODWS for TDS parameter “*The term total dissolved solids refer to inorganic substances dissolved in water. The principal constituents of TDS are chloride, sulphates, calcium, magnesium and bicarbonates. The effects of TDS on drinking water quality depend on the levels of the individual components. Excessive hardness, taste, mineral deposition or corrosion are common properties of highly mineralized water. The palatability of drinking water with a TDS level less than 500 mg/L is generally considered to be good*.”

- ***Corrosion Rationale***: In support of the required rationale with respect to TDS levels in excess of 500 mg/L, the RI and LSI were calculated for the water sample to determine the corrosivity or scale formation potential of the water. The LSI is used to determine the calcium carbonate stability of water and the pH at which water is saturated with calcium carbonate (pHs). The RI is used to determine the aggressiveness of water which can indicate the scale and corrosion potential. Using a water temperature of 10°C (typical of an interior distribution system circulating through a building), the LSI was calculated for the 8-hour sample of 1.78 which indicate the water is scale forming but non-corrosive. The RI was calculated to be 4.72 at the 8-hour sample which indicates heavy scaling. Based on these calculations, the water supply is not considered to be corrosive.
- ***Encrustation Rationale:*** Much like the corrosion rationale, the use of the RI and the LSI calculation is suitable for estimating the likelihood of a water supply being scale forming or the encrustation potential. The proposed water distribution supply is found to be scale forming but non-corrosive and heavy scaling. Further discussion related to the treatability of the TDS to minimize the encrustation potential is included in Section 5.5.
- ***Taste Problems:*** The proposed water supply will be limited to use general water distribution purposes related to cleaning and hygiene. The supply aquifer will not be intended for consumption. This is discussed in Section 5.5, although with the precautionary measures to be implemented to ensure that the supply will not be consumed. For discussion purposes, the palatability of the aquifer will be examined.

  According to the Government of Canada, Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Total Dissolved Solids (TDS), the palatability of a drinking water supply (with respect to TDS) has been rated by participants, and the findings are as follows:

  - **Excellent,** less than 300 mg/L;
  - **Good,** between 300 and 600 mg/L;
  - **Fair,** between 600 and 900 mg/L;
  - **Poor,** between 900 and 1200 mg/L; and
  - **Unacceptable,** greater than 1200 mg/L.

  The raw water results of the test well are in excess of limit deemed unacceptable. Therefore, the proposed water distribution supply has a palatability rating of 'Unacceptable' and not palatable.

A water treatment specialist was consulted to provide a formal recommendation for the treatment of the TDS levels present, with respect to the intended use of the aquifer on the Site. The water is not intended for consumption purposes, therefore the focus of the treatment is to reduce levels to those which would be considered better suited with respect to encrustation. A reverse osmosis system can be effective in removing up to 99% TDS in cases. It is recommended that reverse osmosis system be implemented to reduce the levels of TDS. The proposed treatment options, as proposed by a water treatment specialist, are provided in Section 5.5.

- Turbidity was measured to have a level of 3.8 NTU in the 4-hour sample, and 3.5 NTU in the 8-hour sample. Both of which are above the ODWS OG of 1 NTU if the treatment system is required to provide filtration, however, are below the AO of 5 NTU and the maximum concentration considered reasonably treatable provided in MECP D-5-5 of 5 NTU. If the water is to be disinfected using an ultra-violet filter, it is recommended that the water be pre-treated with a 5 um filter;

- Dissolved Organic Carbon (DOC) with a level of 9.4 and 8.5 mg/L, at the 4- and 8-hour sample, respectively, above the AO of 5 mg/L but below the maximum concentration considered reasonably treatable provided in MECP D-5-5 of 10 mg/L. DOC can cause taste, odour, and colour. DOC can be reduced through the use of an air aspirated filter. A treatment specialist was contacted to provide an opinion on the best suited treatment available for the DOC concentrations which is discussed further in Section 5.5. As the water supply is not for consumption, the odour and colour may be off-putting for cleaning and other hygiene related purposes (i.e. hand washing), therefore treatment should be considered;
- Colour with a level of 8 TCU in both samples collected, above the AO of 5 TCU and the maximum concentration considered reasonably treatable provided in MECP D-5-5 of 7 TCU. The colour can be attributed to the levels of organic materials (i.e. tannin and lignin) encountered, which imparts a yellow/brown tinge to the water. Much like the DOC concentrations discussed above, although the water will not be for consumption, reduction of colour can make the water distribution supply appear more appealing for its intended use (i.e. cleaning or other hygiene related purposes). The color can be reduced by use of an air aspirated. The proposed treatment options are provided in Section 5.5;
- Chloride concentrations exceeded the ODWS AO of 250 mg/L with a value of 4560 mg/L after 4-hours of pumping, and 4460 mg/L after 8-hours of pumping. Chloride levels also exceeded the D-5-5 MCCRT of 250 mg/L. Chloride is found in nature in various forms such as in sodium (NaCl), potassium (KCl) and calcium ($CaCl^2$) salts. Although the concentrations encountered exceed the MCCRT, based on the findings of the samples collected from the neighbouring property, using a high pressure reverse osmosis system, the levels can be reduced. The samples collected from the neighbouring property revealed that chloride concentrations pre- and post-treatment were reported at 4530 mg/L and 300 mg/L, respectively. This demonstrates that the use of a reverse osmosis treatment system, much like that used at the neighbouring property, can be used to lower level of chloride in water distribution system. The levels will still likely exceed the ODWS AO, however, as mentioned, the proposed water supply is not for consumption. The proposed treatment options are provided in Section 5.5;
- Barium concentrations exceeded the ODWS MAC (2020) of 2 mg/L with values of 4.17 and 4.22 mg/L, after four (4) and eight (8) hours of pumping, respectively, as well as the Guidelines for Canadian Drinking Water Quality of 2.0 mg/L. Elevated barium is a health-related parameter. Barium is a naturally occurring element that is found in various minerals. Barium in drinking water is often related to dissolved compounds which migrate through rocks and soil deposits and enter into the supply aquifer. As per the Guidelines for Canadian Drinking Water Quality, Guideline Technical Document, Barium, 2020, lime softening and ion exchange softening are suitable methods for the treatment of barium in a water supply. Furthermore, reverse osmosis can aid in reducing barium from drinking water supplies. Barium can have health-related risks if consumed in concentrations in excess of the ODWS. The proposed water distribution system is not to be used for consumption (non-potable),

therefore the risk for impairment related to the Barium exceedances is considered low.

- Elevated Barium in a water well is often associated with naturally occurring bedrock (metamorphic, igneous and sedimentary formations) as well as it being used in fertilizers, insecticides, drilling 'mud' and paints. The potential sources of the barium concentrations encountered in the proposed supply aquifer on the Site include the following:

  i. The bedrock geology of the Site and surrounding area is the Carlsbad Formation which consists of grey shale, sandy shale, and some dolomitic layers. This is considered a sedimentary formation, therefore, the Barium levels encountered could be attributed to naturally occurring rock formations; and

  ii. Based on historical aerial photographs reviewed, accessible through the City of Ottawa's interactive mapping system (geoOttawa), as of at least the mid 1960's (1965) through the early 1990's (1991), the Site and neighbouring lands included agricultural lands, which maybe a source of historical use of fertilizers or insecticides.

  It is unlikely that drilling mud used during the well installation efforts would continue to be detected in the water well, after eight (8) hours of pumping. Therefore, the most likely source of these concentrations is those mentioned above.

- Barium is considered a health-related parameter which in high concentrations has been associated with variances to blood-pressure levels; intestinal and digestion discomfort; muscle weakness; and loss of feeling of facial features. The potential health effects associated with barium are outlined in the *Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Barium*. A copy of this document for reference is included in **Attachment L**. As discussed in various sections of this report, the proposed water distribution system is not for consumption, but rather limited to flushing of toilettes, other pluming fixtures like sinks for cleaning and hand washing. Ingested barium can cause significant health concerns. Further precautions to be taken, to ensure that the water will not be consumed are outlined below in Section 10;

- Sodium with a level of 2670 mg/L at 4-hours, and 2620 mg/L at 8-hours, which is above the ODWS AO and the maximum concentration considered reasonably treatable provided in MECP D-5-5 of 200 mg/L. The values collected from the test well are comparable to those collected from the neighbouring property which were found to have a concentration of sodium, prior to treatment, of 2010 mg/L, and a post-treatment concentration of 152 mg/L. Following the treatment system at the neighbouring property, the concentrations of sodium were found to be less than the ODWS AO of 200 mg/L. Elevated sodium in a water supply poses a risk for consumption, especially for those with underlying health concerns which can be worsened by increased sodium intake. In cases, increased sodium can also result in damage to pluming components and fixtures through corrosion. Through reverse osmosis treatment, it is found that the concentrations of sodium can be reduced to more suitable levels to maintain the integrity of pluming fixtures for a longer duration. The water distribution supply at the Site is not for consumption, therefore sodium levels do not present a health-related concern to potential future occupants or visitors. A water treatment specialist was contacted to provide rationale on the likely treatment options available to reduce concentrations of sodium in the distribution system on Site. There recommendations are included in Section 5.5.

As the concentrations are above the 20 mg/L warning level notification limit for those on a sodium restricted diet, the local Medical Officer of Health should be notified of these levels so that this information may be communicated to local physicians with regards to landowners in the vicinity of the Site and for general record keeping.

- Total Coliforms were detected with counts of 2 and 1 CFU/100 mL in the four (4)- and eight (8)-hours samples. Although these counts are less than the ODWS MAC, they may be an indicator of possible or potential contamination. It is advisable to include an ultra-violet treatment system as a precautionary measure regardless of the non-potable water conditions to be applied to the supply well in addition to annual disinfection of the test well, and proper maintenance of all treatment components and sewage disposal system upkeep and emptying. The local health unit supports bacteriological analysis for supply wells. Annual testing can be a proactive measure to be taken to ensure conditions do not worsen, at which time determination of the source will need to be resolved and addressed. To the best of our knowledge, no septic systems or other potential sources of contaminates are located within 15 m up-gradient of the supply well on the Site.
- Iron was reported in both the 4-hour and the 8-hour sample with a value equivalent to the ODWS of 0.3 mg/L. Although the concentrations do not exceed the ODWS, it is advisable that treatment be in place to address the potential risk for long-term increases in this parameter. The MCCRT is 5 mg/L, therefore, the values returned are considered within the concentrations considered reasonable treatable. Chemical free air aspirated filters are efficient at maintaining suitable levels of iron in a distribution system. A water treatment specialist was contacted to provide rationale on the likely treatment options available to reduce concentrations of iron in the distribution system on Site was recommended by the treatment specialist that a Chemical-Free Air Aspirator Filter, ETF Series 12", should be used to reduce concentrations of iron in the distribution supply. There recommendations are included in Section 5.5.
- Sulphide concentrations exceeded the ODWS AO of 0.05 mg/L, with values of 0.23 mg/L in both the 4-hour and 8-hour samples collected. Elevated sulphide can result in an un-pleasant odour in the water supply and taste. As mentioned throughout, the intended use of the water supply is not for consumption, therefore aesthetically displeasing attributes of the water supply are not a concern for the proposed development. Alternatively, the levels of sulphide can be reduced through the use of a chemical free air aspirated filter. A water treatment specialist was contacted to provide rationale on the likely treatment options available to reduce concentrations of iron in the distribution system on Site was recommended by the treatment specialist that a Chemical-Free Air Aspirator Filter, ETF Series 12", should be used to reduce concentrations of sulphide in the distribution supply. There recommendations are included in Section 5.5.

VOC parameters were not detected in the samples submitted for analysis.

5.4.4 Supply Aquifer Quality – Contaminates of Concern (November 22nd, 2024)

LRL returned to the Site on November 22nd, 2024, to collect additional samples representative of the proposed supply aquifer, with respect to the contaminates of concern identified in the Phase One Environmental Site Assessment. The sample was collected using a 4-Stage submersible pump, with external power supply and flow regulator, and dedicated wattera tubing. The static water level upon arrival to the Site was measured as 2.73 m btc pump was set at a depth of 5.0 m btc. The pump was run for a period of 30 minutes at a rate of approximately 6 L/minute to remove stagnant water and allow for a better representation of the proposed supply aquifer. The water removed was discharged approximately 12 m from the well, in the vicinity of the ditch located along the northern perimeter of the Site.

After 30 minutes of purging, the pump was temporarily turned off and the water level was allowed to return to within 95% of the initial water level. Once the desired water level was achieved, the pump was turned on once more. The pre-labelled jars were filled in the field from the dedicated waterra tubing, sealed when full, packaged in bubble wrap and placed into an ice-filled cool box to maintain temperatures below 10 °C for storage and transportation. The chain of custody form was completed in the field, placed in a protective wrap, and placed into the cooler box for delivery to the laboratory. As mentioned above, the samples were submitted for analysis of PHC F1 through F4, PAH, PCB and Trace Metals. The Trace Metals were included in the sampling event to confirm the concentrations of previously elevated Barium.

The analytical results were compacted to the MECP ODWS. The following parameters were encountered above the corresponding ODWS:

- Barium concentrations exceeded the ODWS MAC (2020) of 2 mg/L with values of 3.15 mg/L;
- Sodium with a level of 2,430 mg/L which is above the AO and maximum concentration considered reasonably treatable provided in MECP D-5-5 of 200 mg/L;
- Iron concentrations exceeded the ODWS AO of 0.3 mg/ L with a value of 11.1 mg/L; and
- Manganese concentrations exceeded the ODWS AO of 0.05 mg/L with a value of 0.155 mg/L.

These concentrations are comparable to those of the samples collected during the eight (8) hour pumping test on August 30, 2023. The discussion above related to Barium and the health-related concerns and measures to be implemented is reiterated based on these subsequent findings. Sodium concentrations found during the November 22, 2024, sampling event further suggest that to maintain the integrity of the proposed pluming fixtures, thorough treatment is required.

Iron levels are elevated in comparison to the levels encountered in August 2023. The elevated iron is most likely attributed to corrosion of the well casing, as the water level was maintained generally at the static water level, where there is an air / water interface, and likely elevated corrosion on the internal component of the steel casing structure. The inclusion of a water softener can be effective at limiting concentrations of iron, which would be recommended to reduce discolouration to pluming fixtures in the proposed development.

Manganese can also be reduced through a water softener, along with the additional parameters mentioned, and as discussed in Section 5.5.

As there are no set limits for PAH, PCB or PHC F1 through F4 in the ODWS, these parameters were compared to the Ontario Ministry of the Environment, Conservation and Parks, Ontario Regulation 153/04 (as amended) Table 1: Full Depth Background Site Condition Standards. According to the regulation "*The groundwater standards in Table 1 were derived from the Provincial Groundwater Monitoring Information System (PGMIS) from 2002 to 2007 and from groundwater well surveillance data (DWSP) from 1997 to 2002. For parameters where sufficient data was not available values have been derived from the most recent effects-based water criteria including Provincial Water Quality Objectives and the Ontario Drinking Water Quality*

Standards as upper limits and Method Detection Limit as a lower limit. These values are considered to be generally achievable in site situations typical of background while providing a level of human health and ecosystem protection consistent with background conditions and protective of sensitive ecosystems". This is considered reasonable for comparison of these parameters.

PHC F1 through F4 were not detected in the sample collected, nor was there any olfactory or visual evidence of suspected PHC impacts encountered in the samples collected. PCBs were also not detected in the sample collected.

The majority of the PAH parameters analysed were not detected in the sample collected with the exception of Benzo[a]anthracene and Fluoranthene. Both Benzo[a]anthracene and Fluoranthene were detected with a value of 0.02 µg/L, below the Table 1 standard of 0.2 and 0.4 µg/L, respectively. The levels are not considered a potential concern to the proposed development on the Site, and use of the proposed supply aquifer, as further discussed in later sections.

5.4.5 Supply Aquifer Quality – Additional Consideration

As discussed in Section 2.7.4, a Phase Two Environmental Site Assessment was completed at the subject property in March 2023. The findings of this assessment revealed slight impact to the soil, including conductivity at the northwestern portion of the Site which could be attributed to seasonal snow clearing and de-icing operations. Lead concentrations were also above the appliable provincial site condition standard in the borehole advanced along the eastern limit of the Site, which could be a result of the storage of metal components from the neighbouring operations. Both exceedances were detected generally at groundsurface, at depths between grade and 1.0 m below grade. The supply well record identifies a 26.2 m thick layer of clay, which is considered a low-permeable layer isolating the potential surface impacts from the proposed supply aquifer.

Metals and Inorganics parameters analysed during the pumping test, and subsequent sampling on November 22, 2024, revealed that Lead concentrations to the aquifer were below the laboratory detection limits.

Conductivity however was elevated, although no available drinking water standard is available for this parameter. The elevated conductivity is likely associated with the chloride concentrations mentioned above.

5.5 Supply Aquifer Treatability

As discussed above in Section 5.4, representative groundwater samples of the proposed supply aquifer, throughout the hydrogeological assessment, has revealed that various parameters are reported to have concentrations above the appliable Ontario Drinking Water Standards, and of which select parameters exceed the MCCRT set out in the MECP D-5-5 guideline. The proposed water distribution system will not be for consumption purposes but limited to plumbing components typical of a warehouse / office space (i.e. wash basins and lavatory). The parameters which were reported to exceed the respective standards and guidelines included alkalinity, dissolved organic compound, colour, hardness, total dissolved solids, chloride, barium and sodium.

A water treatment specialist was consulted to address the quality of the water and confirm the best suited treatment units which could be implemented to address the quality concerns. The water distribution system will not be consumption; therefore, the intent of the treatment is not to reduce levels to those considered suitable for human consumption, but rather to preserve the integrity of the pluming fixtures and distribution system. A copy of the correspondence with the treatment specialists in included in **Attachment M**. The proposed system, and anticipated costs, are as follows:

- Antiscale Injection – to include a 35 gallon chemical solution tank and mixing tank, to be filled with anti scale concentrate. Unit cost of $840.00, with one (1) annual supply of concentrate;
- ETF Series 12” Chemical-Free Air Aspirated Sulfur/Iron Filter to aid in the removal of various parameters including Iron; DOC; Colour and Sulphide. This unit has a unit rate of $3,699.00;
- RSL High Pressure Reverse Osmosis System, with a higher pressure (225 psi) for feed water and stainless steel piping. This unit has a cost of $13,893.00;
- A Nelson Water Neutralizing Filter to raise the pH at a unit rate of $695.00; and
- An Ultraviolet Water Disinfection System at a unit rate of $1,049.99.

The overall proposed water treatment system, as proposed by the water treatment specialist, is anticipated to cost approximately $31,119.01, with the inclusion of installation, although electrical connections are excluded. As the property will be used for commercial/light industrial purposes, it is considered feasible for such a system series to be supplied and maintained on a regular basis. The treatment specialist has included further details with respect to the proposed components of the water distribution system, and detailed specifications of the units proposed. It is strongly advised that **Attachment M** be consulted for further details and description of the proposed water distribution system treatment units.

5.6 Mineralized Water

Total dissolved solids and chloride concentrations, as mentioned above, are in excess of the defined limit for mineralized water as set out in O. Reg. 903 Wells Regulation, which specifies a concentration limit of 6000 mg/L for total dissolved solids and 500 mg/L for chloride. When mineralized water is encountered, the well owner shall immediately abandon the well or will require ministry approval. A formal request for consent to maintain the well constructed on the Site for future demand supply use was made to the Ontario Ministry of the Environment, Conservation and Parks Director on December 20, 2023. Additional clarification, and supporting information was requested by the Director thereafter.

On August 13, 2024, the Ministry issued a formal **Consent Not to Abandon Water Supply Well (A379014), Located at 363 Entrepreneur Crecent, Ottawa, Ontario**. A copy of the consent notice by the MECP Director is included in **Attachment I**. The conditions to maintain the supply well are included in this consent notice, which will be followed as part of this site development. These requirements, which must be followed, include the following:

- Ensure that the well is properly vented to the outside atmosphere in a manner that will safely disperse all gases, as per Section 15.1 of Ontario Regulation 903;
- The services of a water treatment specialist shall be retained and the owner of the property shall install, operate and maintain a water treatment system in the distribution system, in accordance with recommendations of the water treatment specialist, to address the total dissolved solids and chloride present in the well water prior to the water being used in the building;
- The water treatment system shall be properly maintained and operational at all times in accordance with the recommendations of the water treatment specialist;
- All faucets within the building shall be labelled to indicate that the water is not intended

for human consumption;

- The well water shall not be used as a drinking water source under any circumstances by any person and bottled water shall be supplied for consumption by employees;
- Due to elevated chloride, steps shall be taken to mitigate the impact of corrosion on plumbing including: use of approved PEX pipe and fittings, installation of stainless steel fixtures, and not installing water treatment systems that may increase corrosivity of the water; and
- The well identified by well record number A379014 shall be maintained as per Ontario Regulation 903 until such time as the water supply is no longer required. At that point, the water supply well shall be decommissioned in accordance with Ontario Regulation 903.

The Ministry specifies that once the water treatment system required as mentioned above, becomes operational, the property owner must immediately notify, in writing, the Director appointed for the purposes of subsection 21 (10) of the Well Regulation of the date when the water treatment system is operational.

6 WATER SUPPLY ASSESSMENT

Based on the Site geology and hydrogeology the recommended potential supply aquifer for the Site, is the shale aquifer. The proposed supply well installed on the Site currently intercepts this aquifer, and it is our understanding that the proposed development of the Site will utilize this newly constructed well. The selection of this aquifer is supported by the following:

- The risk to impairment of the on-Site water supply, as well as the possible pathway for contaminates in the shallow soils is considered too great of a risk to explore this as a potential supply aquifer, in addition to clay overburden is not considered a reliable or suitable stratum to obtain an adequate water supply.
- Only one (1) record of neighbouring shallow supply well was returned which suggests it may not be a suitable source.
- The City of Ottawa, at the time of the technical pre-construction reiterated comments from an initial project overview consultation that indicated the thick marine clay deposit identified in local well records may not be a suitable aquifer material for a shallow well. Furthermore, it was indicated that as per Section 5.2.3 of the City of Ottawa Hydrogeological and Terrain Analysis guidelines "*Site Plans will normally not be approved based on dug wells, unless it can be demonstrated, to the satisfaction of the City, that a drilled well is likely to produce unacceptable water quality or quantity.*"
- The thick confining clay layer, above the bedrock, is considered a suitable barrier to prevent possible impartment to the supply aquifer and regional supply aquifer from the site proposed activities.
- Discussions with the neighbouring landowner indicated that the deeper bedrock aquifer was of poor quality, and not considered a suitable source to supply their establishment. They, much like other neighbouring lands, intercept the shale bedrock aquifer for supply.

6.1.1 Demand

Following the calculations set out in the Ontario Building Code, the Total Daily Design Sanitary Sewage Flow (TDDSSF) of 1,273 L/day, divided by the peak demand duration of 120 minutes/day, the anticipated maximum daily demand rate is calculated to be 10.6 L/min. For general consideration, and although not the anticipated volume to be meet at the Site during operations, the maximum daily flow is often estimated based on a multiplier of 1.5 the average daily flow. This is intended to confirm the aquifer can meet this arbitrary value in the event of a possible isolated increase in demand. The maximum daily flow is estimated as 7,632 L/day or 15.9 L/min (1.5 times the average daily flow, over an 8-hour period) and the peak hourly flow is estimated as 19.1 L/min (1.8 times the maximum daily flow). An eight (8) hour period was considered as this is the duration that a typical commercial/industrial operation is in use.

In support of the proposed lot development application, a Stormwater Management and Servicing Report was prepared by LRL. Section 5.1 of this report discusses the water supply servicing design for the Site. The report confirms that the required water supply requirement (the average daily demand) for the proposed industrial building was calculated to be 1,273 L/day following the OBC, 2012 Sewage System Design Flow as detailed above. For additional consideration, the City of Ottawa Design Guidelines – Water Distribution, 2010, is an alternative method for establishing the anticipated daily (over 24-hour) supply demand based on the total surface area of a property. The Site, being 3,000 m2, is estimated to have an Average Daily Damand of 10,500 L/day; a Maximum Daily Demand of 15,750 L/day; and a Maximum Hour Demand of 28,350 L/day. This equates to 7.32 L/minute; 10.92 L/minute; and 19.68 L/minute, respectively. For further details related to these calculations, the Stormwater Management and Servicing Report was prepared by LRL should be consulted

The findings of the pumping test revealed that the overall drawdown was marginal of the potential availability (even with a greater demand utilized for the test), and the aquifer did not demonstrate stressed conditions, which supports that it is suitable for the anticipated development.

As presented in the included **Table 2**, the water levels collected during the pumping test suggests that well marginally missed the 95% recovery requirements. However, after further consideration of the data collected during the entirety of the assessment, it is our professional opinion that the well does in fact meet the recovery requirements, and therefore in accordance with the applicable guidelines and can supply the proposed use of the Site with a sufficient quantity of water. This is further discussed in the immediately below in Section 6.1.1.1.

6.1.1.1 Recovery – Additional Consideration

According to the City of Ottawa's Hydrogeological and Terrain Analysis Guideline, it is recommended that to establish background levels, a test well should be monitored for a period of one (1) week prior to pumping test, and one (1) week post pumping test. The test well was installed approximately one (1) week prior to the pumping test (August 23, 2024). At the time of the corresponding one (1) hour pumping test by the well installer and as included on the well record, a water level of 2.79 m btc was recorded.

LRL returned to the Site on August 30, 2023, to complete the eight (8) – hour pumping test, at which time the static water level was initially recorded to be 2.75 m below top of casing, prior to the pump installation. The pump was installed, and a water level of 2.61 m was recorded. It is suspected, after further review of the available field notes recorded, that the water level did not stabilize sufficiently after the pump being installed. Therefore, the increased displacement of 0.18 m with the pump installed can be considered unlikely and not representative of at the true stabilization level. If the water level with the pump installed was in fact more comparable to that indicated on the water well record (2.79 m), the well would have reached 97.7 % recovery 960 minutes, thus complying with the applicable provincial requirements. And if the water level was closer to the 2.75 m measured prior to the pump being set, the well would have reached 96.6 % recovery 960 minutes.

This is further justified using the *Forward Solution* modeling approach through AQTESOLV software Version 4.5, by HydroSOLVE Inc. *Forward Solution* is a method in AQTESOLV for planning the pumping test or predicting the new drawdown and recovery curves for an existing pumping test. The conceptual model used for the AQTESOLV analysis was of a bounded, leaky confined aquifer. To conduct the *Forward Solution* model, the Huntush-Jacob solution was applied to the aquifer test data with 22 L/min. The displacement-time curve for the anticipated configuration is shown in the included TW1_R2. Using this approach, it was found that it would be expected that the 95% recovery is achieved after 1100 minutes or 0.76 day (18.3 hours), within the 24 hour required duration, and only a 140 minute variable. A copy of the anticipated configuration graph is included in **Attachment N**.

As discussed above in Section It is our professional opinion that using either of the above rationalizations, it is demonstrated that the recovery of the test well corresponds with the D-5-5 requirements of 95% recovery within 24 hours following end of the pumping.

7 TERRAIN ANALYSIS

The terrain analysis was conducted to demonstrate that the unconsolidated material on the Site is appropriate for the construction of an on-Site subsurface sewage disposal system on the Site. The subject property is currently developed with a sewage disposal system, however, to support the re-development and Site up-grades, a new structure and associated components will be constructed in accordance with the Ontario Building Code, 2012. The proposed location of the sewage disposal system is presented in **Figure 7**.

The septic system will be designed by a competent individual and submitted for approval with the Ottawa Septic System Office (OSSO). A formal submission was made to the OSSO, however it is understood that based on subsequent alterations to the proposed Site layout, a revised application will need to be submitted which depicts the updated proposed location. Once the revised application is approved by the OSSO, a copy of the permit will be submitted to the City for their records. The actual proposed location for the installation of the system will be at the southwestern extent of the Site, between the warehouse and the southern property boundary as presented in **Figure 7**. The proposed septic details are as follows:

- The septic system will be a new construction, encompassing an approximate area of 68 m^2;
- The sewage design flow for the Site will be 1,273 L/day;
- The proposed system will be a Class IV ‘Eljen’ partially raised system with the ability to reduce concentrations of total nitrogen by more than 50%;
- The tank will have a capacity of 5,509 L and will be equipped with a Polytek effluent filter; and
- The total capacity of the system will be 6,903 L.

The Site is not considered Hydrogeologically Sensitive in regard to geological formations. Review of geological mapping and additional supporting documents, including MECP water well records, have revealed a deposit of overburden greater than 20 m thickness. This was further confirmed through the advancement of boreholes across the Site at the time of additional sub-surface investigation fieldwork completed by LRL, in support of the proposed development application. These additional investigations included a Geotechnical Investigation and a Phase Two Environmental Site Assessment. No bedrock outcrops were encountered at the time of LRLs Site visits associated with the corresponding investigations and assessments.

Subsurface conditions encountered during these studies are summarized as follows, although greater detail is available in the corresponding reporting documents completed for the respective investigations. Copies of the borehole logs from the Phase Two Environmental Site Assessment and Geotechnical Investigation are included in **Attachment B**.

As part of the Geotechnical Investigation, select soil samples were submitted for laboratory gradation analyses. The results of these analysis are summarized as follows:

Sample Location	Depth (m)	Percent for Each Soil Gradation					Estimated Hydraulic Conductivity K (m/s)
		Sand			Silt (%)	Clay (%)	
		Coarse (%)	Medium (%)	Fine (%)			
BH1	1.52 – 2.13	0.4	0.8	4.1	59.3	35.4	5×10^{-8}
BH2	6.10 – 6.71	0.0	0.0	0.6	31.0	68.4	5×10^{-8}

The subsurface conditions indicated for the Site are considered suitable for a Class IV septic sewage disposal system with a partially to fully raised leaching bed depending on the Site-specific soil and groundwater conditions at the actual location of the proposed septic system leaching bed. The leaching bed should be constructed to conform to the specifications set out in the Ontario Building Code (OBC).

According to the design submitted by others, the overall septic system would require an area of 68.04 m² for the dispersion bed, along with an additional approximate 30 m² for the pump station, tank, dosing chamber and secondary pump station. This equates to a total surface area of 98.04 m². Assuming a replacement area of 70 m², an area of approximately 168 m² would be required for the placement of the sewage disposal system.

The proposed grassed area assigned for the septic system at the southwestern extent of the Site has a surface area of 175 m², which is considered suitable for the placement of the septic. This location is more than 15 m from the location of the proposed supply well on the Site, and the existing supply wells on neighbouring lands.

The ditch located along the northern perimeter of the Site is identified as a watercourse by the City of Ottawa, although an Environmental Impact Study prepared by others has confirmed that the feature does not have Natural Heritage significance. For the purposes of this assessment, it will be assumed that the watercourse is an open water feature, therefore the Site will be considered hydrogeologically sensitive.

8 GROUNDWATER IMPACT ASSESSMENT

As per Section 5.2, Groundwater Impact Assessment in Non-Designated Areas, of the MECP's Procedure D-5-4 outlines the three (3) step assessment process for evaluating the potential risk for "every proposed development involving on-site sewage systems". The steps are intended to be followed in succession, where the conditions established in the previous step determine whether it is necessary to move on to the next step.

Step one of the assessment processes is ***Lot Size Consideration***. If it can be demonstrated that the area of the Site is not hydrogeologically sensitive, developments with lots that average 1 hectare (with no lot smaller than 0.8 ha) may not require a comprehensive hydrogeological assessment. It is expected that attenuative processes inside a one (1) hectare (10,000 m²) parcel of land will be adequate to decrease the nitrate-nitrogen to a satisfactory focus in groundwater underneath contiguous properties. The Site has a surface area of approximately 3,000 m² or 0.75 acre, which does not meet the Lot Size Consideration. Additionally, the Site is considered to be hydrogeologically sensitive based on the presence of the water course immediately north of the property.

Step Two is ***System Isolation Considerations***, which evaluates the risk to groundwater from septic effluent, where geological setting and characteristics present suitable isolation conditions. Such conditions are most often supported by a lower hydraulic or physical boundary of the receiving groundwater. Such boundaries can include a thick layer of underlying soils with low permeability (i.e. clays). As discussed in Section 2.7, a thick layer of clay, inferred to extend from approximately between 1.10 and 1.45 m to 18.6 m below grade on the site. This clay layer is considered a likely isolation barrier from potential surface impacts (i.e. effluent) and the receiving aquifer of neighbouring wells. Due to the soil conditions encountered, and discussed above in Section 7, "***System Isolation***" was considered as part of this terrain analysis and is further rationalized below in Section 8.1.

Step three is the ***Contaminate Attenuation Consideration*** for sites that do not meet the above two points.

8.1 System Isolation Considerations

The geological and hydrogeological conditions of the Site, and the lands within 500 m of the Site support the use of ***System Isolation Considerations*** method with respect to nitrate groundwater impacts.

As discussed in Section 2.8, a search of the Ontario Water Well Records revealed that 21 supply well records are retrieved within a 750 m radius of the Site. All but one (1) of the records retrieved detailed drilled supply wells, which intercept the gravel/bedrock aquifer. The gravel/bedrock aquifer is notably confined by a thick layer of clay ranging in thickness of between 20.7 and 30.3 m as recorded in the water well records. The clay layer is considered to act as a physical boundary between the groundwater anticipated to be the receptor of sewage, and the supply aquifer for the identified wells in the area.

One (1) record of a shallow/dug well is located within the 750 m radius of the Site. More specifically, approximately 370 m southwest (up- to trans-gradient based on the inferred southwesterly groundwater flow direction) of the Site at 100 Entrepreneur Crescent. The shallow well was constructed into the clay overburden to a depth of 7.0 m below grade, with clay reported from depths of between 0.2 m bgs, extending to 7.0 m where the well was terminated.

Based on our in-field observations and measurements at the time of the intrusive investigation activities (discussed above in section 2.7.3 and section 2.7.4), it was confirmed that the clay on the Site extends a depth of approximately 18.6 m below grade, which is slightly less than the recorded thickness included in the water well records for the neighbouring lands. The on-Site intrusive investigation further revealed a perched water table within the shallow silty sand / sand layer, overlying the clay at a depth of between 1.10 and 1.45 m below grade. It is our professional opinion that this perched overburden water within the silty sand / sand is the most probable groundwater receiver for sewage effluent.

To establish the likely travel time of the effluent 'contamination' and risk associated with the proposed private on-Site sewage disposal system to potential receptors, the following calculation is applied:

i. Vertical Contamination Travel Time

The vertical groundwater velocity is calculated using the following equation:

$$v = \frac{Kdh}{n_e dl}$$

Where:

K = hydraulic conductivity (m/s)

dh/dl = hydraulic gradient (m/m)

n_e = effective porosity

The calculation assumes that the hydraulic gradient is the difference between the water levels (dh) divided by the thickness of the physical boundary (dL), divided by the radius of influence (assumed 50 m as the nearest supply well distance on a neighbouring land from the proposed sewage disposal system).

dh = Greatest Difference in Overburden Water Levels (The static water level on March 16, 2023)

= 0.55 m - 0.20 m

= 0.35 m

dl = Approximate Thickness of Clay on Site – Assuming a Max. Depth of 18.6 m

= 17.33 m

dh/dl = 0.35 m/17.33 m

= 0.0202

= 0.0202 / 50 m Radius

= 0.00040

Note ** The static water levels are those collected during the Phase II ESA, discussed further in Section 2.7.4.*

***The clay layer on the Site is found to be thinner than those reported in a 750 m radius from the Site and is therefore considered more conservative.*

According to the *Geotechnical Investigation, Proposed Warehouse, 363 Entrepreneur Crescent, Navan, Ontario – Revision 1, prepared by LRL, February 2023, revised: August 2024*, the overburden material described as silty clay to clayey silt, which is the confining layer between the anticipated effluent, and the drinking water supply aquifer on neighbouring lands, has an estimated hydraulic conductivity of 5 x 10^{-8} m/sec. This was established through gradation analysis of various soil sample collected during the investigation, which is summarized below.

Sample Location	Depth (m)	Percent for Each Soil Gradation					Estimated Hydraulic Conductivity K (m/s)
		Sand			Silt (%)	Clay (%)	
		Coarse (%)	Medium (%)	Fine (%)			
BH1	1.52 – 2.13	0.4	0.8	4.1	59.3	35.4	5 x 10^{-8}
BH2	6.10 – 6.71	0.0	0.0	0.6	31.0	68.4	5 x 10^{-8}
BH5	1.52 – 2.13	0.0	0.1	3.1	29.5	67.3	5 x 10^{-8}
BH5	3.05 – 3.66	0.0	0.0	1.2	31.7	67.1	5 x 10^{-8}

For the purposes of this report, a K value of 5 x 10^{-8} m/s will be used for the confining silty clay/ clayey silt soils across the Site.

A n_e value of 0.55 is considered representative of the clay soils identified across the Site. This is according to the Total and Effective Porosity values (*data from Enviro Wiki Contributors, 2019*) presented in Hydrogeological Properties of Earth Materials and Principles of Groundwater Flow reference document prepared by The Groundwater Project (https://books.gw-project.org).

Using these values, the groundwater velocity has been determined to be as follows:

	dh/dl	k (m/s)	v (m/year)
Vertical (10^{-8})	0.00404	5.0 x 10^{-8}	0.350

The slow travel time would allow for the dilution and natural attenuation of the nitrates prior to reaching the confined gravel/bedrock aquifer below. The vertical travel time was calculated to be approximately 50 years from the septic system to the gravel/bedrock aquifer, which is considered suitable time for the dilution and natural attenuation of the nitrates.

One (1) shallow overburden / dug supply well has been identified within a 500 m radius of the site, more specifically, approximately 370 m southwest of the subject site at 100 Entrepreneur Cresent. Using the calculation above, although modifying it to account for the horizontal distance of 370 m, the anticipated travel time between the possible impacts from on the on-site septic have been calculated. Additionally, the calculation included a '0' difference in the water levels between both the septic and the water in the shallow supply well, as no details were provided in the water well record to this regard. Assuming a clay thickness of 6.8 m and a variance in the water level of 0.0 m, it was established that the effluent would travel at a rate of approximately 0.30 m / year, and would take over 110 years to reach the shallow supply well. Although, in actuality, it is unlikely that the effluent would migrate southwest towards the shallow well, due to the shallow wells up- to trans gradient of the proposed sewage disposal system.

The nearest well to the Site is located on the adjacent land to the west, approximately 50 m up-to trans-gradient of the proposed sewage disposal system. The well record for the neighbouring well reveals that clay was encountered at surface and extends to 22.6 m below grade, which is generally comparable to the conditions encountered on the Site. The well extends into the underlying limestone formation. As the well is up-gradient to trans-gradient of the proposed septic disposal system on the site, the likely impacts are already ruled to be negligible. But for discussion purposes, it can be assumed that the anticipated travel time to the supply well would be 50 years vertically, in addition to an estimated 0.08 m/yr horizonal travel time assuming the same equation above, with a horizonal water level difference of 26.6 m (average water level of in perched overburden compared to the water depth in the neighbouring supply well where water was found – 27 m). Considering the vertical and the horizontal distances which would be needed to reach the neighbouring lands supply well, the infiltration travel time to the neighbouring supply well is calculated as 160 years, which is considered substantially low risk to the supply well, and the remaining drilled wells within a 750 m radius of the site.

Based on this assumption, the impacts to the supply aquifer/water supply of the neighbouring lands are considered negligible.

9 SUMMARY AND CONCLUSIONS

Based on the results of this investigation the following summary and conclusions are provided.

- The Site set within a low-density commercial and light industrial area of Ottawa, Ontario, southeast of the City's urban extents. The Site is legally described as Part of block 3 Plan 50M136 Part 3 ON Plan 50R6694; Subject to an Easement in Gross Over Part 9 ON Plan 4R-27830 As in OC1627867; City of Ottawa.
- The Site is generally undeveloped with exception to a granular base applied across the majority of the surface of the Site and is used as a storage yard for the adjacent YSB Hoisting Equipment & YSB Carpentry facility.
- The Site is a rectangular shape, with a total area of approximately 3,000 m² or 0.75 acre. The topography of the Site and vicinity are generally flat with a slight slope to the southern and western perimeters with elevations across the Site.
- Historically, the Site was used agricultural lands, since at least the mid-1960's (1965). Thereafter, the Site remained undeveloped and densely wooded until approximately 2017, when the vegetation was cleared. Neighbouring lands include commercial and light industrial developments since at least the early 1990's.
- The Hydrogeological Assessment & Terrain Analysis was completed in support of the proposed Site development which is anticipated to include one (1) approximately 592 m² warehouse, in addition to corresponding gravel parking and circulation area and related components. The proposed development will be serviced by a private water supply well and sewage disposal system.
- Using the available features of the interactive mapping tool, *The Atlas of Canada – Toporama*, it appears that the local groundwater flow direction varies on either side of the neighbouring Boundary Road. West of Boundary Road is inferred to flow in a northerly to northwesterly direction towards the Bear Brook, approximately 2.2 km to the northwest of the Site. Surface water features to the east of Boundary Road, where the Site is located, are shown to flow easterly towards the Shaws Creek, approximately 3.3 km east of the Site. Therefore, the groundwater flow direction across the Site in inferred to be towards the east.

- A ditch is present along the northern perimeter of Site. According to an Environmental Impact Statement dated June 23, 2023, and prepared by others, the ditch was described as having high water chemistry measurements related to salt, likely associated with the adjacent snow dumping facility. The Environmental Impact Statement indicated that these conditions would likely result in fish, which could enter the ditch during high seasonal water level conditions from neighbouring sources, to perish. The Environmental Impact Statement concluded that the ditch has no natural heritage values. However, it was recommended that to prevent surface runoff from the Site into the ditch, a 'raised berm' would be constructed to the north of the proposed warehouse development, which would divert runoff into the Sites strategic stormwater management system.
- Surficial soil deposit mapping indicates that the surficial geology is Offshore Marine Deposits: clay, silty clay, and silt, commonly calcareous and fossiliferous; locally overlain by thin sand. Bedrock mapping indicates that the bedrock is described as the Carlsbad Formation: grey shale, sandy shale, and some dolomitic layers.
- The Site is not considered Hydrogeologically Sensitive in regard to shallow soils (less than 2.0 m of overburden) or bedrock outcrops, high permeable soils, or Karts potential. Although, for the purposes of this report, the ditch along the north of the Site, which is considered a watercourse by the City of Ottawa, will be assumed as a water feature. The presence of the water feature renders the Site hydraulically sensitive.
- A search was conducted of the well records from the MECP WWR department. The search by UTM coordinates covered a 750 m radius from the Site. The search returned 30 WWRs, however, several of which did not have any details available related to the construction or subsurface conditions encountered. Nine (9) of the WWR retrieved was for a test well. The records of the wells within 750 m of the Site, where details were available, revealed that the wells include both drilled and shallow overburden wells.
  - The drilled wells, seven (7) of which, were reported to extend to depths of between 28.9 and 61.0 m.
  - Only one (1) shallow overburden/dug supply well was reported, which extended to a depth of between 7.0 m.
- The water well records show that that the geological conditions within 750 m are generally similar and consist of clay to depths between 21.0 and 44.8 m followed by a thin layer of gravel, over shale or limestone bedrock. A thin layer of sand was reported in select wells over the clay, and glacial till was reported over bedrock in the supply well located approximately 640 m northwest of the Site. The water type was reported as sulphur in two (2) of the test well locations.
- On August 23, 2023, the proposed supply well for the anticipated development was constructed at the northeastern portion of the Site. The well was advanced to a depth of 48.7 m. Clay was reported to be encountered at ground surface to a depth 26.2 m followed by gravel to 28.0 m bgs. The well was extended into shale bedrock to 48.7 m bgs. Water was found at a depth 46.9 m, with a static water level measured at 2.80 m.
- Entrepreneur Holding Corporation retained LRL to complete a Phase Two Environmental Site Assessment on the Site in the context of property redevelopment. The assessment was completed to determine if recognized potential environmental concerns have negatively impacted soil and groundwater quality of the subject Site. A total of ten (10) boreholes were advanced across the Site to address the potential environmental concerns identified. The subsurface soil conditions in the area investigated on the Site generally consist of included a layer of sand and gravel fill extending from surface to 0.85

m bgs. Underlying the fill material was a layer of brown silty sand which extended from the bottom of the fill layer to 1.2 m bgs followed by silty clay to a depth of 6.0 m bgs where the boreholes were terminated. Refusal over inferred bedrock was not encountered in any of the boreholes.

- Four (4) groundwater monitoring wells were constructed on the Site as part of a Phase Two Environmental Site Assessment. Groundwater depth measurements in the monitoring wells were between 0.20 and 0.55 m below grade, which corresponded to elevations between 99.32 and 99.69 m, with respect to an arbitrary benchmark established and assigned an elevation of 100.00 m. Based on these elevations the groundwater flow direction on the Site is towards the southeast. Although, regionally, it is likely that groundwater flows east towards Shaws Creek.
- Based on the findings of the Phase Two Environmental Site Assessment, remediation work to address the elevated lead concentrations encountered in the soil be completed during the construction efforts associated with the Site development. The impacted groundwater is also anticipated to be addressed at the time of development.
- To establish the hydraulic properties of the proposed supply aquifer, an eight (8)-hr pump test was conducted on the newly constructed supply well on August 30, 2023. To account for the calculated maximum daily demand rate, the well would be required to support a pumping rate of 10.6 L/minute for a duration of eight (8) hours, and at a rate of 19.1 L/minute to meet the peak hourly flow maximum demand. The pumping rate during the demand test was set at 22 L/minute (±5%) for a duration of eight (8) hours to exceed these requirements and to be in excess of the minimum D-5-5 pumping rate.
- The initial static water level was measured as 2.61 m below top of casing (btc), and test well depth was measured as approximately 49.1 m btc. The pump was set at approximately 45 m btc at the time of the test. The drawdown after eight (8)-hr of pumping was 3.64 m. This represents only approximately 8.1% of the available drawdown in the well, assuming the set pump depth of 45 m is the maximum drawdown which can be reached. The specific capacity of the well after eight (8)-hr of pumping was calculated to be 0.101 L/sec/m with a long-term availability of 82.4 m^3 per day (82,400 L/day). This surpasses the calculated maximum daily demand, and the maximum hour demand of 1,910 L/day and 3,437 L/day, respectively.
- The recovery was commenced at the end of the eight (8)-hr pumping duration. The submersible pump remained in the well throughout this time so not to alter the recovery test process and measurements. After one (1) hour of recovery, the well returned to 90.1% of the initial water level (2.97 m btc). LRL returned after approximately 16 hours and again after 24 hours of recovery to verify the water level. The well was recorded to have reached 92.8% and 91.7% recovery, respectively. Marginally below the D-5-5 guideline requirement of 95% within 24 hours. As indicated in the D-5-5 guidelines, "*where sufficient recovery does not occur, the issue of the long- term safe yield of the aquifer is especially significant and must be addressed*." Although the well marginally missed the 95% recovery requirement, based on the proposed demand pumping rate, in comparison to the maximum available pumping rate, the well can sufficiently supply the proposed light industrial / commercial establishment proposed on the Site. The City of Ottawa's respective Design Guidelines – Water Distribution, 2010, the maximum daily demand was calculated to be 1,910 L/day m^2, which is approximately half the volume removed during the eight (8) hour pumping test, which further support the likeliness that the supply aquifer can support the proposed development.

- To represent the long-term water quality of the well, samples were collected during different stages of the pump test (after four (4) and eight (8)-hours of pumping), and shortly thereafter. The majority of the parameters analysed meet the ODWS parameters tested except for the following:
  - Alkalinity was reported to have values of 703 and 705 mg/L at 4- and 8-hour, respectively. These values are above the ODWS OG limit of 500 mg/L;
  - Hardness was found to be 1020 and 1030 mg/L at 4- and 8-hours, respectively, above the ODWS OG limit of 100 mg/L;
  - TDS values were found to be 7950 and 7880 mg/L in the 4- and 8-hour samples, respectively, above the AO of 500 mg/L
  - Turbidity was measured to have a level of 3.8 NTU in the 4-hour sample, and 3.5 NTU in the 8-hour sample;
  - DOC with a level of 9.4 and 8.5 mg/L, at the 4- and 8-hour sample, respectively, above the AO of 5 mg/L but below the maximum concentration considered reasonably treatable provided in MECP D-5-5 of 10 mg/L;
  - Colour with a level of 8 TCU in both samples collected, above the AO of 5 TCU and the maximum concentration considered reasonably treatable provided in MECP D-5-5 of 7 TCU;.
  - Chloride concentrations exceeded the ODWS AO of 250 mg/L with a value of 4560 mg/L after 4-hours of pumping, and 4460 mg/L after 8-hours of pumping. Chloride levels also exceeded the D-5-5 level of 250 mg/L;
  - Barium concentrations exceeded the ODWS of 1 mg/L with values of 4.17 and 4.22 mg/L and the Guidelines for Canadian Drinking Water Quality of 2.0 mg/L;
  - Sodium with a level of 2670 mg/L at 4-hours, and 2,620 mg/L at 8-hours, which is above the AO and MCCRT provided in MECP D-5-5 of 200 mg/L.
  - Iron was reported in both the 4-hour and the 8-hour sample with a value equivalent to the ODWS of 0.3 mg/L, and less than the MCCRT of 5 mg/L.
  - Sulphide concentrations exceeded the ODWS AO of 0.05 mg/L, with values of 0.23 mg/L in both the 4-hour and 8-hour samples collected.
- Our findings through an initial water quality evaluation of the neighbouring well revealed that the concentrations of alkalinity, hardness, TDS, chloride and sodium, through the use of water treatment units, can be reduced to levels which would be considered better suited for a proposed development, much like that anticipated at the Site, water distribution system. The water is not be considered suitable for consumption (non-potable), but can be treated to levels suitable for non-potable plumbing fixtures (i.e. water closet) or general building housekeeping.
- A water treatment specialist has been consulted. Their recommendations for the system at the proposed development on the Site are as follows:
  - Antiscale Injection – to include a 35 gallon chemical solution tank and mixing tank, to be filled with anti scale concentrate. Unit cost of $840.00, with one (1) annual supply of concentrate;
  - ETF Series 12” Chemical-Free Air Aspirated Sulfur/Iron Filter to aid in the removal of various parameters including Iron; DOC; Colour and Sulphide. This unit has a

unit rate of $3,699.00;

- RSL High Pressure Reverse Osmosis System, with a higher pressure (225 psi) for feed water and stainless steel piping. This unit has a cost of $13,893.00;
- A Nelson Water Neutralizing Filter to raise the pH at a unit rate of $695.00; and
- An Ultraviolet Water Disinfection System at a unit rate of $1,049.99.

The overall anticipated cost for the proposed water distribution system, and treatment components is approximately $31,199.01.

- Total dissolved solids and chloride concentrations are in excess of the defined limit for mineralized water as set out in O. Reg. 903 Wells Regulation, which specifies a concentration limit of 6000 mg/L for total dissolved solids and 500 mg/L for chloride. When mineralized water is encountered, the well owner shall immediately abandon the well or will require ministry approval. A formal request for consent to maintain the well constructed on the Site for future demand supply use was made to the Ontario Ministry of the Environment, Conservation and Parks Director on December 20, 2023. Additional clarification, and supporting information was requested by the Director thereafter. On August 13, 2024, the Ministry issued a formal Consent Not to Abandon Water Supply Well (A379014), Located at 363 Entrepreneur Crecent, Ottawa, Ontario. The conditions to maintain the supply well are included in this consent notice, which must be followed as part of this site development. The conditions are included in the Recommendations, Section 10, of this report.
- According to the design submitted by others, the overall septic system would require an area of 68.04 m² for the dispersion bed, along with an additional approximate 30 m² for the pump station, tank, dosing chamber and secondary pump station. This equates to a total surface area of 98.04 m². Assuming a replacement area of 70 m², an area of approximately 168 m² would be required for the placement of the sewage disposal system. The proposed grassed area assigned for the septic system at the southwestern extent of the Site has a surface area of 175 m², which is considered suitable for the placement of the septic. This location is more than 15 m from the location of the proposed supply well on the Site, and the existing supply wells on neighbouring lands.
- The geological and hydrogeological conditions of the Site, and the lands within 500 m of the Site support the use of ***System Isolation Considerations*** method with respect to nitrate groundwater impacts.
- The **System Isolation Considerations** demonstrates that the slow travel time would allow for the dilution and natural attenuation of the nitrates prior to reaching the confined gravel/bedrock aquifer below. The vertical travel time was calculated to be approximately 50 years from the septic system to the gravel/bedrock aquifer, which is considered suitable time for the dilution and natural attenuation of the nitrates. Additional consideration to identified supply wells within the area of the Site. The findings included the following:
  - One (1) shallow overburden / dug supply well has been identified within a 500 m radius of the site, more specifically, approximately 370 m southwest of the subject site at 100 Entrepreneur Cresent. Assuming a clay thickness of 6.8 m and a variance in the water level of 0.0 m, it was established that the effluent would travel at a rate of approximately 0.30 m / year, and would take over 110 years to reach the shallow supply well. Although, in actuality, it is unlikely that the effluent would migrate southwest towards the shallow well, due to the shallow wells up- to trans

gradient of the proposed sewage disposal system.

- The nearest well to the Site is located on the adjacent land to the west, approximately 50 m up- to trans-gradient of the proposed sewage disposal system. Considering the vertical and the horizontal distances which would be needed to reach the neighbouring lands supply well, the infiltration travel time to the neighbouring supply well is calculated as 160 years, which is considered substantially low risk to the supply well, and the remaining drilled wells within a 750 m radius of the site.
- Based on this assumption, the impacts to the supply aquifer/water supply of the neighbouring lands are considered negligible.

10 RECOMMENDATIONS

Based on the results of this investigation the following recommendations are provided:

1. It is recommended that the recently constructed test well - Proposed Supply Well at the Site be utilized as a water supply for the proposed development features of the Site. The well is found to generally have acceptable groundwater supply for the proposed Site activities and with conventional treatment applied. Furthermore, the well will be able to meet the daily supply demands, as determined through the eight (8)-hour pumping test initiated.
2. The casing of the well must maintain or be extended to 400 mm above final grade after construction.
3. No new potential contamination sources to the proposed supply well shall be introduced within 15 m of the structure.
4. Additional consideration with respect to maintaining the condition of the supply well, and the corresponding supply aquifer include the following:
    a. Snow should not be piled in the area of the well so as not to potentially damage the supply well; and
    b. The Site, post- development, should be graded such that surface run-off and drainage be diverted away from the supply well.
5. The water quality of the proposed supply well is found to be in general accordance with the ODWS. The following exceptions were encountered:

- Alkalinity was reported to have values of 703 and 705 mg/L at 4- and 8-hour, respectively. These values are above the ODWS OG limit of 500 mg/L. A reverse osmosis system is recommended to reduce the levels of alkalinity for the water distribution system;
- Hardness was found to be 1020 and 1030 mg/L at 4- and 8-hours, respectively, above the ODWS OG limit of 100 mg/L. High levels of hardness can lead to scale deposits and excessive utilization of regular soaps. Hardness can be reduced through the use of a reverse osmosis system;
- TDS values were found to be 7950 and 7880 mg/L in the 4- and 8-hour samples, respectively, above the AO of 500 mg/L. TDS can be reduced through the use of a reverse osmosis system;
- Turbidity was measured to have a levels are above the ODWS OG of 1 NTU if the treatment system is required to provide filtration, however, are below the AO of 5 NTU and the MCCRT of 5 NTU. If the water is to be disinfected using an ultra-violet filter, it is recommended that the water be pre-treated with a 5 um filter;
- DOC concentrations in the supply aquifer were elevated, which can cause taste, odour, and colour. DOC can be reduced through the use of an air aspirated filter;
- Colour with a level of 8 TCU in both samples collected, above the AO of 5 TCU and maximum concentration considered reasonably treatable provided in MECP D-5-5 of 7 TCU. The colour can be attributed to the levels of organic materials (tannin and lignin) encountered, which imparts a yellow/brown tinge to the water. The color can be reduced by use of an air aspirated filter;

- Chloride concentrations exceeded the ODWS AO of 250 mg/L with a value of 4560 mg/L after 4-hours of pumping, and 4460 mg/L after 8-hours of pumping. Chloride levels also exceeded the D-5-5 MCCRT level of 250 mg/L. Chloride is found in nature in various forms such as in sodium (NaCl), potassium (KCl) and calcium ($CaCl^2$) salts. A reverse osmosis treatment system can be used to lower level of chloride in the supply distribution system;
- Barium concentrations exceeded the ODWS of 1 mg/L with values of 4.17 and 4.22 mg/L. Barium is a naturally occurring element that is found in various minerals. Barium in drinking water is often related to dissolved compounds which migrate through rocks and soil deposits and enter into the supply aquifer. Barium can be treated through the use of a reverse osmosis system;
- Sodium with a level of 2670 mg/L at 4-hours, and 2,620 mg/L at 8-hours, which is above the AO and the maximum concentration considered reasonably treatable provided in MECP D-5-5 of 200 mg/L. It is also above the 20 mg/L warning level notification limit for those on a sodium restricted diet. The local Medical Officer of Health should be notified of these levels so that this information may be communicated to local physicians with regards to homeowners who follow a sodium-restricted diet. The levels of sodium can be reduced through reverse osmosis system;
- Iron was reported in both the 4-hour and the 8-hour sample with a value equivalent to the ODWS of 0.3 mg/L. Although the concentrations do not exceed the ODWS, it is advisable that treatment be in place to address the potential risk for long-term increases in this parameter. The MCCRT is 5 mg/L, therefore, the values returned are considered within the concentrations considered reasonable treatable. An air aspirated filtration system can be used to reduce the levels of iron in the water distribution system; and
- Sulphide concentrations exceeded the ODWS AO of 0.05 mg/L, with values of 0.23 mg/L in both the 4-hour and 8-hour samples collected. Elevated sulphide can result in an un-pleasant odour in the water supply and taste. As mentioned throughout, the intended use of the water supply is not for consumption, therefore aesthetically displeasing attributes of the water supply are not a concern for the proposed development. An air aspirated filtration system can be used to reduce the levels of sulphide in the water distribution system.

6. A water treatment specialist was consulted to address the quality of the water and confirm the best suited treatment units which could be implemented to address the quality concerns. The water distribution system will not be consumption; therefore, the intent of the treatment is not to reduce levels to those considered suitable for human consumption, but rather to preserve the integrity of the pluming fixtures and distribution system. A copy of the correspondence with the treatment specialists in included in **Attachment M**. The proposed system, and anticipated costs, are as follows:
    - Antiscale Injection – to include a 35 gallon chemical solution tank and mixing tank, to be filled with anti scale concentrate. Unit cost of $840.00, with one (1) annual supply of concentrate;
    - ETF Series 12” Chemical-Free Air Aspirated Sulfur/Iron Filter to aid in the removal of various parameters including Iron; DOC; Colour and Sulphide. This unit has a unit rate of $3,699.00;
    - RSL High Pressure Reverse Osmosis System, with a higher pressure (225 psi)

for feed water and stainless steel piping. This unit has a cost of $13,893.00;

- A Nelson Water Neutralizing Filter to raise the pH at a unit rate of $695.00; and
- An Ultraviolet Water Disinfection System at a unit rate of $1,049.99.

The overall proposed water treatment system, as proposed by the water treatment specialist, is anticipated to cost approximately $31,119.01, with the inclusion of installation, although electrical connections are excluded. As the property will be used for commercial/light industrial purposes, it is considered feasible for such a system series to be supplied and maintained on a regular basis. The treatment specialist has included further details with respect to the proposed components of the water distribution system, and detailed specifications of the units proposed. It is strongly advised that Attachment M be consulted for further details and description of the proposed water distribution system treatment units.

7. Water Treatment options should be considered on an individual basis. Any water treatment system should be maintained on a regular basis in accordance with the manufacturer's recommendations to ensure that it is properly functioning and a suitable water distribution supply for non-potable purposes (i.e. water closets).
8. The owner should maintain their well as outlined in the Ontario Ministry of Agricultural and Rural Affairs Best Management Series – Water Wells.
9. Total dissolved solids and chloride concentrations, as mentioned above, are in excess of the defined limit for mineralized water as set out in O. Reg. 903 Wells Regulation. When mineralized water is encountered, the well owner shall immediately abandon the well or will require ministry approval. A formal request for consent to maintain the well was received on August 13, 2024, by the MECP. The conditions specified by the MECP must be followed to maintain the proposed supply well on the Site. The conditions included:
   - Ensure that the well is property vented to the outside atmosphere in a manner that will safely disperse all gases, as per section 15.1 of Regulation 903;
   - The service of a water treatment specialist shall be retained and shall install, operate and maintain a water treatment system in the distribution system, in accordance with recommendations of the water treatment specialist, to address the total dissolved solids and chloride present in the well water prior to the water being used in the building;
   - The water treatment system shall be properly maintained and operational at all times in accordance with the recommendations of the water treatment specialist;
   - All faucets within the building shall be labelled to indicate that the water is not intended for human consumption;
   - The well water shall not be used as a drinking water source under any circumstances by any person and bottled water shall be supplied for consumption by employees;
   - Due to elevated chloride, steps shall be taken to mitigate the impact of corrosion on plumbing including: use of approved PEX pipe and fittings, installations of stainless steel fixtures; and not installing water treatment systems that may increase corrosivity of the water;
   - The well identified by well record number A379014 shall be maintained as per Ontario Regulation 903 until such time as the water supply is no longer required. At

that point, the water supply well shall be decommissioned in accordance with Ontario Regulation 903;

- Once the water treatment system becomes operations, the Owner shall immediately notify, in writing, the Ontario Ministry of the Environment, Conservation and Parks Director appointed for the purpose of subsection 21 (10) of the Well Regulation of the date when the water treatment system is operations. The Director can be contacted through email correspondence to wellshelpdesk@ontario.ca;
- Failure to comply with the above noted conditions will result in the automatic revocation of the consent without notice;
- The included consent notice must be reviewed by the Owner and should the property change ownership, the conditions must be presented to the new parties and Owners.

10. A notice of title shall be registered to notify future purchasers of the health-related exceedances and mineralized water supply and the resulting requirements.
11. The requirements of Ontario Regulation 332/12: Building Code for non-potable water supplies include the requirements listed in Division B, section 7.7.2, which mentions:
    a. Section 7.7.2.1 (1) Non-potable water piping shall be identified by markings that are permanent, distinct and easily recognized;
    b. 7.7.2.1 (2) Non-potable water system for re-use purposes shall be marked in accordance with Section 12 of CAN/CSA-B128.1, “Design and Installation of Non-Potable Water Systems”.
    c. 7.7.2.1 (3) A sign containing the words Non-Potable Water, Do Not Drink shall be in letters at least 25 mm high with a 5 mm stroke and posted immediately above a fixture that is permitted to receive non-potable water.

    These requirements must be reflected for future use of the Site (i.e. development).
12. The subsurface conditions indicated for the Site are considered suitable for a Class IV septic sewage disposal system with a partially to fully raised leaching bed depending on the specific soil and groundwater conditions at the actual leaching bed locations. Sewage system designs shall be based on specific investigations to evaluate the suitability of local conditions on each lot. The system should be designed using the percolation time of the native and imported sand and according to the Ontario Building Code (OBC). The leaching beds should be constructed to conform to the specifications set out in the OBC. The septic systems shall be constructed above the groundwater table over the native soil once all organic soils have been stripped from is footprint.
13. Prior to installation of the septic disposal system, an updated application must be filed and approved by the Ontario Septic System Office (OSSO).
14. The septic system should be placed at least 15 m from any drilled supply wells, 30 m from any shallow/dug wells, and at least 3 m from the property boundary limits.
15. It is recommended that the water table be surveyed prior to installation of the sewage disposal systems.

11 LIMITATIONS

The findings contained in this report are based on data and information collected during the Hydrogeological Assessment & Terrain Analysis of the subject property conducted by LRL Engineering. The conclusions and recommendations are based solely on-Site conditions encountered at the time of our fieldwork between April 17 and August 31, 2023, November 24, 2023, and November 22, 2024 supplemented by historical information and data obtained as described in this report. The information presented in this report represents the groundwater conditions at the locations sampled. Due to natural variations in geological conditions, no inference is made to the soil or groundwater conditions between sampling points. No assurance is made regarding changes in conditions subsequent to the time of this investigation. If additional information is discovered or obtained, LRL Engineering should be requested to re-evaluate the conclusions presented in this report and to provide amendments as required.

In evaluating the subject property, LRL Engineering has relied in good faith on information provided by individuals as noted in this report. We assume that the information provided is factual and accurate. We accept no responsibility for any deficiencies, misstatements or inaccuracies contained in this report as a result of omissions, misinterpretation or fraudulent acts of the persons contacted.

Yours truly,

LRL Engineering

LICENSED PROFESSIONAL ENGINEER
Mar. 6, 2025
K. MOHAMMADI
100172155
PROVINCE OF ONTARIO

Jessica Arthurs
Environmental Engineering Manager

K. Mohamadi

Kourosh Mohammadi, Ph. D., P. Eng.
Senior Hydrogeological Engineer

W:\FILES 2022\220487\04 Environmental\04 Hydrogeology\05 Reports\2024.08.01 City Comments\2024.08.06.LRL220487.Report.HydrogeologicalAssessment.363EntreneurCresOttawa.R1.docx

FIGURES

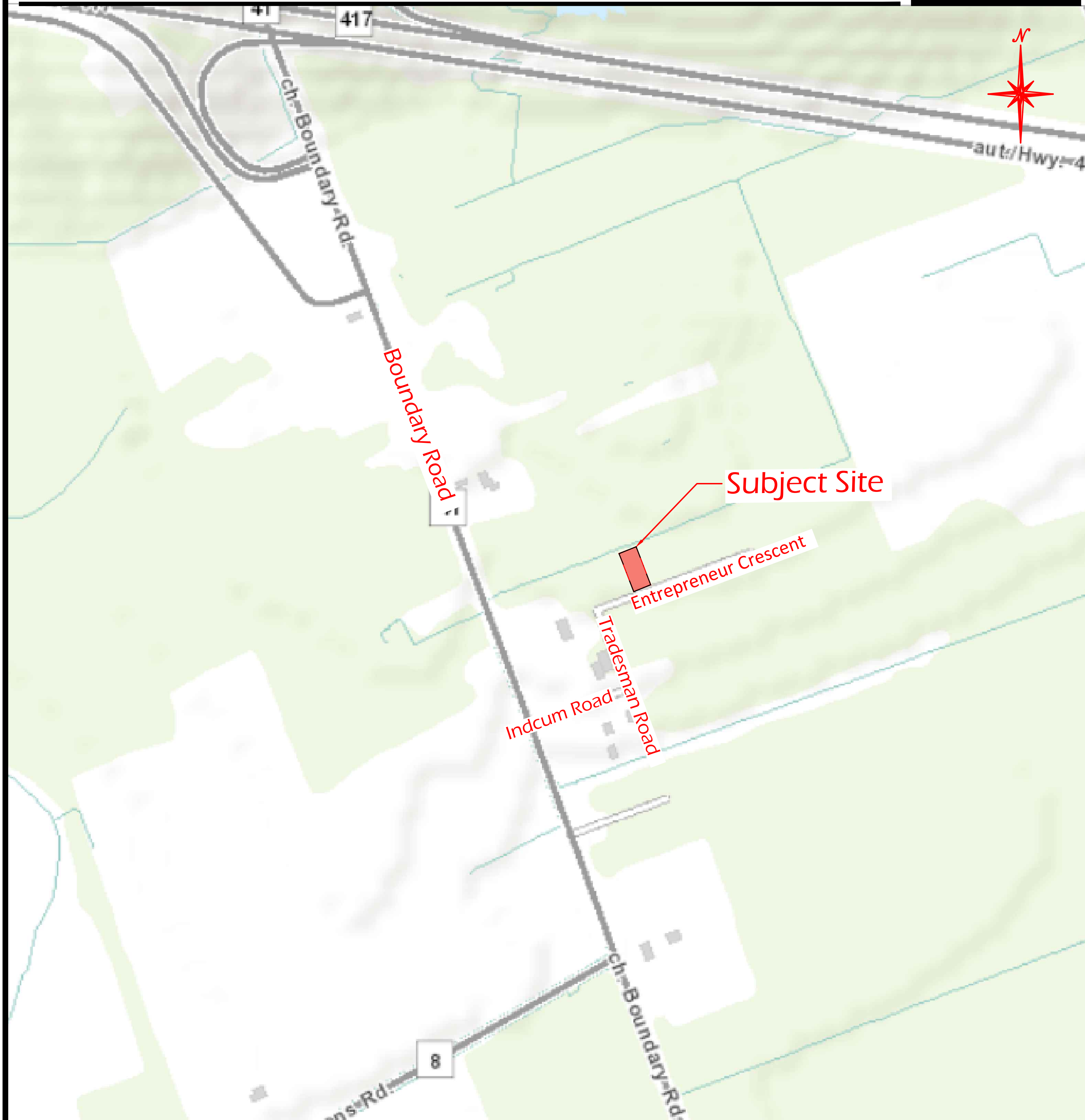
ENGINEERING | INGÉNIERIE

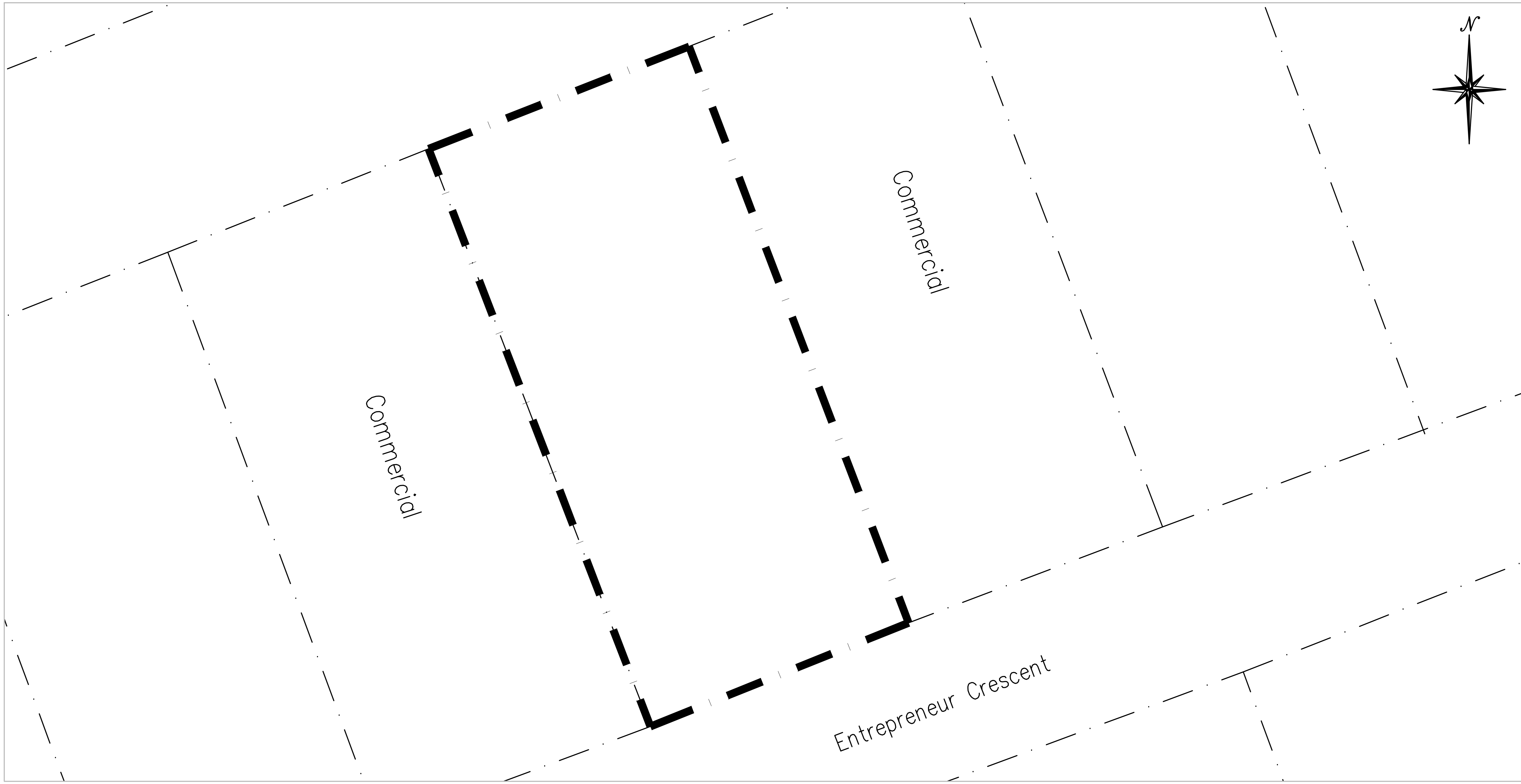
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

PROJECT
HYDROGEOLOGICAL ASSESSMENT & TERRAIN ANALYSIS
PROPOSED WAREHOUSE DEVELOPMENT
363 ENTREPRENEUR CRESCENT
OTTAWA, ONTARIO

DRAWING TITLE
SITE LOCATION
(NOT TO SCALE)
SOURCE: GEOOTTAWA

CLIENT	DATE	PROJECT	
ENTREPRENEUR HOLDING CORPORATION	AUGUST 2024	220487	FIGURE1





LEGEND

- Property Line – Subject Site (363 Entrepreneur Crescent)
- Neighbouring Property Boundaries

15m 0 30 60m

SCALE: 1:1250

No.	REVISIONS	BY	DATE
01	ISSUED FOR REVIEW	C.C.	12/09/2023

LRL

ENGINEERING I INGÉNIERIE

5430 Canotek Road I Ottawa, ON, K1J 9G2
www.lrl.ca I (613) 842-3434

CLIENT
ENTREPRENEUR HOLDING CORPORATION

DESIGNED BY: C.C.
DRAWN BY: C.C.
APPROVED BY: J.A.

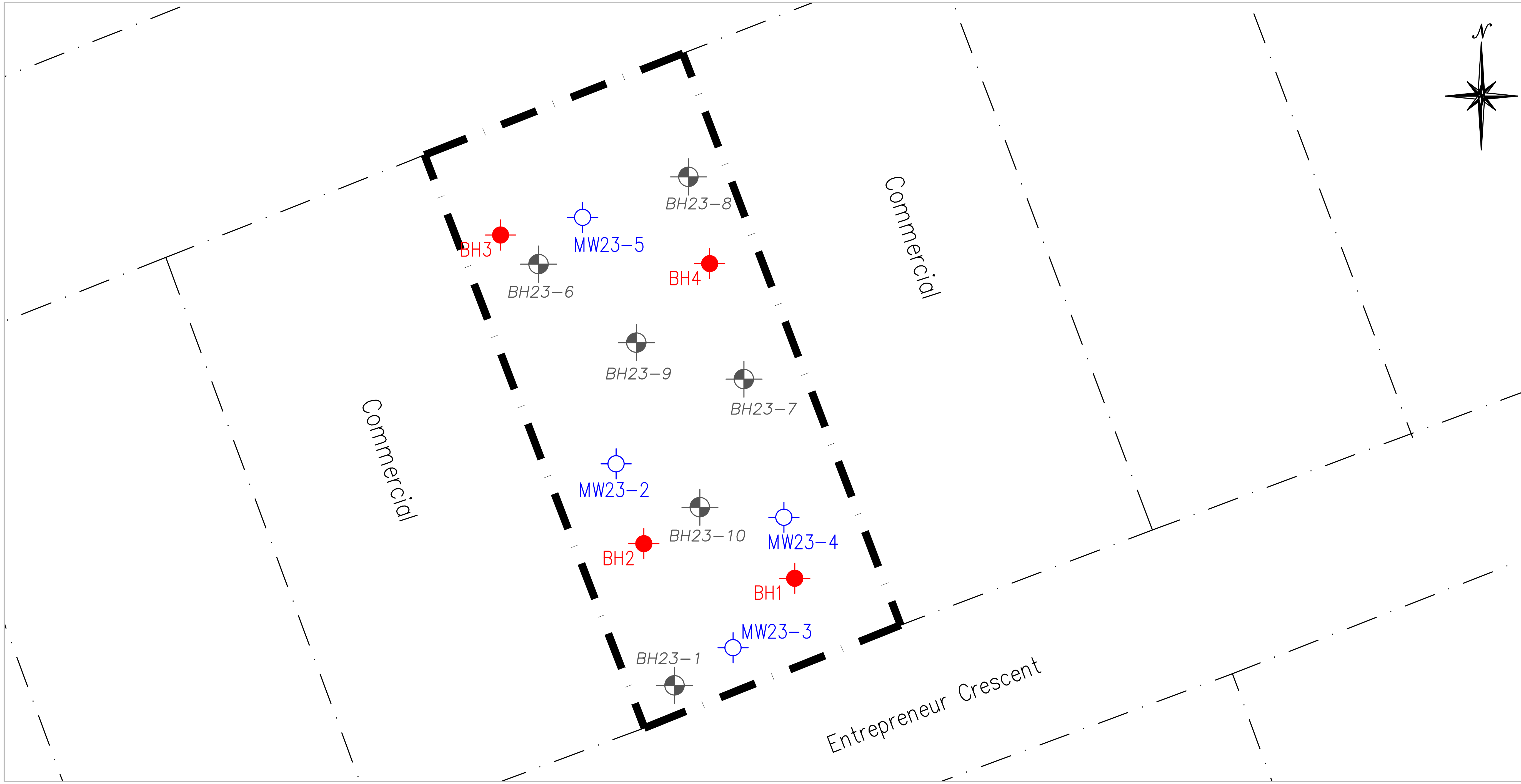
PROJECT
HYDROGEOLOGICAL ASSESSMENT & TERRAIN ANALYSIS
PROPOSED WAREHOUSE DEVELOPMENT
363 ENTREPRENEUR CRESCENT
OTTAWA, ONTARIO

DRAWING TITLE
SITE PLAN

PROJECT NO.
220487

DATE
AUGUST 2024

FIGURE2



LEGEND

— — —	Property Line – Subject Site (363 Entrepreneur Crescent)
— · — · —	Neighbouring Property Boundaries
BH-X	Borehole (Phase Two ESA)
MW23-X	Monitoring Well (Phase Two ESA)
BHX	Borehole (Geotechnical Investigation)

15m 0 30 60m

SCALE: 1:1250

No.	REVISIONS	BY	DATE
01	ISSUED FOR REVIEW	C.C.	12/09/2023

LRL
ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

CLIENT
ENTREPRENEUR HOLDING CORPORATION

DESIGNED BY:	DRAWN BY:	APPROVED BY:
C.C.	C.C.	J.A.

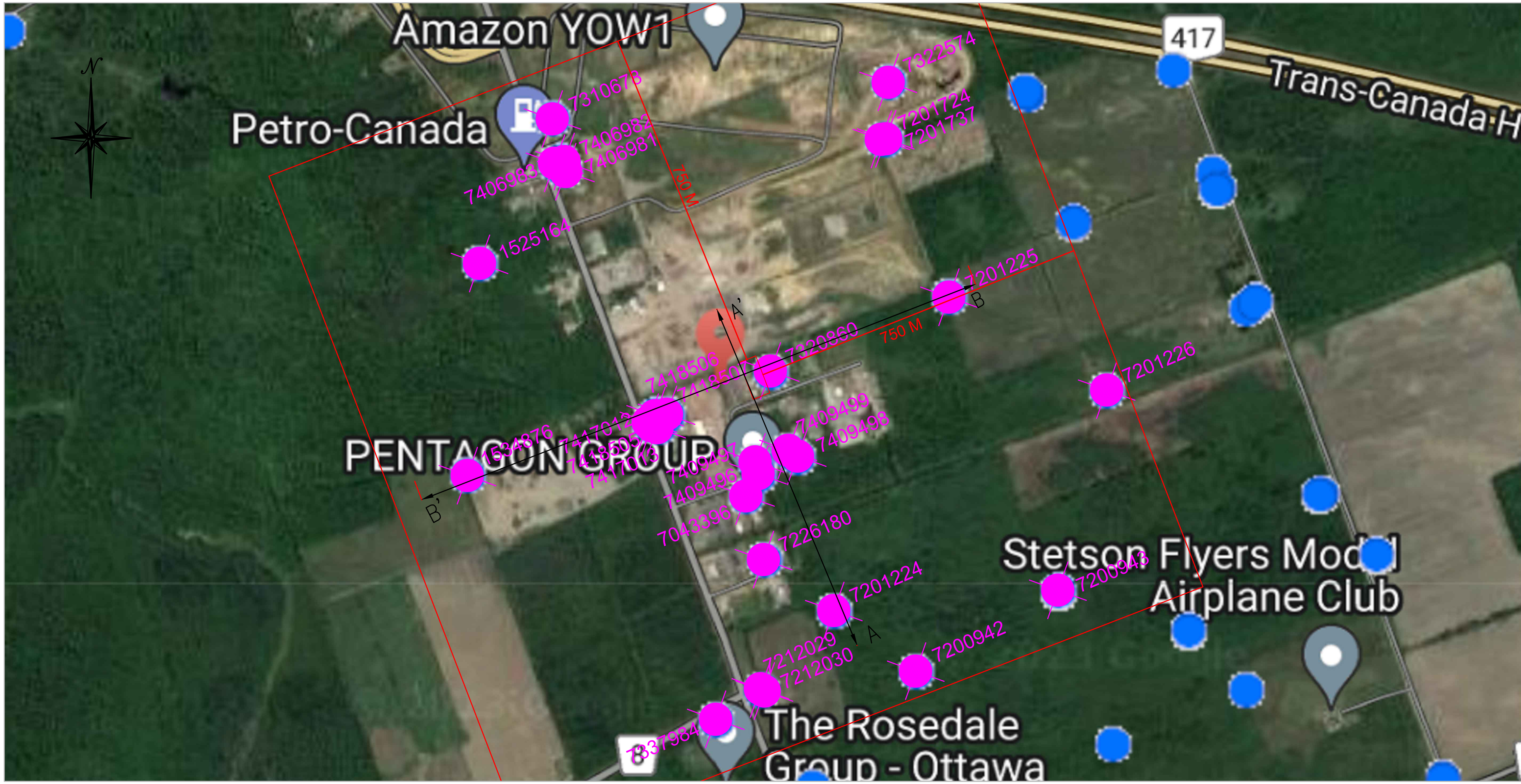
PROJECT
HYDROGEOLOGICAL ASSESSMENT & TERRAIN ANALYSIS
PROPOSED WAREHOUSE DEVELOPMENT
363 ENTREPRENEUR CRESCENT
OTTAWA, ONTARIO

DRAWING TITLE
PREVIOUS INVESTIGATION - BOREHOLE AND MONITORING WELL LOCATIONS

PROJECT NO.
220487

DATE
AUGUST 2024

FIGURE3



Legend

- Property Line – Subject Site (363 Entrepreneur Crescent)
- xxxx Wells within 500 m of the Site
- BH-X Borehole
- MW23-X Monitoring Well

15m 0 30 60m

SCALE: 1:1250

No.	REVISIONS	BY	DATE
01	ISSUED FOR REVIEW	C.C.	12/09/2023

LRL
ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

CLIENT
ENTREPRENEUR HOLDING CORPORATION

DESIGNED BY:	DRAWN BY:	APPROVED BY:
C.C.	C.C.	J.A.

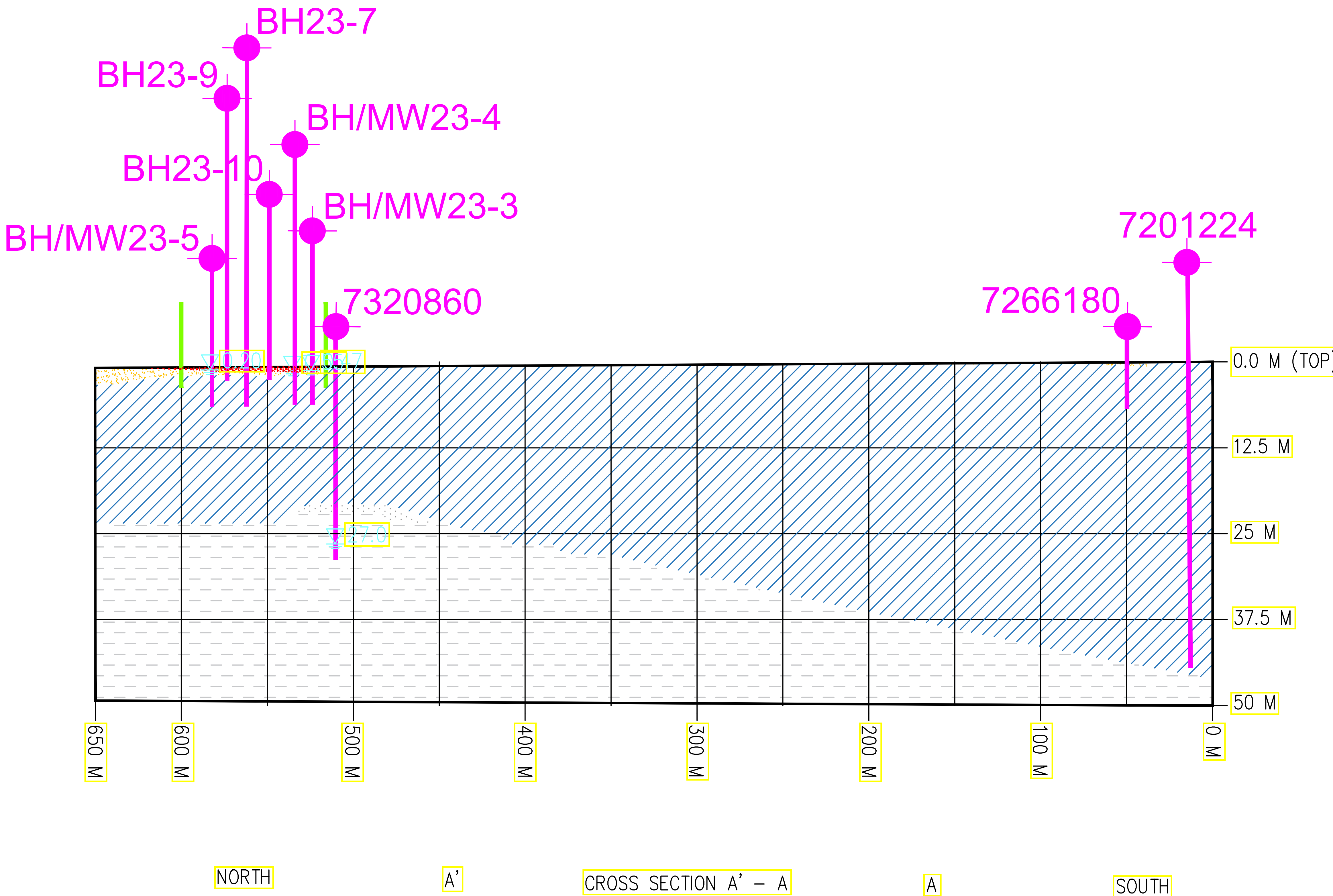
PROJECT
HYDROGEOLOGICAL ASSESSMENT & TERRAIN ANALYSIS
PROPOSED WAREHOUSE DEVELOPMENT
363 ENTREPRENEUR CRESCENT
OTTAWA, ONTARIO

DRAWING TITLE
WELLS WITHIN 750 m OF THE SITE (SOURCE & BASE LAYER: MECP WELL RECORD DATABASE)

PROJECT NO.
220487

DATE
AUGUST 2024

FIGURE4



LEGEND

Supply Well

Subject Site Property Extents

Groundwater Found

Sand (Sand, Gravel, Boulders)

Clay

Gravel

Bedrock

Fill

15m 0 30 60m

SCALE: 1:1250

No.	REVISIONS	BY	DATE
01	ISSUED FOR REVIEW	C.C.	05/09/2023

LRL

ENGINEERING | INGÉNIERIE

5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

CLIENT
ENTREPRENEUR HOLDING CORPORATION

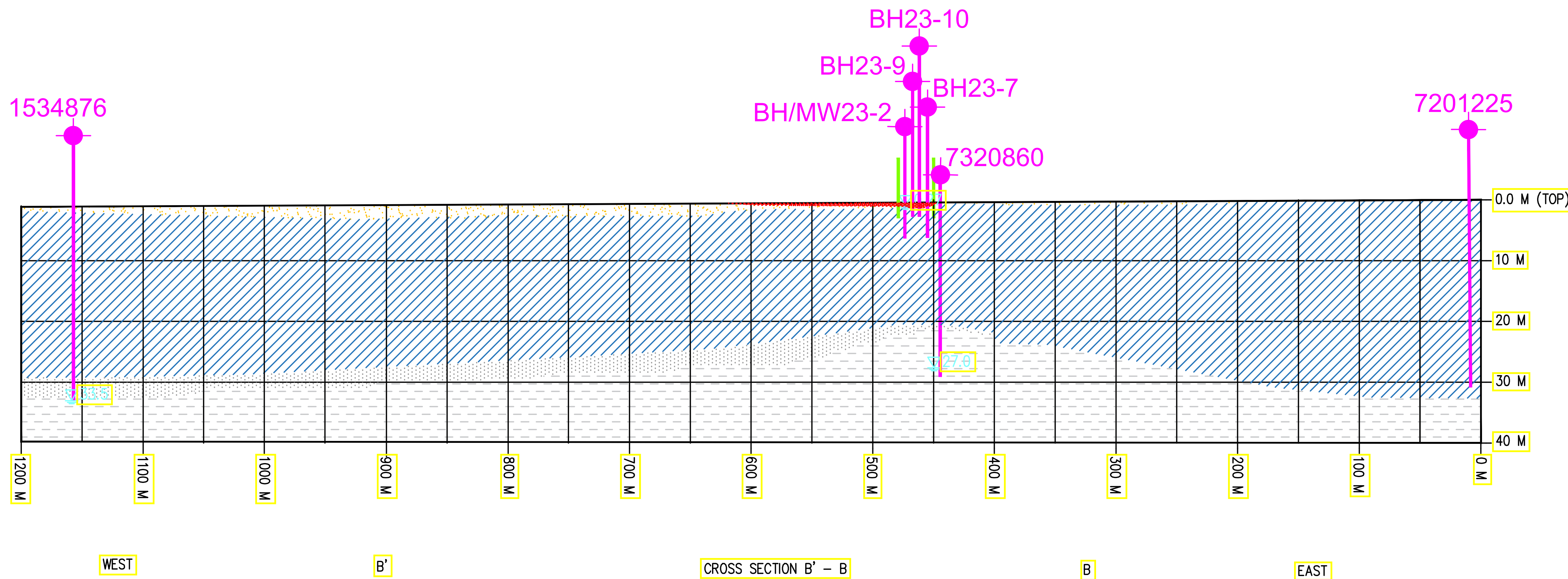
DESIGNED BY:	DRAWN BY:	APPROVED BY:
C.C.	C.C.	J.A.

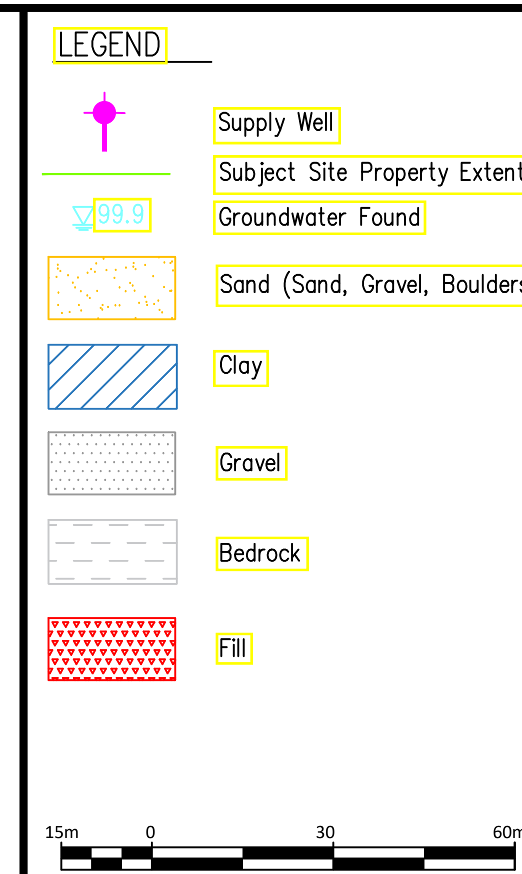
PROJECT
HYDROGEOLOGICAL ASSESSMENT & TERRAIN ANALYSIS
PROPOSED COMMERCIAL DEVELOPMENT
363 ENTREPRENEUR CRESCENT
OTTAWA, ONTARIO

DRAWING TITLE

CROSS SECTION A' - A

FIGURE5A





SCALE: 1:1250

No.	REVISIONS	BY	DATE
01	ISSUED FOR REVIEW	C.C.	05/09/2023

LRL
ENGINEERING I INGÉNIERIE
5430 Canotek Road I Ottawa, ON, K1J 9G2
www.lrl.ca I (613) 842-3434

CLIENT
ENTREPRENEUR HOLDING CORPORATION

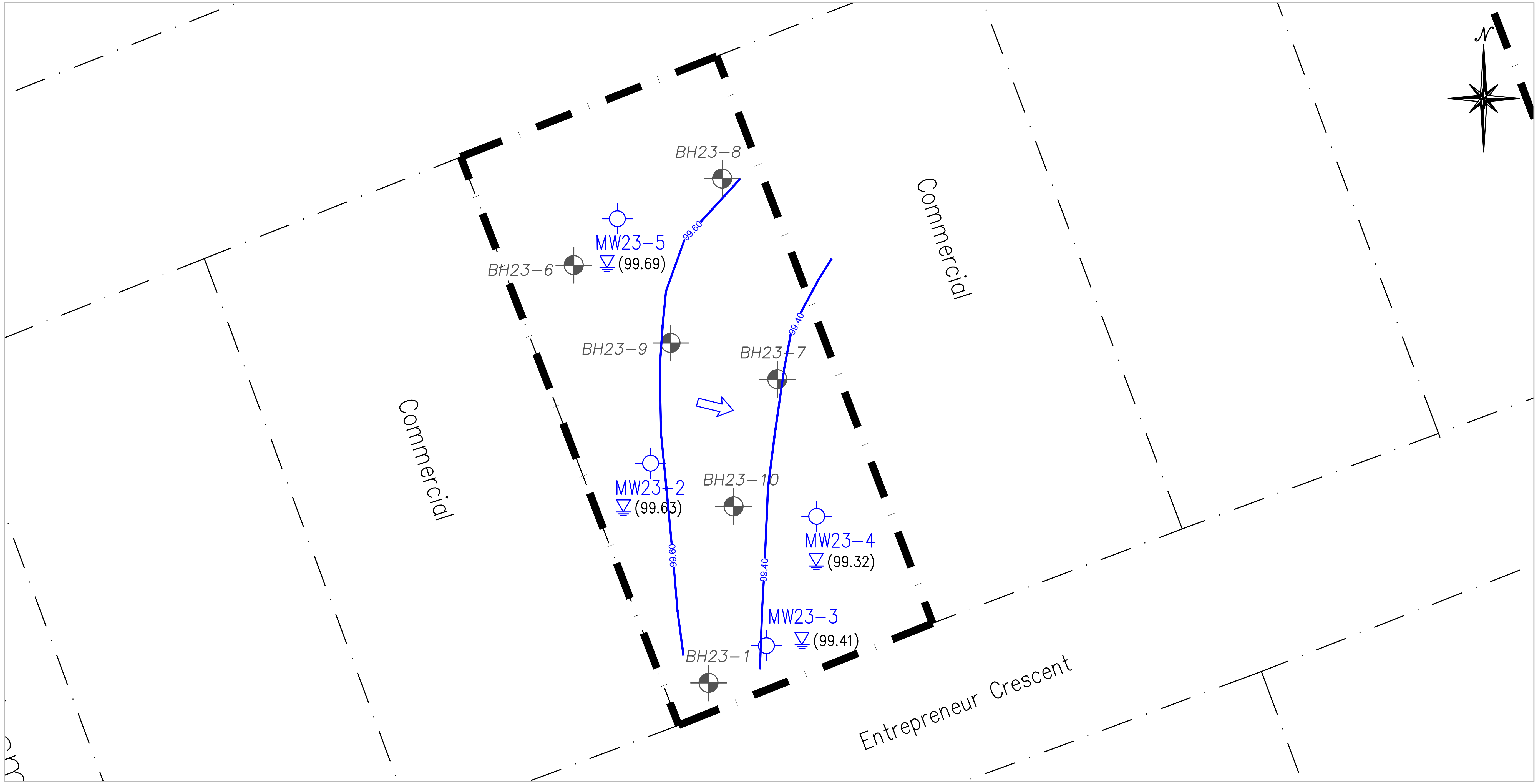
DESIGNED BY:	DRAWN BY:	APPROVED BY:
C.C.	C.C.	J.A.

PROJECT
HYDROGEOLOGICAL ASSESSMENT & TERRAIN ANALYSIS
PROPOSED COMMERCIAL DEVELOPMENT
363 ENTREPRENEUR CRESCENT
OTTAWA, ONTARIO

DRAWING TITLE

CROSS SECTION B' - B

FIGURE5B



LEGEND

- Property Line – Subject Site (363 Entrepreneur Crescent)
- Neighbouring Property Boundaries
- BH-X Borehole
- MW23-X Monitoring Well
- Inferred Groundwater Flow Direction
- 99.99 Groundwater Elevation
- Groundwater Elevation Contour

15m 0 30 60m

SCALE: 1:1250

No.	REVISIONS	BY	DATE
01	ISSUED FOR REVIEW	C.C.	12/09/2023

LRL
ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

CLIENT
ENTREPRENEUR HOLDING CORPORATION

DESIGNED BY:	DRAWN BY:	APPROVED BY:
C.C.	C.C.	J.A.

PROJECT
HYDROGEOLOGICAL ASSESSMENT & TERRAIN ANALYSIS
PROPOSED WAREHOUSE DEVELOPMENT
363 ENTREPRENEUR CRESCENT
OTTAWA, ONTARIO

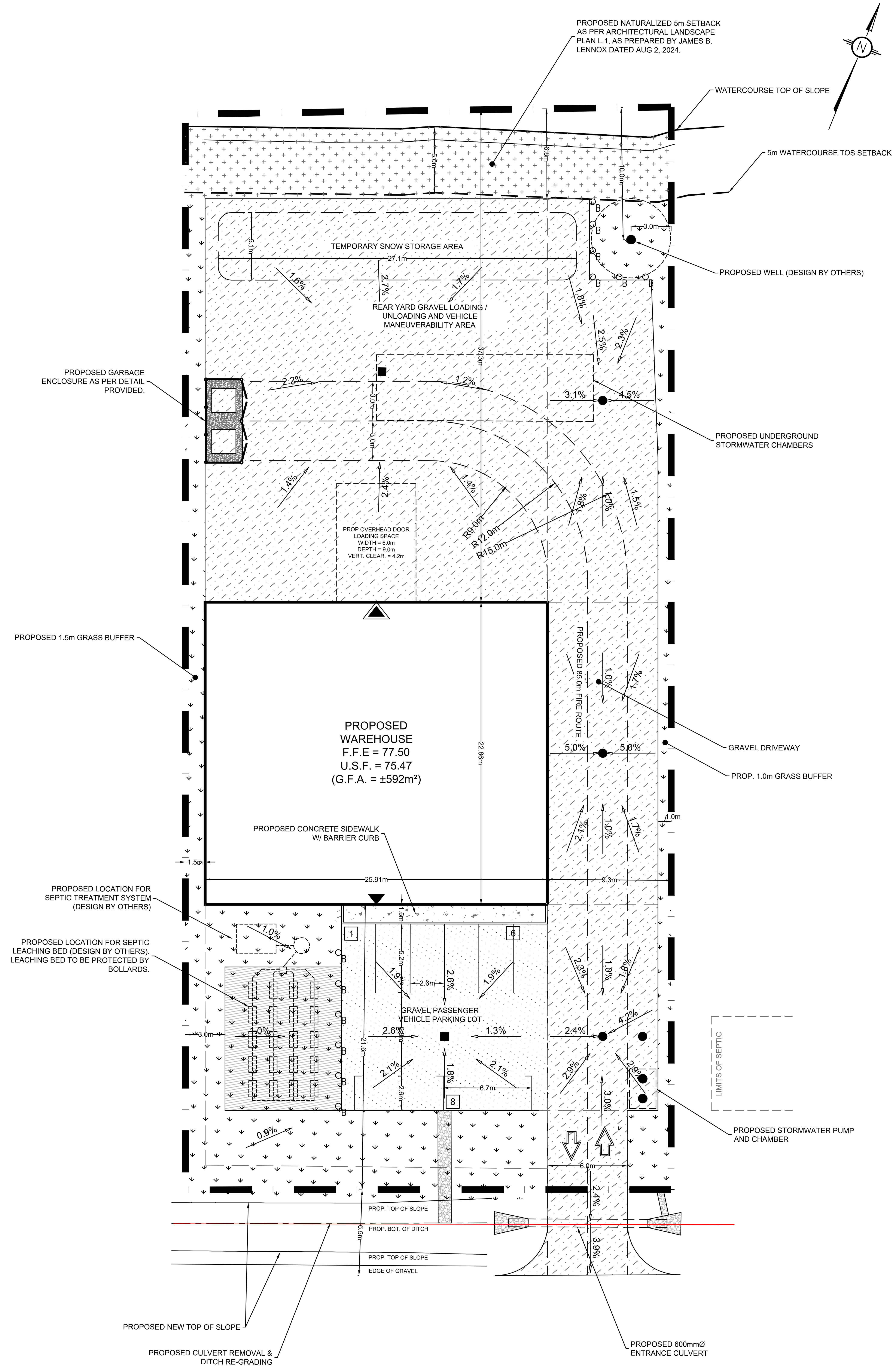
DRAWING TITLE
GROUNDWATER ELEVATIONS AND CONTOURS (MARCH 16, 2023)

PROJECT NO.
220487

DATE
AUGUST 2024

FIGURE 6

KEY PLAN
N.T.S.



LEGEND:

- EXISTING PROPERTY LINE TO REMAIN
- PROPOSED CURB
- PROPOSED DEPRESSED CURB
- PROPOSED TERRACING (3:1 MIN.)
- PROPOSED SILT FENCE AS PER OPSD 219.110
- PROPOSED FENCE
- PROPOSED MAN DOOR ENTRANCE/EXIT
- PROPOSED OVERHEAD DOOR
- PROPOSED GRASS AREA (100mm TOP SOIL & SOD)
- PROPOSED NATURALIZED AREA (AS PER LANDSCAPE PLAN L.1)
- PROPOSED CONCRETE FEATURES/SLAB
- PROPOSED HEAVY DUTY ASPHALT
- PROPOSED LIGHT DUTY ASPHALT
- PROPOSED RIP RAP
- ×50.00 PROPOSED ELEVATION
- ×50.00HP PROPOSED HIGH POINT ELEVATION
- ×50.00BC PROPOSED BOTTOM OF CURB / ASPHALT ELEVATION
- ×50.00TC PROPOSED TOP OF CURB ELEVATION
- ×50.00EX MATCH INTO EXISTING ELEVATION
- ×70.19 EXISTING ELEVATION
- PROPOSED OVERLAND MAJOR FLOW ROUTE
- SUB — SUB PROPOSED 100mmØ PERFORATED SUBDRAIN
- STM — STM PROPOSED STORM SEWER
- SAN — SAN PROPOSED SANITARY SEWER
- WTR — WTR PROPOSED WATERMAIN
- STM — STM EXISTING STORM SEWER
- SAN — SAN EXISTING SANITARY SEWER
- WTR — WTR EXISTING WATERMAIN
- GAS — GAS EXISTING GAS LINE
- EXISTING MANHOLE
- EXISTING CATCHBASIN
- PROPOSED CATCHBASIN-MANHOLE/CATCHBASIN
- PROPOSED MANHOLE
- PROPOSED CURB STOP
- PROPOSED PIPE INSULATION
- PROPOSED 100 YEAR HIGH WATER LEVEL
- STORM WATERSHED EXTENT
- WS-XX — WATERSHED NAME
- CONTROLLED / RUNOFF — RUNOFF COEFFICIENT
- AREA — AREA IN HECTARES

DETAILS OF DEVELOPMENT

DATA		REQUIRED	PROVIDED
	ZONING	RG2 (RURAL GENERAL INDUSTRIAL ZONE)	
SETBACKS	FY	15.0m	21.6m
	RY	15.0m	37.3m
	INT.SY	3.0m / 1.5m (MV)	1.5m
	EXT.SY	3.0m	9.3m
NET LOT AREA (sqm)		3000 sqm	
BUILDING COVERAGE		50 % (MAX)	19.7 %
BUILDING HEIGHT		15.0 m (MAX)	10.8 m
GROSS FLOOR AREA		592 sqm	
No. of UNITS		1	
LOADING SPACES		N/A	N/A
PARKING:		5	8
No. OF STOREYS			1
OTHER:			

TOPOGRAPHICAL DATA AND PROPERTY BOUNDARIES AS PER THE TOPOGRAPHICAL SURVEY PREPARED BY ANNIS, O'SULLIVAN, VOLLEBEKK LTD. JOB NO. E-2488-22 DATED DECEMBER 14TH, 2022.

Bearings are grid, derived and are referred to the Central Meridian of MTM Zone 9 (76°30' West Longitude) NAD-83 (original).

ELEVATION NOTES

1. Elevations shown are geodetic and are referred to the CGVD28 geodetic datum.
2. It is the responsibility of the user of this information to verify that the job benchmark has not been altered or disturbed and that it's relative elevation and description agrees with the information shown on this drawing.

UTILITY NOTES

1. This drawing cannot be accepted as acknowledging all of the utilities and it will be the responsibility of the user to contact the respective utility authorities for confirmation.
2. Only visible surface utilities were located.
3. A field location of underground plant by the pertinent utility authority is mandatory before any work involving breaking ground, probing, excavating etc.

ARCHITECT
ABSOLUTE DRAFTING & DESIGN INC.
1257 DROUIN SIDEROAD, CASSELMAN, ON

LANDSCAPE ARCHITECT
JAMES B. LENNOX & ASSOCIATES INC.
3332 CARLING AVE, OTTAWA, ON

JAMES B. LENNOX & ASSOCIATES INC.
LANDSCAPE ARCHITECTS
3332 CARLING AVE. OTTAWA, ONTARIO K2H 5A8
Tel. (613) 722-5168 Fax. 1(866) 343-3942

ENVIRONMENTAL CONSULTANT
KILGOUR & ASSOCIATES LTD
2285 ST. LAURENT BLVD, OTTAWA, ON

KILGOUR & Associates

USE AND INTERPRETATION OF DRAWINGS

GENERAL CONDITIONS OF THE CONTRACT FOR CONSTRUCTION ARE PART OF THE CONTRACT DOCUMENTS AND DESCRIBE USE AND INTENT OF THE DRAWING. THE CONTRACT DOCUMENTS INCLUDE NOT ONLY THE DRAWINGS, BUT ALSO THE OWNER-CONTRACTOR AGREEMENTS, CONDITIONS OF THE CONTRACT, THE SPECIFICATIONS, ADDENDA, AND MODIFICATIONS ISSUED AFTER EXECUTION OF THE CONTRACT. THESE CONTRACT DOCUMENTS ARE COMPLEMENTARY, AND WHAT IS REQUIRED BY ANY ONE SHALL BE BINDING AS IF REQUIRED BY ALL. WORK NOT COMPLETELY DELINEATED HEREON SHALL BE CONSTRUCTED OF THE SAME MATERIALS AND DETAILED SIMILARLY AS WORK SHOWN MORE COMPLETELY ELSEWHERE IN THE CONTRACT DOCUMENTS.

BY USE OF THE DRAWINGS FOR CONSTRUCTION OF THE PROJECT, THE OWNER CONFIRMS THAT HE HAS REVIEWED AND APPROVED THE DRAWINGS. THE CONTRACTOR CONFIRMS THAT HE HAS VISITED THE SITE, FAMILIARIZED HIMSELF WITH THE LOCAL CONDITIONS, VERIFIED FIELD DIMENSIONS AND CORRELATED HIS OBSERVATIONS WITH THE REQUIREMENTS OF THE CONTRACT DOCUMENTS.

AS INSTRUMENTS OF SERVICE, ALL DRAWINGS, SPECIFICATIONS, CADD FILES OR OTHER ELECTRONIC MEDIA AND COPIED THERE OF FURNISHED BY THE ENGINEER ARE HIS PROPERTY. THEY ARE TO BE USED ONLY FOR THIS PROJECT AND ARE NOT TO BE USED ON ANY OTHER PROJECT, INCLUDING REPEATS OF THE PROJECT. CHANGES TO THE DRAWINGS MAY ONLY BE MADE BY THE ENGINEER.

UNLESS THE REVISION TITLE IS "ISSUED FOR CONSTRUCTION", THESE DRAWINGS SHALL BE CONSIDERED PRELIMINARY AND SHALL NOT BE USED AS A CONSTRUCTION DOCUMENT.

THESE DRAWINGS ILLUSTRATES THE WORK TO BE DONE. THE ENGINEER IS NOT RESPONSIBLE FOR THE MEANS, METHODS, TECHNIQUES, SEQUENCES, AND PROCEDURES USED TO DO THE WORK, OR THE SAFETY ASPECTS OF CONSTRUCTION, AND NOTHING ON THESE DRAWINGS EXPRESSED OR IMPLIED CHANGES THIS CONDITION. CONTRACTOR SHALL DETERMINE ALL CONDITIONS AT THE SITE AND SHALL BE RESPONSIBLE FOR KNOWING HOW THEY AFFECT THE WORK. SUBMITTAL OF A BID TO PERFORM THIS WORK IS ACKNOWLEDGEMENT OF THE RESPONSIBILITIES, AND THAT THEY HAVE BEEN FULLY CONSIDERED IN PLANNING OF THE WORK, AND THE BID PRICE. NO CLAIMS FOR EXTRA CHARGES DUE TO THESE CONDITIONS WILL BE FORTHCOMING.

UNAUTHORIZED CHANGES:

IN THE EVENT THE CLIENT, THE CLIENT'S CONTRACTORS OR SUBCONTRACTORS, OR ANYONE FOR WHOM THE CLIENT IS LEGALLY LIABLE MAKES OR PERMITS TO BE MADE ANY CHANGES TO ANY REPORTS, PLANS, SPECIFICATIONS OR OTHER CONSTRUCTION DOCUMENTS PREPARED BY LRL ASSOCIATES LTD. (LRL) WITHOUT OBTAINING LRL'S PRIOR WRITTEN CONSENT, THE CLIENT SHALL ASSUME FULL RESPONSIBILITY FOR THE RESULTS OF SUCH CHANGES. THEREFORE THE CLIENT AGREES TO WAIVE ANY CLAIM AGAINST LRL AND TO RELEASE LRL FROM ANY LIABILITY ARISING DIRECTLY OR INDIRECTLY FROM SUCH UNAUTHORIZED CHANGES.

IN ADDITION, THE CLIENT AGREES, TO THE FULLEST EXTENT PERMITTED BY LAW, TO INDEMNIFY AND HOLD HARMLESS LRL FROM ANY DAMAGES, LIABILITIES OR COST, INCLUDING REASONABLE ATTORNEY'S FEES AND COST OF DEFENSE, ARISING FROM SUCH CHANGES.

IN ADDITION, THE CLIENT AGREES TO INCLUDE IN ANY CONTRACTS FOR CONSTRUCTION APPROPRIATE LANGUAGE THAT PROHIBITS THE CONTRACTOR OR ANY SUBCONTRACTORS OF ANY TIER FROM MAKING ANY CHANGES OR MODIFICATIONS TO LRL'S CONSTRUCTION DOCUMENTS WITHOUT THE PRIOR WRITTEN APPROVAL OF LRL AND THAT FURTHER REQUIRES THE CONTRACTOR TO INDEMNIFY BOTH LRL AND THE CLIENT FROM ANY LIABILITY OR COST ARISING FROM SUCH CHANGES MADE WITHOUT SUCH PROPER AUTHORIZATION.

GENERAL NOTES:

EXISTING SERVICES AND UTILITIES SHOWN ON THESE DRAWINGS ARE TAKEN FROM THE BEST AVAILABLE RECORDS, BUT MAY NOT BE COMPLETE OR TO DATE. CONTRACTOR SHALL VERIFY IN FIELD FOR LOCATION AND ELEVATION OF PIPES AND CHECK WITH THE UTILITY COMPANIES BEFORE DIGGING OR PERFORMING WORK.

CONTRACTOR IS ADVISED TO COLLECT INFORMATION ON SOIL CONDITIONS BEFORE START OF CONSTRUCTION.

THE ENGINEER WAIVES ANY AND ALL RESPONSIBILITY AND LIABILITY FOR PROBLEMS WHICH ARISE FROM FAILURE TO FOLLOW THESE PLANS, SPECIFICATIONS AND THE DESIGN INTENT THEY CONVEY, OR FOR PROBLEMS WHICH ARISE FROM OTHERS' FAILURE TO OBTAIN AND/OR FOLLOW THE ENGINEER'S GUIDANCE WITH RESPECT TO ANY ERRORS, OMISSIONS, INCONSISTENCIES AMBIGUITIES OR CONFLICTS WHICH ARE ALLEGED.

CONTRACTOR TO VERIFY ALL DIMENSIONS AND NOTIFY THE ENGINEER OF ANY DISCREPANCIES BEFORE WORK COMMENCES. DO NOT SCALE DRAWINGS.

5m 2 0 5m

SCALE: 1:200

NOT FOR CONSTRUCTION TENDER OR PERMIT

No.	REVISIONS	BY	DATE
02	ISSUED FOR SITE PLAN CONSTROL	K.H.	AUG 2024
01	ISSUED FOR SITE PLAN CONTROL	K.H.	10 OCT 2023

NOT AUTHENTIC UNLESS SIGNED AND DATED

CIVIL, GEOTECHNICAL, ENVIRONMENTAL ENGINEERS

LRL
ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

CLIENT
ENTREPRENEUR HOLDING CORPORATION

DESIGNED BY:	DRAWN BY:	APPROVED BY:
K.H.	K.H.	M.B.

PROJECT
HYDROGEOLOGICAL ASSESSMENT & TERRAIN ANALYSIS
PROPOSED WAREHOUSE DEVELOPMENT
363 ENTREPRENEUR CRESCENT, OTTAWA

DRAWING TITLE
PROPOSED DEVELOPMENT PLAN

PROJECT NO.
220487

DATE
AUGUST 2024

FIGURE 7

Tables

Table 1
Summary of Analysis of Water Sample Collected from the Neighbouring Supply Wells - 357 Entrepreneur Crescent
Hydrogeological Assessment and Terrain Analysis
Proposed Warehouse Development - 363 Entrepreneur Crescent, Ottawa, Ontario
LRL File: 220487

Parameter	Units	MRL	Ontario Drinking Water Standards		MECP	Sample	
			Standard	Type	D-5-5[5]	357 Entrepreneur - Pre	357 Entrepreneur - Post
Sample Date (d/m/y)						**17-Apr-23**	**17-Apr-23**
Microbiological Parameters							
E. Coli	CFU/100 mL	1	0	MAC		<1	<1
Fecal Coliforms	CFU/100 mL	1	0 [1]	MAC		<1	<1
Heterotrophic Plate Count	CFU/ml	10	--			<10	150
Total Coliforms	CFU/100 mL	1	0/5[1]	MAC		<1	<1
General Inorganics							
Alkalinity, total	mg/L	5	30 - 500	OG		**605**	**16**
Ammonia as N	mg/L	0.01	--			3.28	0.46
Dissolved Organic Carbon	mg/L	0.5	5	AO	10	7.8	<0.5
Colour	TCU	2	5	AO	7	5	<2
Conductivity	uS/cm	5	--			13100	1050
Hardness	mg/L	1	80 - 100	OG		**1050**	**0.00**
pH	pH Units	0.05	6.5 - 8.5	OG		8.2	7.0
Phenolics	mg/L	0.001	--			<0.001	<0.001
Total Dissolved Solids	mg/L	10	500	AO		**7640**	**508**
Sulphide	mg/L	0.02	0.05	AO		0.24	<0.02
Tannin & Lignin	mg/L	0.1	--			0.7	<0.1
Total Kjeldahl Nitrogen	mg/L	0.1	--			3.4	0.5
Organic Nitrogen	mg/L		0.15	OG		0.12	0.04
Turbidity	NTU	0.1	1/5[2]	MAC/AO	5	***12.0***	<0.1
Anions							
Chloride	mg/L	1	250	AO	250	***4350***	**302**
Fluoride	mg/L	0.1	1.5[3]/2.4	MAC		0.7	<0.1
Nitrate as N	mg/L	0.1	10	MAC		<0.1	<0.1
Nitrite as N	mg/L	0.05	1	MAC		<0.50	<0.05
Sulphate	mg/L	1	500	AO	500	13	<1
Metals							
Calcium	mg/L	0.1	--			97.8	<0.1
Iron	mg/L	0.1	0.3	AO	5	**1.3**	<0.1
Magnesium	mg/L	0.2	--			196	<0.2
Manganese	mg/L	0.005	0.05	AO	1	0.03	<0.005
Potassium	mg/L	0.1	--			91.4	1.9
Sodium	mg/L	0.2	20[4]/200	AO	200	***2010***	*152*

NOTES

MRL	Minimum Reportable Limit	**ODWS**	Ontario Drinking Water Standards (2006)
MAC	Maximum Acceptable Concentration	**NA**	Not Analysed
AO	Aesthetic Objective	**UNDERLINE**	Parameter level above ODWS
OG	Operational Guideline	*Italics*	Notify Medical Officer of Health
		BOLD	Parameter level above D-5-5 maximum treatability limits

[1] As per Table 1 of MECP's technical guideline "*D-5-5 Private Wells: Water Supply Assessment*"

[2] 1.0 NTU MAC if treatment system required to provide filtration for disinfection. 5.0 NTU AO for all points of consumption

[3] Where supplies of naturally occuring flouride at levels above 1.5 mg/L but below 2.4 mg/L the Ministry of Health recommends notification of local board of health of levels to avoid excesses exposure from other sources.

[4] Limit at which Local Medical Officer of Health should be notified of Levels.

[5] MECP D-5-5 guideline, maximum concentration considered reasonably treatable

Table 2
Specific Capacity and Longterm Availability
Hydrogeological Assessment & Terrain Analysis
Proposed Warehouse Development - 363 Entrepreneur Crescent, Ottawa, Ontario
LRL File: 220487

Well	Cs - Static mTOC	EOH mTOC	Cp - Pump* mTOC	Cp - Cs	Drawdown (m)	Pumping Rate L/min	*Sc* - Specific Capacity L/sec/m	Qsc -Maximum Pumping Rate L/min	Long Term Availability m^3/day	Qsc GPM (US)	Qsc GPM (IMP)
Proposed Supply Well	2.61	6.25	45.00	42.4	3.64	22.0	0.101	57.2	82.4	15.1	12.6

Notes:

$$Qsc = 0.67\frac{(C_p - C_s)S_c}{SF}$$

Qsc	Pumping rate with safety factor (SF) of 3 (L/min);
$C_p - C_s$	Difference between pump level and static water level (m);
S_c	Specific capacity (L/min/m); and
0.67	Is a factor that compensates for the variation of the static water level due to seasonal variations as well as to drawdown from nearby wells
SF	3
Minimum Daily Demand	1.91 m^3
*	Depth of pump at the time of the pumping test - measured in field
	Greater than Minimum Demand
	Less than Minimum Demand

Table 3A
Summary of Analysis of Water Sample Collected - Proposed Supply Well (363 Entrepreneur Crescent)
Hydrogeological Assessment and Terrain Analysis
Proposed Warehouse Development - 363 Entrepreneur Crescent , Ottawa, Ontario
LRL File: 220487

Parameter	Units	MRL	Ontario Drinking Water Standards		MECP	Sample		
			Standard	Type	D-5-5[5]	363 Entrepreneur Crescent Supply - 4 Hour	363 Entrepreneur Crescent Supply - 8 Hour	364 Entrepreneur Crescent Supply
Sample Date (d/m/y)						**30-Aug-23**	**30-Aug-23**	**22-Nov-24**
Microbiological Parameters								
E. Coli	CFU/100 mL	1	0	MAC		<1	<1	--
Fecal Coliforms	CFU/100 mL	1	0 [1]	MAC		<1	<1	--
Heterotrophic Plate Count	CFU/ml	10	--			90	40	--
Total Coliforms	CFU/100 mL	1	0/5[1]	MAC		2	1	--
General Inorganics								
Alkalinity, total	mg/L	5	30 - 500	OG		**703**	**705**	--
Ammonia as N	mg/L	0.01	--			4.72	4.71	--
Dissolved Organic Carbon	mg/L	0.5	5	AO	10	**9.4**	**8.5**	--
Colour	TCU	2	5	AO	7	**8**	**8**	--
Conductivity	uS/cm	5	--			14300	14200	--
Hardness	mg/L	1	80 - 100	OG		**1020**	**1030**	--
pH	pH Units	0.05	6.5 - 8.5	OG		8.2	8.3	--
Phenolics	mg/L	0.001	--			<0.001	<0.001	--
Total Dissolved Solids	mg/L	10	500	AO		**7950**	**7880**	--
Sulphide	mg/L	0.02	0.05	AO		**0.23**	**0.23**	--
Tannin & Lignin	mg/L	0.1	--			0.7	0.7	--
Total Kjeldahl Nitrogen	mg/L	0.1	--			4.7	4.7	--
Organic Nitrogen	mg/L		0.15	OG		-0.02	-0.01	--
Turbidity	NTU	0.1	1/5[2]	OG/AO	5	**3.8**	**3.5**	--
Anions								
Chloride	mg/L	1	250	AO	250	***4560***	***4460***	--
Fluoride	mg/L	0.1	1.5[3]/2.4	MAC		0.2	0.2	--
Nitrate as N	mg/L	0.1	10	MAC		<0.1	<0.1	--
Nitrite as N	mg/L	0.05	1	MAC		<0.25	<0.25	--
Sulphate	mg/L	1	500	AO	500	3	4	--

NOTES

MRL	Minimum Reportable Limit	**ODWS**	Ontario Drinking Water Standards (2006)
MAC	Maximum Acceptable Concentration	**NA**	Not Analysed
AO	Aesthetic Objective	**UNDERLINE**	Parameter level above ODWS
OG	Operational Guideline	*Italics*	Notify Medical Officer of Health
		BOLD	Parameter level above D-5-5 maximum treatability limits

1 As per Table 1 of MECP's technical guideline "*D-5-5 Private Wells: Water Supply Assessment*"
2 1.0 NTU MAC if treatment system required to provide filtration for disinfection. 5.0 NTU AO for all points of consumption
3 Where supplies of naturally occuring flouride at levels above 1.5 mg/L but below 2.4 mg/L the Ministry of Health recommends notification of local board of health of levels to avoid excesses exposure from other sources.
4 Limit at which Local Medical Officer of Health should be notified of Levels.
5 MECP D-5-5 guideline, maximum concentration considered reasonably treatable

Table 3B
Summary of Analysis of Water Sample Collected (Metals) - Proposed Supply Well (363 Entrepreneur Crescent)
Hydrogeological Assessment and Terrain Analysis
Proposed Warehouse Development - 363 Entrepreneur Crescent , Ottawa, Ontario
LRL File: 220487

Parameter	Units	MRL	Ontario Drinking Water Standards: Standard	Ontario Drinking Water Standards: Type	MECP D-5-5[5]	Sample: 363 Entrepreneur Crescent Supply - 4 Hour	Sample: 363 Entrepreneur Crescent Supply - 8 Hour	Sample: 363 Entrepreneur Crescent Supply
Sample Date (d/m/y)						**30-Aug-23**	**30-Aug-23**	**22-Nov-24**
Metals								
Aluminum	mg/L	0.001	0.1	AO		0.025	0.018	0.014
Antimony	mg/L	0.0005	0.006	MAC		<0.0005	<0.0005	<0.0005
Arsenic	mg/L	0.001	0.01	MAC		<0.001	<0.001	<0.001
Barium	mg/L	0.001	1	MAC		**4.17**	**4.22**	**3.15**
Beryllium	mg/L	0.0005				<0.0005	<0.0005	<0.0005
Boron	mg/L	0.01	5	MAC		0.79	0.76	0.92
Cadmium	mg/L	0.0001	0.005	MAC		<0.0001	<0.0001	<0.0001
Calcium	mg/L	0.1				48.3	49.0	42.7
Chromium	mg/L	0.001	0.05			<0.001	<0.001	<0.001
Cobalt	mg/L	0.0005				<0.0005	<0.0005	<0.0005
Copper	mg/L	0.0005	1	AO		<0.0005	<0.0005	<0.0005
Iron	mg/L	0.1	0.3	AO	5	0.3	0.3	***11.1***
Lead	mg/L	0.0001	0.01	MAC		<0.0001	<0.0001	<0.0001
Magnesium	mg/L	0.2				218	220	129
Manganese	mg/L	0.005	0.05	AO	1	0.009	0.007	0.155
Molybdenum	mg/L	0.0005				<0.0005	<0.0005	<0.0005
Nickel	mg/L	0.001				<0.001	<0.001	<0.001
Potassium	mg/L	0.1				61.3	63.3	60.4
Selenium	mg/L	0.001	0.05	MAC		<0.001	<0.001	<0.001
Silver	mg/L	0.0001				<0.0001	<0.0001	<0.0001
Sodium	mg/L	0.2	20/200	MAC/AO	200	***2670***	***2620***	***2430***
Strontium	mg/L	0.01				5.71	5.71	5.08
Thallium	mg/L	0.001				<0.001	<0.001	<0.001
Tin	mg/L	0.01				<0.01	<0.01	<0.01
Titanium	mg/L	0.005				<0.005	<0.005	<0.005
Tungsten	mg/L	0.01				<0.01	<0.01	<0.01
Uranium	mg/L	0.0001	0.02	MAC		<0.0001	<0.0001	<0.0001
Vanadium	mg/L	0.0005				<0.0005	<0.0005	<0.0005
Zinc	mg/L	0.005	5	AO		<0.005	<0.005	0.010

NOTES

MRL	Minimum Reportable Limit	**ODWS**	Ontario Drinking Water Standards (2006)
MAC	Maximum Acceptable Concentration	**NA**	Not Analysed
AO	Aesthetic Objective	**UNDERLINE**	Parameter level above ODWS
OG	Operational Guideline	*Italics*	Notify Medical Officer of Health
		BOLD	Parameter level above D-5-5 maximum treatability limits

[1] As per Table 1 of MECP's technical guideline "*D-5-5 Private Wells: Water Supply Assessment*"
[2] 1.0 NTU MAC if treatment system required to provide filtration for disinfection. 5.0 NTU AO for all points of consumption
[3] Where supplies of naturally occuring flouride at levels above 1.5 mg/L but below 2.4 mg/L the Ministry of Health recommends notification of local board of health of levels to avoid excesses exposure from other sources.
[4] Limit at which Local Medical Officer of Health should be notified of Levels.
[5] MECP D-5-5 guideline, maximum concentration considered reasonably treatable

Table 3C
Summary of Analysis of Water Sample Collected (VOC) - Proposed Supply Well (363 Entrepreneur Crescent)
Hydrogeological Assessment and Terrain Analysis
Proposed Warehouse Development - 363 Entrepreneur Crescent , Ottawa, Ontario
LRL File: 220487

Parameter	Units	MRL	Sample		
			363 Entrepreneur Crescent Supply - 4 Hour	363 Entrepreneur Crescent Supply - 8 Hour	363 Entrepreneur Crescent Supply
Sample Date (d/m/y)			**30-Aug-23**	**30-Aug-23**	**22-Nov-24**
Volatile Organic Compounds (VOCs)					
Acetone	mg/L	0.0050	<0.0050	<0.0050	--
Benzene	mg/L	0.0005	<0.0005	<0.0005	--
Bromodichloromethane	mg/L	0.0005	<0.0005	<0.0005	--
Bromoform	mg/L	0.0005	<0.0005	<0.0005	--
Bromomethane	mg/L	0.0005	<0.0005	<0.0005	--
Carbon Tetrachloride	mg/L	0.0002	<0.0002	<0.0002	--
Chlorobenzene	mg/L	0.0005	<0.0005	<0.0005	--
Chloroethane	mg/L	0.0010	<0.0010	<0.0010	--
Chloroform	mg/L	0.0005	<0.0005	<0.0005	--
Dibromochloromethane	mg/L	0.0005	<0.0005	<0.0005	--
Dichlorodifluoromethane	mg/L	0.0010	<0.0010	<0.0010	--
Ethylene dibromide (dibromoethane, 1,2-)	mg/L	0.0002	<0.0002	<0.0002	--
1,2-Dichlorobenzene	mg/L	0.0005	<0.0005	<0.0005	--
1,3-Dichlorobenzene	mg/L	0.0005	<0.0005	<0.0005	--
1,4-Dichlorobenzene	mg/L	0.0005	<0.0005	<0.0005	--
1,1-Dichloroethane	mg/L	0.0005	<0.0005	<0.0005	--
1,2-Dichloroethane	mg/L	0.0005	<0.0005	<0.0005	--
1,1-Dichloroethylene	mg/L	0.0005	<0.0005	<0.0005	--
cis-1,2-Dichloroethylene	mg/L	0.0005	<0.0005	<0.0005	--
trans-1,2-Dichloroethylene	mg/L	0.0005	<0.0005	<0.0005	--
1,2-Dichloroethylene, total	mg/L	0.0005	<0.0005	<0.0005	--
1,2-Dichloropropane	mg/L	0.0005	<0.0005	<0.0005	--
cis-1,3-Dichloropropylene	mg/L	0.0005	<0.0005	<0.0005	--
trans-1,3-Dichloropropylene	mg/L	0.0005	<0.0005	<0.0005	--
1,3-Dichloropropene, total	mg/L	0.0005	<0.0005	<0.0005	--
Ethylbenzene	mg/L	0.0005	<0.0005	<0.0005	--
Hexane	mg/L	0.0010	<0.0010	<0.0010	--
Methyl Ethyl Ketone (2-Butanone)	mg/L	0.0050	<0.0050	<0.0050	--
Methyl Isobutyl Ketone	mg/L	0.0050	<0.0050	<0.0050	--
Methyl tert-butyl ether	mg/L	0.0020	<0.0020	<0.0020	--
Methylene Chloride	mg/L	0.0050	<0.0050	<0.0050	--
Styrene	mg/L	0.0005	<0.0005	<0.0005	--
1,1,1,2-Tetrachloroethane	mg/L	0.0005	<0.0005	<0.0005	--
1,1,2,2-Tetrachloroethane	mg/L	0.0005	<0.0005	<0.0005	--
Tetrachloroethylene	mg/L	0.0005	<0.0005	<0.0005	--
Toluene	mg/L	0.0005	<0.0005	<0.0005	--
1,1,1-Trichloroethane	mg/L	0.0005	<0.0005	<0.0005	--
1,1,2-Trichloroethane	mg/L	0.0005	<0.0005	<0.0005	--
Trichloroethylene	mg/L	0.0005	<0.0005	<0.0005	--
Trichlorofluoromethane	mg/L	0.0010	<0.0010	<0.0010	--
Vinyl Chloride	mg/L	0.0002	<0.0002	<0.0002	--
m/p-Xylene	mg/L	0.0005	<0.0005	<0.0005	--
o-Xylene	mg/L	0.0005	<0.0005	<0.0005	--
Xylenes, total	mg/L	0.0005	<0.0005	<0.0005	--

Table 3D
Summary of Analysis of Water Sample Collected (PHC, PCB, PAH) - Proposed Supply Well (363 Entrepreneur Crescent)
Hydrogeological Assessment and Terrain Analysis
Proposed Warehouse Development - 363 Entrepreneur Crescent , Ottawa, Ontario
LRL File: 220487

Parameter	Units	MRL	Sample		
			363 Entrepreneur Crescent Supply - 4 Hour	363 Entrepreneur Crescent Supply - 8 Hour	363 Entrepreneur Crescent Supply
Sample Date (d/m/y)			**30-Aug-23**	**30-Aug-23**	**22-Nov-24**
Semi-Volatiles					
Acenaphthene	mg/L	0.0050	--	--	<0.05
Acenaphthylene	mg/L	0.0005	--	--	<0.05
Anthracene	mg/L	0.0005	--	--	<0.01
Benzo[a]anthracene	mg/L	0.0005	--	--	0.02
Benzo[a]pyrene	mg/L	0.0005	--	--	<0.01
Benzo[b]fluoranthene	mg/L	0.0002	--	--	<0.05
Benzo[g,h,i]perylene	mg/L	0.0005	--	--	<0.05
Benzo[k]fluoranthene	mg/L	0.0010	--	--	<0.05
1,1-Biphenyl	mg/L	0.0005	--	--	<0.05
Chrysene	mg/L	0.0005	--	--	<0.05
Dibenzo[a,h]anthracene	mg/L	0.0010	--	--	<0.05
Fluoranthene	mg/L	0.0002	--	--	0.02
Fluorene	mg/L	0.0005	--	--	<0.05
Indeno [1,2,3-cd] pyrene	mg/L	0.0005	--	--	<0.05
1-Methylnaphthalene	mg/L	0.0005	--	--	<0.05
2-Methylnaphthalene	mg/L	0.0005	--	--	<0.05
Methylnaphthalene (1&2)	mg/L	0.0005	--	--	<0.10
Naphthalene	mg/L	0.0005	--	--	<0.05
Phenanthrene	mg/L	0.0005	--	--	<0.05
Pyrene	mg/L	0.0005	--	--	<0.01
Hydrocarbons	mg/L	0.0005			
F1 PHCs (C6-C10)	mg/L	0.0005	--	--	<0.025
F2 PHCs (C10-C16)	mg/L	0.0005	--	--	<0.1
F3 PHCs (C16-C34)	mg/L	0.0005	--	--	<0.1
F4 PHCs (C34-C50)	mg/L	0.0005	--	--	<0.1
PCBs	mg/L	0.0005			
PCBs, total	mg/L	0.0010	--	--	<0.05

Table 4
Langelier and Ryznar Calculations
Hydrogeological Assessment & Terrain Analysis
Proposed Warehouse Development - 363 Entrepreneur Crescent , Ottawa, Ontario
LRL File: 220487

Analyzed Parameters

TDS (mg/L)	7880
Hardness(mg/L)	1030
alkalinity(mg/L)	705
pH (pH units)	8.3
Temperature °C	10

Langelier

LSI = pH - pHs

pHs = (9.3 +A+B) - (C+D)	Where	A= (Log10(TDS)-1)/10	=	0.2896526
		B= (-13.12*Log10(T°C+273)+34.55	=	2.382562
		C= Log10(Hardness)-0.4	=	2.6128372
		D= Log10(Alkalinity)	=	2.8481891

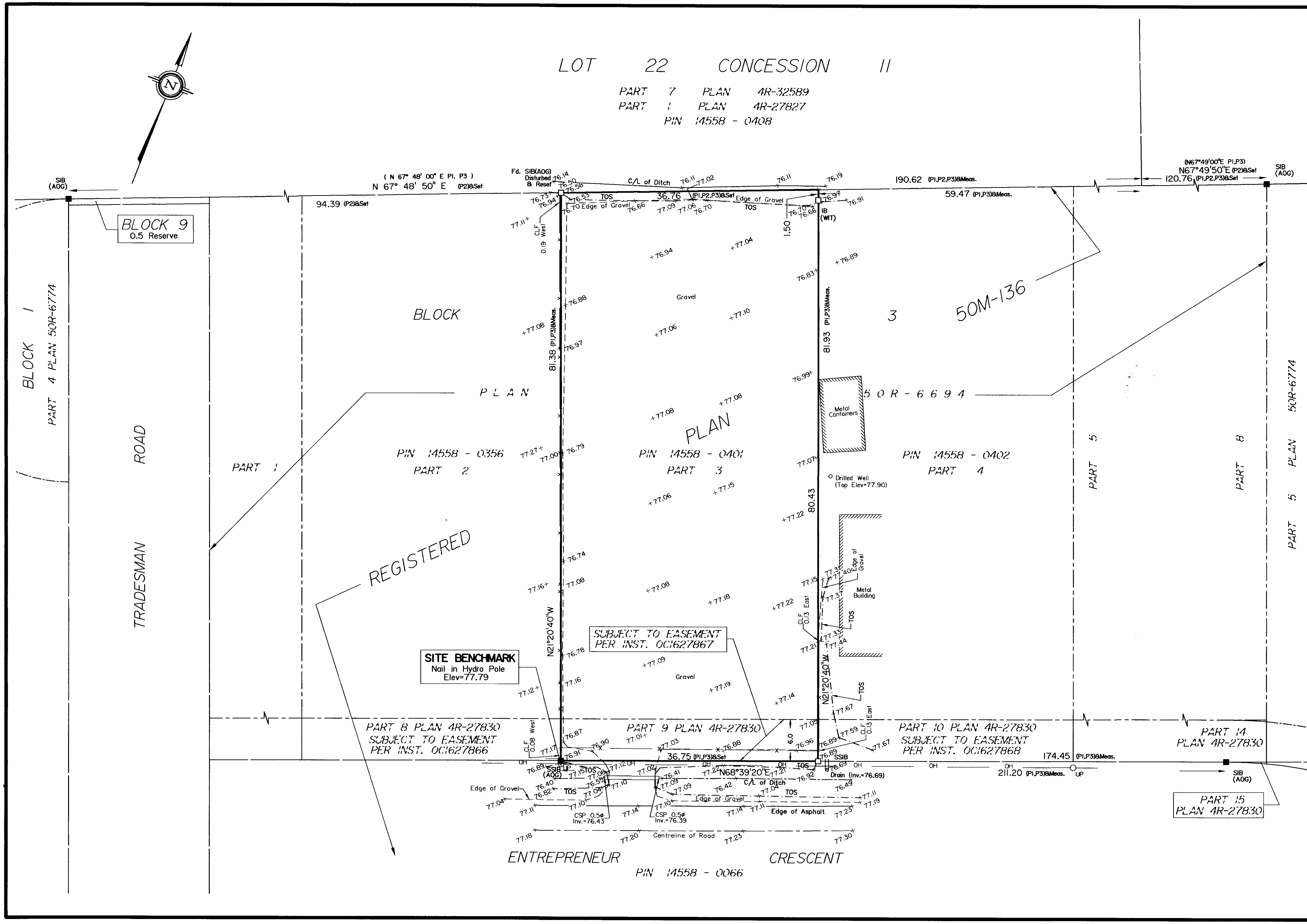
Ryznar

RI=2pHs-pH

pHs=	6.511188
LSI=	1.788812
RI=	4.722376

ATTACHMENT A

Topographic Survey Plan



TOPOGRAPHICAL PLAN OF SURVEY OF

PART OF BLOCK 3
REGISTERED PLAN 50M-136
CITY OF OTTAWA

Surveyed by Annis, O'Sullivan, Vollebekk Ltd.

Scale 1 : 400

16 12 8 4 0 8 16 Metres

Metric

DISTANCES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048

Surveyor's Certificate

I CERTIFY THAT :

1. This survey and plan are correct and in accordance with the Surveys Act, the Surveyors Act and the regulations made under them.
2. The survey was completed on December 8, 2022.

Dec 14/22
Date

Tyler J. Allison
Ontario Land Surveyor

ASSOCIATION OF ONTARIO LAND SURVEYORS PLAN SUBMISSION FORM
V-33900

THIS PLAN IS NOT VALID UNLESS IT IS AN EMBOSSED ORIGINAL COPY ISSUED BY THE SURVEYOR IN ACCORDANCE WITH Regulation 1026, Section 29 (3)

Notes & Legend

—□—	Denotes	Survey Monument Planted
—■—	"	Survey Monument Found
SIB	"	Standard Iron Bar
SSIB	"	Short Standard Iron Bar
IB	"	Iron Bar
(WIT)	"	Witness
Meas.	"	Measured
(P1)	"	Plan 4R-27830
(P2)	"	Plan 4R-32589
(P3)	"	Plan 50R-6694
(AOG)	"	Annis, O'Sullivan, Vollebekk Ltd.
—OH—	"	Overhead Wires
UP	"	Utility Pole
CSP	"	Corrugated Steel Pipe
Inv.	"	Invert
CLF	"	Chain Link Fence
TOS	"	Top of Slope
+ 65.00	"	Location of Elevations
C/L	"	Centreline

Bearings are grid, derived and are referred to the Central Meridian of MTM Zone 9 (76°30' West Longitude) NAD-83 (original).

ELEVATION NOTES

1. Elevations shown are geodetic and are referred to the CGVD28 geodetic datum.
2. It is the responsibility of the user of this information to verify that the job benchmark has not been altered or disturbed and that it's relative elevation and description agrees with the information shown on this drawing.

UTILITY NOTES

1. This drawing cannot be accepted as acknowledging all of the utilities and it will be the responsibility of the user to contact the respective utility authorities for confirmation.
2. Only visible surface utilities were located.
3. A field location of underground plant by the pertinent utility authority is mandatory before any work involving breaking ground, probing, excavating etc.

ANNIS, O'SULLIVAN, VOLLEBEKK LTD.
165 Bay Street
Embrun, Ont. K0A 1W1
Phone: (613) 443-3364
Email: Embrun@aovltd.com
Ontario Land Surveyors

Job No. E-2488-22

BIN

ATTACHMENT B

Borehole Logs – Previous Investigations

Symbols and Terms Used on Borehole and Test Pit Logs

The following explains the data presented in the borehole and test pit logs.

1. Soil Description

The soil descriptions presented in this report are based on commonly accepted methods of classification and identification employed in geotechnical practice. Classification and identification of soil involves some judgement and LRL Associates Ltd. does not guarantee descriptions as exact, but infers accuracy to the extent that is common in current geotechnical practice. Boundaries between zones on the logs are often not distinct but transitional and were interpreted.

a. Proportion

The proportion of each constituent part, as defined by the grain size distribution, is denoted by the following terms:

Term	Proportions
"trace"	1% to 10%
"some"	10% to 20%
prefix (i.e. "sandy" silt)	20% to 35%
"and" (i.e. sand "and" gravel)	35% to 50%

b. Compactness and Consistency

The state of compactness of granular soils is defined on the basis of the Standard Penetration Test. See Section 2c for more details. The consistency of clayey or cohesive soils is based on the shear strength of the soil, as determined by field vane tests and by a visual and tactile assessment of the soil strength.

The state of compactness of granular soils is defined by the following terms:

State of Compactness Granular Soils	Standard Penetration Number "N"
Very loose	0 – 4
Loose	4 – 10
Compact or medium	10 - 30
Dense	30 - 50
Very dense	over - 50

The consistency of cohesive soils is defined by the following terms:

Consistency Cohesive Soils	Undrained Shear Strength (Cu) (kPa)
Very soft	under 10
Soft	10 - 25
Medium or firm	25 - 50
Stiff	50 - 100
Very stiff	100 - 200
Hard	over - 200

2. Sample Data

a. Elevation depth

This is a reference to the geodesic elevation of the soil or to a benchmark of an arbitrary elevation at the location of the borehole or test pit. The depth of geological boundaries is measured from ground surface.

b. Type

Symbol	Type	Letter Code
	Auger	AU
	Split spoon	SS
	Shelby tube	ST
	Rock Core	RC

c. Sample Number

Each sample taken from the borehole is numbered in the field as shown in this column.

LETTER CODE (as above) – Sample Number

d. Blows (N) or RQD

This column indicates the Standard Penetration Number (N) as per ASTM D-1586. This is used to determine the state of compactness of the soil sampled. It corresponds to the number of blows required to drive 300 mm of the split spoon sampler using a 622 kg*m/s² hammer falling freely from a height of 760 mm. For a 600 mm long split spoon, the blow counts are recorded for every 150 mm. The "N" index is obtained by adding the number of blows from the 2nd and 3rd count. Technical refusal indicates a number of blows greater than 50.

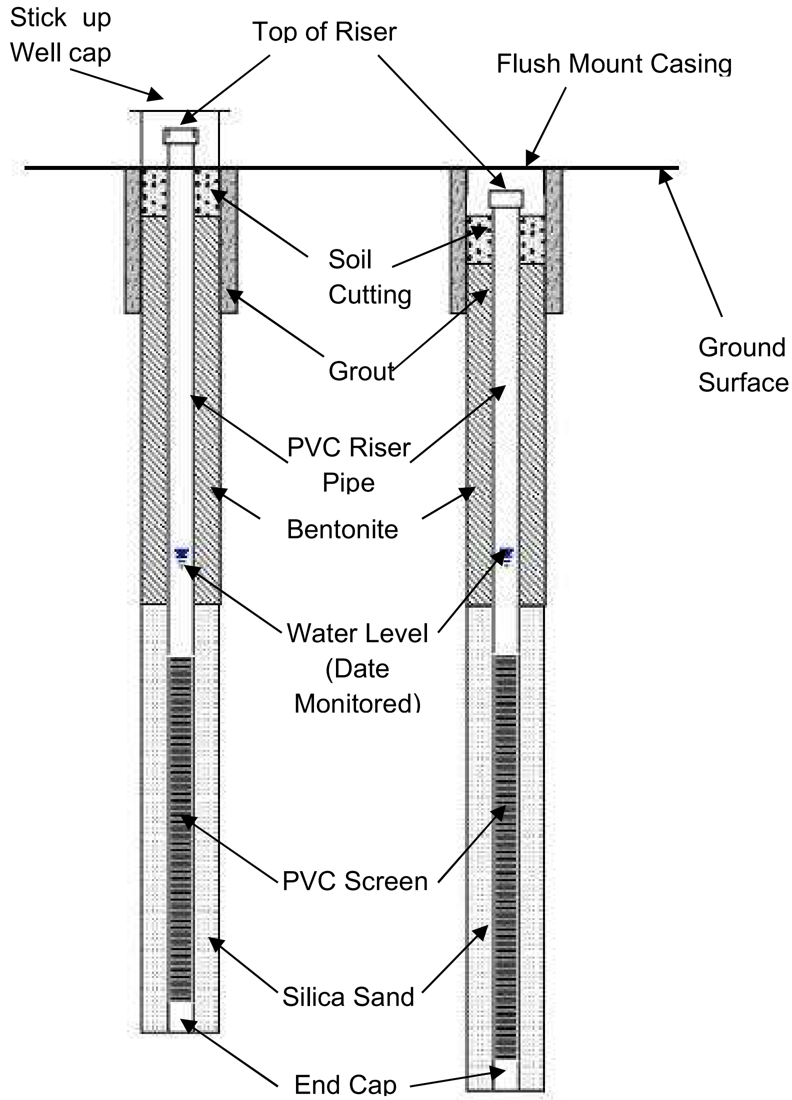
In the case of rock, this column presents the Rock Quality Designation (RQD). The RQD is calculated as the cumulative length of rock pieces recovered having lengths of 10 cm or more divided by the length of coring. The qualitative description of the bedrock based on RQD is given below.

Rock Quality Designation (RQD) (%)	Description of Rock Quality
0 –25	very poor
25 – 50	poor
50 – 75	fair
75 – 90	good
90 – 100	excellent

e. Recovery (%)

For soil samples this is the percentage of the recovered sample obtained versus the length sampled. In the case of rock, the percentage is the length of rock core recovered compared to the length of the drill run.

3. General Monitoring Well Data



Borehole Log: BH1

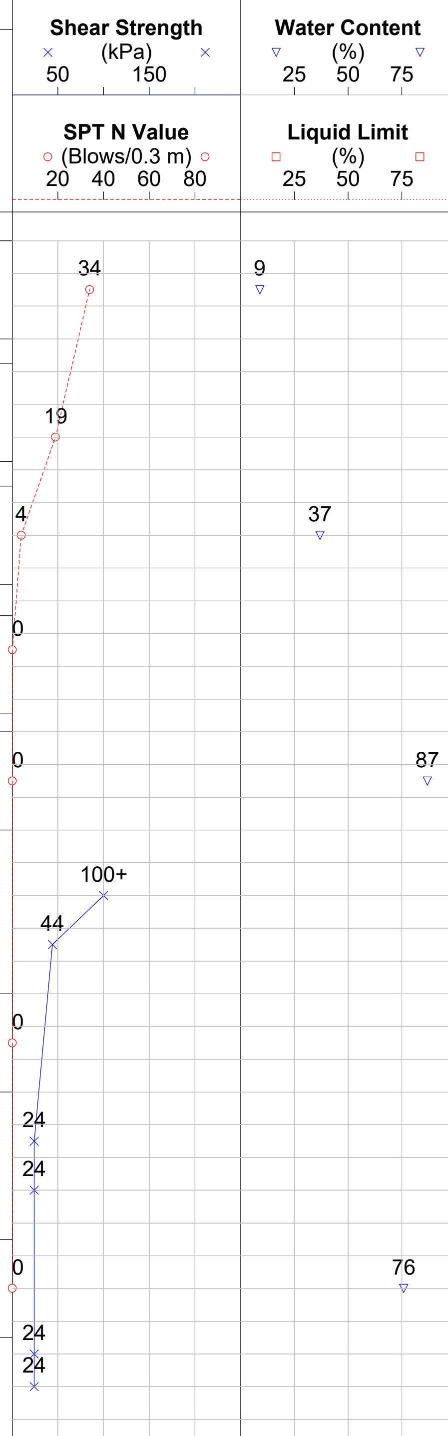
Project No.: 220487
Project: Proposed Warehouse
Client: Entrepreneur Holding Corp.
Location: 363 Entrepreneur Cres. Vars ON
Date: November 17, 2022
Field Personnel: BJ

Driller: CCC Geotech and Enviro Drilling **Drilling Equipment:** Track Mount CME 75 **Drilling Method:** Hollow Stew Auger

SUBSURFACE PROFILE / SAMPLE DATA

Soil Description	Elev./Depth (m)
Ground Surface	100.28 / 0.00
FILL MATERIAL crushed stone, grey, moist, dense.	100.28 / 0.00
SILTY SAND brown, moist, compact.	99.22 / 1.07
CLAYEY SILT trace sand, grey, firm to very soft, wet.	98.83 / 1.45
SILTY CLAY grey, very soft, wet.	96.16 / 4.12
End of Borehole	93.28 / 7.00

Sample Number	N or RQD	Recovery (%)
SS1	34	42
SS2	19	58
SS3	4	50
SS4	WH	100
SS5	WH	100
SS6	WH	100
SS7	WH	100



Monitoring Well Details

Easting: 465773 m **Northing:** 5020883 m

Site Datum: TBM - Top of Culvert located at Southwest of Driveway entrance. (100.00 m)

Groundsurface Elevation: 100.285 m **Top of Riser Elev.:** NA

Hole Diameter: 200 mm **Monitoring Well Diameter:** N/A

NOTES:

Borehole Log: BH2

Project No.: 220487 | **Project:** Proposed Warehouse

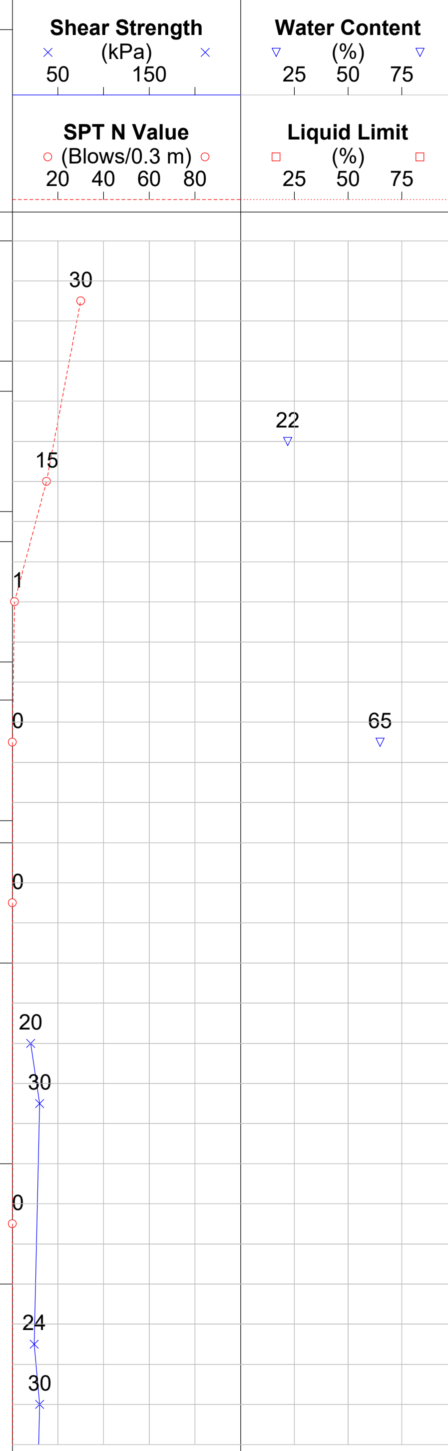
Client: Entrepreneur Holding Corp. | **Location:** 363 Entrepreneur Cres. Vars ON

Date: November 17, 2022 | **Field Personnel:** BJ

Driller: CCC Geotech and Enviro Drilling | **Drilling Equipment:** Track Mount CME 75 | **Drilling Method:** Hollow Stew Auger

SUBSURFACE PROFILE / SAMPLE DATA

Depth	Soil Description	Elev./Depth (m)	Type	Sample Number	N or RQD	Recovery (%)
0 ft / 0 m	Ground Surface	100.17				
	FILL MATERIAL crushed stone, grey, moist, dense.	0.00		SS1	30	42
		99.57				
	SILTY SAND brown, moist, compact.	0.60		SS2	15	50
		98.72				
	CLAYEY SILT trace sand, grey, firm to very soft, wet.	1.45		SS3	1	50
				SS4	WH	58
				SS5	WH	75
		96.05				
	SILTY CLAY grey, very soft, wet.	4.12		SS6	WH	100



Monitoring Well Details

Easting: 465762 m | **Northing:** 5020885 m

Site Datum: TBM - Top of Culvert located at Southwest of Driveway entrance. (100.00 m)

Groundsurface Elevation: 100.165 m | **Top of Riser Elev.:** NA

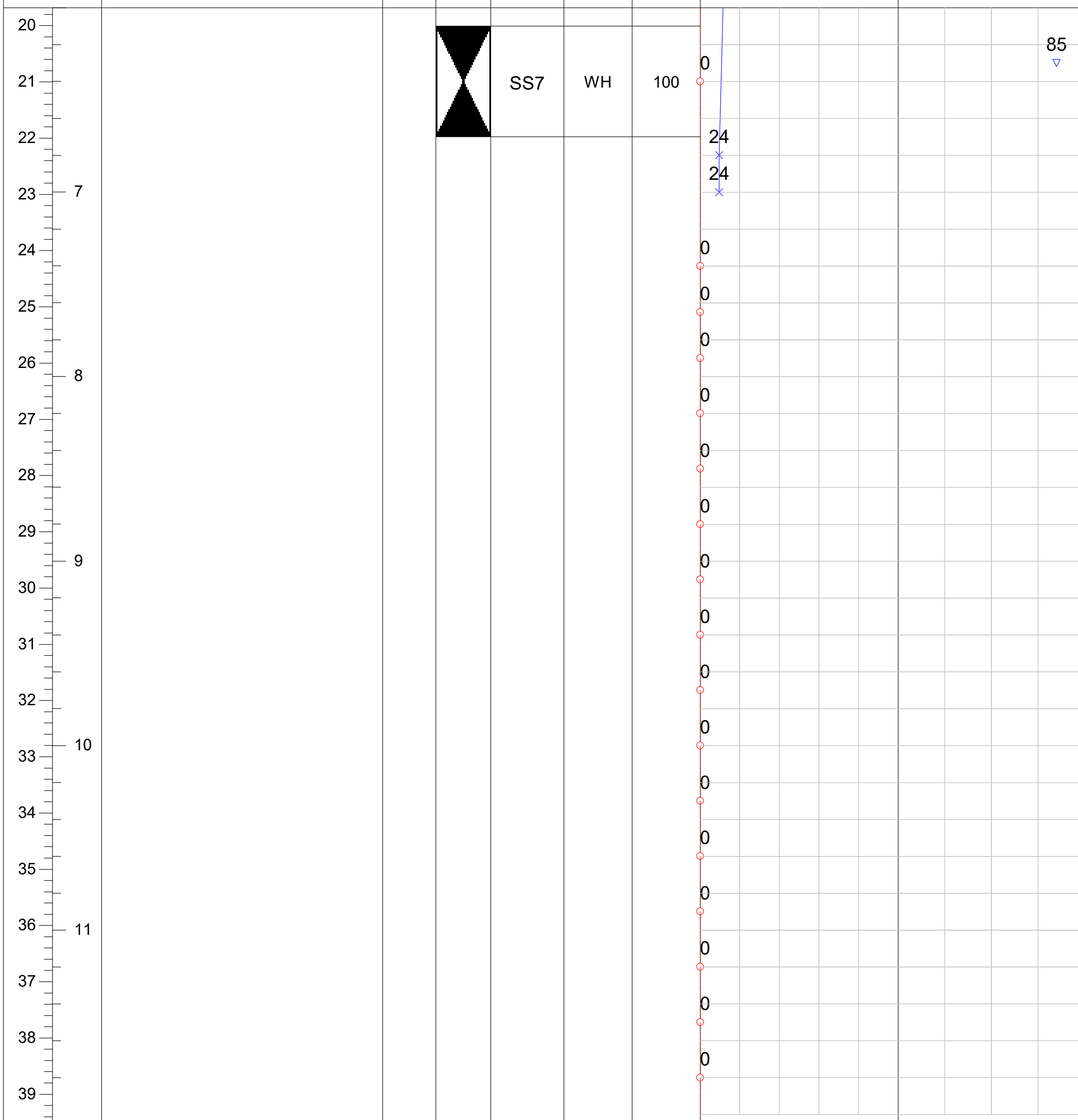
Hole Diameter: 200 mm | **Monitoring Well Diameter:** N/A

NOTES:

Borehole Log (continued): BH2

Project No.: 220487
Project: Proposed Warehouse
Client: Entrepreneur Holding Corp.
Location: 363 Entrepreneur Cres. Vars ON
Date: November 17, 2022
Field Personnel: BJ
Driller: CCC Geotech and Enviro Drilling
Drilling Equipment: Track Mount CME 75
Drilling Method: Hollow Stew Auger

SUBSURFACE PROFILE		SAMPLE DATA					Shear Strength (kPa) 50 150 / SPT N Value (Blows/0.3 m) 20 40 60 80	Water Content (%) 25 50 75 / Liquid Limit (%) 25 50 75	Monitoring Well Details
Depth	Soil Description	Elev./Depth (m)	Type	Sample Number	N or RQD	Recovery (%)			
20–39 ft (7–11 m)				SS7	WH	100			

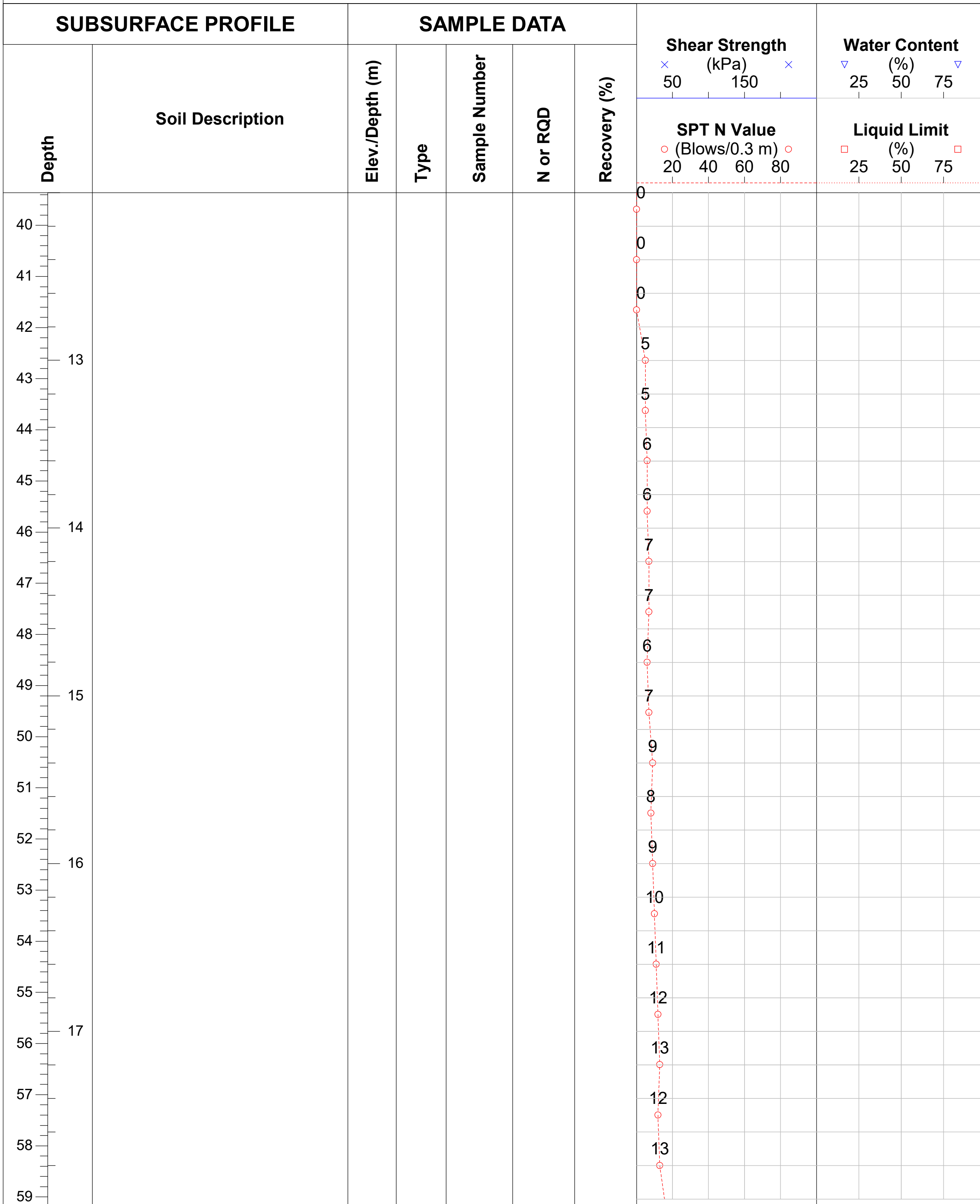


NOTES

Borehole Log (continued): BH2

Project No.: 220487
Project: Proposed Warehouse
Client: Entrepreneur Holding Corp.
Location: 363 Entrepreneur Cres. Vars ON
Date: November 17, 2022
Field Personnel: BJ
Driller: CCC Geotech and Enviro Drilling
Drilling Equipment: Track Mount CME 75
Drilling Method: Hollow Stew Auger

SUBSURFACE PROFILE		SAMPLE DATA							
Depth	Soil Description	Elev./Depth (m)	Type	Sample Number	N or RQD	Recovery (%)	Shear Strength (kPa) 50 150 / SPT N Value (Blows/0.3 m) 20 40 60 80	Water Content (%) 25 50 75 / Liquid Limit (%) 25 50 75	Monitoring Well Details
40–59 ft (13–17 m)									



NOTES

Borehole Log (continued): BH2

LRL ASSOCIATES • ASSOCIÉS ENGINEERS INGÉNIEURS

Project No.: 220487
Project: Proposed Warehouse
Client: Entrepreneur Holding Corp.
Location: 363 Entrepreneur Cres. Vars ON
Date: November 17, 2022
Field Personnel: BJ
Driller: CCC Geotech and Enviro Drilling
Drilling Equipment: Track Mount CME 75
Drilling Method: Hollow Stew Auger

SUBSURFACE PROFILE		SAMPLE DATA							
Depth	Soil Description	Elev./Depth (m)	Type	Sample Number	N or RQD	Recovery (%)	Shear Strength × (kPa) × 50 150 / SPT N Value ○ (Blows/0.3 m) ○ 20 40 60 80	Water Content ▽ (%) ▽ 25 50 75 / Liquid Limit □ (%) □ 25 50 75	Monitoring Well Details
61 ft (18.6 m)	**INFERRED GLACIAL TILL**	81.56 / 18.60							

Depth scale: 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78 (ft); 19, 20, 21, 22, 23 (m)

SPT N values (top to bottom): 17, 21, 20, 14, 20, 15, 15, 15, 15, 13, 18, 15, 15, 16, 17, 17, 16, 27, 35, 47

NOTES

Borehole Log (continued): BH2

LRL ASSOCIATES • ASSOCIÉS ENGINEERS INGÉNIEURS

Project No.: 220487
Project: Proposed Warehouse
Client: Entrepreneur Holding Corp.
Location: 363 Entrepreneur Cres. Vars ON
Date: November 17, 2022
Field Personnel: BJ
Driller: CCC Geotech and Enviro Drilling
Drilling Equipment: Track Mount CME 75
Drilling Method: Hollow Stew Auger

Depth (ft)	Depth (m)	Soil Description	Elev./Depth (m)	Type	Sample Number	N or RQD	Recovery (%)	Shear Strength (kPa) 50 150 / SPT N Value (Blows/0.3 m) 20 40 60 80	Water Content (%) 25 50 75 / Liquid Limit (%) 25 50 75	Monitoring Well Details
79								44		
80			75.67 24.50					50		
81		End of Borehole								
82	25									
83										
84										
85	26									
86										
87										
88										
89	27									
90										
91										
92	28									
93										
94										
95	29									
96										
97										
98										

NOTES

Borehole Log: BH3

Project No.: 220487 | **Project:** Proposed Warehouse

Client: Entrepreneur Holding Corp. | **Location:** 363 Entrepreneur Cres. Vars ON

Date: November 17, 2022 | **Field Personnel:** BJ

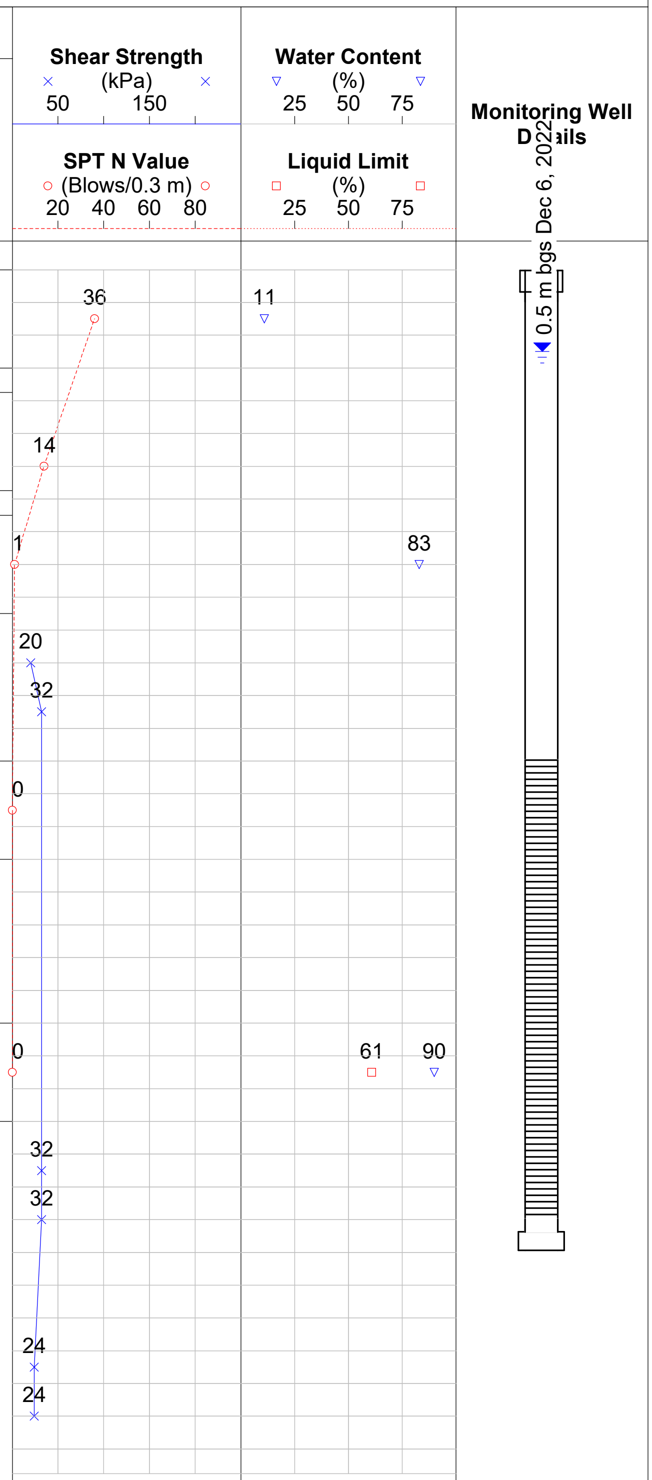
Driller: CCC Geotech and Enviro Drilling | **Drilling Equipment:** Track Mount CME 75 | **Drilling Method:** Hollow Stew Auger

SUBSURFACE PROFILE

Soil Description	Elev./Depth (m)
Ground Surface	100.18
FILL MATERIAL crushed stone, grey, moist, dense.	100.18 / 0.00
SILTY SAND brown, moist, compact.	99.49 / 0.69
CLAYEY SILT trace sand, grey, very soft, wet. -Sand seam at about 3.65 m bgs	98.73 / 1.45
SILTY CLAY grey, very soft, wet.	96.06 / 4.12
End of Borehole	93.18 / 7.00

SAMPLE DATA

Sample Number	N or RQD	Recovery (%)
SS1	36	50
SS2	14	50
SS3	1	100
SS4	WH	100
SS5	WH	100



Easting: 465745 m | **Northing:** 5020920 m

NOTES:

Site Datum: TBM - Top of Culvert located at Southwest of Driveway entrance. (100.00 m)

Groundsurface Elevation: 100.180 m | **Top of Riser Elev.:** NA

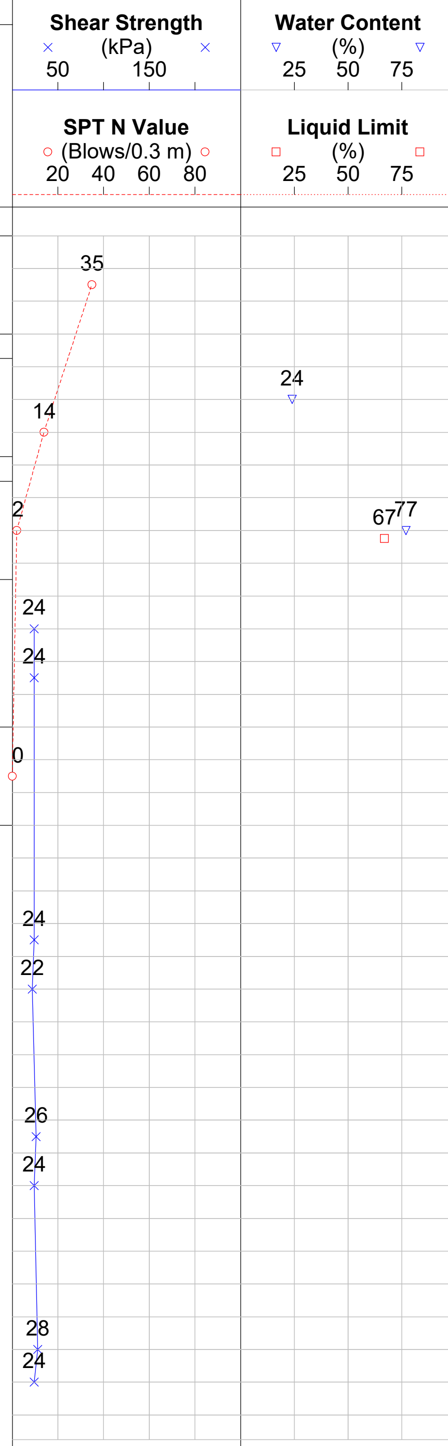
Hole Diameter: 200 mm | **Monitoring Well Diameter:** 19 mm

Borehole Log: BH4

Project No.: 220487	**Project:** Proposed Warehouse
Client: Entrepreneur Holding Corp.	**Location:** 363 Entrepreneur Cres. Vars ON
Date: November 17, 2022	**Field Personnel:** BJ

Driller: CCC Geotech and Enviro Drilling **Drilling Equipment:** Track Mount CME 75 **Drilling Method:** Hollow Stew Auger

SUBSURFACE PROFILE		SAMPLE DATA						
Depth (ft / m)	Soil Description	Elev./Depth (m)	Type	Sample Number	N or RQD	Recovery (%)	Shear Strength (kPa) / SPT N Value (Blows/0.3 m); Water Content (%) / Liquid Limit (%)	Monitoring Well Details
0 / 0	Ground Surface	100.22						
0–2 ft	**FILL MATERIAL** crushed stone, grey, moist, dense.	0.00	Split spoon	SS1	35	33		
2 ft	**SILTY SAND** brown, moist, compact.	99.63 / 0.60	Split spoon	SS2	14	50		
5 ft	**CLAYEY SILT** trace sand, grey, firm to very soft, wet.	98.77 / 1.45	Split spoon	SS3	2	100		
			Split spoon	SS4	WH	100		
13.5 ft	**SILTY CLAY** grey, very soft, wet.	96.10 / 4.12						
23 ft / 7 m	End of Borehole	93.22 / 7.00						



Easting: 465770 m	**Northing:** 5020920 m

NOTES:

Site Datum: TBM - Top of Culvert located at Southwest of Driveway entrance. (100.00 m)

Groundsurface Elevation: 100.225 m	**Top of Riser Elev.:** NA
Hole Diameter: 200 mm	**Monitoring Well Diameter:** N/A

LRL ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

BOREHOLE LOG: BH23-1

PROJECT NO.: 220487
PROJECT: PHASE II ENVIRONMENTAL SITE ASSESSMENT
CLIENT: ENTREPRENEUR HOLDING CORPORATION
LOCATION: 363 ENTREPRENEUR CRESCENT, OTTAWA, ONTARIO
DATE: MARCH 14, 2023
FIELD PERSONNEL: ABDUL KADER

DRILLER: GEORGE DOWNING ESTATE DRILLING LTD.
DRILLING EQUIPMENT: TRACK MOUNTED GEO-PROBE
DRILLING METHOD: DIRECT PUSH

DEPTH (M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	LITHOLOGY	TYPE	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS	Combustible Soil Vapours (ppm) / ISOBUTYLENE (ppm)	MONITORING WELL DETAILS
0.0		99.88								
0.0 – 0.85	**FILL:** Sand and gravel, grey, loose, moist, saturated at (0.0 - 0.2 m bgs).	0.00 / 99.03			SS1 (SS50)		100	PHC, VOC, Metals & General Inorganics	0.1	
0.85 – 1.20	**SAND:** Silty, brown, moist becoming saturated with depth.	0.85 / 98.68			SS2				<0.1	
1.20 – 6.0	**CLAY:** Silty at (1.20 - 1.95 m bgs) and at (3.65 - 4.50 m bgs), grey, brown at (1.20 - 1.95 m bgs), saturated.	1.20			SS3		100	PHC & VOC	<0.1	
					SS4			PAH & PCB	<0.1	
					SS5		100		<0.1	
					SS6				<0.1	
					SS7		100		<0.1	
					SS8				<0.1	
					SS9		100		<0.1	
					SS10				<0.1	
6.0	End of Borehole	93.88 / 6.0								

Depth scale: FT 0.0 – 20.0; M 0.0 – 6.0

Combustible Soil Vapours (ppm): 10, 30, 50, 70, 90
ISOBUTYLENE (ppm): 200, 600, 1000, 1400, 1800

EASTING: 18T 0465761
NORTHING: 5020902
SITE DATUM: Elevations measured from temporary benchmark established at the top surface of the Entrepreneur Crescent Centerline opposite the the Site entrance (100.00 m).
GROUNDSURFACE ELEVATION: 99.88 m
TOP OF RISER ELEVATION: N/A
HOLE DIAMETER: 91 mm
MONITORING WELL DIAMETER: N/A

NOTES:
bgs: Below Ground Surface
VOC: Volatile Organic Compounds
PHC: Petroleum Hydrocarbons
PAH: Polycyclic Aromatic Hydrocarbons
PCB: Polychlorinated Biphenyls
N/A: Not applicable

BOREHOLE LOG: BH/MW23-2

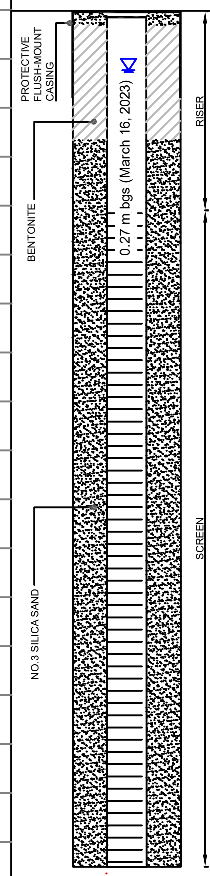
LRL ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

PROJECT NO.: 220487
PROJECT: PHASE II ENVIRONMENTAL SITE ASSESSMENT
CLIENT: ENTREPRENEUR HOLDING CORPORATION
LOCATION: 363 ENTREPRENEUR CRESCENT, OTTAWA, ONTARIO
DATE: MARCH 14, 2023
FIELD PERSONNEL: ABDUL KADER
DRILLER: GEORGE DOWNING ESTATE DRILLING LTD.
DRILLING EQUIPMENT: TRACK MOUNTED GEO-PROBE
DRILLING METHOD: DIRECT PUSH

DEPTH (M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS	Combustible Soil Vapours (ppm)
0.0	**FILL:** Sand and gravel, grey, loose, moist, saturated at (0.0 - 0.2 m bgs).	99.90 / 0.00	SS1 (SS40)		100	PHC, VOC, Metals & General Inorganics	0.2
	SAND: Silty, brown, moist.	99.05 / 0.85	SS2				<0.1
	CLAY: Silty at (1.20 - 1.95 m bgs) and at (3.60 - 4.80 m bgs), brown becoming grey at (1.95 m bgs), saturated.	98.70 / 1.20	SS3		100		<0.1
			SS4				<0.1
			SS5		100		<0.1
			SS6				<0.1
			SS7		100		<0.1
			SS8				<0.1
			SS9		100		<0.1
			SS10				<0.1
6.0	End of Borehole	93.90 / 6.0					

Depth scale: FT 0.0–20.0; M 0.0–6.0. Combustible Soil Vapours (ppm): 10, 30, 50, 70, 90. ISOBUTYLENE (ppm): 200, 600, 1000, 1400, 1800.

MONITORING WELL DETAILS



Groundwater samples collected March 16, 2023 were submitted for laboratory analysis of VOC, PHC, PAH, Metals, Metals hydrides, and General Inorganics.

EASTING: 18T 0465753
NORTHING: 5020904
SITE DATUM: Elevations measured from temporary benchmark established at the top surface of the Entrepreneur Crescent Centerline opposite the the Site entrance (100.00 m).
GROUNDSURFACE ELEVATION: 99.90 m
TOP OF RISER ELEVATION: N/A
HOLE DIAMETER: 91 mm
MONITORING WELL DIAMETER: N/A

NOTES:
bgs: Below Ground Surface
VOC: Volatile Organic Compounds
PHC: Petroleum Hydrocarbons
PAH: Polycyclic Aromatic Hydrocarbons
PCB: Polychlorinated Biphenyls
N/A: Not applicable

BOREHOLE LOG: BH/MW23-3

LRL ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

PROJECT NO.: 220487 **PROJECT:** PHASE II ENVIRONMENTAL SITE ASSESSMENT

CLIENT: ENTREPRENEUR HOLDING CORPORATION **LOCATION:** 363 ENTREPRENEUR CRESCENT, OTTAWA, ONTARIO

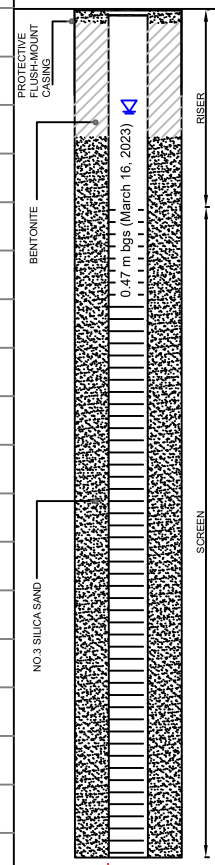
DATE: MARCH 14, 2023 **FIELD PERSONNEL:** ABDUL KADER

DRILLER: GEORGE DOWNING ESTATE DRILLING LTD. **DRILLING EQUIPMENT:** TRACK MOUNTED GEO-PROBE **DRILLING METHOD:** DIRECT PUSH

DEPTH (M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS	Combustible Soil Vapours (ppm)
0.0		99.88					
0.0 – 0.85	**FILL:** Sand and gravel, grey, loose, moist, saturated at (0.0 - 0.2 m bgs).	0.00	SS1		69	PHC, VOC, Metals & General Inorganics	0.1
0.85 – 1.20	**SAND:** Silty, green, moist.	99.03 / 0.85	SS2			PHC & VOC	<0.1
1.20 – 6.0	**CLAY:** Silty at (1.20 - 1.95 m bgs) and at (3.60 - 4.25 m bgs), brown becoming grey at (1.95 m bgs), some red at (1.95 - 2.4 m bgs) and at (4.25 - 4.8 m bgs), saturated.	98.68 / 1.20	SS3		100	Metals & General Inorganics	<0.1
			SS4			PAH & PCB	<0.1
			SS5		100		<0.1
			SS6				<0.1
			SS7		100		<0.1
			SS8				<0.1
			SS9		100		<0.1
			SS10				<0.1
6.0	End of Borehole	93.88 / 6.0					

Combustible Soil Vapours (ppm): 10, 30, 50, 70, 90
ISOBUTYLENE (ppm): 200, 600, 1000, 1400, 1800

MONITORING WELL DETAILS



Groundwater samples collected March 16, 2023 were submitted for laboratory analysis of VOC, PHC, PAH, Metals, Metals hydrides, and General Inorganics.

EASTING: 18T 0465763 **NORTHING:** 5020877

SITE DATUM: Elevations measured from temporary benchmark established at the top surface of the Entrepreneur Crescent Centerline opposite the the Site entrance (100.00 m).

GROUNDSURFACE ELEVATION: 99.88 m **TOP OF RISER ELEVATION:** N/A

HOLE DIAMETER: 91 mm **MONITORING WELL DIAMETER:** N/A

NOTES:
bgs: Below Ground Surface
VOC: Volatile Organic Compounds
PHC: Petroleum Hydrocarbons
PAH: Polycyclic Aromatic Hydrocarbons
PCB: Polychlorinated Biphenyls
N/A: Not applicable

BOREHOLE LOG: BH/MW23-4

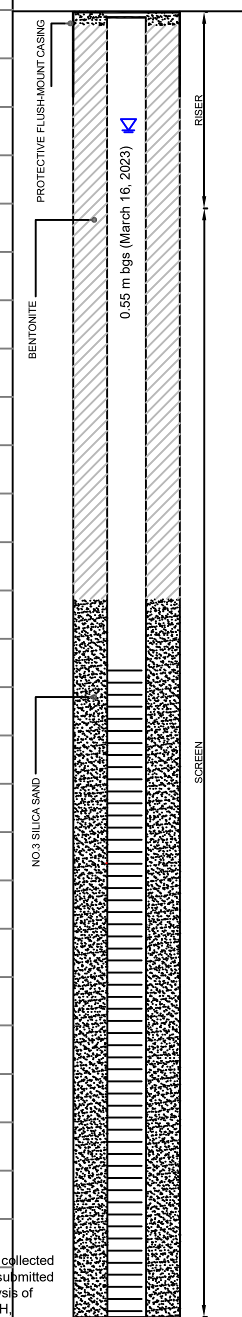
LRL ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

PROJECT NO.: 220487
PROJECT: PHASE II ENVIRONMENTAL SITE ASSESSMENT
CLIENT: ENTREPRENEUR HOLDING CORPORATION
LOCATION: 363 ENTREPRENEUR CRESCENT, OTTAWA, ONTARIO
DATE: MARCH 13, 2023
FIELD PERSONNEL: ABDUL KADER

DRILLER: GEORGE DOWNING ESTATE DRILLING LTD. **DRILLING EQUIPMENT:** TRACK MOUNTED GEO-PROBE **DRILLING METHOD:** DIRECT PUSH

DEPTH (FT / M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	LITHOLOGY	TYPE	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS	Combustible Soil Vapours (ppm) 10 30 50 70 90 / ISOBUTYLENE (ppm) 200 600 1000 1400 1800
0.0 FT / 0.0 M		99.87							
	FILL: Sand and gravel, grey, loose, moist, saturated at (0.0 - 0.2 m bgs).	0.00			SS1		65	Metals & General Inorganics	0.1
1.0 M	**SAND:** Silty, brown, moist.	98.87 / 1.0			SS2			PHC & Metals	<0.1
	CLAY: Silty sandy at (1.20 - 2.0 m bgs), silty at (3.60 - 4.25 m bgs), brown becoming grey at (2.0 m bgs), saturated.	98.67 / 1.20			SS3		100	Metals & General Inorganics	<0.1
					SS4			PAH & PCB	<0.1
					SS5		100		<0.1
					SS6				<0.1
					SS7		100		<0.1
					SS8				<0.1
					SS9		100		<0.1
					SS10				<0.1
20.0 FT / 6.0 M	End of Borehole	93.87 / 6.0							

MONITORING WELL DETAILS



Groundwater samples collected March 16, 2023 were submitted for laboratory analysis of VOC, PHC, PAH, Metals, Metals hydrides, and General Inorganics.

EASTING: 18T 0465769 **NORTHING:** 5020895
SITE DATUM: Elevations measured from temporary benchmark established at the top surface of the Entrepreneur Crescent Centerline opposite the the Site entrance (100.00 m).
GROUNDSURFACE ELEVATION: 99.87 m **TOP OF RISER ELEVATION:** N/A
HOLE DIAMETER: 91 mm **MONITORING WELL DIAMETER:** N/A

NOTES:
bgs: Below Ground Surface
VOC: Volatile Organic Compounds
PHC: Petroleum Hydrocarbons
PAH: Polycyclic Aromatic Hydrocarbons
PCB: Polychlorinated Biphenyls
N/A: Not applicable

BOREHOLE LOG: BH/MW23-5

LRL
ENGINEERING | INGENIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

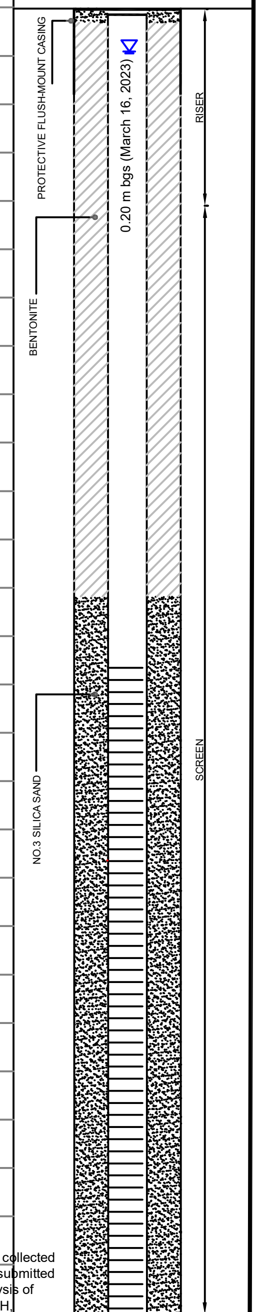
PROJECT NO.: 220487
PROJECT: PHASE II ENVIRONMENTAL SITE ASSESSMENT
CLIENT: ENTREPRENEUR HOLDING CORPORATION
LOCATION: 363 ENTREPRENEUR CRESCENT, OTTAWA, ONTARIO
DATE: MARCH 13, 2023
FIELD PERSONNEL: ABDUL KADER

DRILLER: GEORGE DOWNING ESTATE DRILLING LTD. **DRILLING EQUIPMENT:** TRACK MOUNTED GEO-PROBE **DRILLING METHOD:** DIRECT PUSH

DEPTH (M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	LITHOLOGY	TYPE	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS	Combustible Soil Vapours (ppm)
0.0 – 1.0	**FILL:** Sand and gravel, brown at (0.0 - 0.2 m bgs) followed by grey to (0.9 m bgs) followed by red stone to (1.0 m bgs), moist.	99.89 / 0.00 – 98.89 / 1.0			SS2 (SS20)		75	PHC, VOC, Metals & General Inorganics	0.3
1.0 – 1.20	**SAND:** Silty, brown, moist.	98.89 / 1.0 – 98.69 / 1.20			SS2				0.2
1.20 – 6.0	**CLAY:** Silty at (1.20 - 1.75 m bgs), brown becoming grey at (1.75 m bgs), some red, saturated.	98.69 / 1.20 – 93.89 / 6.0			SS3		100	PHC, VOC, & Metals	0.1
					SS4				<0.1
					SS5		100		<0.1
					SS6				<0.1
					SS7		100		<0.1
					SS8				<0.1
					SS9		100		<0.1
					SS10				<0.1
6.0	End of Borehole								

Combustible Soil Vapours (ppm): 10, 30, 50, 70, 90
ISOBUTYLENE (ppm): 200, 600, 1000, 1400, 1800

MONITORING WELL DETAILS



Groundwater samples collected March 16, 2023 were submitted for laboratory analysis of VOC, PHC, PAH, Metals, Metals hydrides, and General Inorganics.

EASTING: 18T 0465749 **NORTHING:** 5020933

SITE DATUM: Elevations measured from temporary benchmark established at the top surface of the Entrepreneur Crescent Centerline opposite the the Site entrance (100.00 m).

GROUNDSURFACE ELEVATION: 99.89 m **TOP OF RISER ELEVATION:** N/A
HOLE DIAMETER: 91 mm **MONITORING WELL DIAMETER:** N/A

NOTES:
bgs: Below Ground Surface
VOC: Volatile Organic Compounds
PHC: Petroleum Hydrocarbons
PAH: Polycyclic Aromatic Hydrocarbons
PCB: Polychlorinated Biphenyls
N/A: Not applicable

BOREHOLE LOG: BH23-6

LRL ENGINEERING | INGÉNIERIE
5430 Canotek Road| Ottawa, ON, K1J 9G2
www.lrl.ca| (613) 842-3434

PROJECT NO.: 220487
CLIENT: ENTREPRENEUR HOLDING CORPORATION
DATE: MARCH 13, 2023

PROJECT: PHASE II ENVIRONMENTAL SITE ASSESSMENT
LOCATION: 363 ENTREPRENEUR CRESCENT, OTTAWA, ONTARIO
FIELD PERSONNEL: ABDUL KADER

DRILLER: GEORGE DOWNING ESTATE DRILLING LTD. **DRILLING EQUIPMENT:** TRACK MOUNTED GEO-PROBE **DRILLING METHOD:** DIRECT PUSH

DEPTH (FT / M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	LITHOLOGY	TYPE	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS	Combustible Soil Vapours (ppm) / ISOBUTYLENE (ppm)	MONITORING WELL DETAILS
0.0 / 0.0		99.90 / 0.00								
	FILL: Sand and gravel, brown at (0.0 - 0.35 m bgs) followed by grey to (0.85 m bgs), dry, loose.				SS1		100		0.1	
	SAND: Silty, brown, moist.	99.05 / 0.85			SS2			PHC, VOC, Metals & General Inorganics	0.1	
	CLAY: Silty sandy at (1.20 - 1.9 m bgs), silty at (4.8 - 6.0 m bgs), brown becoming grey with depth, saturated, the sampling tube was empty at (3.6 - 4.8 m bgs) due to high water content.	98.70 / 1.20			SS3		100		<0.1	
					SS4				<0.1	
					SS5		100		<0.1	
					SS6				<0.1	
					SS7		100		<0.1	
					SS8				<0.1	
20.0 / 6.0	End of Borehole	93.90 / 6.0								

Combustible Soil Vapours (ppm) scale: 10, 30, 50, 70, 90. ISOBUTYLENE (ppm) scale: 200, 600, 1000, 1400, 1800.

EASTING: 18T 0465743 **NORTHING:** 5020927
SITE DATUM: Elevations measured from temporary benchmark established at the top surface of the Entrepreneur Crescent Centerline opposite the the Site entrance (100.00 m).
GROUNDSURFACE ELEVATION: 99.90 m **TOP OF RISER ELEVATION:** N/A
HOLE DIAMETER: 91 mm **MONITORING WELL DIAMETER:** N/A

NOTES:
bgs: Below Ground Surface
VOC: Volatile Organic Compounds
PHC: Petroleum Hydrocarbons
PAH: Polycyclic Aromatic Hydrocarbons
PCB: Polychlorinated Biphenyls
N/A: Not applicable

BOREHOLE LOG: BH23-7

LRL ENGINEERING | INGÉNIERIE
5430 Canotek Road| Ottawa, ON, K1J 9G2
www.lrl.ca| (613) 842-3434

PROJECT NO.: 220487
CLIENT: ENTREPRENEUR HOLDING CORPORATION
DATE: MARCH 14, 2023

PROJECT: PHASE II ENVIRONMENTAL SITE ASSESSMENT
LOCATION: 363 ENTREPRENEUR CRESCENT, OTTAWA, ONTARIO
FIELD PERSONNEL: ABDUL KADER

DRILLER: GEORGE DOWNING ESTATE DRILLING LTD. **DRILLING EQUIPMENT:** TRACK MOUNTED GEO-PROBE **DRILLING METHOD:** DIRECT PUSH

DEPTH (M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	LITHOLOGY	TYPE	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS	Combustible Soil Vapours (ppm) / ISOBUTYLENE (ppm)	MONITORING WELL DETAILS
0.0		99.89 / 0.00								
0.0 – 1.0	**FILL:** Sand and gravel, grey, dry, moist at (0.0 - 0.1 m bgs).	98.89 / 1.0	Fill		SS1		71	PHC, VOC, Metals & General Inorganics	0.3	
1.0 – 1.20	**SAND:** Silty, brown, moist.	98.69 / 1.20	Sand		SS2				<0.1	
1.20 – 6.0	**CLAY:** Silty at (1.20 - 1.95 m bgs) and at (3.6 - 4.20 m bgs), grey, brown at (1.20 - 1.95 m bgs), some red at (1.20 - 2.4 m bgs) and at (4.8 - 6.0 m bgs), saturated.		Clay		SS3		100	Metals	<0.1	
					SS4				<0.1	
					SS5		100		<0.1	
					SS6				<0.1	
					SS7		100		<0.1	
					SS8				<0.1	
					SS9		100		<0.1	
					SS10				<0.1	
6.0	End of Borehole	93.89 / 6.0								

Depth scale: FT 0.0 – 20.0; M 0.0 – 6.0

Combustible Soil Vapours (ppm): 10, 30, 50, 70, 90
ISOBUTYLENE (ppm): 200, 600, 1000, 1400, 1800

EASTING: 18T 0465765 **NORTHING:** 5020919

SITE DATUM: Elevations measured from temporary benchmark established at the top surface of the Entrepreneur Crescent Centerline opposite the the Site entrance (100.00 m).

GROUNDSURFACE ELEVATION: 99.89 m **TOP OF RISER ELEVATION:** N/A
HOLE DIAMETER: 91 mm **MONITORING WELL DIAMETER:** N/A

NOTES:
bgs: Below Ground Surface
VOC: Volatile Organic Compounds
PHC: Petroleum Hydrocarbons
PAH: Polycyclic Aromatic Hydrocarbons
PCB: Polychlorinated Biphenyls
N/A: Not applicable

BOREHOLE LOG: BH23-8

LRL ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

PROJECT NO.: 220487
PROJECT: PHASE II ENVIRONMENTAL SITE ASSESSMENT
CLIENT: ENTREPRENEUR HOLDING CORPORATION
LOCATION: 363 ENTREPRENEUR CRESCENT, OTTAWA, ONTARIO
DATE: MARCH 13, 2023
FIELD PERSONNEL: ABDUL KADER

DRILLER: GEORGE DOWNING ESTATE DRILLING LTD. **DRILLING EQUIPMENT:** TRACK MOUNTED GEO-PROBE **DRILLING METHOD:** DIRECT PUSH

DEPTH (M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	LITHOLOGY	TYPE	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS	Combustible Soil Vapours (ppm) / ISOBUTYLENE (ppm)	MONITORING WELL DETAILS
0.0	**FILL:** Sand and gravel, grey, moist.	99.87 / 0.00			SS1		92		0.1	
0.80	**SAND:** Silty to (1.10 m bgs). followed by silty clayey, brown with some red spots, wet.	98.07 / 0.80			SS2			PHC, VOC, Metals & General Inorganics	<0.1	
1.20	**CLAY:** Silty at (1.20 - 1.95 m bgs), grey, grey-brown at (1.20 - 1.95 m bgs), some red at (1.95 - 2.4 m bgs), saturated.	98.67 / 1.20			SS3		100	Metals	<0.1	
					SS4				<0.1	
					SS5		100		<0.1	
					SS6				<0.1	
					SS7		100		<0.1	
					SS8				<0.1	
					SS9		100		<0.1	
					SS10				<0.1	
6.0	End of Borehole	93.87 / 6.0								

Depth scale: FT 0.0 – 20.0; M 0.0 – 6.0. Combustible Soil Vapours (ppm) axis: 10, 30, 50, 70, 90. ISOBUTYLENE (ppm) axis: 200, 600, 1000, 1400, 1800.

EASTING: 18T 0465756 **NORTHING:** 5020940

SITE DATUM: Elevations measured from temporary benchmark established at the top surface of the Entrepreneur Crescent Centerline opposite the the Site entrance (100.00 m).

GROUNDSURFACE ELEVATION: 99.87 m **TOP OF RISER ELEVATION:** N/A
HOLE DIAMETER: 91 mm **MONITORING WELL DIAMETER:** N/A

NOTES:
bgs: Below Ground Surface
VOC: Volatile Organic Compounds
PHC: Petroleum Hydrocarbons
PAH: Polycyclic Aromatic Hydrocarbons
PCB: Polychlorinated Biphenyls
N/A: Not applicable

BOREHOLE LOG: BH23-9

LRL ENGINEERING | INGÉNIERIE
5430 Canotek Road| Ottawa, ON, K1J 9G2
www.lrl.ca| (613) 842-3434

PROJECT NO.: 220487
PROJECT: PHASE II ENVIRONMENTAL SITE ASSESSMENT
CLIENT: ENTREPRENEUR HOLDING CORPORATION
LOCATION: 363 ENTREPRENEUR CRESCENT, OTTAWA, ONTARIO
DATE: MARCH 14, 2023
FIELD PERSONNEL: ABDUL KADER

DRILLER: GEORGE DOWNING ESTATE DRILLING LTD.
DRILLING EQUIPMENT: TRACK MOUNTED GEO-PROBE
DRILLING METHOD: DIRECT PUSH

DEPTH (M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	LITHOLOGY	TYPE	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS	Combustible Soil Vapours (ppm) / ISOBUTYLENE (ppm)	MONITORING WELL DETAILS
0.0		99.89								
0.0 – 1.0	**FILL:** Sand and gravel, grey, dry, moist at (0.0 - 0.1 m bgs).	0.00 / 98.89			SS1		92	PHC, VOC, Metals & General Inorganics	<0.1	
1.0 – 1.20	**SAND:** Silty, brown, moist.	1.0 / 98.69			SS2				<0.1	
1.20 – 2.4	**CLAY:** Silty at (1.20 - 1.85 m bgs), grey-brown with some red at (1.20 - 1.85 m bgs) followed by grey at (1.85 - 2.4 m bgs), saturated.	1.20 / 97.49			SS3		100		<0.1	
					SS4				<0.1	
2.4	End of Borehole	2.4								

Combustible Soil Vapours scale (ppm): 10, 30, 50, 70, 90
ISOBUTYLENE scale (ppm): 200, 600, 1000, 1400, 1800
Depth scale: FT 0.0 – 20.0; M 0.0 – 6.0

EASTING: 18T 0465765
NORTHING: 5020921
SITE DATUM: Elevations measured from temporary benchmark established at the top surface of the Entrepreneur Crescent Centerline opposite the the Site entrance (100.00 m).
GROUNDSURFACE ELEVATION: 99.89 m
TOP OF RISER ELEVATION: N/A
HOLE DIAMETER: 91 mm
MONITORING WELL DIAMETER: N/A

NOTES:
bgs: Below Ground Surface
VOC: Volatile Organic Compounds
PHC: Petroleum Hydrocarbons
PAH: Polycyclic Aromatic Hydrocarbons
PCB: Polychlorinated Biphenyls
N/A: Not applicable

BOREHOLE LOG: BH23-10

LRL ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

PROJECT NO.: 220487
PROJECT: PHASE II ENVIRONMENTAL SITE ASSESSMENT
CLIENT: ENTREPRENEUR HOLDING CORPORATION
LOCATION: 363 ENTREPRENEUR CRESCENT, OTTAWA, ONTARIO
DATE: MARCH 14, 2023
FIELD PERSONNEL: ABDUL KADER
DRILLER: GEORGE DOWNING ESTATE DRILLING LTD.
DRILLING EQUIPMENT: TRACK MOUNTED GEO-PROBE
DRILLING METHOD: DIRECT PUSH

DEPTH (M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	LITHOLOGY	TYPE	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS	Combustible Soil Vapours (ppm) / ISOBUTYLENE (ppm)	MONITORING WELL DETAILS
0.0	**FILL:** Sand and gravel, grey, dry, moist at (0.0 - 0.1 m bgs).	99.88 / 0.00			SS1		90	PHC, VOC, Metals & General Inorganics	<0.1	
0.85	**SAND:** Silty, brown, moist.	99.03 / 0.85			SS2			Metals	<0.1	
1.20	**CLAY:** Silty at (1.20 - 1.9 m bgs), grey-brown with some red at (1.20 - 1.9 m bgs), followed by grey with red at (1.9 - 2.4 m bgs), saturated.	98.68 / 1.20			SS3		100		<0.1	
					SS4				<0.1	
2.4	End of Borehole	97.48 / 2.4								

Depth scale: FT 0.0–20.0; M 0.0–6.0
Combustible Soil Vapours (ppm) scale: 10, 30, 50, 70, 90
ISOBUTYLENE (ppm) scale: 200, 600, 1000, 1400, 1800

EASTING: 18T 0465761
NORTHING: 5020893
SITE DATUM: Elevations measured from temporary benchmark established at the top surface of the Entrepreneur Crescent Centerline opposite the the Site entrance (100.00 m).
GROUNDSURFACE ELEVATION: 99.88 m
TOP OF RISER ELEVATION: N/A
HOLE DIAMETER: 91 mm
MONITORING WELL DIAMETER: N/A

NOTES:
bgs: Below Ground Surface
VOC: Volatile Organic Compounds
PHC: Petroleum Hydrocarbons
PAH: Polycyclic Aromatic Hydrocarbons
PCB: Polychlorinated Biphenyls
N/A: Not applicable

ATTACHMENT C

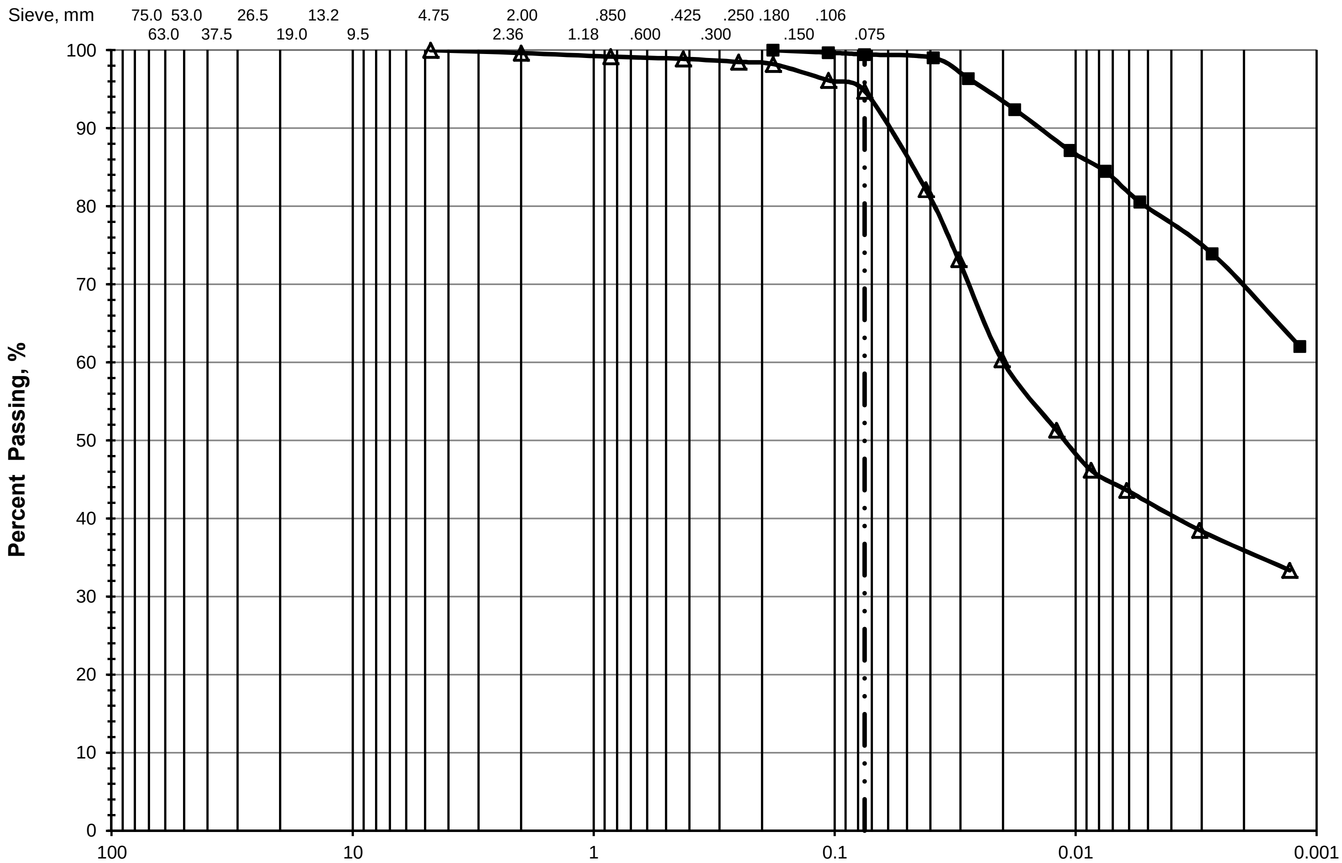
Gradation Analytical Report

LRL Associates Ltd.

PARTICLE SIZE ANALYSIS

ASTM D 422 / LS-702

Client:	Entrepreneur Holding Corporation	**File No.:**	220487
Project:	Geotechnical Investigation	**Report No.:**	2
Location:	363 Entrepreneur Crescent, Navan, ON.	**Date:**	November 17, 2022



Unified Soil Classification System

	> 75 mm	% GRAVEL		% SAND			% FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
△	0.0	0.0	0.0	0.4	0.8	4.1	59.3	35.4
■	0.0	0.0	0.0	0.0	0.0	0.6	31.0	68.4

	Location	Sample	Depth, m	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
△	BH 1	SS-3	1.52 - 2.13	0.0199	0.0111					
■	BH 2	SS-7	6.10 - 6.71							

ATTACHMENT D

MECP Water Well Records

on-site well

Ontario — Ministry of the Environment, Conservation and Parks

Tag#:A379014 (Print Below)

A379014

Well Record

Regulation 903 Ontario Water Resources Act

Page ____ of ____

Measurements recorded in: ☐ Metric ☒ Imperial

Well Owner's Information

First Name	Last Name/Organization	E-mail Address	☐ Well Constructed by Well Owner
	Dustin Wilson		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
310 Sanctuary Private	Ottawa	ON	K1S 5W1	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
363 Entrepreneur Crescent	Cumberland	23	11

County/District/Municipality	City/Town/Village	Province	Postal Code
Ottawa Carleton	Navan	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	465760	5020936	50R-6694	

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	To
	Clay			0'	86'
	Gravel			86'	92'
Black	~~Sandstone~~ Shale			92'	154'
Black	~~Sandstone~~ Shale			154'	160'

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
98'	88'	Neat cement	12.48
88'	0'	Bentonite slurry	21.00

Results of Well Yield Testing

After test of well yield, water was: ☐ Clear and sand free ☐ Other, specify Not tested

If pumping discontinued, give reason: X

Pump intake set at (m/ft): 150

Pumping rate (l/min / GPM): 15

Duration of pumping: 1 hrs + 0 min

Final water level end of pumping (m/ft): 103.2"

If flowing give rate (l/min/GPM): X

Recommended pump depth (m/ft): 150'

Recommended pump rate (l/min/GPM): 10

Well production (l/min/GPM): 15

Disinfected? ☒ Yes ☐ No

Draw Down Time (min)	Water Level (m/ft)	Recovery Time (min)	Water Level (m/ft)
Static Level	9'2"		103.2"
1	22.4	1	87
2	31.9	2	78.6
3	37.5	3	71.1
4	42.2	4	63.8
5	46.4	5	57.4
10	61.7	10	32.8
15	71.9	15	19.7
20	79.4	20	11.3
25	85.1	25	9.5
30	89.9	30	9.2
40	97	40	9.2
50	100.9	50	9.2
60	103.2"	60	9.2"

Method of Construction

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

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	To
6 1/4"	Steel	.188"	+2'	98'
6"	Open Hole		98'	160'

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

Construction Record - Screen

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

Water Details

Water found at Depth 154 (m/ft) ☐ Gas — Kind of Water: ☐ Fresh ☒ Untested ☐ Other, specify

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

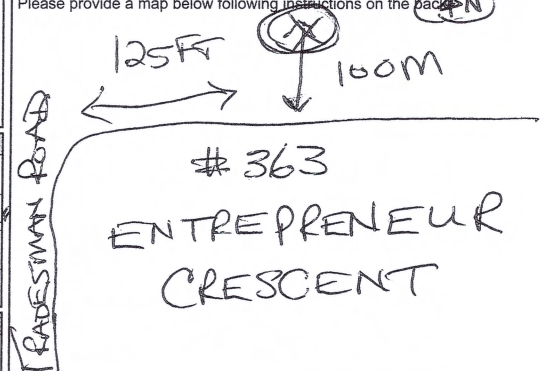
Water found at Depth (m/ft) ☐ Gas — Kind of Water: ☐ Fresh ☐ Untested ☐ Other, specify

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0'	98'	9 3/4"
98'	160'	6"

Map of Well Location

Please provide a map below following instructions on the back. N



Comments: 3/4HP-10GPM Set @ 150 FT

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Air Rock Drilling Co. Ltd.	C7681

Business Address (Street Number/Name)	Municipality
6659 Franktown Road	Richmond

Province	Postal Code	Business E-mail Address
ON	K0A 2Z0	air-rock@sympatico.ca

Bus.Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
6138382170	Hanna, Jeremy

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
T3632		2023 09 29

Well owner's information package delivered ☒ Yes ☐ No

Date Package Delivered 2023 08 28

Date Work Completed ~~2023~~ 20230823

Ministry Use Only — Audit No. Z408138 — Received

Ministry of the Environment

Ontario

OTTAWA - CARLETON

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

The Ontario Water Resources Act
WATER WELL RECORD

11 1525164 MUNICIP. 15002 CON. CON 09

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON. BLOCK, TRACT, SURVEY, ETC.	LOT 25-27
[redacted]	[redacted]cester	9	1

[redacted] rlesbad Springs

DATE COMPLETED 48-53: DAY 3 MO 5 YR 90

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
Yellow	Sand	Loam	Loose	0	2
Blue	Clay		Dense	2	70
Grey	Till		Packed	70	77
Grey	Limestone		Layered	77	100

31

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
95	☒ 3 SULPHUR

51 CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
6 1/4	☒ 1 STEEL	188	0	77
6	☒ 4 OPEN HOLE		77	100

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.)
2	77	Clay

71 PUMPING TEST

PUMPING TEST METHOD	PUMPING RATE	DURATION OF PUMPING
☒ 1 PUMP ☐ 2 BAILER	25 GPM	1 HOURS 0 MINS

WATER LEVELS DURING: ☒ 1 PUMPING ☐ 2 RECOVERY

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
6 FEET	40 FEET	16 FEET	26 FEET	36 FEET	40 FEET

IF FLOWING, GIVE RATE	PUMP INTAKE SET AT	WATER AT END OF TEST
GPM	40 FEET	☐ 1 CLEAR ☒ 2 CLOUDY

RECOMMENDED PUMP TYPE	RECOMMENDED PUMP SETTING	RECOMMENDED PUMPING RATE
☐ SHALLOW ☒ DEEP	40 FEET	25 GPM

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

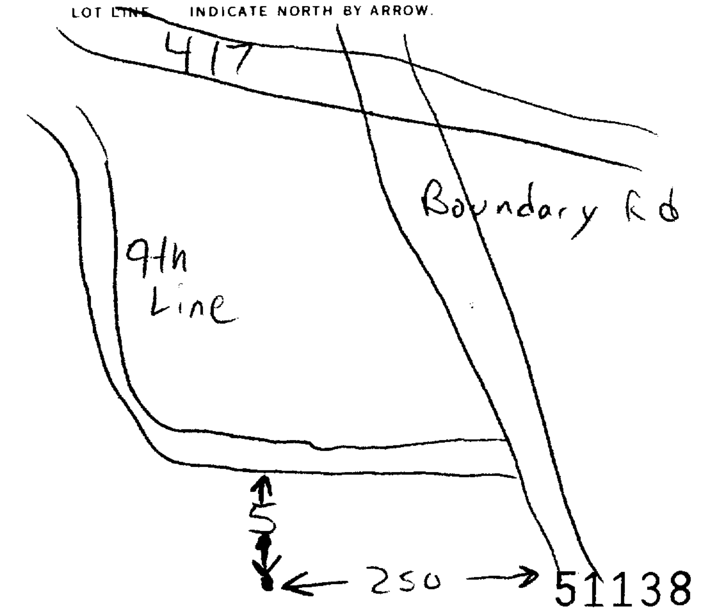
☐ 1 DOMESTIC; ☐ 2 STOCK; ☐ 3 IRRIGATION; ☐ 4 INDUSTRIAL; ☐ OTHER; ☒ 5 COMMERCIAL; ☐ 6 MUNICIPAL; ☐ 7 PUBLIC SUPPLY; ☐ 8 COOLING OR AIR CONDITIONING; ☐ 9 NOT USED

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

LOCATION OF WELL

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



51138

DRILLERS REMARKS

CONTRACTOR

NAME OF WELL CONTRACTOR	WELL CONTRACTOR'S LICENCE NUMBER
Roy's LBR Ltd	4609

ADDRESS: Cornwall

NAME OF WELL TECHNICIAN	WELL TECHNICIAN'S LICENCE NUMBER
Roger Roy	T-0330

SIGNATURE OF TECHNICIAN/CONTRACTOR | SUBMISSION DATE DAY ___ MO. ___ YR. ___

OFFICE USE ONLY

DATA SOURCE | CONTRACTOR 4609 | DATE RECEIVED DEC 04 1990

DATE OF INSPECTION | INSPECTOR

REMARKS

MINISTRY OF THE ENVIRONMENT COPY

FORM NO. 0506 (11/86) FORM 9

Ontario Ministry of the Environment

Well Tag Number (Place sticker and print number below)
A012415
A012415

Well Record

Regulation 903 Ontario Water Resources Act

page ___ of ___

Instructions for Completing Form

- For use in the **Province of Ontario** only. This document is a permanent **legal** document. Please retain for future reference.
- All Sections **must** be completed in full to avoid delays in processing. Further instructions and explanations are available on the back of this form.
- Questions regarding completing this application can be directed to the Water Well Management Coordinator at 416-235-6203.
- **All metre measurements shall be reported to 1/10th of a metre.**
- Please print clearly in blue or black ink only.

Ministry Use Only

MUN	CON	LOT
15002	OF	02

Well Owner's Information and Location of Well Information

[redacted]

Plan 50M-136 Pt BLK1 | Cumberland (Ottawa) | Pt 2-3 RP 50R26420

RR#/Street Number/Name	City/Town/Village	Site/Compartment/Block/Tract etc.
145 Endeum Rd. Carlsbad Springs	Carlsbad Spring	

GPS Reading	NAD	Zone	Easting	Northing	Unit Make/Model	Mode of Operation
	83	18	465747	5020692	Magellan	☐ Undifferentiated ☑ Averaged ☐ Differentiated, specify

Log of Overburden and Bedrock Materials (see instructions)

General Colour	Most common material	Other Materials	General Description	Depth (feet / ~~Metres~~) From	To
Brown	Sandy soil	clay		0	5
grey	clay			5	15
blue	clay			15	95
grey	hard pan	gravel		95	109
grey	rock			109	110

Hole Diameter

Depth From (Metres)	To	Diameter (Centimetres)
0	110	6"

Water Record

Water found at Metres	Kind of Water
110' m	☐ Fresh ☐ Sulphur ☐ Gas ☑ Salty ☐ Minerals ☐ Other:
m	☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:
m	☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

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

Chlorinated ☑ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth (Metres) From	To
Casing				
6 1/4	☑ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	188	0	109'
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☐ Open hole			

Test of Well Yield

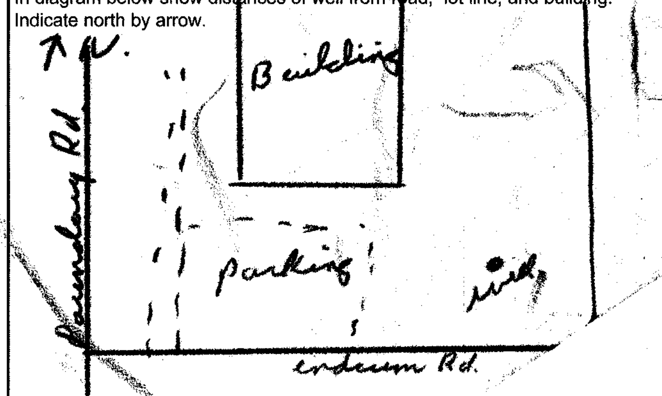
	Draw Down Time min	Water Level Metres	Recovery Time min	Water Level Metres
Pumping test method: Sub.				
Pump intake set at - (metres) 52'	Static Level	2.60		2.77
Pumping rate - (litres/min) 42	1	2.70	1	2.65
Duration of pumping: 1 hrs + ___ min	2	2.70	2	2.64
Final water level end of pumping ___ metres	3	2.70	3	2.63
Recommended pump type. ☐ Shallow ☑ Deep	4	2.72	4	2.62
Recommended pump depth. 50' ~~metres~~	5	2.72	5	2.61
Recommended pump rate. 50 (litres/min)	10	2.72	10	2.60
	15	2.74	15	2.60
If flowing give rate - (litres/min)	20	2.74	20	2.60
	25	2.75	25	2.60
If pumping discontinued, give reason.	30	2.75	30	2.60
	40	2.75	40	2.60
	50	2.76	50	2.60
	60	2.77	60	2.60

Plugging and Sealing Record ☑ Annular space ☐ Abandonment

Depth set at - Metres From	To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	30'	grout.	3 bag.

Location of Well

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



Method of Construction

☑ Cable Tool ☐ Rotary (air) ☐ Diamond ☐ Digging
☐ Rotary (conventional) ☐ Air percussion ☐ Jetting ☐ Other
☐ Rotary (reverse) ☐ Boring ☐ Driving

Water Use

☑ Domestic ☐ Industrial ☐ Public Supply ☐ Other
☐ Stock ☐ Commercial ☐ Not used
☐ Irrigation ☐ Municipal ☐ Cooling & air conditioning

Final Status of Well

☑ Water Supply ☐ Recharge well ☐ Unfinished ☐ Abandoned, (Other)
☐ Observation well ☐ Abandoned, insufficient supply ☐ Dewatering
☐ Test Hole ☐ Abandoned, poor quality ☐ Replacement well

Well Contractor/Technician Information

Name of Well Contractor	Well Contractor's Licence No.
Maurice Cayer Ltd	1517

Business Address (street name, number, city etc.): Casselman ont

Name of Well Technician (last name, first name)	Well Technician's Licence No.

Signature of Technician/Contractor: x Maurice Cayer
Date Submitted YYYY MM DD: 2004

Audit No. Z 12477

Date Well Completed YYYY MM DD: 2004 05 27

Was the well owner's information package delivered? ☑ Yes ☐ No

Date Delivered YYYY MM DD: 2004 05 27

Ministry Use Only

Data Source	Contractor 1517
Date Received YYYY MM DD: AUG 18 2004	Date of Inspection YYYY MM DD
Remarks	Well Record Number 1534876

0506E (09/03) Contractor's Copy ☐ Ministry's Copy ☐ Well Owner's Copy ☐ Cette formule est disponible en français

Ontario Ministry of the Environment

Well Tag Number (Place sticker and print number below)
A 053936
A053936

Well Record

Regulation 903 Ontario Water Resources Act

Instructions for Completing Form

- For use in the **Province of Ontario** only. This document is a permanent **legal** document. Please retain for future reference.
- All Sections **must** be completed in full to avoid delays in processing. Further instructions and explanations are available on the back of this form.
- Questions regarding completing this application can be directed to the Water Well Help Desk (Toll Free) at 1-888-396-9355.
- **All metre measurements shall be reported to 1/10th of a metre.**
- Please print clearly in blue or black ink only.

Ministry Use Only: MUN | CON | LOT

[redacted]

Address of Well Location (County/District/Municipality)	Township	Lot	Concession
OTTAWA - City	Cumberland	2	11

RR#/Street Number/Name	City/Town/Village	Site/Compartment/Block/Tract etc.
120 Indcum	CARlsbad - ON	5OR-6420

GPS Reading	NAD	Zone	Easting	Northing	Unit Make/Model	Mode of Operation
	83	18	465723	5020642	Magellan	UTM; ☐ Undifferentiated ☑ Averaged ☐ Differentiated, specify

Log of Overburden and Bedrock Materials (see instructions)

General Colour	Most common material	Other Materials	General Description	Depth Metres From	Depth Metres To
Brown	Clay		Soft	0	0.90
Red	Clay		Soft	0.90	3.63
Grey	Clay		Soft	3.63	30.30
Grey	Gravel		Soft	30.30	31.51
Grey	SHALE		Porous	31.51	32.42

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	7.57	20.32

Water Record

Water found at Metres	Kind of Water
31.51 m	☐ Fresh ☑ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:
m	☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:
m	☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

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

Chlorinated ☑ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.55	☑ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	0.48	0	31.51
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen (Outside diam)	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
15.55	☑ Open hole		31.51	32.42

Test of Well Yield

	Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Pumping test method: Submersible	Static Level	2.89		3.04
Pump intake set at - (metres) 9.09	1	3.20	1	2.89
Pumping rate - (litres/min) 58.50	2	3.17	2	
Duration of pumping: 1 hrs + 00 min	3	3.12	3	
Final water level end of pumping 3.04 metres	4	3.10	4	
Recommended pump type: ☑ Shallow ☐ Deep	5	3.10	5	
Recommended pump depth: 9.09 metres	10	3.08	10	
Recommended pump rate: 45.50 (litres/min)	15	3.04	15	
If flowing give rate - (litres/min)	20	3.04	20	
	25	3.04	25	
If pumping discontinued, give reason.	30	3.04	30	
	40	3.04	40	
	50	3.04	50	
	60	3.04	60	

Plugging and Sealing Record

☑ Annular space ☐ Abandonment

Depth set at - Metres From	To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	7.57	Cement Grout	120 Kg.

Method of Construction

☐ Cable Tool ☑ Rotary (air) ☐ Diamond ☐ Digging ☐ Rotary (conventional) ☐ Air percussion ☐ Jetting ☐ Other ☐ Rotary (reverse) ☐ Boring ☐ Driving

Water Use

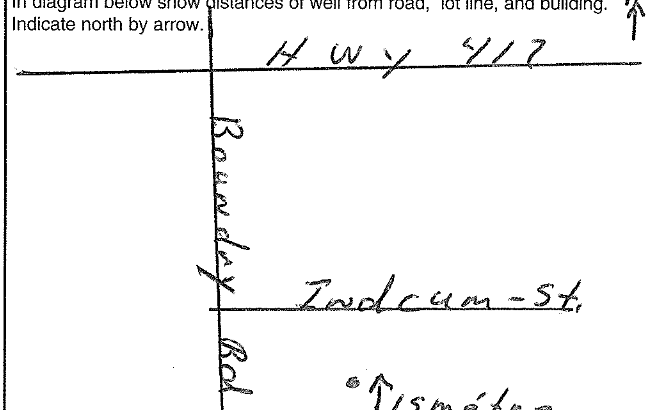
☑ Domestic ☐ Industrial ☐ Public Supply ☐ Other ☐ Stock ☑ Commercial ☐ Not used ☐ Irrigation ☐ Municipal ☐ Cooling & air conditioning

Final Status of Well

☑ Water Supply ☐ Recharge well ☐ Unfinished ☐ Abandoned, (Other) ☐ Observation well ☐ Abandoned, insufficient supply ☐ Dewatering ☐ Test Hole ☐ Abandoned, poor quality ☐ Replacement well

Location of Well

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



Audit No.	Date Well Completed (YYYY MM DD)
Z 71657	2007 04 26

Was the well owner's information package delivered? ☑ Yes ☐ No — Date Delivered (YYYY MM DD): 2007 04 26

Well Contractor/Technician Information

Name of Well Contractor	Well Contractor's Licence No.
DXR-WATER-well-Drilling	6006

Business Address (street name, number, city etc.): CP 98 - St-Albert - ON

Name of Well Technician (last name, first name)	Well Technician's Licence No.
Louis Desnoyers	T-625

Signature of Technician/Contractor: X [signature] — Date Submitted (YYYY MM DD): 2007 04 26

Ministry Use Only

Data Source	Contractor 6006
Date Received: MAY 09 2007	Date of Inspection
Remarks	Well Record Number

Ontario Ministry of the Environment

Measurements recorded in: ☒ Metric ☐ Imperial

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

Tag#: A145269 A145269

S-13834

Well Record

Regulation 903 Ontario Water Resources Act

Page ______ of ______

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
Capital Region Resources Recovery Centre Ltd.			

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
708 - 225 Metcalfe St.	Ottawa	ON	K2P1P9	6134545580

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
Frontier Rd.			

County/District/Municipality	City/Town/Village	Province	Postal Code
	OTTAWA	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	466097	5020251		

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	To
Brown	Sand.	organics	Soft Loose.	0	.91
Grey	Clay		Loose, Soft	.91	1.5

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	.31	Benseal.	
.31	1.5	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)	Water Level (m/ft)	Recovery Time (min)	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 Direct push

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	To
3.45	plastic	.356	0	.5

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

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To
4.21	plastic	10	.5	1.5

Map of Well Location

Please provide a map below following instructions on the back.

Labelled
13-14-3
S on Map

Water Details

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

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	1.5	11.43

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Strata Soil Sampling	7241

Business Address (Street Number/Name)	Municipality
2-147 West Beaver Creek Rd.	Richmond Hill

Province	Postal Code	Business E-mail Address
ON	L4B1C6	wrecords@stratasoil.com

Bus.Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
9057649304	Parsons Robert

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3722		20130328

Comments:

Well owner's information package delivered	Date Package Delivered	Date Work Completed
☐ Yes ☐ No	Y Y Y Y M M D D	20130326

Ministry Use Only

Audit No. Z152745

Received APR 30 2013

0506E (2007/12)

Ministry's Copy

S13834

C-7241
Z152745

APR 3 0 2013

Ontario Ministry of the Environment

Measurements recorded in: ☒ Metric ☐ Imperial

Well Tag No. (Place Sticker and/or Print Below)

Tag#: A145268

A145268

S-13834

Well Record

Regulation 903 Ontario Water Resources Act

Page ______ of ______

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
Capital Region	Resources Recovery Centre Ltd		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
708 - 225 Metcalfe St.	Ottawa	ON	K2P1P9	6134545580

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
Boundary Rd.			

County/District/Municipality	City/Town/Village	Province	Postal Code
	OTTAWA	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	466412	5020426		

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	To
Brown	Sand	organics	soft, loose.	0	.91
Grey	Clay		wet.	.91	6.4

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	3.96	Bonseal	
3.96	6.4	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)	Water Level (m/ft)	Recovery Time (min)	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 Direct push

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	To
3.45	plastic	.356	0	4.88

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

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To
4.21	plastic	10	4.88	6.4

Map of Well Location

Please provide a map below following instructions on the back.

Labelled 13-15-3
P on Map

Water Details

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

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	6.4	11.43

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Strata Soil Sampling	7241

Business Address (Street Number/Name)	Municipality
2-147 West Beaver Creek Rd.	Richmond Hill

Province	Postal Code	Business E-mail Address
ON	L4B1C6	wrecords@stratasoil.com

Bus.Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
9052649304	Parsons Robert

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3722	[signature]	20130328

Comments:

Well owner's information package delivered ☐ Yes ☐ No

Date Package Delivered Y Y Y Y M M D D

Date Work Completed 20130326

Ministry Use Only

Audit No. Z152746

Received APR 30 2013

0506E (2007/12) © Queen's Printer for Ontario, 2007

Ministry's Copy

5-13834

C-7241
2152746

APR 30 2013

Ontario Ministry of the Environment

Measurements recorded in: ☐ Metric ☐ Imperial

Well Tag No. *(Place Sticker and/or Print Below)*
A111206 ✓

13-6-3

Well Record

Regulation 903 Ontario Water Resources Act

Page ____ of ____

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
~~Golder~~	Capital Region Resource	–	

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. *(inc. area code)*
708 -225 Metcalfe St	Ottawa	ON	K2P 1P9	613 45 45580

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
5800 Frontier Rd	Ottawa		

County/District/Municipality	City/Town/Village	Province	Postal Code
Ottawa	Ottawa	Ontario	K0A 3H0

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	465914	5020386		

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	To
GRAY	CLAY	SAND TILL·ROCK		0	147'10"

Annular Space

Depth Set at *(m/ft)* From	To	Type of Sealant Used *(Material and Type)*	Volume Placed *(m³/ft³)*
		bentonite Tablets	
		bentonite-grout with portland	
		bentonite chips	

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)*	Water Level *(m/ft)*	Recovery Time *(min)*	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
☑ Rotary (Conventional)
☐ Rotary (Reverse)
☐ Boring
☐ Air percussion
☐ Other, *specify* ____
☐ Diamond
☐ Jetting
☐ Driving
☐ Digging

Well Use

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

Construction Record - Casing

Inside Diameter *(cm/in)*	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness *(cm/in)*	Depth *(m/ft)* From	To
2¼	PLASTIC	1/8	0	147'10"

Status of Well

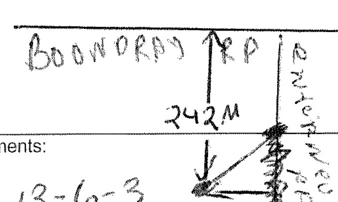
☐ Water Supply
☐ Replacement Well
☑ Test Hole
☐ Recharge Well
☐ Dewatering Well
☐ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, *specify* ____
☐ Other, *specify* ____

Construction Record - Screen

Outside Diameter *(cm/in)*	Material (Plastic, Galvanized, Steel)	Slot No.	Depth *(m/ft)* From	To

Map of Well Location

Please provide a map below following instructions on the back.



Comments:
13-6-3

Water Details

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

Hole Diameter

Depth *(m/ft)* From	To	Diameter *(cm/in)*

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Marathon Drilling Co ltd	6894

Business Address (Street Number/Name)	Municipality
6847 Hiram Dr	Greely

Province	Postal Code	Business E-mail Address
ON	K4P 1A2	mwebb@marathondrilling.ca

Bus.Telephone No. *(inc. area code)*	Name of Well Technician (Last Name, First Name)
6138220571	Webb Matthew

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3279		2013 03 25

Well owner's information package delivered	Date Package Delivered	Date Work Completed
☐ Yes ☐ No	Y Y Y Y M M D D	Y Y Y Y M M D D

Ministry Use Only
Audit No. Z 82647
Received MAY 0_ 2013

Ministry's Copy

13-05-4D

Ontario — Ministry of the Environment

Measurements recorded in: ☐ Metric ☐ Imperial

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

A111204 W

Well Record

Regulation 903 Ontario Water Resources Act

Page ____ of ____

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	Well Constructed by Well Owner
~~Gordon~~	Capital Region Resource	—	☐

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
708-225 Metcalfe St	Ottawa	ON	K2P1P9	613 454 5580

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
5508 Frontier Rd	Ottawa		

County/District/Municipality	City/Town/Village	Province	Postal Code
Ottawa	Ottawa	Ontario	K0A3H0

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	466179	5021081		

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	To
GRAY	CLAY	SAND & Till & Rock		0	103''

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
		Benontite Tablets	
		Benotite grout & Portland	
		Benotite Chips	

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)	Water Level (m/ft)	Recovery Time (min)	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	To
1''		1/8	0	103''

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

Construction Record - Screen

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

Water Details

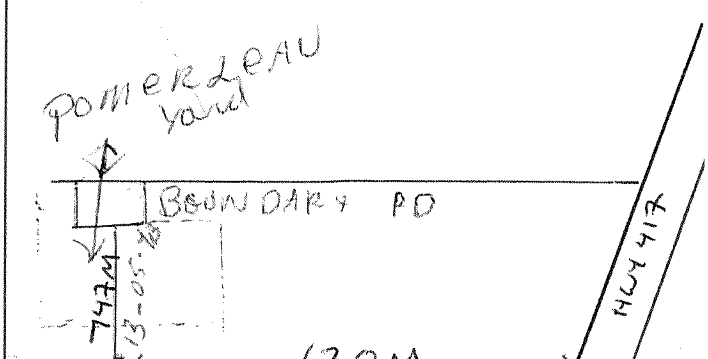
Water found at Depth ____ (m/ft) Kind of Water: ☐ Fresh ☐ Untested ☐ Gas ☐ Other, specify ____
Water found at Depth ____ (m/ft) Kind of Water: ☐ Fresh ☐ Untested ☐ Gas ☐ Other, specify ____
Water found at Depth ____ (m/ft) Kind of Water: ☐ Fresh ☐ Untested ☐ Gas ☐ Other, specify ____

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)

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.
Marathon Drilling Co Ltd.	6894

Business Address (Street Number/Name)	Municipality
6847 Hiram Dr.	Greely

Province	Postal Code	Business E-mail Address
ON	K4P 1A2	mwebb@marathondrilling.ca

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
613 822 0571	Webb, Matthew

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3279	[signature]	2013 04 25

Well owner's information package delivered ☐ Yes ☐ No

Date Package Delivered Y Y Y Y M M D D

Date Work Completed Y Y Y Y M M D D

Ministry Use Only

Audit No. Z 82643

MAY 06 2013

Received

0506E (12/2007)

Ministry's Copy

S-13894

Ontario Ministry of the Environment

Tag#: A145308 (Well Tag No. ... and/or Print Below)

A145308

Well Record

Regulation 903 Ontario Water Resources Act

Page ____ of ____

Measurements recorded in: ☑ Metric ☐ Imperial

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
Capital Region Resources Recovery Centre			

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
708-225 Metcalfe	Ottawa	ON	K2P1P9	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
Boundry Rd			

County/District/Municipality	City/Town/Village	Province	Postal Code
	Ottawa	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	466030	5021430		

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
Brn	fine Sand		Soft, wet	0	1.5

Annular Space

Depth Set at (m/ft) From	Depth Set at (m/ft) To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	.61	Benseal	
.61	1.5	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)	Water Level (m/ft)	Recovery Time (min)	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 D.P.

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
3.45	PVC	.356	0	.61

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

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To
4.21	PVC	10	.61	1.5

Map of Well Location

Please provide a map below following instructions on the back.

See Map "M"

Water Details

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

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

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	1.5	11.43

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Strata Drilling Group	7241

Business Address (Street Number/Name)	Municipality
47-2 W. Beaver Creek	Richmond Hill

Province	Postal Code	Business E-mail Address
ON	L4B1C6	WRECORDS@STRATASOIL.COM

Bus.Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
9057649304	BEATTY BRIAN

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3616		20130412

Comments:

Well owner's information package delivered ☐ Yes ☐ No

Date Package Delivered Y Y Y Y M M D D

Date Work Completed 20130410

Ministry Use Only

Audit No. Z152773

Received MAY 15 2013

Ministry's Copy

5-13894

12-1125-0045-1000

Boundary Road Site

location I tuesday

C-7241
2152773

MAY 15 2013

Ontario Ministry of the Environment

Well Tag No. (Place Sticker and/or Print Below)

Tag#: A145307 A145307

S-13894

Well Record

Regulation 903 Ontario Water Resources Act

Page ____ of ____

Measurements recorded in: ☑ Metric ☐ Imperial

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
Capital Region	Resources Recovery Centre		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
708-225 Metcalfe	Ottawa	ON	K2P1P9	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
Boundry Rd			

County/District/Municipality	City/Town/Village	Province	Postal Code
	Ottawa	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	466037	5021430		

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	To
Brn	Sand		Soft wet	0	1.5
Gry	Clay		soft, wet	1.5	6.4

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	3.96	Holeplug	
3.96	6.4	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)	Water Level (m/ft)	Recovery Time (min)	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 D.P

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	To
3.45	PVC	.56	0	4.88

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

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To
4.21	PVC	10	4.88	6.4

Map of Well Location

Please provide a map below following instructions on the back.

See map "M"

Water Details

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

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

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

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	6.4	11.43

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Strata Drilling Group	7241

Business Address (Street Number/Name)	Municipality
147-2 W. Beaver creek	Ottawa

Province	Postal Code	Business E-mail Address
ON	L4B1C6	wrecords@stratasoil.com

Bus.Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
9057649304	Beatty Brian

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3616		20130412

Comments:

Well owner's information package delivered ☐ Yes ☐ No

Date Package Delivered YYYYMMDD

Date Work Completed 20130410

Ministry Use Only

Audit No. Z152772

MAY 15 2013 Received

Ministry's Copy

S-13894

LEGEND

12-1125-0045-1000

Boundary Road Site

location I tuesday

C-7241
2152772

MAY 15 2013

7212029

S-14748

Ontario Ministry of the Environment

Well Tag No. *(Place Sticker and/or Print Below)* A154128 **Tag#: A154128**

Well Record

Regulation 903 Ontario Water Resources Act

Page ______ of ______

Measurements recorded in: ☑ Metric ☐ Imperial

TAGGART MILLER ENVIRONMENTAL SERVICES

[redacted]

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
5775 Boundary Road			

County/District/Municipality	City/Town/Village	Province	Postal Code
	Ottawa	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	465754	5020210		

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
BLK	gravel	sand	loose	0	.31
BRN	sand	silt, clay	soft	.31	2.44
GRY	clay	silt	soft	2.44	6.4

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	.31	concrete/flushmount	
.31	5.88	bentonite	
5.88	6.4	filter 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)	Water Level (m/ft)	Recovery Time (min)	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* Direct Push

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	To
3.25	PVC	.356	0	5.49

Status of Well

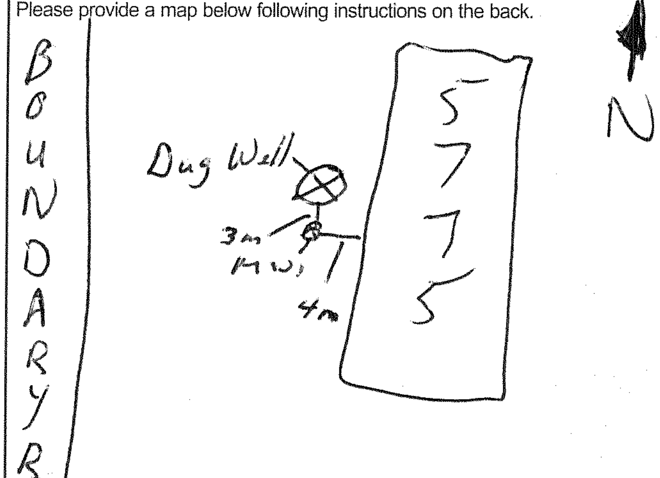
☐ Water Supply ☐ Replacement Well ☑ Test Hole ☐ Recharge Well ☐ Dewatering Well ☑ Observation and/or Monitoring Hole ☐ Alteration (Construction) ☐ Abandoned, Insufficient Supply ☐ Abandoned, Poor Water Quality ☐ Abandoned, other, *specify* ☐ Other, *specify*

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To
4.21	PVC	10	5.49	6.4

Map of Well Location

Please provide a map below following instructions on the back.



Comments:

Water Details

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

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	6.4	8.25

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Strata Drilling Group	7241

Business Address (Street Number/Name)	Municipality
147 West Beaver Creek	Richmond Hill

Province	Postal Code	Business E-mail Address
ON	L4B1C6	wrecords@stratasoil.com

Bus.Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
905 764-9304	McCoy, James

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3656		2013 11 22

Well owner's information package delivered	Date Package Delivered	Date Work Completed
☐ Yes ☐ No	YYYY MM DD	2013 10 28

Ministry Use Only

Audit No. Z179935

NOV 2 3 2013

Received

7212030

S-14748

Ontario Ministry of the Environment

Well Record

Regulation 903 Ontario Water Resources Act

Well Tag No. (Place Sticker and/or Print ...) A154131 Tag#: A154131

Page ______ of ______

Measurements recorded in: ☑ Metric ☐ Imperial

TAGGART MILLER ENVIRONMENTAL SERVICES

[redacted]

Well Location

0X25

Address of Well Location (Street Number/Name)	Township	Lot	Concession
5775 Boundary Rd			

County/District/Municipality	City/Town/Village	Province	Postal Code
	Ottawa	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	465752	5020214		

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	To
BLK	gravel	sand	loose	0	.31
BRN	sand	silt, clay	soft	.31	2.44
GRY	clay	silt	soft	2.44	6.4

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	.31	concrete/flushmount	
.31	5.18	bentonite	
5.18	6.4	Filter 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)	Water Level (m/ft)	Recovery Time (min)	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 Direct Push

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	To
3.43	PVC	.356	0	5.49

Status of Well

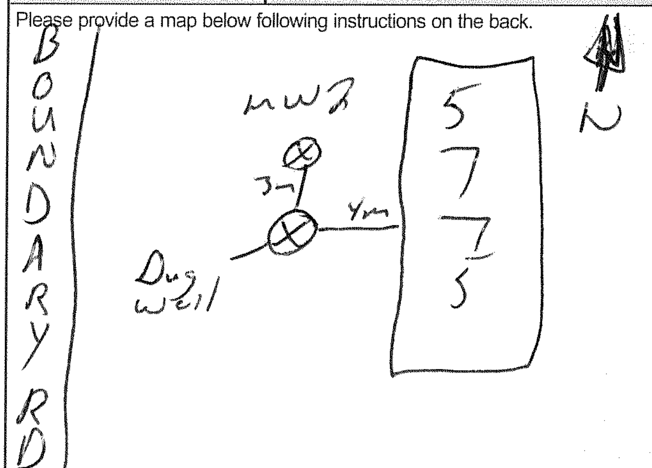
☐ Water Supply ☐ Replacement Well ☑ Test Hole ☐ Recharge Well ☐ Dewatering Well ☑ Observation and/or Monitoring Hole ☐ Alteration (Construction) ☐ Abandoned, Insufficient Supply ☐ Abandoned, Poor Water Quality ☐ Abandoned, other, specify ☐ Other, specify

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To
4.21	PVC	10	5.49	6.4

Map of Well Location

Please provide a map below following instructions on the back.



Water Details

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

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

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

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	6.4	8.25

Well Contractor and Well Technician Information

Business Name of Well Contractor: Strata Drilling Group — Well Contractor's Licence No.: 7241

Business Address (Street Number/Name): 147 West Beaver Creek — Municipality: Richmond Hill

Province: ON — Postal Code: L4B1C6 — Business E-mail Address: wrecords@stratasoil.com

Bus. Telephone No. (inc. area code): 905 764 9304 — Name of Well Technician (Last Name, First Name): McLay, JAMES

Well Technician's Licence No.: 3656 — Signature of Technician and/or Contractor — Date Submitted: 20131122

Comments:

Well owner's information package delivered ☐ Yes ☐ No — Date Package Delivered: YYYYMMDD — Date Work Completed: 20131028

Ministry Use Only — Audit No. Z 179936 — Received NOV 2 8 2013

Ontario Ministry of the Environment

Well Tag Tag#: A131930 (ow)

A-131930

Well Record

Regulation 903 Ontario Water Resources Act

Page 1 of 1

Measurements recorded in: ☑ Metric ☐ Imperial

[redacted]

Address of Well Location (Street Number/Name)	Township	Lot	Concession
100 Entrepreneur Crescent	Ottawa		
County/District/Municipality: Ottawa	City/Town/Village: Ottawa	Province: Ontario	Postal Code:
UTM Coordinates NAD 83, Zone 18, Easting 465599, Northing 5020270	Municipal Plan and Sublot Number	Other	

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	To
Brown	topsoil		compacted	0	.20m
Grey	Fissured clay		" "	.20m	2.75m
Grey/Blue	elastic clay.		" "	2.75m	4.0m
Blue	very elastic clay.		" "	4.0m	7.0m

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	2.5m	elastic clay	15.0m³

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	To
	PVC schedule 40	.20m	0	7.5m

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

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To
	geotextile synthetic		0	3.0m

Water Details

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

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

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

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	3.0m	6.0m
3.0m	5.0m	4.0m
5.0m	7.0m	4.0m

Results of Well Yield Testing

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

If pumping discontinued, give reason: see report attach

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)

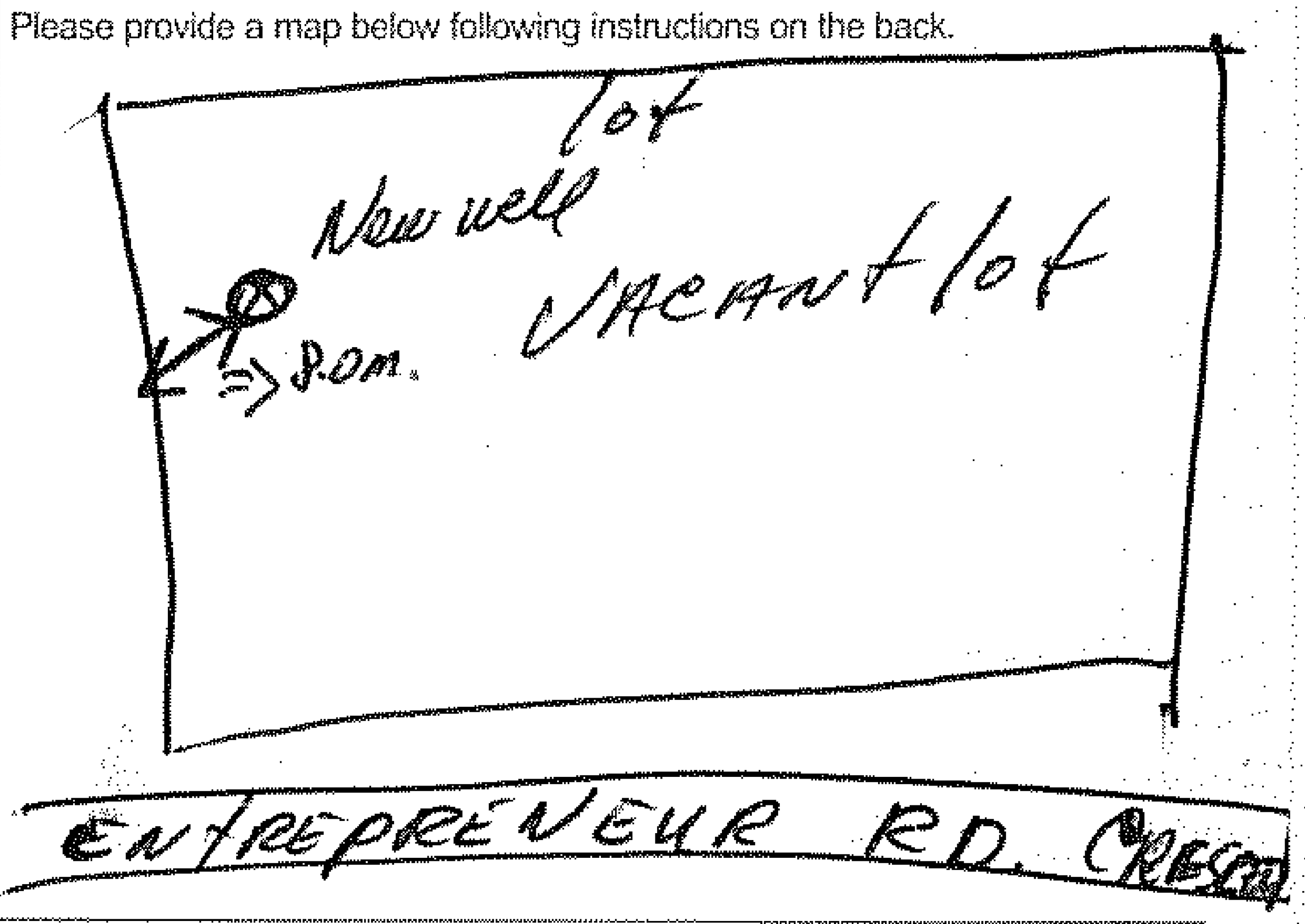
Well production (l/min / GPM)

Disinfected? ☐ Yes ☑ No

Draw Down Time (min)	Water Level (m/ft)	Recovery Time (min)	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	

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: Leo Sarault & Fils Inc — Well Contractor's Licence No.: 7667

Business Address (Street Number/Name): 4882 County Rd 10 Fournier — Municipality: Nation

Province: Ontario — Postal Code: K0B1G0 — Business E-mail Address: leoSarault@yahoo.com

Bus.Telephone No. (inc. area code): 6135245449 — Name of Well Technician (Last Name, First Name): Gilles Sarault

Well Technician's Licence No.: T2124 — Signature of Technician and/or Contractor — Date Submitted: 20150323

Well owner's information package delivered: ☐ Yes ☐ No

Date Package Delivered: 20150323

Date Work Completed: 20150323

Ministry Use Only

Audit No. Z197003

Received JUL 11 2016

Ministry's Copy

Ontario Ministry of the Environment and Climate Change

Measurements recorded in: ☒ Metric ☐ Imperial

Well Tag No. (Tag#:A236242

A 236242

Well Record

Regulation 903 Ontario Water Resources Act

Page ____ of ____

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
	Boundry Road Development Inc.	N/A	

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
16766 Transcanadienne Suite 500	Kirland	QC.	H9H4M7	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
5371 Boundry Road	Cumberland	21	11

County/District/Municipality	City/Town/Village	Province	Postal Code
Ottawa	Carlsbad Spring	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	465300	5021483		

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	To
Brown	Fill	clay, Stone	Hard	0	1.8
Brown	clay	Silt	Hard	1.8	3.9
Grey	clay		SOFT	3.9	21.0
Grey	gravel	Silt, Sand	packed	21.0	~~60.96~~ 22.25
Grey	shale		layered	22.25	60.96

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	24.99	cinent grout	1.5 m³

Results of Well Yield Testing

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

If pumping discontinued, give reason:

Pump intake set at (m/ft): 60

Pumping rate (l/min / GPM): 42

Duration of pumping: 1 hrs + ____ min

Final water level end of pumping (m/ft): 5.75

If flowing give rate (l/min / GPM):

Recommended pump depth (m/ft): 58

Recommended pump rate (l/min / GPM): 66

Well production (l/min / GPM): 75

Disinfected? ☒ Yes ☐ No

Draw Down Time (min)	Water Level (m/ft)	Recovery Time (min)	Water Level (m/ft)
Static Level	3.83		5.75
1	4.42	1	4.64
2	4.61	2	4.36
3	4.75	3	4.26
4	4.78	4	4.23
5	4.79	5	4.18
10	4.96	10	4.10
15	5.16	15	4.03
20	5.24	20	3.95
25	5.31	25	3.89
30	5.32	30	3.85
40	5.62	40	3.83
50	5.70	50	3.83
60	5.75	60	3.83

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	To
15.55	Steel	.48	4.6	24.99
15.32	Open Hole		24.99	60.96

Status of Well

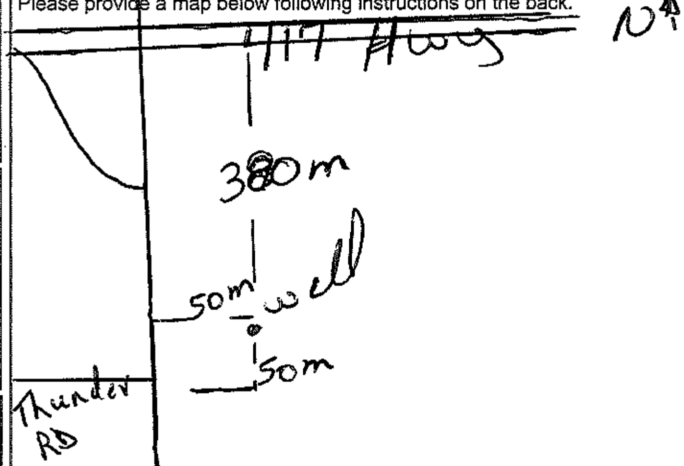
☐ Water Supply
☐ Replacement Well
☐ Test Hole
☐ Recharge Well
☐ Dewatering Well
☒ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, specify
☐ Other, specify

Construction Record - Screen

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

Map of Well Location

Please provide a map below following instructions on the back.



Comments:

Water Details

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

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	24.99	24.9
24.99	60.9	

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Bourgeois Well Drilling Ltd.	7417

Business Address (Street Number/Name)	Municipality
14245 Conc. 10-11	Crysler

Province	Postal Code	Business E-mail Address
On	K0A1R0	N/A

Bus.Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
6139875291	GENIER, MICHAEL

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3493		20180326

Well owner's information package delivered ☒ Yes ☐ No

Date Package Delivered: 20180327

Date Work Completed: 20180323

Ministry Use Only

Audit No. Z276189

MAY 07 2018

Received

0506E (2014/11) Ministry's Copy

Ontario — Ministry of the Environment and Climate Change

Measurements recorded in: ☒ Metric ☐ Imperial

Well Tag No. Tag#: A249297
A249297

Well Record

Regulation 903 Ontario Water Resources Act

Page ____ of ____

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
	VSB Carpentry Inc.	N/A	

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
357 Entrepreneur Crescent	Navan	On.	K4B1T8	6138291925

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
357 Entrepreneur Crescent	City of Ottawa	23	11

County/District/Municipality	City/Town/Village	Province	Postal Code
Cumberland		Ontario	K4B1T8

UTM Coordinates Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83 18	465777	5020916	50R-6694 Part 4	

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	To
Brown	clay	Silt, Stone	Hard	0	3.7
Grey	clay	silt	Soft	3.7	21.3
Grey	gravel	Medium Sand	packed	21.3	22.6
Grey	Shale		layered	22.6	28.9

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	12.1	cement grout	.3 m³

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	To
15.55	Steel	.48	+.6	23.1
15.32	Open Hole		23.1	28.9

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

Construction Record - Screen

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

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): 22

Pumping rate (l/min / GPM): 13

Duration of pumping: 1 hrs + ____ min

Final water level end of pumping (m/ft): 21.61

If flowing give rate (l/min / GPM):

Recommended pump depth (m/ft): 22

Recommended pump rate (l/min / GPM): 15

Well production (l/min / GPM): 20

Disinfected? ☒ Yes ☐ No

Draw Down Time (min)	Water Level (m/ft)	Recovery Time (min)	Water Level (m/ft)
Static Level	9.62		21.61
1	10.49	1	20.79
2	10.73	2	19.58
3	11.15	3	19.27
4	11.53	4	19.07
5	11.71	5	18.50
10	13.38	10	16.91
15	14.71	15	14.99
20	15.88	20	13.21
25	16.87	25	12.83
30	17.77	30	10.99
40	19.40	40	9.74
50	20.65	50	9.69
60	21.61	60	9.62

Water Details

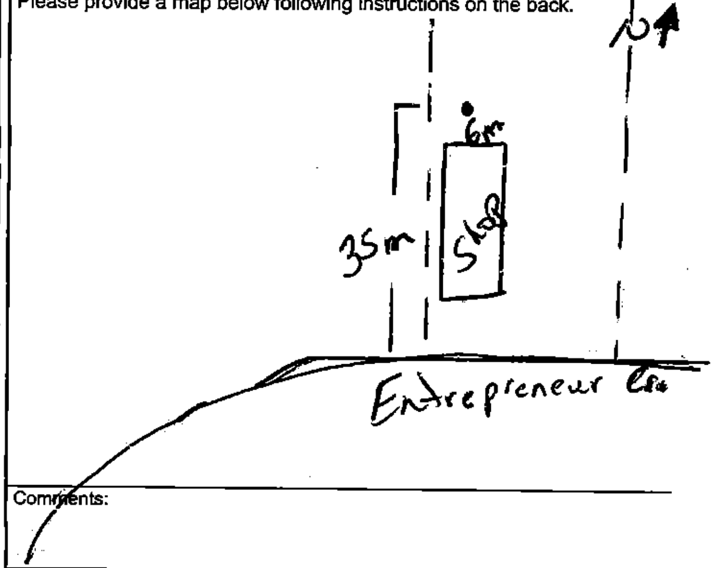
Water found at Depth	Kind of Water
27 (m/ft) ☐ Gas	☐ Fresh ☒ Untested ☐ Other, specify
(m/ft) ☐ Gas	☐ Fresh ☐ Untested ☐ Other, specify
(m/ft) ☐ Gas	☐ Fresh ☐ Untested ☐ Other, specify

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	12.1	24.9
12.1	28.9	15.32

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.
Bourgeois Well Drilling Ltd	7417

Business Address (Street Number/Name)	Municipality
14245 Conc. 10-11	Crysler

Province	Postal Code	Business E-mail Address
On.	K0A1R0	N/A

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
6139875291	GENIER, MICHAEL

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3493		20181010

Well owner's information package delivered	Date Package Delivered	Date Work Completed
☒ Yes ☐ No	20181010	20181005

Ministry Use Only — Audit No. Z300222 — Received OCT 25 2018

Ontario Ministry of the Environment and Climate Change

Well Tag N Tag#: A244754

A244754

Well Record

Regulation 903 Ontario Water Resources Act

Page 1 of 1

Measurements recorded in: ☑ Metric ☐ Imperial

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
Amazon	OTTAWA		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
5371 Boundary, Rd	Cumberland	ON	K4B1P6	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
5371 Boundary, Road	Cumberland.	21	11

County/District/Municipality	City/Town/Village	Province	Postal Code
OTTAWA City	Navan	Ontario	K4B1P6

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	466045	5021560		

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	To
Brown	Sand.		Soft	0	2.12
Bleu	Clay		Soft	2.12	24.24
Grey	Gravel		Soft	24.24	26.06
Grey	Limestone		Hard.	26.06	42.42

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	6.06	Quik Grout	4 Bag.

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): 24.24

Pumping rate (l/min / GPM): 54:00

Duration of pumping: 1 hrs + 00 min

Final water level end of pumping (m/ft): 2.25

If flowing give rate (l/min / GPM):

Recommended pump depth (m/ft): 24.24

Recommended pump rate (l/min / GPM): 56:00

Well production (l/min / GPM): 90:00

Disinfected? ☑ Yes ☐ No

Draw Down Time (min)	Water Level (m/ft)	Recovery Time (min)	Water Level (m/ft)
Static Level	2.12		2.25
1	2.14	1	2.18
2	2.16	2	2.16
3	2.18	3	2.12
4	2.20	4	2.12
5	2.21	5	2.12
10	2.23	10	2.12
15	2.24	15	2.12
20	2.25	20	2.12
25	2.25	25	2.12
30	2.25	30	2.12
40	2.25	40	2.12
50	2.25	50	2.12
60	2.25	60	2.12

Method of Construction

☐ Cable Tool ☐ Diamond
☐ Rotary (Conventional) ☐ Jetting
☑ Rotary (Reverse) Air ☐ 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	To
15.55	Steel	0.48	+0.90	26.06

Status of Well

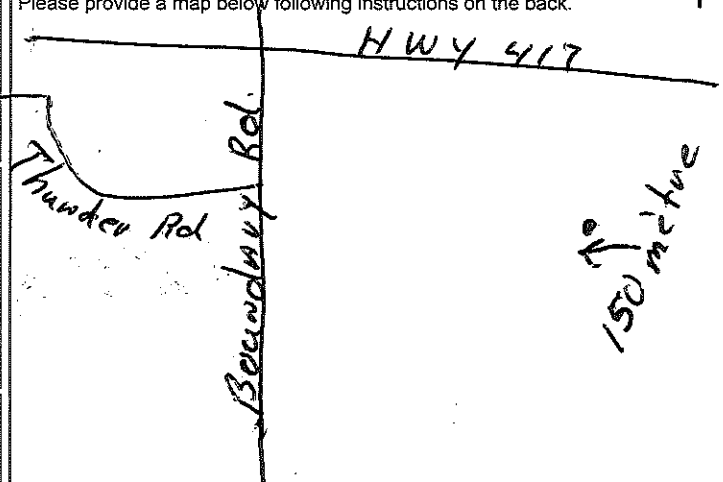
☑ Water Supply
☐ Replacement Well
☐ Test Hole
☐ Recharge Well
☐ Dewatering Well
☐ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, specify
☐ Other, specify

Construction Record - Screen

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

Map of Well Location

Please provide a map below following instructions on the back.



Comments: Mitch Owens, Rd County Rd 8

Water Details

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

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	6.06	25.40
0	42.42	15.55

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
DXR-WATER-Well-Drilling	7526

Business Address (Street Number/Name)	Municipality
1763 - Route 900 west	Nation

Province	Postal Code	Business E-mail Address
ON	K0A3C0	

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
6139875598	Mowette Karl

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3773	Karl Mowette	20180924

Well owner's information package delivered ☑ Yes ☐ No

Date Package Delivered: 20180924

Date Work Completed: 20180911

Ministry Use Only

Audit No. Z280974

Received NOV 22 2018

0506E (2014/11) Ministry's Copy

Ontario — Ministry of the Environment and Climate Change

Measurements recorded in: ☐ Metric ☒ Imperial

Well Tag No. (Place Sticker and/or Print Below): N/A

Well Record

Regulation 903 Ontario Water Resources Act

Page ____ of ____

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
2030470	ONTARIO LIMITED	C/o Rosedale	

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
Transport Group, 6845 Invader Cres,	Mississauga	Ont	L5T 2B7	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
#9460 MITCH OWENS ROAD	OSGOODE	PL 1	11

County/District/Municipality	City/Town/Village	Province	Postal Code
OTTAWA-CARLETON	EDWARDS	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	465655	5020146	RP-5R-13558 Part 2	

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	To
	6" Drilled Well Abandonment			0'	85'

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
85'	5'	3/8 Hole Plug	24 Bags
5'	0'	Backfill	

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)	Water Level (m/ft)	Recovery Time (min)	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	To

Status of Well

☐ Water Supply ☐ Replacement Well ☐ Test Hole ☐ Recharge Well ☐ Dewatering Well ☐ Observation and/or Monitoring Hole ☐ Alteration (Construction) ☐ Abandoned, Insufficient Supply ☐ Abandoned, Poor Water Quality ☒ Abandoned, other, specify New Construction ☐ Other, specify

Construction Record - Screen

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

Water Details

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

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

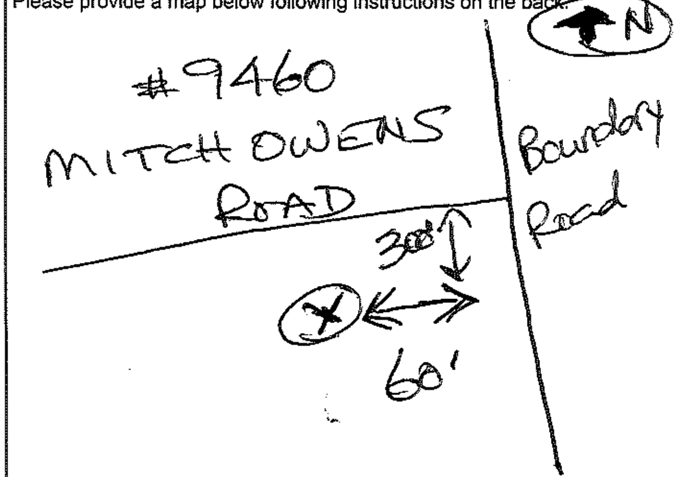
Water found at Depth ____ (m/ft) ☐ Gas — Kind of Water: ☐ Fresh ☐ Untested ☐ Other, specify

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)

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.
AIR ROCK DRILLING Co LTD	C-7681

Business Address (Street Number/Name)	Municipality
6659 Franktown Road	Richmond

Province	Postal Code	Business E-mail Address
Ont	K0A 2Z0	

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
6138382170	HANNA JEREMY

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
T3632	[signature]	20190628

Well owner's information package delivered: ☐ Yes ☒ No

Date Package Delivered: YYYYMMDD

Date Work Completed: 20190626

Ministry Use Only

Audit No. Z302260

Received JUL 25 2019

0506E (2014/11) Ministry's Copy

Ontario Ministry of the Environment

12-04-2

Well Record

Regulation 903 Ontario Water Resources Act

Page ______ of ______

Measurements recorded in: ☐ Metric ☑ Imperial

Well Tag No. (Place Sticker and/or Print Below)

A111208 i

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
~~Golder~~	Capital Region Resource	—	

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
708-225 Metcalfe St	Ottawa	ON	K2P1P9	6134545581

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
570 FRONTIER RD	Ottawa		

County/District/Municipality	City/Town/Village	Province	Postal Code
Ottawa	Ottawa	Ontario	K0A3H0

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 8 3	18T	466522	5020872		

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	To
GRAY	CLAY	SAND TILL-ROCK	SAND TO CLAY TO TILL then ROCK	0	143 6
					VSP

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
		COATED BENTONITES	
		bentonite chips	
		bentonite GROUT	

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)	Water Level (m/ft)	Recovery Time (min)	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	To
2"	PLASTIC	1/4		

Status of Well

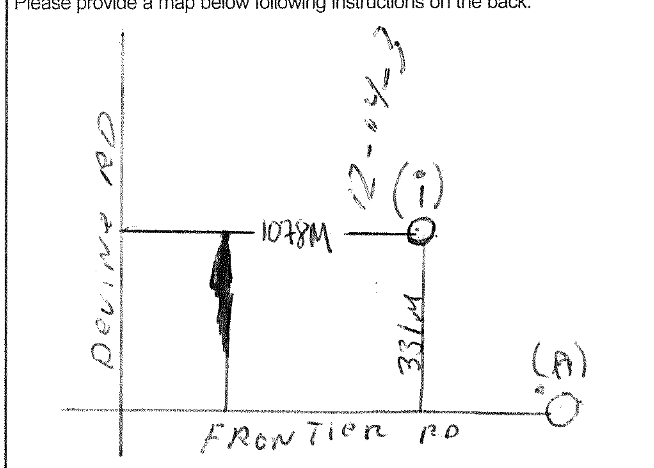
☐ Water Supply
☐ Replacement Well
☐ Test Hole
☐ Recharge Well
☐ Dewatering Well
☐ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, specify
☐ Other, specify

Construction Record - Screen

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

Map of Well Location

Please provide a map below following instructions on the back.



Comments:

Water Details

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

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Marathon Drilling Co. Ltd	6894

Business Address (Street Number/Name)	Municipality
6847 Hiram DR	Greely

Province	Postal Code	Business E-mail Address
ON	K4P1A2	mwelsh@marathondrilling.ca

Bus.Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
6138220571	Welsh, Matthew

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3279	[signature]	20130425

Well owner's information package delivered ☐ Yes ☐ No

Date Package Delivered Y Y Y Y M M D D

Date Work Completed Y Y Y Y M M D D

Ministry Use Only

Audit No. Z 82629

Received MAY 06 2013

0506E (12/2007) Ministry's Copy © Queen's Printer for Ontario, 2007

ATTACHMENT E

**Shallow Groundwater Quality –
Laboratory Certificates of Analysis**

PARACEL LABORATORIES LTD.
TRUSTED. RESPONSIVE. RELIABLE.

300 - 2319 St. Laurent Blvd
Ottawa, ON, K1G 4J8
1-800-749-1947
www.paracellabs.com

Certificate of Analysis

LRL Associates Ltd.

5430 Canotek Road
Ottawa, ON K1J 9G2
Attn: Abdul Kader Alhaj

Client PO:
Project: 220487
Custody: 139922

Report Date: 22-Mar-2023
Order Date: 16-Mar-2023

Order #: 2311446

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

Paracel ID	Client ID
2311446-01	MW23-2
2311446-02	MW23-3
2311446-03	MW23-4
2311446-04	MW23-5

Approved By: Mark Foto

Mark Foto, M.Sc.
Lab Supervisor

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Chromium, hexavalent - water	MOE E3056 - colourimetric	21-Mar-23	21-Mar-23
Conductivity	EPA 9050A- probe @25 °C	17-Mar-23	17-Mar-23
Mercury by CVAA	EPA 245.2 - Cold Vapour AA	20-Mar-23	20-Mar-23
Metals, ICP-MS	EPA 200.8 - ICP-MS	17-Mar-23	17-Mar-23
pH	EPA 150.1 - pH probe @25 °C	17-Mar-23	17-Mar-23
PHC F1	CWS Tier 1 - P&T GC-FID	17-Mar-23	17-Mar-23
PHCs F2 to F4	CWS Tier 1 - GC-FID, extraction	21-Mar-23	22-Mar-23
Phenolics	EPA 420.2 - Auto Colour, 4AAP	20-Mar-23	20-Mar-23
REG 153: PAHs by GC-MS	EPA 625 - GC-MS, extraction	20-Mar-23	20-Mar-23
REG 153: VOCs by P&T GC/MS	EPA 624 - P&T GC-MS	17-Mar-23	17-Mar-23
SAR	Calculated	21-Mar-23	21-Mar-23

Certificate of Analysis

Client: **LRL Associates Ltd.**

Client PO:

Report Date: 22-Mar-2023

Order Date: 16-Mar-2023

Project Description: 220487

Client ID:		MW23-2	MW23-3	MW23-4	MW23-5
Sample Date:		16-Mar-23 15:50	16-Mar-23 15:40	16-Mar-23 15:30	16-Mar-23 15:20
Sample ID:		2311446-01	2311446-02	2311446-03	2311446-04
	MDL/Units	Ground Water	Ground Water	Ground Water	Ground Water
General Inorganics					
SAR	0.01	4.79	3.26	9.00	7.78
Conductivity	5 uS/cm	1710	1030	2910	2430
pH	0.1 pH Units	7.6	10.9	7.9	7.9
Phenolics	0.001 mg/L	-	0.068	0.001	-
Metals					
Mercury	0.1 ug/L	<0.1	<0.1	<0.1	<0.1
Antimony	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Arsenic	1 ug/L	2	2	2	2
Barium	1 ug/L	84	28	124	99
Beryllium	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Boron	10 ug/L	56	23	167	157
Cadmium	0.1 ug/L	<0.1	<0.1	<0.1	<0.1
Chromium	1 ug/L	<1	1	<1	2
Chromium (VI)	10 ug/L	<10	<10	<10	<10
Cobalt	0.5 ug/L	2.1	<0.5	0.7	1.1
Copper	0.5 ug/L	0.9	3.0	3.3	3.6
Lead	0.1 ug/L	<0.1	<0.1	<0.1	0.3
Molybdenum	0.5 ug/L	2.5	16.7	1.4	0.6
Nickel	1 ug/L	5	12	2	3
Selenium	1 ug/L	<1	<1	<1	<1
Silver	0.1 ug/L	<0.1	<0.1	<0.1	<0.1
Sodium	200 ug/L	161000	106000	381000	306000
Thallium	0.1 ug/L	<0.1	<0.1	<0.1	<0.1
Uranium	0.1 ug/L	1.8	0.8	0.6	0.4
Vanadium	0.5 ug/L	1.7	20.9	1.6	2.8
Zinc	5 ug/L	<5	<5	<5	<5
Volatiles					
Acetone	5.0 ug/L	5.3	33.6	<5.0	<5.0
Benzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Bromodichloromethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Bromoform	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Bromomethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Carbon Tetrachloride	0.2 ug/L	<0.2	<0.2	<0.2	<0.2
Chlorobenzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Chloroform	0.5 ug/L	<0.5	<0.5	<0.5	<0.5

PARACEL LABORATORIES LTD.

Order #: 2311446

Certificate of Analysis

Client: LRL Associates Ltd.

Client PO:

Report Date: 22-Mar-2023

Order Date: 16-Mar-2023

Project Description: 220487

Client ID:		MW23-2	MW23-3	MW23-4	MW23-5
Sample Date:		16-Mar-23 15:50	16-Mar-23 15:40	16-Mar-23 15:30	16-Mar-23 15:20
Sample ID:		2311446-01	2311446-02	2311446-03	2311446-04
	MDL/Units	Ground Water	Ground Water	Ground Water	Ground Water
Dibromochloromethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Dichlorodifluoromethane	1.0 ug/L	<1.0	<1.0	<1.0	<1.0
1,2-Dichlorobenzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,3-Dichlorobenzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,4-Dichlorobenzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,1-Dichloroethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,2-Dichloroethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,1-Dichloroethylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
cis-1,2-Dichloroethylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
trans-1,2-Dichloroethylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,2-Dichloropropane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
cis-1,3-Dichloropropylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
trans-1,3-Dichloropropylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,3-Dichloropropene, total	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Ethylene dibromide (dibromoethane, 1,2-)	0.2 ug/L	<0.2	<0.2	<0.2	<0.2
Hexane	1.0 ug/L	<1.0	<1.0	<1.0	<1.0
Methyl Ethyl Ketone (2-Butanone)	5.0 ug/L	<5.0	<5.0	<5.0	<5.0
Methyl Isobutyl Ketone	5.0 ug/L	<5.0	<5.0	<5.0	<5.0
Methyl tert-butyl ether	2.0 ug/L	<2.0	<2.0	<2.0	<2.0
Methylene Chloride	5.0 ug/L	<5.0	<5.0	<5.0	<5.0
Styrene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,1,1,2-Tetrachloroethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,1,2,2-Tetrachloroethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Tetrachloroethylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Toluene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,1,1-Trichloroethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Trichloroethylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Trichlorofluoromethane	1.0 ug/L	<1.0	<1.0	<1.0	<1.0
Vinyl chloride	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
m,p-Xylenes	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
o-Xylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Xylenes, total	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
4-Bromofluorobenzene	Surrogate	102%	102%	102%	102%
Dibromofluoromethane	Surrogate	74.2%	75.5%	90.9%	89.0%

PARACEL
LABORATORIES LTD.

Order #: 2311446

Certificate of Analysis

Client: LRL Associates Ltd.

Client PO:

Report Date: 22-Mar-2023

Order Date: 16-Mar-2023

Project Description: 220487

Client ID:	**Sample Date:** / **Sample ID:** / **MDL/Units**	MW23-2	MW23-3	MW23-4	MW23-5
	Sample Date	16-Mar-23 15:50	16-Mar-23 15:40	16-Mar-23 15:30	16-Mar-23 15:20
	Sample ID	2311446-01	2311446-02	2311446-03	2311446-04
	MDL/Units	Ground Water	Ground Water	Ground Water	Ground Water
Toluene-d8	Surrogate	110%	110%	111%	110%
Hydrocarbons					
F1 PHCs (C6-C10)	25 ug/L	<25	<25	<25	<25
F2 PHCs (C10-C16)	100 ug/L	<100	<100	<100	<100
F3 PHCs (C16-C34)	100 ug/L	<100	<100	<100	<100
F4 PHCs (C34-C50)	100 ug/L	<100	<100	<100	<100
Semi-Volatiles					
Acenaphthene	0.05 ug/L	<0.05	0.59	<0.05	<0.05
Acenaphthylene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Anthracene	0.01 ug/L	<0.01	0.26	<0.01	<0.01
Benzo [a] anthracene	0.01 ug/L	<0.01	0.48	<0.01	<0.01
Benzo [a] pyrene	0.01 ug/L	<0.01	0.33	<0.01	<0.01
Benzo [b] fluoranthene	0.05 ug/L	<0.05	0.52	<0.05	<0.05
Benzo [g,h,i] perylene	0.05 ug/L	<0.05	0.19	<0.05	<0.05
Benzo [k] fluoranthene	0.05 ug/L	<0.05	0.24	<0.05	<0.05
Chrysene	0.05 ug/L	<0.05	0.56	<0.05	<0.05
Dibenzo [a,h] anthracene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Fluoranthene	0.01 ug/L	0.06	0.91	0.02	<0.01
Fluorene	0.05 ug/L	<0.05	0.41	<0.05	<0.05
Indeno [1,2,3-cd] pyrene	0.05 ug/L	<0.05	0.18	<0.05	<0.05
1-Methylnaphthalene	0.05 ug/L	<0.05	0.44	<0.05	<0.05
2-Methylnaphthalene	0.05 ug/L	<0.05	0.49	<0.05	<0.05
Methylnaphthalene (1&2)	0.10 ug/L	<0.10	0.93	<0.10	<0.10
Naphthalene	0.05 ug/L	<0.05	4.98	<0.05	<0.05
Phenanthrene	0.05 ug/L	0.11	0.96	0.07	<0.05
Pyrene	0.01 ug/L	0.05	0.68	<0.01	<0.01
2-Fluorobiphenyl	Surrogate	57.0%	60.7%	64.4%	74.1%
Terphenyl-d14	Surrogate	60.0%	55.5%	52.9%	56.5%

Certificate of Analysis
Client: **LRL Associates Ltd.**
Client PO:

Report Date: 22-Mar-2023
Order Date: 16-Mar-2023
Project Description: 220487

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
General Inorganics									
Conductivity	ND	5	uS/cm						
Phenolics	ND	0.001	mg/L						
Hydrocarbons									
F1 PHCs (C6-C10)	ND	25	ug/L						
F2 PHCs (C10-C16)	ND	100	ug/L						
F3 PHCs (C16-C34)	ND	100	ug/L						
F4 PHCs (C34-C50)	ND	100	ug/L						
Metals									
Mercury	ND	0.1	ug/L						
Antimony	ND	0.5	ug/L						
Arsenic	ND	1	ug/L						
Barium	ND	1	ug/L						
Beryllium	ND	0.5	ug/L						
Boron	ND	10	ug/L						
Cadmium	ND	0.1	ug/L						
Chromium (VI)	ND	10	ug/L						
Chromium	ND	1	ug/L						
Cobalt	ND	0.5	ug/L						
Copper	ND	0.5	ug/L						
Lead	ND	0.1	ug/L						
Molybdenum	ND	0.5	ug/L						
Nickel	ND	1	ug/L						
Selenium	ND	1	ug/L						
Silver	ND	0.1	ug/L						
Sodium	ND	200	ug/L						
Thallium	ND	0.1	ug/L						
Uranium	ND	0.1	ug/L						
Vanadium	ND	0.5	ug/L						
Zinc	ND	5	ug/L						
Semi-Volatiles									
Acenaphthene	ND	0.05	ug/L						
Acenaphthylene	ND	0.05	ug/L						
Anthracene	ND	0.01	ug/L						
Benzo [a] anthracene	ND	0.01	ug/L						
Benzo [a] pyrene	ND	0.01	ug/L						
Benzo [b] fluoranthene	ND	0.05	ug/L						
Benzo [g,h,i] perylene	ND	0.05	ug/L						
Benzo [k] fluoranthene	ND	0.05	ug/L						
Chrysene	ND	0.05	ug/L						
Dibenzo [a,h] anthracene	ND	0.05	ug/L						
Fluoranthene	ND	0.01	ug/L						
Fluorene	ND	0.05	ug/L						
Indeno [1,2,3-cd] pyrene	ND	0.05	ug/L						
1-Methylnaphthalene	ND	0.05	ug/L						
2-Methylnaphthalene	ND	0.05	ug/L						
Methylnaphthalene (1&2)	ND	0.10	ug/L						
Naphthalene	ND	0.05	ug/L						
Phenanthrene	ND	0.05	ug/L						
Pyrene	ND	0.01	ug/L						
Surrogate: 2-Fluorobiphenyl	*15.0*		*ug/L*		*75.1*	*50-140*			
Surrogate: Terphenyl-d14	*19.2*		*ug/L*		*96.0*	*50-140*			
Volatiles									
Acetone	ND	5.0	ug/L						
Benzene	ND	0.5	ug/L						
Bromodichloromethane	ND	0.5	ug/L						
Bromoform	ND	0.5	ug/L						
Bromomethane	ND	0.5	ug/L						

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Carbon Tetrachloride	ND	0.2	ug/L						
Chlorobenzene	ND	0.5	ug/L						
Chloroform	ND	0.5	ug/L						
Dibromochloromethane	ND	0.5	ug/L						
Dichlorodifluoromethane	ND	1.0	ug/L						
1,2-Dichlorobenzene	ND	0.5	ug/L						
1,3-Dichlorobenzene	ND	0.5	ug/L						
1,4-Dichlorobenzene	ND	0.5	ug/L						
1,1-Dichloroethane	ND	0.5	ug/L						
1,2-Dichloroethane	ND	0.5	ug/L						
1,1-Dichloroethylene	ND	0.5	ug/L						
cis-1,2-Dichloroethylene	ND	0.5	ug/L						
trans-1,2-Dichloroethylene	ND	0.5	ug/L						
1,2-Dichloropropane	ND	0.5	ug/L						
cis-1,3-Dichloropropylene	ND	0.5	ug/L						
trans-1,3-Dichloropropylene	ND	0.5	ug/L						
1,3-Dichloropropene, total	ND	0.5	ug/L						
Ethylbenzene	ND	0.5	ug/L						
Ethylene dibromide (dibromoethane, 1,2-	ND	0.2	ug/L						
Hexane	ND	1.0	ug/L						
Methyl Ethyl Ketone (2-Butanone)	ND	5.0	ug/L						
Methyl Isobutyl Ketone	ND	5.0	ug/L						
Methyl tert-butyl ether	ND	2.0	ug/L						
Methylene Chloride	ND	5.0	ug/L						
Styrene	ND	0.5	ug/L						
1,1,1,2-Tetrachloroethane	ND	0.5	ug/L						
1,1,2,2-Tetrachloroethane	ND	0.5	ug/L						
Tetrachloroethylene	ND	0.5	ug/L						
Toluene	ND	0.5	ug/L						
1,1,1-Trichloroethane	ND	0.5	ug/L						
1,1,2-Trichloroethane	ND	0.5	ug/L						
Trichloroethylene	ND	0.5	ug/L						
Trichlorofluoromethane	ND	1.0	ug/L						
Vinyl chloride	ND	0.5	ug/L						
m,p-Xylenes	ND	0.5	ug/L						
o-Xylene	ND	0.5	ug/L						
Xylenes, total	ND	0.5	ug/L						
Surrogate: 4-Bromofluorobenzene	*81.7*		*ug/L*		*102*	*50-140*			
Surrogate: Dibromofluoromethane	*64.7*		*ug/L*		*80.9*	*50-140*			
Surrogate: Toluene-d8	*90.6*		*ug/L*		*113*	*50-140*			

Certificate of Analysis
Client: LRL Associates Ltd.
Client PO:

Report Date: 22-Mar-2023
Order Date: 16-Mar-2023
Project Description: 220487

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
General Inorganics									
Conductivity	330	5	uS/cm	324			1.7	5	
pH	7.9	0.1	pH Units	7.9			0.3	3.3	
Phenolics	0.001	0.001	mg/L	0.001			NC	10	
Hydrocarbons									
F1 PHCs (C6-C10)	ND	25	ug/L	ND			NC	30	
Metals									
Mercury	ND	0.1	ug/L	ND			NC	20	
Antimony	ND	0.5	ug/L	ND			NC	20	
Arsenic	ND	1	ug/L	ND			NC	20	
Beryllium	ND	0.5	ug/L	ND			NC	20	
Boron	15	10	ug/L	14			9.9	20	
Cadmium	ND	0.1	ug/L	ND			NC	20	
Chromium (VI)	ND	10	ug/L	ND			NC	20	
Chromium	ND	1	ug/L	8.0			NC	20	
Cobalt	0.51	0.5	ug/L	2.95			NC	20	
Copper	2.26	0.5	ug/L	8.98			NC	20	
Lead	0.24	0.1	ug/L	9.29			NC	20	
Molybdenum	3.32	0.5	ug/L	4.12			NC	20	
Nickel	1.6	1	ug/L	5.8			NC	20	
Selenium	ND	1	ug/L	1.6			NC	20	
Silver	ND	0.1	ug/L	ND			NC	20	
Sodium	559000	2000	ug/L	609000			8.5	20	
Thallium	ND	0.1	ug/L	ND			NC	20	
Uranium	0.7	0.1	ug/L	0.8			13.9	20	
Vanadium	1.49	0.5	ug/L	13.1			NC	20	
Zinc	ND	5	ug/L	14			NC	20	
Volatiles									
Acetone	8.22	5.0	ug/L	9.52			14.7	30	
Benzene	ND	0.5	ug/L	ND			NC	30	
Bromodichloromethane	ND	0.5	ug/L	ND			NC	30	
Bromoform	ND	0.5	ug/L	ND			NC	30	
Bromomethane	ND	0.5	ug/L	ND			NC	30	
Carbon Tetrachloride	ND	0.2	ug/L	ND			NC	30	
Chlorobenzene	ND	0.5	ug/L	ND			NC	30	
Chloroform	ND	0.5	ug/L	ND			NC	30	
Dibromochloromethane	ND	0.5	ug/L	ND			NC	30	
Dichlorodifluoromethane	ND	1.0	ug/L	ND			NC	30	
1,2-Dichlorobenzene	ND	0.5	ug/L	ND			NC	30	
1,3-Dichlorobenzene	ND	0.5	ug/L	ND			NC	30	
1,4-Dichlorobenzene	ND	0.5	ug/L	ND			NC	30	
1,1-Dichloroethane	ND	0.5	ug/L	ND			NC	30	
1,2-Dichloroethane	ND	0.5	ug/L	ND			NC	30	
1,1-Dichloroethylene	ND	0.5	ug/L	ND			NC	30	
cis-1,2-Dichloroethylene	ND	0.5	ug/L	ND			NC	30	
trans-1,2-Dichloroethylene	ND	0.5	ug/L	ND			NC	30	
1,2-Dichloropropane	ND	0.5	ug/L	ND			NC	30	
cis-1,3-Dichloropropylene	ND	0.5	ug/L	ND			NC	30	
trans-1,3-Dichloropropylene	ND	0.5	ug/L	ND			NC	30	
Ethylbenzene	3.85	0.5	ug/L	2.92			27.5	30	
Ethylene dibromide (dibromoethane, 1,2-	ND	0.2	ug/L	ND			NC	30	
Hexane	ND	1.0	ug/L	ND			NC	30	
Methyl Ethyl Ketone (2-Butanone)	ND	5.0	ug/L	ND			NC	30	
Methyl Isobutyl Ketone	ND	5.0	ug/L	ND			NC	30	
Methyl tert-butyl ether	ND	2.0	ug/L	ND			NC	30	
Methylene Chloride	ND	5.0	ug/L	ND			NC	30	
Styrene	ND	0.5	ug/L	ND			NC	30	

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
1,1,1,2-Tetrachloroethane	ND	0.5	ug/L	ND			NC	30	
1,1,2,2-Tetrachloroethane	ND	0.5	ug/L	ND			NC	30	
Tetrachloroethylene	ND	0.5	ug/L	ND			NC	30	
Toluene	7.60	0.5	ug/L	5.91			25.0	30	
1,1,1-Trichloroethane	ND	0.5	ug/L	ND			NC	30	
1,1,2-Trichloroethane	ND	0.5	ug/L	ND			NC	30	
Trichloroethylene	ND	0.5	ug/L	ND			NC	30	
Trichlorofluoromethane	ND	1.0	ug/L	ND			NC	30	
Vinyl chloride	ND	0.5	ug/L	ND			NC	30	
m,p-Xylenes	14.6	0.5	ug/L	11.1			27.6	30	
o-Xylene	7.09	0.5	ug/L	5.40			27.1	30	
Surrogate: 4-Bromofluorobenzene	*80.6*		*ug/L*		*101*	*50-140*			
Surrogate: Dibromofluoromethane	*60.9*		*ug/L*		*76.1*	*50-140*			
Surrogate: Toluene-d8	*88.4*		*ug/L*		*110*	*50-140*			

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
General Inorganics									
Phenolics	0.026	0.001	mg/L	0.001	101	67-133			
Hydrocarbons									
F1 PHCs (C6-C10)	1910	25	ug/L	ND	95.6	68-117			
F2 PHCs (C10-C16)	1770	100	ug/L	ND	111	60-140			
F3 PHCs (C16-C34)	4520	100	ug/L	ND	115	60-140			
F4 PHCs (C34-C50)	2360	100	ug/L	ND	95.3	60-140			
Metals									
Mercury	2.60	0.1	ug/L	ND	86.8	70-130			
Arsenic	51.7	1	ug/L	ND	102	80-120			
Beryllium	44.7	0.5	ug/L	ND	89.1	80-120			
Boron	54	10	ug/L	14	81.5	80-120			
Cadmium	43.2	0.1	ug/L	ND	86.2	80-120			
Chromium (VI)	199	10	ug/L	ND	99.5	70-130			
Chromium	61.5	1	ug/L	8.0	107	80-120			
Cobalt	57.3	0.5	ug/L	2.95	109	80-120			
Copper	52.0	0.5	ug/L	8.98	86.1	80-120			
Lead	56.8	0.1	ug/L	ND	114	80-120			
Molybdenum	60.4	0.5	ug/L	4.12	113	80-120			
Nickel	54.9	1	ug/L	5.8	98.3	80-120			
Selenium	41.1	1	ug/L	1.6	79.1	80-120			QM-07
Silver	42.7	0.1	ug/L	ND	85.3	80-120			
Sodium	11700	200	ug/L	ND	117	80-120			
Thallium	43.5	0.1	ug/L	ND	86.9	80-120			
Uranium	49.3	0.1	ug/L	0.8	97.1	80-120			
Vanadium	64.5	0.5	ug/L	13.1	103	80-120			
Semi-Volatiles									
Acenaphthene	4.61	0.05	ug/L	ND	92.2	50-140			
Acenaphthylene	4.14	0.05	ug/L	ND	82.9	50-140			
Anthracene	4.23	0.01	ug/L	ND	84.6	50-140			
Benzo [a] anthracene	4.98	0.01	ug/L	ND	99.6	50-140			
Benzo [a] pyrene	5.51	0.01	ug/L	ND	110	50-140			
Benzo [b] fluoranthene	5.88	0.05	ug/L	ND	118	50-140			
Benzo [g,h,i] perylene	3.97	0.05	ug/L	ND	79.5	50-140			
Benzo [k] fluoranthene	5.56	0.05	ug/L	ND	111	50-140			
Chrysene	5.33	0.05	ug/L	ND	107	50-140			
Dibenzo [a,h] anthracene	4.34	0.05	ug/L	ND	86.8	50-140			
Fluoranthene	4.36	0.01	ug/L	ND	87.1	50-140			
Fluorene	4.35	0.05	ug/L	ND	87.0	50-140			
Indeno [1,2,3-cd] pyrene	4.55	0.05	ug/L	ND	91.0	50-140			
1-Methylnaphthalene	4.93	0.05	ug/L	ND	98.6	50-140			
2-Methylnaphthalene	5.31	0.05	ug/L	ND	106	50-140			
Naphthalene	4.88	0.05	ug/L	ND	97.5	50-140			
Phenanthrene	4.19	0.05	ug/L	ND	83.8	50-140			
Pyrene	4.42	0.01	ug/L	ND	88.4	50-140			
Surrogate: 2-Fluorobiphenyl	*19.5*		*ug/L*		*97.4*	*50-140*			
Surrogate: Terphenyl-d14	*22.4*		*ug/L*		*112*	*50-140*			
Volatiles									
Acetone	110	5.0	ug/L	ND	110	50-140			

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Benzene	42.2	0.5	ug/L	ND	105	60-130			
Bromodichloromethane	45.5	0.5	ug/L	ND	114	60-130			
Bromoform	35.9	0.5	ug/L	ND	89.7	60-130			
Bromomethane	48.7	0.5	ug/L	ND	122	50-140			
Carbon Tetrachloride	36.0	0.2	ug/L	ND	90.0	60-130			
Chlorobenzene	44.4	0.5	ug/L	ND	111	60-130			
Chloroform	44.7	0.5	ug/L	ND	112	60-130			
Dibromochloromethane	35.5	0.5	ug/L	ND	88.8	60-130			
Dichlorodifluoromethane	42.8	1.0	ug/L	ND	107	50-140			
1,2-Dichlorobenzene	39.8	0.5	ug/L	ND	99.4	60-130			
1,3-Dichlorobenzene	37.5	0.5	ug/L	ND	93.7	60-130			
1,4-Dichlorobenzene	37.0	0.5	ug/L	ND	92.4	60-130			
1,1-Dichloroethane	42.3	0.5	ug/L	ND	106	60-130			
1,2-Dichloroethane	46.2	0.5	ug/L	ND	116	60-130			
1,1-Dichloroethylene	45.4	0.5	ug/L	ND	113	60-130			
cis-1,2-Dichloroethylene	41.0	0.5	ug/L	ND	103	60-130			
trans-1,2-Dichloroethylene	37.9	0.5	ug/L	ND	94.7	60-130			
1,2-Dichloropropane	46.3	0.5	ug/L	ND	116	60-130			
cis-1,3-Dichloropropylene	43.5	0.5	ug/L	ND	109	60-130			
trans-1,3-Dichloropropylene	42.1	0.5	ug/L	ND	105	60-130			
Ethylbenzene	46.0	0.5	ug/L	ND	115	60-130			
Ethylene dibromide (dibromoethane, 1,2-	38.4	0.2	ug/L	ND	96.0	60-130			
Hexane	45.9	1.0	ug/L	ND	115	60-130			
Methyl Ethyl Ketone (2-Butanone)	129	5.0	ug/L	ND	129	50-140			
Methyl Isobutyl Ketone	125	5.0	ug/L	ND	125	50-140			
Methyl tert-butyl ether	111	2.0	ug/L	ND	111	50-140			
Methylene Chloride	44.2	5.0	ug/L	ND	111	60-130			
Styrene	34.2	0.5	ug/L	ND	85.6	60-130			
1,1,1,2-Tetrachloroethane	35.7	0.5	ug/L	ND	89.4	60-130			
1,1,2,2-Tetrachloroethane	37.4	0.5	ug/L	ND	93.6	60-130			
Tetrachloroethylene	39.2	0.5	ug/L	ND	98.1	60-130			
Toluene	48.1	0.5	ug/L	ND	120	60-130			
1,1,1-Trichloroethane	44.2	0.5	ug/L	ND	111	60-130			
1,1,2-Trichloroethane	47.5	0.5	ug/L	ND	119	60-130			
Trichloroethylene	42.9	0.5	ug/L	ND	107	60-130			
Trichlorofluoromethane	49.7	1.0	ug/L	ND	124	60-130			
Vinyl chloride	39.6	0.5	ug/L	ND	99.0	50-140			
m,p-Xylenes	90.2	0.5	ug/L	ND	113	60-130			
o-Xylene	45.8	0.5	ug/L	ND	115	60-130			
Surrogate: 4-Bromofluorobenzene	*79.8*		*ug/L*		*99.8*	*50-140*			
Surrogate: Dibromofluoromethane	*82.2*		*ug/L*		*103*	*50-140*			
Surrogate: Toluene-d8	*85.8*		*ug/L*		*107*	*50-140*			

Qualifier Notes:

Login Qualifiers :

Container(s) - Labeled improperly/insufficient information - (VOC x2) Sample labelled as MW23-5 chain of custody reads MW23-4

Applies to samples: MW23-4

QC Qualifiers :

QM-07 The spike recovery was outside acceptance limits for the MS and/or MSD. The batch was accepted based on other acceptable QC.

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

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

CCME PHC additional information:

- The method for the analysis of PHCs complies with the Reference Method for the CWS PHC and is validated for use in the laboratory. All prescribed quality criteria identified in the method has been met.
- F1 range corrected for BTEX.
- F2 to F3 ranges corrected for appropriate PAHs where available.
- The gravimetric heavy hydrocarbons (F4G) are not to be added to C6 to C50 hydrocarbons.
- In the case where F4 and F4G are both reported, the greater of the two results is to be used for comparison to CWS PHC criteria.
- When reported, data for F4G has been processed using a silica gel cleanup.

PARACEL LABORATORIES LTD.

Paracel ID: 2311446

Paracel Order Number (Lab Use Only)	Chain Of Custody (Lab Use Only)
2311446	№ 139922

Client Name: LRL Associates	Project Ref: 220487
Contact Name: Abdul Kader	Quote #:
Address: 5430 Canotek Rd Ottawa, ON	PO #:
	E-mail: akader@lrl.ca
Telephone: 613 315 6602	

Page 1 of 1

Turnaround Time

☐ 1 day ☐ 3 day ☐ 2 day ☒ Regular

Date Required:

☐ REG 153/04 ☐ REG 406/19 | Other Regulation

☐ Table 1 ☐ Res/Park ☐ Med/Fine ☐ REG 558 ☐ PWQO

☒ Table 2 ☐ Ind/Comm ☐ Coarse ☐ CCME ☐ MISA

☐ Table 3 ☐ Agri/Other ☐ SU - Sani ☐ SU - Storm

☐ Table ___ Mun: ___

For RSC: ☐ Yes ☐ No ☐ Other:

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

Required Analysis

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Date	Time	PHCs F1-F4+BTEX	VOCs	PAHs	Metals by ICP	Hg	CrVI	B (HWS)	Metal Hydrids	EC	SAR	PH	Phenols
1	MW23-2	GW		8	2023.03.16	3:50	X	X	X	X				X	X	X	X	
2	MW23-3	↓		9	↓	3:40	↓	↓	↓	↓				↓	↓	↓	↓	X
3	MW23-4	↓		9	↓	3:30	↓	↓	↓	↓				↓	↓	↓	↓	X
4	MW23-5	↓		8	↓	3:20	↓	↓	↓	↓				↓	↓	↓	↓	
5																		
6																		
7																		
8																		
9																		
10																		

Comments:

Method of Delivery: Walk In

Relinquished By (Sign): [signature]	Received By Driver/Depot:	Received at Lab: Clouds 1627	Verified By: Sandra Demenins
Relinquished By (Print): Abdul Kader	Date/Time:	Date/Time: March 16, 2023	Date/Time: Mar 17, 8:50
Date/Time: 2023.03.16 / 4:20	Temperature: °C	Temperature: 4.3 °C	pH Verified: ☐ By: Sandra Demenins

PARACEL LABORATORIES LTD.
TRUSTED. RESPONSIVE. RELIABLE.

300 - 2319 St. Laurent Blvd
Ottawa, ON, K1G 4J8
1-800-749-1947
www.paracellabs.com

Certificate of Analysis

LRL Associates Ltd.

5430 Canotek Road
Ottawa, ON K1J 9G2
Attn: Jessica Arthurs

Client PO:
Project: 220487
Custody: 69848

Report Date: 20-Apr-2023
Order Date: 17-Apr-2023

Order #: 2316082

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

Paracel ID	Client ID
2316082-01	MW23-3

Approved By:

Dale Robertson, BSc
Laboratory Director

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Metals, ICP-MS	EPA 200.8 - ICP-MS	19-Apr-23	19-Apr-23
REG 153: PAHs by GC-MS	EPA 625 - GC-MS, extraction	19-Apr-23	20-Apr-23

Certificate of Analysis

Client: LRL Associates Ltd.

Client PO:

Report Date: 20-Apr-2023

Order Date: 17-Apr-2023

Project Description: 220487

	Client ID:	MW23-3	-	-	-
	Sample Date:	17-Apr-23 12:00	-	-	-
	Sample ID:	2316082-01	-	-	-
	MDL/Units	Ground Water	-	-	-
Metals					
Antimony	0.5 ug/L	<0.5	-	-	-
Arsenic	1 ug/L	4	-	-	-
Barium	1 ug/L	26	-	-	-
Beryllium	0.5 ug/L	<0.5	-	-	-
Boron	10 ug/L	23	-	-	-
Cadmium	0.1 ug/L	<0.1	-	-	-
Chromium	1 ug/L	<1	-	-	-
Cobalt	0.5 ug/L	<0.5	-	-	-
Copper	0.5 ug/L	<0.5	-	-	-
Lead	0.1 ug/L	<0.1	-	-	-
Molybdenum	0.5 ug/L	6.6	-	-	-
Nickel	1 ug/L	6	-	-	-
Selenium	1 ug/L	<1	-	-	-
Silver	0.1 ug/L	<0.1	-	-	-
Sodium	200 ug/L	115000	-	-	-
Thallium	0.1 ug/L	<0.1	-	-	-
Uranium	0.1 ug/L	2.9	-	-	-
Vanadium	0.5 ug/L	5.4	-	-	-
Zinc	5 ug/L	<5	-	-	-
Semi-Volatiles					
Acenaphthene	0.05 ug/L	0.98	-	-	-
Acenaphthylene	0.05 ug/L	<0.05	-	-	-
Anthracene	0.01 ug/L	0.15	-	-	-
Benzo [a] anthracene	0.01 ug/L	0.09	-	-	-
Benzo [a] pyrene	0.01 ug/L	0.07	-	-	-
Benzo [b] fluoranthene	0.05 ug/L	0.09	-	-	-
Benzo [g,h,i] perylene	0.05 ug/L	0.05	-	-	-
Benzo [k] fluoranthene	0.05 ug/L	0.06	-	-	-
Chrysene	0.05 ug/L	0.06	-	-	-
Dibenzo [a,h] anthracene	0.05 ug/L	<0.05	-	-	-
Fluoranthene	0.01 ug/L	0.24	-	-	-
Fluorene	0.05 ug/L	0.40	-	-	-
Indeno [1,2,3-cd] pyrene	0.05 ug/L	<0.05	-	-	-
1-Methylnaphthalene	0.05 ug/L	0.38	-	-	-
2-Methylnaphthalene	0.05 ug/L	0.48	-	-	-

	Client ID:	MW23-3	-	-	-
	Sample Date:	17-Apr-23 12:00	-	-	-
	Sample ID:	2316082-01	-	-	-
	MDL/Units	Ground Water	-	-	-
Methylnaphthalene (1&2)	0.10 ug/L	0.85	-	-	-
Naphthalene	0.05 ug/L	4.36	-	-	-
Phenanthrene	0.05 ug/L	0.64	-	-	-
Pyrene	0.01 ug/L	0.18	-	-	-
2-Fluorobiphenyl	Surrogate	84.4%	-	-	-
Terphenyl-d14	Surrogate	130%	-	-	-

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Metals									
Antimony	ND	0.5	ug/L						
Arsenic	ND	1	ug/L						
Barium	ND	1	ug/L						
Beryllium	ND	0.5	ug/L						
Boron	ND	10	ug/L						
Cadmium	ND	0.1	ug/L						
Chromium	ND	1	ug/L						
Cobalt	ND	0.5	ug/L						
Copper	ND	0.5	ug/L						
Lead	ND	0.1	ug/L						
Molybdenum	ND	0.5	ug/L						
Nickel	ND	1	ug/L						
Selenium	ND	1	ug/L						
Silver	ND	0.1	ug/L						
Sodium	ND	200	ug/L						
Thallium	ND	0.1	ug/L						
Uranium	ND	0.1	ug/L						
Vanadium	ND	0.5	ug/L						
Zinc	ND	5	ug/L						
Semi-Volatiles									
Acenaphthene	ND	0.05	ug/L						
Acenaphthylene	ND	0.05	ug/L						
Anthracene	ND	0.01	ug/L						
Benzo [a] anthracene	ND	0.01	ug/L						
Benzo [a] pyrene	ND	0.01	ug/L						
Benzo [b] fluoranthene	ND	0.05	ug/L						
Benzo [g,h,i] perylene	ND	0.05	ug/L						
Benzo [k] fluoranthene	ND	0.05	ug/L						
Chrysene	ND	0.05	ug/L						
Dibenzo [a,h] anthracene	ND	0.05	ug/L						
Fluoranthene	ND	0.01	ug/L						
Fluorene	ND	0.05	ug/L						
Indeno [1,2,3-cd] pyrene	ND	0.05	ug/L						
1-Methylnaphthalene	ND	0.05	ug/L						
2-Methylnaphthalene	ND	0.05	ug/L						
Methylnaphthalene (1&2)	ND	0.10	ug/L						
Naphthalene	ND	0.05	ug/L						
Phenanthrene	ND	0.05	ug/L						
Pyrene	ND	0.01	ug/L						
Surrogate: 2-Fluorobiphenyl	*22.7*		*ug/L*		*114*	*50-140*			
Surrogate: Terphenyl-d14	*22.7*		*ug/L*		*114*	*50-140*			

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Metals									
Antimony	0.51	0.5	ug/L	0.52			2.5	20	
Arsenic	ND	1	ug/L	ND			NC	20	
Barium	49.0	1	ug/L	51.0			3.9	20	
Beryllium	ND	0.5	ug/L	ND			NC	20	
Boron	29	10	ug/L	30			1.3	20	
Cadmium	ND	0.1	ug/L	ND			NC	20	
Chromium	ND	1	ug/L	ND			NC	20	
Cobalt	ND	0.5	ug/L	ND			NC	20	
Copper	1.84	0.5	ug/L	1.86			1.2	20	
Lead	ND	0.1	ug/L	ND			NC	20	
Molybdenum	0.80	0.5	ug/L	0.85			5.5	20	
Nickel	ND	1	ug/L	ND			NC	20	
Selenium	ND	1	ug/L	ND			NC	20	
Silver	ND	0.1	ug/L	ND			NC	20	
Sodium	70000	200	ug/L	75800			7.9	20	
Thallium	ND	0.1	ug/L	ND			NC	20	
Uranium	0.4	0.1	ug/L	0.4			5.2	20	
Vanadium	ND	0.5	ug/L	ND			NC	20	
Zinc	ND	5	ug/L	ND			NC	20	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Metals									
Arsenic	52.1	1	ug/L	ND	103	80-120			
Barium	91.0	1	ug/L	51.0	80.2	80-120			
Beryllium	43.5	0.5	ug/L	ND	87.0	80-120			
Boron	68	10	ug/L	30	76.7	80-120			QM-07
Cadmium	44.9	0.1	ug/L	ND	89.8	80-120			
Chromium	51.4	1	ug/L	ND	102	80-120			
Cobalt	48.0	0.5	ug/L	ND	95.9	80-120			
Copper	45.1	0.5	ug/L	1.86	86.4	80-120			
Lead	41.6	0.1	ug/L	ND	83.2	80-120			
Molybdenum	43.5	0.5	ug/L	0.85	85.4	80-120			
Nickel	49.9	1	ug/L	ND	98.2	80-120			
Selenium	45.5	1	ug/L	ND	90.0	80-120			
Silver	44.2	0.1	ug/L	ND	88.5	80-120			
Sodium	9980	200	ug/L	ND	99.8	80-120			
Thallium	42.6	0.1	ug/L	ND	85.2	80-120			
Uranium	44.9	0.1	ug/L	0.4	89.0	80-120			
Vanadium	53.7	0.5	ug/L	ND	107	80-120			
Zinc	44	5	ug/L	ND	83.2	80-120			
Semi-Volatiles									
Acenaphthene	4.08	0.05	ug/L	ND	81.7	50-140			
Acenaphthylene	3.62	0.05	ug/L	ND	72.4	50-140			
Anthracene	3.88	0.01	ug/L	ND	77.6	50-140			
Benzo [a] anthracene	4.39	0.01	ug/L	ND	87.9	50-140			
Benzo [a] pyrene	4.89	0.01	ug/L	ND	97.7	50-140			
Benzo [b] fluoranthene	4.72	0.05	ug/L	ND	94.4	50-140			
Benzo [g,h,i] perylene	3.41	0.05	ug/L	ND	68.2	50-140			
Benzo [k] fluoranthene	5.20	0.05	ug/L	ND	104	50-140			
Chrysene	5.22	0.05	ug/L	ND	104	50-140			
Dibenzo [a,h] anthracene	3.63	0.05	ug/L	ND	72.7	50-140			
Fluoranthene	3.76	0.01	ug/L	ND	75.2	50-140			
Fluorene	4.10	0.05	ug/L	ND	82.0	50-140			
Indeno [1,2,3-cd] pyrene	3.55	0.05	ug/L	ND	71.0	50-140			
1-Methylnaphthalene	5.39	0.05	ug/L	ND	108	50-140			
2-Methylnaphthalene	5.57	0.05	ug/L	ND	111	50-140			
Naphthalene	4.68	0.05	ug/L	ND	93.5	50-140			
Phenanthrene	3.95	0.05	ug/L	ND	79.1	50-140			
Pyrene	3.87	0.01	ug/L	ND	77.5	50-140			
Surrogate: 2-Fluorobiphenyl	*21.0*		*ug/L*		*105*	*50-140*			
Surrogate: Terphenyl-d14	*22.3*		*ug/L*		*111*	*50-140*			

Qualifier Notes:

Login Qualifiers :

Sample - Filtered and preserved by Paracel upon receipt at the laboratory - metals

Applies to samples: MW23-3

Sample - ICP-MS Metals not submitted according to Reg. 153/04, Amended 2011 - not field filtered and preserved

Applies to samples: MW23-3

QC Qualifiers :

QM-07 The spike recovery was outside acceptance limits for the MS and/or MSD. The batch was accepted based on other acceptable QC.

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

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

PARACEL LABORATORIES LTD

Paracel ID: 2316082

Paracel Order Number (Lab Use Only)	Chain Of Custody (Lab Use Only)
	№ 69848

Client Name: LRL	Project Ref: 220487		Page 1 of 1
Contact Name: Jessica Arthurs	Quote #:		Turnaround Time
Address: 5430 Canotek Road Ottawa, ON K1J 9G2	PO #:		☐ 1 day ☐ 3 day
	E-mail: jarthurs@lrl.ca		☐ 2 day ☑ Regular
Telephone: 613 842 3434			Date Required:

☐ REG 153/04 ☐ REG 406/19

☐ Table 1 ☐ Res/Park ☐ Med/Fine
☒ Table 2 ☐ Ind/Comm ☐ Coarse
☐ Table 3 ☐ Agri/Other
☐ Table ___
For RSC: ☐ Yes ☒ No

Other Regulation
☐ REG 558 ☐ PWQO
☐ CCME ☐ MISA
☐ SU - Sani ☐ SU - Storm
Mun: ___
☐ Other:

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

Required Analysis

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	PAH	ICP Metals										
1	MW23-3	GW		2	April 17/23	12⁰⁰ pm	X	X										
2																		
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		

Comments:
Metals not filtered - Rinsed in field

Method of Delivery: Walk in

Relinquished By (Sign): [signature]	Received By Driver/Depot:	Received at Lab: [signature]	Verified By: [signature]
Relinquished By (Print): Jessica Arthurs	Date/Time:	Date/Time: Apr 17/23 1pm	Date/Time: Apr 17/23 1326
Date/Time: 2023.04.17 12:58 pm	Temperature: °C	Temperature: 8.6 °C	pH Verified: ☑ By: [initials]

ATTACHMENT F

Pumping Test – Field Data

Pump Test Data
Hydrogeological Assessment & Terrain Analysis
Proposed Warehouse Development - 363 Entrepreneur Crescent, Ottawa, Ontario
LRL File No. 220487

Date:	**30/07/2023**	**Technician:**	E. Lavergne
Well Number:	**Tag A37901**	**Pump Depth (m BTC):**	45.7
Depth of Well (m BTC):	49.10	**Start Time:**	8:15 AM
Ground Surface Elev. (m):	--	**End Time:**	4:30 PM
Top of Casing Elev. (m):	--	**Average Pump Rate (L/min):**	22.0
Water Level before Pump In (m BTC)	2.75		
Water Level after Pump In (m BTC)	2.61		

Time[1] (min)	Water Level (Pump In) (m BTC)	Drawdown (m)	Flow Rate (L/min)	Turbidity (NTU)	Field Parameters: Residual Chlorine (mg/L)	Colour (TCU)	pH	Conductivity (µs)	Total Dissolved (mg/L)
0.0	2.61	0.00							
0.5	3.01	0.40	22.0						
1.0	3.75	1.14	22.0						
1.5	4.01	1.40	22.0						
2.0	4.26	1.65	22.0						
2.5	4.50	1.89	22.0						
3.0	4.71	2.10	22.0						
3.5	4.95	2.34	22.0						
4.0	5.13	2.52	22.0						
4.5	5.23	2.62	22.0						
5.0	5.30	2.69	22.0						
6.0	5.38	2.77	22.0						
7.0	5.52	2.91	22.0						
8.0	5.59	2.98	22.0						
9.0	5.67	3.06	22.0						
10.0	5.73	3.12	22.0						
15.0	5.88	3.27	22.0						
20.0	5.97	3.36	22.0						
25.0	6.03	3.42	22.0						
30.0	6.06	3.45	22.0						
40.0	6.11	3.50	22.0						
50.0	6.13	3.52	22.0						
60.0	6.18	3.57	22.0	3.58	0.03	92	7.90	3999+	2000+
90.0	6.19	3.58	22.0						
120.0	6.20	3.59	22.0	2.31	0.05	52	7.92	3999+	2000+
150.0	6.21	3.60	22.0						
180.0	6.20	3.59	22.0	2.04	0.06	13	8.05	3999+	2000+
240.0	6.22	3.61	22.0	2.54	0.02	66	8.40	3999+	2000+
300.0	6.23	3.62	22.0	2.12	0.02	33	8.05	3999+	2000+
360.0	6.21	3.60	22.0	2.23	0.06	12	8.10	3999+	2000+
420.0	6.24	3.63	22.0	2.16	0.02	21	8.12	3999+	2000+
480.0	6.25	3.64	22.0	2.54	0.02	34	8.10	3999+	2000+
495.0	6.23	3.62	22.0						
Recovery				**% Recovery**					
0 (2.95)	6.23	3.62		0.0					
0.5	4.30	1.69		53.3					
1.0	4.19	1.58		56.4					
1.5	4.11	1.50		58.6					
2.0	4.05	1.44		60.2					
2.5	3.94	1.33		63.3					
3.0	3.81	1.20		66.9					
3.5	3.68	1.07		70.4					
4.0	3.56	0.95		73.8					
4.5	3.51	0.90		75.1					
5.0	3.45	0.84		76.8					
6.0	3.38	0.77		78.7					
7.0	3.32	0.71		80.4					
8.0	3.28	0.67		81.5					
9.0	3.26	0.65		82.0					
10.0	3.22	0.61		83.1					
15.0	3.14	0.53		85.4					
20.0	3.09	0.48		86.7					
25.0	3.05	0.44		87.8					
30.0	3.03	0.42		88.4					
40.0	2.99	0.38		89.5					
50.0	2.98	0.37		89.8					
60.0	2.97	0.36		90.1					
960.0	2.87	0.26		92.8					
1440.0	2.93	0.32		91.2					

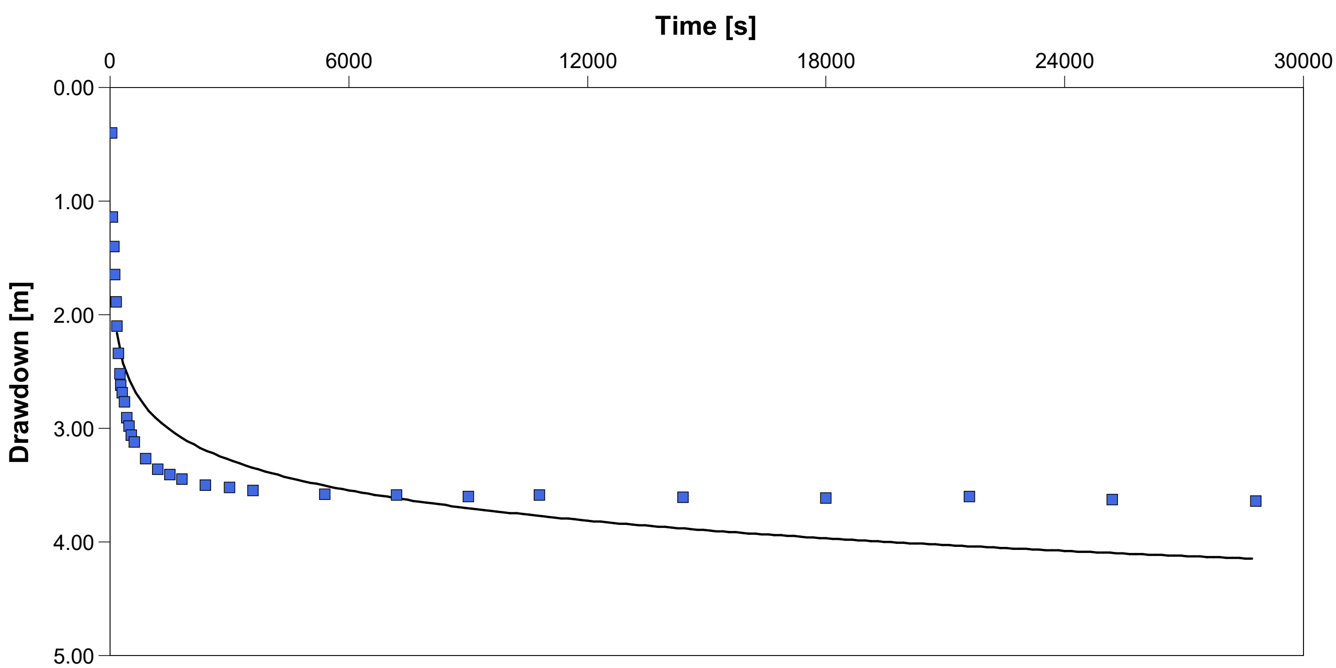
[1] Time elapse from pump turning on or off.
BTC: Below Top of Casing

ATTACHMENT G

Aquifer Test – Theis Analysis

LRL Associates Ltd. 5430 Canotek Road Ottawa, Ontario	**Pumping Test Analysis Report**
	Project: 363 Entrepreneur Cresent
	Number: 220487
	Client: Entrepreneur Holding

Location: 363 Entrepreneur Cresent	Pumping Test: Pumping Test 1	Pumping Well: Well 1
Test Conducted by: LRL Engineering		Test Date: 2023-08-30
Analysis Performed by: LRL Engineering	Draw Down - August 30 2023	Analysis Date: 2023-09-07
Aquifer Thickness:	Discharge Rate: 0.022 [m³/min]	



Calculation using Theis

Observation Well	Transmissivity [m²/s]	Storage coefficient	Radial Distance to PW [m]	
Well 1	7.59×10^{-5}	4.51×10^{-3}	0.15	

ATTACHMENT H

Supply Aquifer –
Laboratory Certificate of Analysis

PARACEL LABORATORIES LTD.
TRUSTED. RESPONSIVE. RELIABLE.

300 - 2319 St. Laurent Blvd
Ottawa, ON, K1G 4J8
1-800-749-1947
www.paracellabs.com

Certificate of Analysis

LRL Associates Ltd.

5430 Canotek Road
Ottawa, ON K1J 9G2
Attn: Jessica Arthurs

Client PO:
Project: 220487
Custody: 18167

Report Date: 25-Apr-2023
Order Date: 17-Apr-2023

Order #: 2316079

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

Paracel ID	Client ID
2316079-01	357 Entrepreneur-Pre
2316079-02	357 Entrepreneur-Post

Approved By: Mark Foto

Mark Foto, M.Sc.
Lab Supervisor

Certificate of Analysis
Client: **LRL Associates Ltd.**
Client PO:

Report Date: 25-Apr-2023
Order Date: 17-Apr-2023
Project Description: 220487

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Alkalinity, total to pH 4.5	EPA 310.1 - Titration to pH 4.5	18-Apr-23	18-Apr-23
Ammonia, as N	EPA 351.2 - Auto Colour	19-Apr-23	19-Apr-23
Anions	EPA 300.1 - IC	18-Apr-23	18-Apr-23
Colour	SM2120 - Spectrophotometric	18-Apr-23	18-Apr-23
Conductivity	EPA 9050A- probe @25 °C	18-Apr-23	18-Apr-23
Dissolved Organic Carbon	MOE 3247B - Combustion IR	20-Apr-23	20-Apr-23
E. coli	MOE E3407	18-Apr-23	18-Apr-23
Fecal Coliform	SM 9222D	18-Apr-23	18-Apr-23
Heterotrophic Plate Count	SM 9215C	18-Apr-23	18-Apr-23
Metals, ICP-MS	EPA 200.8 - ICP-MS	18-Apr-23	18-Apr-23
pH	EPA 150.1 - pH probe @25 °C	18-Apr-23	18-Apr-23
Phenolics	EPA 420.2 - Auto Colour, 4AAP	19-Apr-23	19-Apr-23
Hardness	Hardness as CaCO3	18-Apr-23	18-Apr-23
Sulphide	SM 4500SE - Colourimetric	21-Apr-23	21-Apr-23
Tannin/Lignin	SM 5550B - Colourimetric	20-Apr-23	20-Apr-23
Total Coliform	MOE E3407	18-Apr-23	18-Apr-23
Total Dissolved Solids	SM 2540C - gravimetric, filtration	18-Apr-23	19-Apr-23
Total Kjeldahl Nitrogen	EPA 351.2 - Auto Colour, digestion	18-Apr-23	18-Apr-23
Turbidity	SM 2130B - Turbidity meter	19-Apr-23	19-Apr-23

Certificate of Analysis

Client: **LRL Associates Ltd.**

Client PO:

Report Date: 25-Apr-2023

Order Date: 17-Apr-2023

Project Description: 220487

	Client ID:	357 Entrepreneur-Pre	357 Entrepreneur-Post	-	-
	Sample Date:	17-Apr-23 11:15	17-Apr-23 11:35	-	-
	Sample ID:	2316079-01	2316079-02	-	-
	MDL/Units	Drinking Water	Drinking Water	-	-
Microbiological Parameters					
E. coli	1 CFU/100mL	ND	ND [1]	-	-
Fecal Coliforms	1 CFU/100mL	ND	ND	-	-
Total Coliforms	1 CFU/100mL	ND	ND [1]	-	-
Heterotrophic Plate Count	10 CFU/mL	<10	150	-	-
General Inorganics					
Alkalinity, total	5 mg/L	605	16	-	-
Ammonia as N	0.01 mg/L	3.28	0.46	-	-
Dissolved Organic Carbon	0.5 mg/L	7.8	<0.5	-	-
Colour	2 TCU	5	<2	-	-
Conductivity	5 uS/cm	13100	1050	-	-
Hardness	mg/L	1050	0.00	-	-
pH	0.1 pH Units	8.2	7.0	-	-
Phenolics	0.001 mg/L	<0.001	<0.001	-	-
Total Dissolved Solids	10 mg/L	7640	508	-	-
Sulphide	0.02 mg/L	0.24	<0.02	-	-
Tannin & Lignin	0.1 mg/L	0.7	<0.1	-	-
Total Kjeldahl Nitrogen	0.1 mg/L	3.4	0.5	-	-
Turbidity	0.1 NTU	12.0	<0.1	-	-
Anions					
Chloride	1 mg/L	4350	302	-	-
Fluoride	0.1 mg/L	0.7	<0.1	-	-
Nitrate as N	0.1 mg/L	<0.1	<0.1	-	-
Nitrite as N	0.05 mg/L	<0.50 [2]	<0.05	-	-
Sulphate	1 mg/L	13	<1	-	-
Metals					
Calcium	0.1 mg/L	97.8	<0.1	-	-
Iron	0.1 mg/L	1.3	<0.1	-	-
Magnesium	0.2 mg/L	196	<0.2	-	-
Manganese	0.005 mg/L	0.030	<0.005	-	-
Potassium	0.1 mg/L	91.4	1.9	-	-
Sodium	0.2 mg/L	2010	152	-	-

Method Quality Control: Blank

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

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	157	1	mg/L	158			0.1	20	
Fluoride	ND	0.1	mg/L	ND			NC	20	
Nitrate as N	ND	0.1	mg/L	ND			NC	20	
Nitrite as N	ND	0.05	mg/L	ND			NC	20	
Sulphate	32.4	1	mg/L	32.6			0.7	20	
General Inorganics									
Alkalinity, total	15.2	5	mg/L	16.2			6.2	14	
Ammonia as N	0.150	0.01	mg/L	0.151			1.0	17.7	
Dissolved Organic Carbon	ND	0.5	mg/L	ND			NC	37	
Colour	5	2	TCU	5			0.0	12	
Conductivity	1000	5	uS/cm	1050			4.0	5	
pH	7.0	0.1	pH Units	7.0			0.6	3.3	
Phenolics	ND	0.001	mg/L	ND			NC	10	
Total Dissolved Solids	7550	10	mg/L	7640			1.2	10	
Sulphide	ND	0.02	mg/L	ND			NC	10	
Tannin & Lignin	0.2	0.1	mg/L	0.2			4.5	11	
Total Kjeldahl Nitrogen	3.34	0.2	mg/L	3.42			2.2	16	
Turbidity	ND	0.1	NTU	12.0			NC	10	
Metals									
Calcium	110	0.1	mg/L	97.8			11.9	20	
Iron	1.5	0.1	mg/L	1.3			12.4	20	
Magnesium	219	0.2	mg/L	196			11.3	20	
Manganese	0.035	0.005	mg/L	0.030			13.8	20	
Potassium	102	0.1	mg/L	91.4			10.5	20	
Sodium	2140	0.2	mg/L	2010			6.3	20	
Microbiological Parameters									
E. coli	ND	1	CFU/100mL	ND			NC	30	
Fecal Coliforms	ND	1	CFU/100mL	ND			NC	30	
Total Coliforms	ND	1	CFU/100mL	ND			NC	30	
Heterotrophic Plate Count	ND	10	CFU/mL	ND			NC	30	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	167	1	mg/L	158	90.3	70-124			
Fluoride	1.00	0.1	mg/L	ND	100	70-130			
Nitrate as N	1.09	0.1	mg/L	ND	109	77-126			
Nitrite as N	0.940	0.05	mg/L	ND	94.0	82-115			
Sulphate	41.5	1	mg/L	32.6	88.4	70-130			
General Inorganics									
Ammonia as N	1.21	0.01	mg/L	0.151	106	81-124			
Dissolved Organic Carbon	17.2	0.5	mg/L	7.8	93.5	60-133			
Phenolics	0.027	0.001	mg/L	ND	107	67-133			
Total Dissolved Solids	100	10	mg/L	ND	100	75-125			
Sulphide	0.48	0.02	mg/L	ND	96.0	79-115			
Tannin & Lignin	1.2	0.1	mg/L	0.2	92.9	71-113			
Total Kjeldahl Nitrogen	4.31	0.1	mg/L	3.42	88.9	81-126			
Metals									
Calcium	8370	0.1	mg/L	ND	83.7	80-120			
Magnesium	8180	0.2	mg/L	ND	81.8	80-120			
Manganese	42.2	0.005	mg/L	ND	84.3	80-120			
Potassium	10400	0.1	mg/L	1820	85.6	80-120			
Sodium	8460	0.2	mg/L	ND	84.6	80-120			

Qualifier Notes:

Sample Qualifiers :

1 : Confluent background colonies on filter: may interfere with target reactions and the analysts' ability to count E. coli & Total Coliform. The target colonies may be under-represented.

2 : Elevated reporting limit due to dilution required because of high target analyte concentration.

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

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

Paracel ID: 2316079

PARACEL LABORATORIES LTD

Paracel Order Number	Chain Of Custody Ontario Drinking Water Samples № 18167

Client Name: LRL	Project Ref: 220487	Waterworks Name:	Samples Taken By:
Contact Name: Jessica Arthurs	Quote #:	Waterworks Number:	Name: Jessica Arthurs
Address: 5430 Canotek Rd. Ottawa, On K1J9G2	PO #:	Address: 357 Entrepreneur	Signature:
After Hours Contact: Jessica Arthurs	E-mail: Jarthurs@lrl.ca	Ottawa, Ontario	Page 1 of 1
Telephone: 613842 3434	Fax:	Public Health Unit:	Turn Around Time Required: ☐ 1 day ☐ 2 day ☐ 3 day ☒ 4 day

Samples Submitted Under: (Indicate ONLY one)
☐ ON REG 170/03 ☐ ON REG 319/08 ☐ Private Well
☐ ON REG 243/07 ☒ Other ODWS

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

Have LSN forms been submitted to MOE/MOHLTC?: ☐ Yes ☒ No ☐ N/A
Are these samples for human consumption?: ☒ Yes ☐ No

All information must be completed before samples will be processed.

Required Analyses

	LOCATION NAME	SAMPLE ID	Sample Type: R/T/D/P	Source Type: G/S	Reportable: Y/N	Resample	DATE	TIME	# of Containers	Free/Combined Chlorine Residual mg/L	Standing / Flushed: S/F (REG 243)	Total Coliform/E. Coli	HPC	Lead	THM	Subdivision Package			
1	Pressure Tank	357 Entrepreneur-Pre	R	G	N	–	April 17/23	11:15	8	–	F					X			
2	Washroom Tap	357 Entrepreneur-Post	T	G	N	–	April 17/23	11:35	8	–	F					X			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			

Comments:

Method of Delivery: Walk-in

Relinquished By (Sign):	Received By Driver/Depot:	Received at Lab:	Verified By:
Relinquished By (Print): Jessica Arthurs	Date/Time:	Date/Time: Apr 17/23 1pm	Date/Time: Apr 17/23 1:19pm
Date/Time: April 17, 2023 12:58 pm	Temperature: °C	Temperature: 11.6 °C	pH Verified: ☐ By:

1-800-749-1947
www.paracellabs.com

Certificate of Analysis

LRL Associates Ltd.
5430 Canotek Road
Ottawa, ON K1J 9G2
Attn: Eric Lavergne

Report Date: 5-Sep-2023
Order Date: 31-Aug-2023

Client PO:
Project: 220487
Custody: 18335

Order #: 2335315

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

Paracel ID	Client ID
2335315-01	363 Entrepreneur Crescent Supply Well - 4 Hour
2335315-02	363 Entrepreneur Crescent Supply Well - 8 Hour

Approved By:

Dale Robertson, BSc
Laboratory Director

Certificate of Analysis

Report Date: 05-Sep-2023

Client: **LRL Associates Ltd.**

Order Date: 31-Aug-2023

Client PO:

Project Description: 220487

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Alkalinity, total to pH 4.5	EPA 310.1 - Titration to pH 4.5	1-Sep-23	1-Sep-23
Ammonia, as N	EPA 351.2 - Auto Colour	1-Sep-23	1-Sep-23
Anions	EPA 300.1 - IC	31-Aug-23	31-Aug-23
Colour	SM2120 - Spectrophotometric	31-Aug-23	31-Aug-23
Conductivity	EPA 9050A- probe @25 °C	1-Sep-23	1-Sep-23
Dissolved Organic Carbon	MOE 3247B - Combustion IR	31-Aug-23	31-Aug-23
E. coli	MOE E3407	31-Aug-23	31-Aug-23
Fecal Coliform	SM 9222D	31-Aug-23	31-Aug-23
Heterotrophic Plate Count	SM 9215C	31-Aug-23	31-Aug-23
Metals, ICP-MS	EPA 200.8 - ICP-MS	31-Aug-23	1-Sep-23
pH	EPA 150.1 - pH probe @25 °C	1-Sep-23	1-Sep-23
Phenolics	EPA 420.2 - Auto Colour, 4AAP	31-Aug-23	31-Aug-23
Hardness	Hardness as CaCO3	31-Aug-23	1-Sep-23
Sulphide	SM 4500SE - Colourimetric	1-Sep-23	1-Sep-23
Tannin/Lignin	SM 5550B - Colourimetric	31-Aug-23	1-Sep-23
Total Coliform	MOE E3407	31-Aug-23	31-Aug-23
Total Dissolved Solids	SM 2540C - gravimetric, filtration	31-Aug-23	1-Sep-23
Total Kjeldahl Nitrogen	EPA 351.2 - Auto Colour, digestion	1-Sep-23	1-Sep-23
Turbidity	SM 2130B - Turbidity meter	31-Aug-23	31-Aug-23
VOCs by P&T GC-MS	EPA 624 - P&T GC-MS	1-Sep-23	1-Sep-23

PARACEL LABORATORIES LTD.

Certificate of Analysis

Order #: 2335315

Report Date: 05-Sep-2023

Client: **LRL Associates Ltd.**

Order Date: 31-Aug-2023

Client PO:

Project Description: 220487

Client ID:		363 Entrepreneur Crescent Supply Well - 4 Hour	363 Entrepreneur Crescent Supply Well - 8 Hour	-	-		
Sample Date:		30-Aug-23 12:05	30-Aug-23 16:15	-	-	-	-
Sample ID:		2335315-01	2335315-02	-	-		
Matrix:		Drinking Water	Drinking Water	-	-		
	MDL/Units						
Microbiological Parameters							
E. coli	1 CFU/100mL	ND [1]	1 [1]	-	-	-	-
Total Coliforms	1 CFU/100mL	2 [1]	1 [1]	-	-	-	-
Fecal Coliforms	1 CFU/100mL	ND	ND	-	-	-	-
Heterotrophic Plate Count	10 CFU/mL	90	70 [4]	-	-	-	-
General Inorganics							
Alkalinity, total	5 mg/L	703	705	-	-	-	-
Ammonia as N	0.01 mg/L	4.72	4.71	-	-	-	-
Dissolved Organic Carbon	0.5 mg/L	9.4	8.5	-	-	-	-
Colour	2 TCU	8	8	-	-	-	-
Conductivity	5 uS/cm	14300	14200	-	-	-	-
Hardness	mg/L	1020	1030	-	-	-	-
pH	0.1 pH Units	8.2	8.3	-	-	-	-
Phenolics	0.001 mg/L	<0.001	<0.001	-	-	-	-
Total Dissolved Solids	10 mg/L	7950	7880	-	-	-	-
Sulphide	0.02 mg/L	0.23	0.23	-	-	-	-
Tannin & Lignin	0.1 mg/L	0.7	0.7	-	-	-	-
Total Kjeldahl Nitrogen	0.1 mg/L	4.7	4.7	-	-	-	-
Turbidity	0.1 NTU	3.8	3.5	-	-	-	-
Anions							
Chloride	1 mg/L	4560	4460	-	-	-	-
Fluoride	0.1 mg/L	0.2	0.2	-	-	-	-
Nitrate as N	0.1 mg/L	<0.1	<0.1	-	-	-	-
Nitrite as N	0.05 mg/L	<0.25 [2]	<0.25 [2]	-	-	-	-
Sulphate	1 mg/L	3	4	-	-	-	-

Certificate of Analysis

Report Date: 05-Sep-2023

Client: **LRL Associates Ltd.**

Order Date: 31-Aug-2023

Client PO:

Project Description: 220487

	MDL/Units	363 Entrepreneur Crescent Supply Well - 4 Hour	363 Entrepreneur Crescent Supply Well - 8 Hour	-	-		
Sample Date:		30-Aug-23 12:05	30-Aug-23 16:15	-	-	-	-
Sample ID:		2335315-01	2335315-02	-	-		
Matrix:		Drinking Water	Drinking Water	-	-		
Metals							
Aluminum	0.001 mg/L	0.025	0.018	-	-	-	-
Antimony	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Arsenic	0.001 mg/L	<0.001	<0.001	-	-	-	-
Barium	0.001 mg/L	4.17	4.22	-	-	-	-
Beryllium	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Boron	0.01 mg/L	0.79	0.76	-	-	-	-
Cadmium	0.0001 mg/L	<0.0001	<0.0001	-	-	-	-
Calcium	0.1 mg/L	48.3	49.0	-	-	-	-
Chromium	0.001 mg/L	<0.001	<0.001	-	-	-	-
Cobalt	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Copper	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Iron	0.1 mg/L	0.3	0.3	-	-	-	-
Lead	0.0001 mg/L	<0.0001	<0.0001	-	-	-	-
Magnesium	0.2 mg/L	218	220	-	-	-	-
Manganese	0.005 mg/L	0.009	0.007	-	-	-	-
Molybdenum	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Nickel	0.001 mg/L	<0.001	<0.001	-	-	-	-
Potassium	0.1 mg/L	61.3	63.3	-	-	-	-
Selenium	0.001 mg/L	<0.001	<0.001	-	-	-	-
Silver	0.0001 mg/L	<0.0001	<0.0001	-	-	-	-
Sodium	0.2 mg/L	2670	2620	-	-	-	-
Strontium	0.01 mg/L	5.71	5.71	-	-	-	-
Thallium	0.001 mg/L	<0.001	<0.001	-	-	-	-

Certificate of Analysis

Order #: 2335315

Report Date: 05-Sep-2023

Client: **LRL Associates Ltd.**

Order Date: 31-Aug-2023

Client PO:

Project Description: 220487

Client ID:		363 Entrepreneur Crescent Supply Well - 4 Hour	363 Entrepreneur Crescent Supply Well - 8 Hour	-	-		
Sample Date:		30-Aug-23 12:05	30-Aug-23 16:15	-	-	-	-
Sample ID:		2335315-01	2335315-02	-	-		
Matrix:		Drinking Water	Drinking Water	-	-		
	MDL/Units						
Metals							
Tin	0.01 mg/L	<0.01	<0.01	-	-	-	-
Titanium	0.005 mg/L	<0.005	<0.005	-	-	-	-
Tungsten	0.01 mg/L	<0.01	<0.01	-	-	-	-
Uranium	0.0001 mg/L	<0.0001	<0.0001	-	-	-	-
Vanadium	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Zinc	0.005 mg/L	<0.005	<0.005	-	-	-	-
Volatiles							
Acetone	0.005 mg/L	<0.0050	<0.0050	-	-	-	-
Benzene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Bromodichloromethane	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Bromoform	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Bromomethane	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Carbon Tetrachloride	0.0002 mg/L	<0.0002	<0.0002	-	-	-	-
Chlorobenzene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Chloroethane	0.001 mg/L	<0.0010	<0.0010	-	-	-	-
Chloroform	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Dibromochloromethane	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Dichlorodifluoromethane	0.001 mg/L	<0.0010	<0.0010	-	-	-	-
1,2-Dibromoethane	0.0002 mg/L	<0.0002	<0.0002	-	-	-	-
1,2-Dichlorobenzene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
1,3-Dichlorobenzene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
1,4-Dichlorobenzene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
1,1-Dichloroethane	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-

PARACEL LABORATORIES LTD.

Order #: 2335315

Certificate of Analysis

Report Date: 05-Sep-2023

Client: **LRL Associates Ltd.**

Order Date: 31-Aug-2023

Client PO:

Project Description: 220487

	Client ID:	363 Entrepreneur Crescent Supply Well - 4 Hour	363 Entrepreneur Crescent Supply Well - 8 Hour	-	-		
	Sample Date:	30-Aug-23 12:05	30-Aug-23 16:15	-	-	-	-
	Sample ID:	2335315-01	2335315-02	-	-		
	Matrix:	Drinking Water	Drinking Water	-	-		
	MDL/Units						
Volatiles							
1,2-Dichloroethane	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
1,1-Dichloroethylene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
cis-1,2-Dichloroethylene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
trans-1,2-Dichloroethylene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
1,2-Dichloroethylene, total	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
1,2-Dichloropropane	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
cis-1,3-Dichloropropylene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
trans-1,3-Dichloropropylene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
1,3-Dichloropropene, total	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Ethylbenzene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Hexane	0.001 mg/L	<0.0010	<0.0010	-	-	-	-
Methyl Ethyl Ketone (2-Butanone)	0.005 mg/L	<0.0050	<0.0050	-	-	-	-
Methyl Isobutyl Ketone	0.005 mg/L	<0.0050	<0.0050	-	-	-	-
Methyl tert-butyl ether	0.002 mg/L	<0.0020	<0.0020	-	-	-	-
Methylene Chloride	0.005 mg/L	<0.0050	<0.0050	-	-	-	-
Styrene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
1,1,1,2-Tetrachloroethane	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
1,1,2,2-Tetrachloroethane	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Tetrachloroethylene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Toluene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
1,1,1-Trichloroethane	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
1,1,2-Trichloroethane	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Trichloroethylene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-

Certificate of Analysis

Report Date: 05-Sep-2023

Client: **LRL Associates Ltd.**

Order Date: 31-Aug-2023

Client PO:

Project Description: 220487

	Client ID:	363 Entrepreneur Crescent Supply Well - 4 Hour	363 Entrepreneur Crescent Supply Well - 8 Hour	-	-		
	Sample Date:	30-Aug-23 12:05	30-Aug-23 16:15	-	-	-	-
	Sample ID:	2335315-01	2335315-02	-	-		
	Matrix:	Drinking Water	Drinking Water	-	-		
	MDL/Units						
Volatiles							
Trichlorofluoromethane	0.001 mg/L	<0.0010	<0.0010	-	-	-	-
Vinyl chloride	0.0002 mg/L	<0.0002	<0.0002	-	-	-	-
m,p-Xylenes	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
o-Xylene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Xylenes, total	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Toluene-d8	Surrogate	102%	103%	-	-	-	-
4-Bromofluorobenzene	Surrogate	100%	105%	-	-	-	-
Dibromofluoromethane	Surrogate	103%	92.7%	-	-	-	-

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions								
Chloride	ND	1	mg/L					
Fluoride	ND	0.1	mg/L					
Nitrate as N	ND	0.1	mg/L					
Nitrite as N	ND	0.05	mg/L					
Sulphate	ND	1	mg/L					
General Inorganics								
Alkalinity, total	ND	5	mg/L					
Ammonia as N	ND	0.01	mg/L					
Dissolved Organic Carbon	ND	0.5	mg/L					
Colour	ND	2	TCU					
Conductivity	ND	5	uS/cm					
Phenolics	ND	0.001	mg/L					
Total Dissolved Solids	ND	10	mg/L					
Sulphide	ND	0.02	mg/L					
Tannin & Lignin	ND	0.1	mg/L					
Total Kjeldahl Nitrogen	ND	0.1	mg/L					
Turbidity	ND	0.1	NTU					
Metals								
Aluminum	ND	0.001	mg/L					
Antimony	ND	0.0005	mg/L					
Arsenic	ND	0.001	mg/L					
Barium	ND	0.001	mg/L					
Beryllium	ND	0.0005	mg/L					
Boron	ND	0.01	mg/L					
Cadmium	ND	0.0001	mg/L					
Calcium	ND	0.1	mg/L					
Chromium	ND	0.001	mg/L					
Cobalt	ND	0.0005	mg/L					
Copper	ND	0.0005	mg/L					
Iron	ND	0.1	mg/L					
Lead	ND	0.0001	mg/L					
Magnesium	ND	0.2	mg/L					

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	%REC	%REC Limit	RPD	RPD Limit	Notes
Manganese	ND	0.005	mg/L					
Molybdenum	ND	0.0005	mg/L					
Nickel	ND	0.001	mg/L					
Potassium	ND	0.1	mg/L					
Selenium	ND	0.001	mg/L					
Silver	ND	0.0001	mg/L					
Sodium	ND	0.2	mg/L					
Strontium	ND	0.01	mg/L					
Thallium	ND	0.001	mg/L					
Tin	ND	0.01	mg/L					
Titanium	ND	0.005	mg/L					
Tungsten	ND	0.01	mg/L					
Uranium	ND	0.0001	mg/L					
Vanadium	ND	0.0005	mg/L					
Zinc	ND	0.005	mg/L					
Microbiological Parameters								
E. coli	ND	1	CFU/100mL					
Total Coliforms	ND	1	CFU/100mL					
Fecal Coliforms	ND	1	CFU/100mL					
Heterotrophic Plate Count	ND	10	CFU/mL					
Volatiles								
Acetone	ND	0.0050	mg/L					
Benzene	ND	0.0005	mg/L					
Bromodichloromethane	ND	0.0005	mg/L					
Bromoform	ND	0.0005	mg/L					
Bromomethane	ND	0.0005	mg/L					
Carbon Tetrachloride	ND	0.0002	mg/L					
Chlorobenzene	ND	0.0005	mg/L					
Chloroethane	ND	0.0010	mg/L					
Chloroform	ND	0.0005	mg/L					
Dibromochloromethane	ND	0.0005	mg/L					
Dichlorodifluoromethane	ND	0.0010	mg/L					
1,2-Dibromoethane	ND	0.0002	mg/L					

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	%REC	%REC Limit	RPD	RPD Limit	Notes
1,2-Dichlorobenzene	ND	0.0005	mg/L					
1,3-Dichlorobenzene	ND	0.0005	mg/L					
1,4-Dichlorobenzene	ND	0.0005	mg/L					
1,1-Dichloroethane	ND	0.0005	mg/L					
1,2-Dichloroethane	ND	0.0005	mg/L					
1,1-Dichloroethylene	ND	0.0005	mg/L					
cis-1,2-Dichloroethylene	ND	0.0005	mg/L					
trans-1,2-Dichloroethylene	ND	0.0005	mg/L					
1,2-Dichloroethylene, total	ND	0.0005	mg/L					
1,2-Dichloropropane	ND	0.0005	mg/L					
cis-1,3-Dichloropropylene	ND	0.0005	mg/L					
trans-1,3-Dichloropropylene	ND	0.0005	mg/L					
1,3-Dichloropropene, total	ND	0.0005	mg/L					
Ethylbenzene	ND	0.0005	mg/L					
Hexane	ND	0.0010	mg/L					
Methyl Ethyl Ketone (2-Butanone)	ND	0.0050	mg/L					
Methyl Isobutyl Ketone	ND	0.0050	mg/L					
Methyl tert-butyl ether	ND	0.0020	mg/L					
Methylene Chloride	ND	0.0050	mg/L					
Styrene	ND	0.0005	mg/L					
1,1,1,2-Tetrachloroethane	ND	0.0005	mg/L					
1,1,2,2-Tetrachloroethane	ND	0.0005	mg/L					
Tetrachloroethylene	ND	0.0005	mg/L					
Toluene	ND	0.0005	mg/L					
1,1,1-Trichloroethane	ND	0.0005	mg/L					
1,1,2-Trichloroethane	ND	0.0005	mg/L					
Trichloroethylene	ND	0.0005	mg/L					
Trichlorofluoromethane	ND	0.0010	mg/L					
Vinyl chloride	ND	0.0002	mg/L					
m,p-Xylenes	ND	0.0005	mg/L					
o-Xylene	ND	0.0005	mg/L					
Xylenes, total	ND	0.0005	mg/L					

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	%REC	%REC Limit	RPD	RPD Limit	Notes
Surrogate: 4-Bromofluorobenzene	*0.0808*		*%*	*101*	*50-140*			
Surrogate: Dibromofluoromethane	*0.0781*		*%*	*97.6*	*50-140*			
Surrogate: Toluene-d8	*0.0793*		*%*	*99.1*	*50-140*			

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	4460	20	mg/L	4460			0.0	20	
Fluoride	0.20	0.1	mg/L	0.19			3.0	20	
Nitrate as N	ND	0.1	mg/L	ND			NC	20	
Nitrite as N	ND	0.25	mg/L	ND			NC	20	GEN07
Sulphate	4.24	1	mg/L	4.47			5.4	20	
General Inorganics									
Alkalinity, total	698	5	mg/L	703			0.7	14	
Ammonia as N	4.66	0.04	mg/L	4.71			0.9	18	
Dissolved Organic Carbon	8.4	0.5	mg/L	9.4			11.2	37	
Colour	4	2	TCU	4			0.0	12	
Conductivity	14000	5	uS/cm	14300			1.7	5	
pH	8.2	0.1	pH Units	8.2			0.1	3.3	
Phenolics	ND	0.001	mg/L	ND			NC	10	
Total Dissolved Solids	92.0	10	mg/L	84.0			9.1	10	
Sulphide	ND	0.02	mg/L	ND			NC	10	
Tannin & Lignin	0.7	0.1	mg/L	0.7			1.4	11	
Total Kjeldahl Nitrogen	4.82	0.2	mg/L	4.70			2.6	16	
Turbidity	ND	0.1	NTU	ND			NC	10	
Metals									
Aluminum	0.022	0.001	mg/L	0.025			15.3	20	
Antimony	ND	0.0005	mg/L	ND			NC	20	
Arsenic	ND	0.001	mg/L	ND			NC	20	
Barium	4.52	0.010	mg/L	4.17			7.9	20	
Beryllium	ND	0.0005	mg/L	ND			NC	20	
Boron	0.82	0.01	mg/L	0.79			2.8	20	
Cadmium	ND	0.0001	mg/L	ND			NC	20	
Calcium	45.8	0.1	mg/L	48.3			5.4	20	
Chromium	ND	0.001	mg/L	ND			NC	20	
Cobalt	ND	0.0005	mg/L	ND			NC	20	
Copper	ND	0.0005	mg/L	ND			NC	20	

PARACEL LABORATORIES LTD.

Order #: 2335315

Certificate of Analysis

Report Date: 05-Sep-2023

Client: **LRL Associates Ltd.**

Order Date: 31-Aug-2023

Client PO:

Project Description: 220487

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Iron	0.3	0.1	mg/L	0.3			12.2	20	
Lead	0.0001	0.0001	mg/L	ND			NC	20	
Magnesium	203	0.2	mg/L	218			7.1	20	
Manganese	0.008	0.005	mg/L	0.009			11.6	20	
Molybdenum	ND	0.0005	mg/L	ND			NC	20	
Nickel	ND	0.001	mg/L	ND			NC	20	
Potassium	59.1	0.1	mg/L	61.3			3.7	20	
Selenium	ND	0.001	mg/L	ND			NC	20	
Silver	0.0002	0.0001	mg/L	ND			NC	20	
Sodium	2650	2.0	mg/L	2670			1.0	20	
Thallium	ND	0.001	mg/L	ND			NC	20	
Tin	ND	0.01	mg/L	ND			NC	20	
Titanium	ND	0.005	mg/L	ND			NC	50	
Tungsten	ND	0.01	mg/L	ND			NC	20	
Uranium	ND	0.0001	mg/L	ND			NC	20	
Vanadium	ND	0.0005	mg/L	ND			NC	20	
Zinc	ND	0.005	mg/L	ND			NC	20	
Microbiological Parameters									
E. coli	ND	1	CFU/100mL	1			NC	30	BAC01
Total Coliforms	ND	1	CFU/100mL	1			NC	30	BAC01
Fecal Coliforms	ND	1	CFU/100mL	ND			NC	30	
Heterotrophic Plate Count	60	10	CFU/mL	70			15.0	30	
Volatiles									
Acetone	ND	0.0050	mg/L	ND			NC	30	
Benzene	ND	0.0005	mg/L	ND			NC	30	
Bromodichloromethane	ND	0.0005	mg/L	ND			NC	30	
Bromoform	ND	0.0005	mg/L	ND			NC	30	
Bromomethane	ND	0.0005	mg/L	ND			NC	30	
Carbon Tetrachloride	ND	0.0002	mg/L	ND			NC	30	
Chlorobenzene	ND	0.0005	mg/L	ND			NC	30	
Chloroethane	ND	0.0010	mg/L	ND			NC	30	

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Chloroform	ND	0.0005	mg/L	ND			NC	30	
Dibromochloromethane	ND	0.0005	mg/L	ND			NC	30	
Dichlorodifluoromethane	ND	0.0010	mg/L	ND			NC	30	
1,2-Dibromoethane	ND	0.0002	mg/L	ND			NC	30	
1,2-Dichlorobenzene	ND	0.0005	mg/L	ND			NC	30	
1,3-Dichlorobenzene	ND	0.0005	mg/L	ND			NC	30	
1,4-Dichlorobenzene	ND	0.0005	mg/L	ND			NC	30	
1,1-Dichloroethane	ND	0.0005	mg/L	ND			NC	30	
1,2-Dichloroethane	ND	0.0005	mg/L	ND			NC	30	
1,1-Dichloroethylene	ND	0.0005	mg/L	ND			NC	30	
cis-1,2-Dichloroethylene	ND	0.0005	mg/L	ND			NC	30	
trans-1,2-Dichloroethylene	ND	0.0005	mg/L	ND			NC	30	
1,2-Dichloropropane	ND	0.0005	mg/L	ND			NC	30	
cis-1,3-Dichloropropylene	ND	0.0005	mg/L	ND			NC	30	
trans-1,3-Dichloropropylene	ND	0.0005	mg/L	ND			NC	30	
Ethylbenzene	ND	0.0005	mg/L	ND			NC	30	
Hexane	ND	0.0010	mg/L	ND			NC	30	
Methyl Ethyl Ketone (2-Butanone)	ND	0.0050	mg/L	ND			NC	30	
Methyl Isobutyl Ketone	ND	0.0050	mg/L	ND			NC	30	
Methyl tert-butyl ether	ND	0.0020	mg/L	ND			NC	30	
Methylene Chloride	ND	0.0050	mg/L	ND			NC	30	
Styrene	ND	0.0005	mg/L	ND			NC	30	
1,1,1,2-Tetrachloroethane	ND	0.0005	mg/L	ND			NC	30	
1,1,2,2-Tetrachloroethane	ND	0.0005	mg/L	ND			NC	30	
Tetrachloroethylene	ND	0.0005	mg/L	ND			NC	30	
Toluene	ND	0.0005	mg/L	ND			NC	30	
1,1,1-Trichloroethane	ND	0.0005	mg/L	ND			NC	30	
1,1,2-Trichloroethane	ND	0.0005	mg/L	ND			NC	30	
Trichloroethylene	ND	0.0005	mg/L	ND			NC	30	
Trichlorofluoromethane	ND	0.0010	mg/L	ND			NC	30	
Vinyl chloride	ND	0.0002	mg/L	ND			NC	30	

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
m,p-Xylenes	ND	0.0005	mg/L	ND			NC	30	
o-Xylene	ND	0.0005	mg/L	ND			NC	30	
Surrogate: 4-Bromofluorobenzene	*0.0886*		*%*		*111*	*50-140*			
Surrogate: Dibromofluoromethane	*0.0765*		*%*		*95.7*	*50-140*			
Surrogate: Toluene-d8	*0.0798*		*%*		*99.8*	*50-140*			

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	9.86	1	mg/L	ND	98.6	78-114			
Fluoride	1.17	0.1	mg/L	0.19	97.8	70-130			
Nitrate as N	1.00	0.1	mg/L	ND	99.6	77-126			
Nitrite as N	1.08	0.05	mg/L	ND	108	82-110			
Sulphate	14.8	1	mg/L	4.47	103	70-130			
General Inorganics									
Ammonia as N	1.02	0.01	mg/L	ND	102	81-124			
Dissolved Organic Carbon	12.8	0.5	mg/L	3.1	97.1	60-133			
Phenolics	0.026	0.001	mg/L	ND	103	67-133			
Total Dissolved Solids	96.0	10	mg/L	ND	96.0	75-125			
Sulphide	0.50	0.02	mg/L	ND	100	79-115			
Tannin & Lignin	1.8	0.1	mg/L	0.7	110	71-113			
Total Kjeldahl Nitrogen	0.99	0.1	mg/L	ND	98.7	81-126			
Metals									
Aluminum	82.2	0.001	mg/L	25.1	114	80-120			
Arsenic	49.1	0.001	mg/L	0.246	97.8	80-120			
Barium	48.6	0.001	mg/L	ND	97.3	80-120			
Beryllium	37.3	0.0005	mg/L	0.0182	74.5	80-120			QM-07
Boron	50.0	0.01	mg/L	ND	100	80-120			
Cadmium	50.6	0.0001	mg/L	ND	101	80-120			
Calcium	10600	0.1	mg/L	ND	106	80-120			
Chromium	50.5	0.001	mg/L	0.330	100	80-120			
Cobalt	49.6	0.0005	mg/L	0.287	98.7	80-120			
Copper	44.3	0.0005	mg/L	0.0834	88.5	80-120			
Iron	2510	0.1	mg/L	344	86.5	80-120			
Lead	40.8	0.0001	mg/L	0.0346	81.6	80-120			
Magnesium	10200	0.2	mg/L	ND	102	80-120			
Manganese	55.0	0.005	mg/L	9.04	92.0	80-120			
Molybdenum	53.7	0.0005	mg/L	0.137	107	80-120			
Nickel	46.5	0.001	mg/L	0.196	92.6	80-120			

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Potassium	69700	0.1	mg/L	61300	83.6	80-120			
Selenium	48.9	0.001	mg/L	ND	97.8	80-120			
Silver	51.0	0.0001	mg/L	ND	102	80-120			
Sodium	10100	0.2	mg/L	ND	101	80-120			
Thallium	45.7	0.001	mg/L	0.014	91.4	80-120			
Tin	39.5	0.01	mg/L	0.05	78.8	80-120			QM-07
Titanium	57.8	0.005	mg/L	ND	116	70-130			
Tungsten	55.5	0.01	mg/L	0.17	111	80-120			
Uranium	51.3	0.0001	mg/L	0.0266	103	80-120			
Vanadium	51.7	0.0005	mg/L	0.221	103	80-120			
Zinc	35.2	0.005	mg/L	2.19	66.0	80-120			QM-07
Volatiles									
Acetone	0.0934	0.0050	mg/L	ND	93.4	50-140			
Benzene	0.0447	0.0005	mg/L	ND	112	60-130			
Bromodichloromethane	0.0478	0.0005	mg/L	ND	120	60-130			
Bromoform	0.0338	0.0005	mg/L	ND	84.5	60-130			
Bromomethane	0.0422	0.0005	mg/L	ND	105	50-140			
Carbon Tetrachloride	0.0417	0.0002	mg/L	ND	104	60-130			
Chlorobenzene	0.0377	0.0005	mg/L	ND	94.3	60-130			
Chloroethane	0.0504	0.0010	mg/L	ND	126	50-140			
Chloroform	0.0410	0.0005	mg/L	ND	102	60-130			
Dibromochloromethane	0.0421	0.0005	mg/L	ND	105	60-130			
Dichlorodifluoromethane	0.0446	0.0010	mg/L	ND	112	50-140			
1,2-Dibromoethane	0.0442	0.0002	mg/L	ND	110	60-130			
1,2-Dichlorobenzene	0.0395	0.0005	mg/L	ND	98.7	60-130			
1,3-Dichlorobenzene	0.0419	0.0005	mg/L	ND	105	60-130			
1,4-Dichlorobenzene	0.0396	0.0005	mg/L	ND	99.0	60-130			
1,1-Dichloroethane	0.0473	0.0005	mg/L	ND	118	60-130			
1,2-Dichloroethane	0.0407	0.0005	mg/L	ND	102	60-130			
1,1-Dichloroethylene	0.0451	0.0005	mg/L	ND	113	60-130			
cis-1,2-Dichloroethylene	0.0502	0.0005	mg/L	ND	125	60-130			

PARACEL LABORATORIES LTD.

Order #: 2335315

Certificate of Analysis

Report Date: 05-Sep-2023

Client: **LRL Associates Ltd.**

Order Date: 31-Aug-2023

Client PO:

Project Description: 220487

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
trans-1,2-Dichloroethylene	0.0486	0.0005	mg/L	ND	122	60-130			
1,2-Dichloropropane	0.0460	0.0005	mg/L	ND	115	60-130			
cis-1,3-Dichloropropylene	0.0453	0.0005	mg/L	ND	113	60-130			
trans-1,3-Dichloropropylene	0.0446	0.0005	mg/L	ND	111	60-130			
Ethylbenzene	0.0371	0.0005	mg/L	ND	92.8	60-130			
Hexane	0.0490	0.0010	mg/L	ND	122	60-130			
Methyl Ethyl Ketone (2-Butanone)	0.0958	0.0050	mg/L	ND	95.8	50-140			
Methyl Isobutyl Ketone	0.0931	0.0050	mg/L	ND	93.1	50-140			
Methyl tert-butyl ether	0.127	0.0020	mg/L	ND	127	50-140			
Methylene Chloride	0.0406	0.0050	mg/L	ND	101	60-130			
Styrene	0.0440	0.0005	mg/L	ND	110	60-130			
1,1,1,2-Tetrachloroethane	0.0432	0.0005	mg/L	ND	108	60-130			
1,1,2,2-Tetrachloroethane	0.0454	0.0005	mg/L	ND	114	60-130			
Tetrachloroethylene	0.0404	0.0005	mg/L	ND	101	60-130			
Toluene	0.0374	0.0005	mg/L	ND	93.6	60-130			
1,1,1-Trichloroethane	0.0418	0.0005	mg/L	ND	105	60-130			
1,1,2-Trichloroethane	0.0430	0.0005	mg/L	ND	107	60-130			
Trichloroethylene	0.0496	0.0005	mg/L	ND	124	60-130			
Trichlorofluoromethane	0.0445	0.0010	mg/L	ND	111	60-130			
Vinyl chloride	0.0476	0.0002	mg/L	ND	119	50-140			
m,p-Xylenes	0.0744	0.0005	mg/L	ND	93.0	60-130			
o-Xylene	0.0359	0.0005	mg/L	ND	89.8	60-130			
Surrogate: 4-Bromofluorobenzene	*0.0701*		*%*		*87.6*	*50-140*			
Surrogate: Dibromofluoromethane	*0.0841*		*%*		*105*	*50-140*			
Surrogate: Toluene-d8	*0.0729*		*%*		*91.2*	*50-140*			

Qualifier Notes:

Login Qualifiers :

Container(s) - Labeled improperly/insufficient information - 1x VOC vial received unlabelled.

Applies to Samples: 363 Entrepreneur Crescent Supply Well - 8 Hour

Sample Qualifiers :

1: Greater than 200 CFU of background colonies present. This may interfere with target growth and ability of the analyst to count E. coli & Total Coliform. The target colonies may be under-represented.

2: Elevated reporting limit due to dilution required because of high target analyte concentration.

4: This isolate was present as a spreading colony, potentially caused as a consequence of condensation within the strip/plate. Typically, this type of colony is a result of a few colonies or less. The proportions may differ and other isolates may be masked.

QC Qualifiers:

BAC01 Greater than 200 CFU of background colonies present. This may interfere with target growth and ability of the analyst to count E. coli & Total Coliform. The target colonies may be under-represented.

GEN07 Elevated reporting limit due to dilution required because of high target analyte concentration.

QM-07 The spike recovery was outside acceptance limits for the MS and/or MSD. The batch was accepted based on other acceptable QC.

Sample Data Revisions:

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable

ND: Not Detected

MDL: Method Detection Limit

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

%REC: Percent recovery.

RPD: Relative percent difference.

NC: Not Calculated

PARACEL LABORATORIES LTD.

Paracel ID: 2335315

Paracel Order Number	Chain Of Custody
2335315	Ontario Drinking Water Samples № 18335

Client Name:	LRL Associates Ltd.	Project Ref:	220487	Waterworks Name:	
Contact Name:	Eric Lavergne	Quote #:		Waterworks Number:	
Address:	5430 Canotek Rd	PO #:		Address:	
After Hours Contact:		E-mail:	elavergne@lrl.ca		
Telephone:	613 842 3434	Fax:		Public Health Unit:	

Samples Taken By:

Name: Eric Lavergne

Signature: [signature]

Page ____ of ____

Turn Around Time Required: ☐ 1 day ☐ 2 day ☐ 3 day ☒ 4 day

Samples Submitted Under: (Indicate ONLY one)
☐ ON REG 170/03 ☐ ON REG 319/08 ☐ Private Well
☐ ON REG 243/07 ☒ Other ODWS

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

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

Are these samples for human consumption?: ☐ Yes ☒ No

All information must be completed before samples will be processed.

	LOCATION NAME	SAMPLE ID	Sample Type: R/T/D/P	Source Type: G/S	Reportable: Y/N	Resample	DATE	TIME	# of Containers	Free/Combined Chlorine Residual mg/L	Standing / Flushed: S/F (REG 243)	Total Coliform/E. Coli	HPC	Lead	THM	Subdivision Package	VOC	Trace Metals	
1	363 Entrepreneur crescent	363 Entrepreneur crescent Supply Well - 4 Hour	R	G			Aug 30/2023	12:15 pm	12							X	X	X	
2																			
3	363 Entrepreneur crescent	363 Entrepreneur crescent Supply Well - 8 Hour	R	G				4:15 PM	12							X	X	X	
4																			
5																			
6																			
7																			
8																			
9																			
10																			

Comments:

Method of Delivery: Walk In

Relinquished By (Sign): [signature]	Received By Driver/Depot:	Received at Lab: KB 904	Verified By: SD
Relinquished By (Print): Eric Lavergne	Date/Time:	Date/Time: Aug 31/23	Date/Time: Aug 31, 2023 9:31am
Date/Time:	Temperature: °C	Temperature: 16.1 °C	pH Verified: ☒ By: SD

PARACEL LABORATORIES LTD.
TRUSTED. RESPONSIVE. RELIABLE.

1-800-749-1947
www.paracellabs.com

Certificate of Analysis

LRL Associates Ltd.
5430 Canotek Road
Ottawa, ON K1J 9G2
Attn: Jessica Arthurs

Report Date: 28-Nov-2024
Order Date: 22-Nov-2024

Client PO:
Project: 220487
Custody: 19762

Order #: 2447459

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

Paracel ID	Client ID
2447459-01	363 Entreneur Crescent Supply

Approved By: Mark Foto

Mark Foto, M.Sc.
Lab Supervisor

PARACEL LABORATORIES LTD.

Order #: 2447459

Certificate of Analysis

Report Date: 28-Nov-2024

Client: **LRL Associates Ltd.**

Order Date: 22-Nov-2024

Client PO:

Project Description: 220487

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Metals, ICP-MS	EPA 200.8 - ICP-MS	26-Nov-24	27-Nov-24
PAHs by GC-MS	EPA 625 - GC-MS, extraction	27-Nov-24	28-Nov-24
PCBs, total	EPA 608 - GC-ECD	25-Nov-24	26-Nov-24
PHC F1	CWS Tier 1 - P&T GC-FID	26-Nov-24	26-Nov-24
PHCs F2 to F4	CWS Tier 1 - GC-FID, extraction	27-Nov-24	28-Nov-24

PARACEL LABORATORIES LTD.

Order #: 2447459

Certificate of Analysis

Report Date: 28-Nov-2024

Client: **LRL Associates Ltd.**

Order Date: 22-Nov-2024

Client PO:

Project Description: 220487

	Client ID:	363 Entreneur Crescent Supply	-	-	-		
	Sample Date:	22-Nov-24 12:00	-	-	-	-	-
	Sample ID:	2447459-01	-	-	-		
	Matrix:	Drinking Water	-	-	-		
	MDL/Units						
Metals							
Aluminum	0.001 mg/L	0.014	-	-	-	-	-
Antimony	0.0005 mg/L	<0.0005	-	-	-	-	-
Arsenic	0.001 mg/L	<0.001	-	-	-	-	-
Barium	0.001 mg/L	3.15	-	-	-	-	-
Beryllium	0.0005 mg/L	<0.0005	-	-	-	-	-
Boron	0.01 mg/L	0.92	-	-	-	-	-
Cadmium	0.0001 mg/L	<0.0001	-	-	-	-	-
Calcium	0.1 mg/L	42.7	-	-	-	-	-
Chromium	0.001 mg/L	<0.001	-	-	-	-	-
Cobalt	0.0005 mg/L	<0.0005	-	-	-	-	-
Copper	0.0005 mg/L	<0.0005	-	-	-	-	-
Iron	0.1 mg/L	11.1	-	-	-	-	-
Lead	0.0001 mg/L	<0.0001	-	-	-	-	-
Magnesium	0.2 mg/L	129	-	-	-	-	-
Manganese	0.005 mg/L	0.155	-	-	-	-	-
Molybdenum	0.0005 mg/L	<0.0005	-	-	-	-	-
Nickel	0.001 mg/L	<0.001	-	-	-	-	-
Potassium	0.1 mg/L	60.4	-	-	-	-	-
Selenium	0.001 mg/L	<0.001	-	-	-	-	-
Silver	0.0001 mg/L	<0.0001	-	-	-	-	-
Sodium	0.2 mg/L	2430	-	-	-	-	-
Strontium	0.01 mg/L	5.08	-	-	-	-	-
Thallium	0.001 mg/L	<0.001	-	-	-	-	-
Tin	0.01 mg/L	<0.01	-	-	-	-	-

PARACEL LABORATORIES LTD.

Certificate of Analysis

Order #: 2447459

Client: **LRL Associates Ltd.**

Client PO:

Report Date: 28-Nov-2024

Order Date: 22-Nov-2024

Project Description: 220487

	Client ID:	363 Entreneur Crescent Supply	-	-	-		
	Sample Date:	22-Nov-24 12:00	-	-	-	-	-
	Sample ID:	2447459-01	-	-	-		
	Matrix:	Drinking Water	-	-	-		
	MDL/Units						
Metals							
Titanium	0.005 mg/L	<0.005	-	-	-	-	-
Tungsten	0.01 mg/L	<0.01	-	-	-	-	-
Uranium	0.0001 mg/L	<0.0001	-	-	-	-	-
Vanadium	0.0005 mg/L	<0.0005	-	-	-	-	-
Zinc	0.005 mg/L	0.010	-	-	-	-	-
Hydrocarbons							
F1 PHCs (C6-C10)	0.025 mg/L	<0.025	-	-	-	-	-
F2 PHCs (C10-C16)	0.1 mg/L	<0.1	-	-	-	-	-
F3 PHCs (C16-C34)	0.1 mg/L	<0.1	-	-	-	-	-
F4 PHCs (C34-C50)	0.1 mg/L	<0.1	-	-	-	-	-
Semi-Volatiles							
Acenaphthene	0.05 ug/L	<0.05	-	-	-	-	-
Acenaphthylene	0.05 ug/L	<0.05	-	-	-	-	-
Anthracene	0.01 ug/L	<0.01	-	-	-	-	-
Benzo [a] anthracene	0.01 ug/L	0.02	-	-	-	-	-
Benzo [a] pyrene	0.01 ug/L	<0.01	-	-	-	-	-
Benzo [b] fluoranthene	0.05 ug/L	<0.05	-	-	-	-	-
Benzo [g,h,i] perylene	0.05 ug/L	<0.05	-	-	-	-	-
Benzo [k] fluoranthene	0.05 ug/L	<0.05	-	-	-	-	-
Biphenyl	0.05 ug/L	<0.05	-	-	-	-	-
Chrysene	0.05 ug/L	<0.05	-	-	-	-	-
Dibenzo [a,h] anthracene	0.05 ug/L	<0.05	-	-	-	-	-
Fluoranthene	0.01 ug/L	0.02	-	-	-	-	-
Fluorene	0.05 ug/L	<0.05	-	-	-	-	-

Certificate of Analysis

Report Date: 28-Nov-2024

Client: **LRL Associates Ltd.**

Order Date: 22-Nov-2024

Client PO:

Project Description: 220487

	Client ID:	363 Entreneur Crescent Supply	-	-	-		
	Sample Date:	22-Nov-24 12:00	-	-	-	-	-
	Sample ID:	2447459-01	-	-	-		
	Matrix:	Drinking Water	-	-	-		
	MDL/Units						
Semi-Volatiles							
Indeno [1,2,3-cd] pyrene	0.05 ug/L	<0.05	-	-	-	-	-
1-Methylnaphthalene	0.05 ug/L	<0.05	-	-	-	-	-
2-Methylnaphthalene	0.05 ug/L	<0.05	-	-	-	-	-
Methylnaphthalene (1&2)	0.10 ug/L	<0.10	-	-	-	-	-
Naphthalene	0.05 ug/L	<0.05	-	-	-	-	-
Phenanthrene	0.05 ug/L	<0.05	-	-	-	-	-
Pyrene	0.01 ug/L	<0.01	-	-	-	-	-
2-Fluorobiphenyl	Surrogate	83.6%	-	-	-	-	-
Terphenyl-d14	Surrogate	88.7%	-	-	-	-	-
PCBs							
PCBs, total	0.05 ug/L	<0.05	-	-	-	-	-
Decachlorobiphenyl	Surrogate	127%	-	-	-	-	-

Certificate of Analysis

Report Date: 28-Nov-2024

Client: **LRL Associates Ltd.**

Order Date: 22-Nov-2024

Client PO:

Project Description: 220487

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons								
F1 PHCs (C6-C10)	ND	0.025	mg/L					
F2 PHCs (C10-C16)	ND	0.1	mg/L					
F3 PHCs (C16-C34)	ND	0.1	mg/L					
F4 PHCs (C34-C50)	ND	0.1	mg/L					
Metals								
Aluminum	ND	0.001	mg/L					
Antimony	ND	0.0005	mg/L					
Arsenic	ND	0.001	mg/L					
Barium	ND	0.001	mg/L					
Beryllium	ND	0.0005	mg/L					
Boron	ND	0.01	mg/L					
Cadmium	ND	0.0001	mg/L					
Calcium	ND	0.1	mg/L					
Chromium	ND	0.001	mg/L					
Cobalt	ND	0.0005	mg/L					
Copper	ND	0.0005	mg/L					
Iron	ND	0.1	mg/L					
Lead	ND	0.0001	mg/L					
Magnesium	ND	0.2	mg/L					
Manganese	ND	0.005	mg/L					
Molybdenum	ND	0.0005	mg/L					
Nickel	ND	0.001	mg/L					
Potassium	ND	0.1	mg/L					
Selenium	ND	0.001	mg/L					
Silver	ND	0.0001	mg/L					
Sodium	ND	0.2	mg/L					
Strontium	ND	0.01	mg/L					
Thallium	ND	0.001	mg/L					
Tin	ND	0.01	mg/L					
Titanium	ND	0.005	mg/L					
Tungsten	ND	0.01	mg/L					
Uranium	ND	0.0001	mg/L					

PARACEL LABORATORIES LTD.

Order #: 2447459

Certificate of Analysis

Report Date: 28-Nov-2024

Client: **LRL Associates Ltd.**

Order Date: 22-Nov-2024

Client PO:

Project Description: 220487

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	%REC	%REC Limit	RPD	RPD Limit	Notes
Vanadium	ND	0.0005	mg/L					
Zinc	ND	0.005	mg/L					
PCBs								
PCBs, total	ND	0.05	ug/L					
Surrogate: Decachlorobiphenyl	*0.650*		*%*	*130*	*60-140*			
Semi-Volatiles								
Acenaphthene	ND	0.05	ug/L					
Acenaphthylene	ND	0.05	ug/L					
Anthracene	ND	0.01	ug/L					
Benzo [a] anthracene	ND	0.01	ug/L					
Benzo [a] pyrene	ND	0.01	ug/L					
Benzo [b] fluoranthene	ND	0.05	ug/L					
Benzo [g,h,i] perylene	ND	0.05	ug/L					
Benzo [k] fluoranthene	ND	0.05	ug/L					
Biphenyl	ND	0.05	ug/L					
Chrysene	ND	0.05	ug/L					
Dibenzo [a,h] anthracene	ND	0.05	ug/L					
Fluoranthene	ND	0.01	ug/L					
Fluorene	ND	0.05	ug/L					
Indeno [1,2,3-cd] pyrene	ND	0.05	ug/L					
1-Methylnaphthalene	ND	0.05	ug/L					
2-Methylnaphthalene	ND	0.05	ug/L					
Methylnaphthalene (1&2)	ND	0.10	ug/L					
Naphthalene	ND	0.05	ug/L					
Phenanthrene	ND	0.05	ug/L					
Pyrene	ND	0.01	ug/L					
Surrogate: 2-Fluorobiphenyl	*16.5*		*%*	*82.4*	*50-140*			
Surrogate: Terphenyl-d14	*16.2*		*%*	*80.8*	*50-140*			

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	ND	0.025	mg/L	ND			NC	30	
Metals									
Aluminum	0.001	0.001	mg/L	ND			NC	20	
Antimony	ND	0.0005	mg/L	ND			NC	20	
Arsenic	ND	0.001	mg/L	ND			NC	20	
Barium	0.043	0.001	mg/L	0.044			1.7	20	
Beryllium	ND	0.0005	mg/L	ND			NC	20	
Boron	0.03	0.01	mg/L	0.03			3.5	20	
Cadmium	ND	0.0001	mg/L	ND			NC	20	
Calcium	81.2	0.1	mg/L	80.4			1.0	20	
Chromium	ND	0.001	mg/L	ND			NC	20	
Cobalt	ND	0.0005	mg/L	ND			NC	20	
Copper	0.0061	0.0005	mg/L	0.0060			1.2	20	
Iron	ND	0.1	mg/L	ND			NC	20	
Lead	ND	0.0001	mg/L	ND			NC	20	
Magnesium	16.8	0.2	mg/L	17.1			1.7	20	
Manganese	ND	0.005	mg/L	ND			NC	20	
Molybdenum	ND	0.0005	mg/L	ND			NC	20	
Nickel	ND	0.001	mg/L	ND			NC	20	
Potassium	2.3	0.1	mg/L	2.3			0.8	20	
Selenium	ND	0.001	mg/L	ND			NC	20	
Silver	ND	0.0001	mg/L	ND			NC	20	
Sodium	55.0	0.2	mg/L	54.9			0.3	20	
Thallium	ND	0.001	mg/L	ND			NC	20	
Tin	ND	0.01	mg/L	ND			NC	20	
Titanium	ND	0.005	mg/L	ND			NC	50	
Tungsten	ND	0.01	mg/L	ND			NC	20	
Uranium	0.0004	0.0001	mg/L	0.0004			3.9	20	
Vanadium	ND	0.0005	mg/L	ND			NC	20	
Zinc	0.013	0.005	mg/L	0.013			0.9	20	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	1.87	0.025	mg/L	ND	93.5	85-115			
F2 PHCs (C10-C16)	1.5	0.1	mg/L	ND	90.7	60-140			
F3 PHCs (C16-C34)	4.6	0.1	mg/L	ND	117	60-140			
F4 PHCs (C34-C50)	2.7	0.1	mg/L	ND	108	60-140			
Metals									
Aluminum	48.4	0.001	mg/L	0.693	95.4	80-120			
Arsenic	50.5	0.001	mg/L	0.126	101	80-120			
Barium	85.6	0.001	mg/L	43.7	83.7	80-120			
Beryllium	50.4	0.0005	mg/L	0.0200	101	80-120			
Boron	71.3	0.01	mg/L	25.6	91.5	80-120			
Cadmium	44.1	0.0001	mg/L	0.0059	88.2	80-120			
Calcium	86500	0.1	mg/L	80400	61.1	80-120			QM-07
Chromium	53.0	0.001	mg/L	0.369	105	80-120			
Cobalt	51.5	0.0005	mg/L	0.0280	103	80-120			
Copper	53.9	0.0005	mg/L	6.01	95.9	80-120			
Iron	2360	0.1	mg/L	20.5	93.7	80-120			
Lead	44.8	0.0001	mg/L	0.0804	89.4	80-120			
Magnesium	25200	0.2	mg/L	17100	81.8	80-120			
Manganese	48.5	0.005	mg/L	0.534	96.0	80-120			
Molybdenum	44.9	0.0005	mg/L	0.277	89.3	80-120			
Nickel	50.4	0.001	mg/L	0.527	99.8	80-120			
Potassium	12400	0.1	mg/L	2330	101	80-120			
Selenium	47.9	0.001	mg/L	0.325	95.2	80-120			
Silver	43.6	0.0001	mg/L	0.0085	87.1	80-120			
Sodium	62400	0.2	mg/L	54900	75.5	80-120			QM-07
Thallium	44.9	0.001	mg/L	0.024	89.7	80-120			
Tin	45.2	0.01	mg/L	0.06	90.3	80-120			
Titanium	62.2	0.005	mg/L	ND	124	70-130			
Tungsten	47.8	0.01	mg/L	0.20	95.2	80-120			
Uranium	49.4	0.0001	mg/L	0.383	98.0	80-120			

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Vanadium	52.7	0.0005	mg/L	0.121	105	80-120			
Zinc	56.5	0.005	mg/L	12.8	87.4	80-120			
PCBs									
PCBs, total	1.00	0.05	ug/L	ND	100	35-135			
Surrogate: Decachlorobiphenyl	*0.653*		*%*		*131*	*60-140*			
Semi-Volatiles									
Acenaphthene	4.91	0.05	ug/L	ND	98.2	50-140			
Acenaphthylene	5.25	0.05	ug/L	ND	105	50-140			
Anthracene	4.62	0.01	ug/L	ND	92.3	50-140			
Benzo [a] anthracene	4.33	0.01	ug/L	ND	86.6	50-140			
Benzo [a] pyrene	4.87	0.01	ug/L	ND	97.4	50-140			
Benzo [b] fluoranthene	5.65	0.05	ug/L	ND	113	50-140			
Benzo [g,h,i] perylene	5.40	0.05	ug/L	ND	108	50-140			
Benzo [k] fluoranthene	5.47	0.05	ug/L	ND	109	50-140			
Biphenyl	4.67	0.05	ug/L	ND	93.5	50-140			
Chrysene	4.69	0.05	ug/L	ND	93.9	50-140			
Dibenzo [a,h] anthracene	5.59	0.05	ug/L	ND	112	50-140			
Fluoranthene	5.42	0.01	ug/L	ND	108	50-140			
Fluorene	5.19	0.05	ug/L	ND	104	50-140			
Indeno [1,2,3-cd] pyrene	4.93	0.05	ug/L	ND	98.6	50-140			
1-Methylnaphthalene	4.63	0.05	ug/L	ND	92.5	50-140			
2-Methylnaphthalene	4.64	0.05	ug/L	ND	92.8	50-140			
Naphthalene	4.88	0.05	ug/L	ND	97.6	50-140			
Phenanthrene	4.95	0.05	ug/L	ND	99.0	50-140			
Pyrene	3.98	0.01	ug/L	ND	79.6	50-140			
Surrogate: 2-Fluorobiphenyl	*16.3*		*%*		*81.4*	*50-140*			
Surrogate: Terphenyl-d14	*15.6*		*%*		*77.9*	*50-140*			

Qualifier Notes:

Login Qualifiers :

Metals sample was decanted from the generals container and preserved at the lab as directed by client.

Applies to Samples: 363 Entreneur Crescent Supply

QC Qualifiers:

QM-07 The spike recovery was outside acceptance limits for the MS and/or MSD. The batch was accepted based on other acceptable QC.

Sample Data Revisions:

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable

ND: Not Detected

MDL: Method Detection Limit

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

%REC: Percent recovery.

RPD: Relative percent difference.

NC: Not Calculated

CCME PHC additional information:

- The method for the analysis of PHCs complies with the Reference Method for the CWS PHC and is validated for use in the laboratory. All prescribed quality criteria identified in the method has been met.
- F1 range corrected for BTEX.
- F2 to F3 ranges corrected for appropriate PAHs where available.
- The gravimetric heavy hydrocarbons (F4G) are not to be added to C6 to C50 hydrocarbons.
- In the case where F4 and F4G are both reported, the greater of the two results is to be used for comparison to CWS PHC criteria.
- When reported, data for F4G has been processed using a silica gel cleanup.

PARACEL LABORATORIES LTD

Paracel ID: 2447459

Paracel Order Number	Chain Of Custody — Ontario Drinking Water Samples
2447459	№ 19762

Client Name:	LRL Engineering	Project Ref:	220487	Waterworks Name:		Samples Taken By:
Contact Name:	Jessica Arthurs	Quote #:		Waterworks Number:		Name: Jessica Arthurs
Address:	5430 Canotek Road	PO #:		Address:		Signature: [signature]
After Hours Contact:	Jessica Arthurs	E-mail:	Jarthurs@lrl.ca			Page 1 of 1 — Turn Around Time Required: ☐ 1 day ☐ 2 day ☐ 3 day ☒ 4 day
Telephone:	6139780658	Fax:		Public Health Unit:		

Samples Submitted Under: (Indicate **ONLY one**)
❑ ON REG 170/03 ❑ ON REG 319/08 ☒ Private Well
❑ ON REG 243/07 ❑ Other

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

Have LSN forms been submitted to MOE/MOHLTC?: ☐ Yes ☒ No ☐ N/A
Are these samples for human consumption?: ☐ Yes ☒ No

All information must be completed before samples will be processed.

Required Analyses

	LOCATION NAME	SAMPLE ID	Sample Type: R/T/D/P	Source Type: G/S	Reportable: Y/N	Resample	SAMPLE COLLECTED DATE	SAMPLE COLLECTED TIME	# of Containers	Free/Combined Chlorine Residual mg/L	Standing / Flushed: S/F (REG 243)	Total Coliform/E. Coli	HPC	Lead	THM	Trace Metals	PHC F1-F4	PAH	PCB
1	Supply well	363 Entreneur Cresent Supply	R	G	N	N	Nov 22, 2024	12:00	6	—	F					X	X	X	X
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			

Comments:

Method of Delivery: Walk in

Relinquished By (Sign): [signature]	Received By Driver/Depot:	Received at Lab: JM	Verified By: SS
Relinquished By (Print): Jessica Arthurs	Date/Time:	Date/Time: 11-22-24 12:57	Date/Time: 22 Nov 24 1435
Date/Time: 2024.11.22 12:58	Temperature: °C	Temperature: 8.3 °C	pH Verified: ☒ By: SO

ATTACHMENT I

Consent Not to Abandon Water Supply Well (A379014)

Ministry of the Environment, Conservation and Parks

Environmental Monitoring and Reporting Branch
125 Resources Road
Toronto ON M9P 3V6

Ministère de l'Environnement, de la Protection de la nature et des Parcs

Direction de la surveillance environnementale
125, chemin Resources
Toronto ON M9P 3V6

Ontario

August 13, 2024

Entrepreneur Holding Corporation
c/o Dustin Wilson
310 Sanctuary Private
Ottawa, ON K1S 5W1

Dear:

Re: **Consent Not to Abandon Water Supply Well (A379014), Located at 363 Entrepreneur Crescent, Ottawa, Ontario**

You have submitted a request under subsection 21(10) of R.R.O 1990, Regulation 903: Wells, as amended (**"Wells Regulation"**), made under the *Ontario Water Resources Act*, R.S.O. 1990, c. O.40 (**"OWRA"**) for a written consent permitting you to not abandon one (1) well identified by well record number A379014. The well produces mineralized water[1] and accordingly would otherwise be required to be abandoned per section 21 (4) of the Wells Regulation.

You retained the services of LRL Engineering ("LRL") to provide the Ministry of the Environment, Conservation and Parks (the "Ministry") with a hydrogeological report regarding the potential impact of not abandoning the well located at 363 Entrepreneur Crescent, Ottawa, ON ("Subject Site").

The location of the well is described in Schedule A – PH4650-1 MECP Water Well Location Plan hereto, and forms part of this letter.

[1] "Mineralized water" means means water containing in excess of 6,000 milligrams per litre total dissolved solids or 500 milligrams per litre chlorides or 500 milligrams per litre sulphates, subsection 1(1) of R.R.O. 1990, Regulation 903 (Wells) as amended made under the Ontario Water Resources Act, R.S.O. 1990, c. O. 40, E-laws - https://www.ontario.ca/laws/regulation/900903

LRL produced a report titled "2023.12.20.LRL220487.LETTER.MineralizedWaterMECPNotification&Written Consent Request"; with File number 220487; and dated December 20, 2023 (the "LRL Report"). A copy of the LRL Report has been provided to me and is attached as part of Schedule B to this letter.

Based on the results provided in the LRL Report, I understand that a water quality sample collected from the well on August 30, 2023 during an 8-hour pumping test at the midpoint (4 hours) and end (8 hours) showed total dissolved solids (TDS) concentrations to be 7,950 and 7,880 milligrams per litre and chloride concentrations of 4,560 and 4,460 milligrams per litre, respectively. The water in the well is therefore "mineralized water" as defined in subsection 1(1) of the Wells Regulation.

The LRL Report proposed that the well be used as a non-potable water supply at the Subject Site and recommended that the following water treatment systems be considered, with modifications recommended by a water treatment system specialist:

- Water softener that uses salt;
- Series of three (3) carbon filters;
- Iodine dosage; and
- Reverse osmosis

The LRL Report also proposes that corrosion resistant plumbing be incorporated into the construction of the warehouse as a precautionary measure. The LRL Report recognizes the need to maintain all water treatment units and that the 'mineralized water within the well, supply line, and pressure tank prior to treatment may have a reduced operational duration or "life-span", and may need more frequent replacement.'

In coming to a decision on your request for consent not to abandon this well, I have reviewed the following reports and documents (attached as part of Schedule B):

- December 20, 2023, File: 220487, 2023.12.20.LRL220487.LETTER.MineralizedWaterMECPNotification&Written Consent Request.

Based on a review of the materials, the Ministry has determined that the well is unlikely to act as a pathway to allow mineralized water to intermingle with fresh groundwater resources and thus is unlikely to impair the quality of local groundwater resources.

In respect of the well, you have agreed to the following requirements (attached as part of Schedule C – Letter to Wells Director Accepting Conditions for Director Consent) as conditions of the Director granting consent permitting you not to abandon this well:

1. Ensure that the well is properly vented to the outside atmosphere in a manner that will safely disperse all gases, as per section 15.1 of Regulation 903;

2. The services of a water treatment specialist shall be retained and you shall install, operate and maintain a water treatment system in the distribution system, in accordance with recommendations of the water treatment specialist, to address the total dissolved solids and chloride present in the well water prior to the water being used in the building;

3. The water treatment system shall be properly maintained and operational at all times in accordance with the recommendations of the water treatment specialist;

4. All faucets within the building shall be labelled to indicate that the water is not intended for human consumption;

5. The well water shall not be used as a drinking water source under any circumstances by any person and botted water shall be supplied for consumption by employees; and

6. Due to elevated chloride, steps shall be taken to mitigate the impact of corrosion on plumbing including: use of approved PEX pipe and fittings, installation of stainless steel fixtures, and not installing water treatment systems that may increase corrosivity of the water; and

7. The well identified by well record number A379014 shall be maintained as per Reg. 903 until such time as the water supply is no longer required. At that point, the water supply well shall be decommissioned in accordance with Reg. 903.

Once the water treatment system becomes operational, you shall immediately notify, in writing, the Director appointed for the purposes of subsection 21 (10) of the Wells Regulation of the date when the water treatment system is operational.
To contact the Director, please send email correspondence to the wellshelpdesk@ontario.ca.

Failure to comply with the conditions specified above shall result in the automatic revocation of this consent without notice.

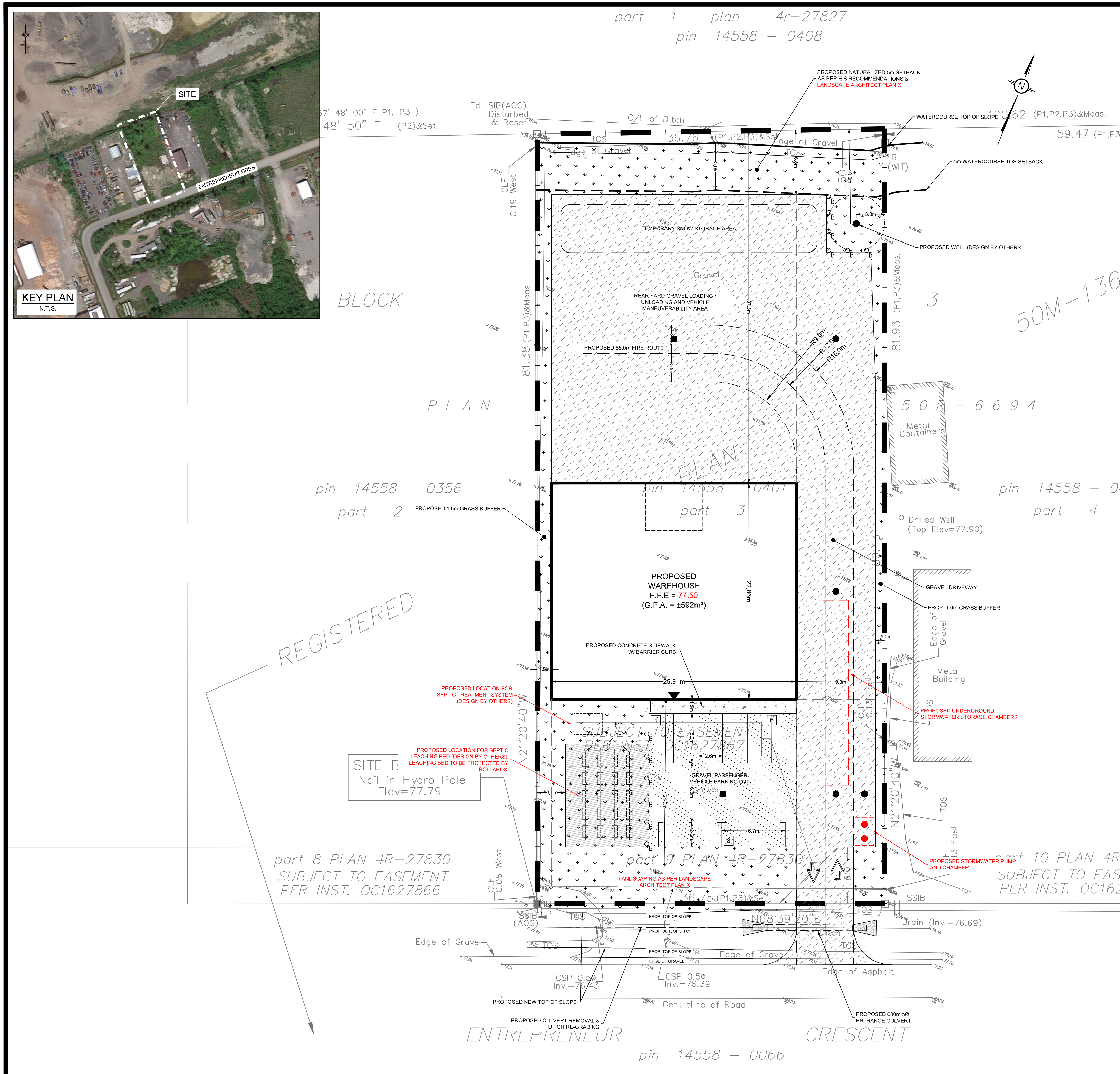
This consent is not assignable to a successor or assign without the express written authorization of the Director.

The issuance of and compliance with the conditions of this consent does not relieve any person of any obligation to comply with any provision of any other applicable statute, regulation or other legal requirement, including, but not limited to, any requirement to obtain and comply with any other approvals required by the Ministry of the Environment, Conservation and Parks or the City of Ottawa.

Shelley Kilby, M.Sc., P.Geo
Director
Appointed for the purposes of subsection 21(10) of the Wells Regulation

c: Tracy Hart, District Manager, Ottawa District Office
Alija Bos, Hydrogeologist, Eastern Region
Richard Bonner, Environmental Monitoring and Reporting Branch
Jessica Arthurs, Environmental Engineering Manager, LRL Associates Ltd.
Stephane Leclerc, P. Eng, LRL Associates Ltd.
Sean Harrigan, City of Ottawa
Tessa Di Iorio, City of Ottawa

SCHEDULE A



LEGEND:

- EXISTING PROPERTY LINE TO REMAIN
- PROPOSED CURB
- PROPOSED DEPRESSED CURB
- PROPOSED TERRACING (3:1 MIN.)
- PROPOSED SILT FENCE AS PER OPSD 219.110
- PROPOSED FENCE
- PROPOSED DOOR ENTRANCE/EXIT
- PROPOSED GRASS AREA (100mm TOP SOIL & SOD)
- PROPOSED CONCRETE FEATURES/SLAB
- PROPOSED HEAVY DUTY ASPHALT
- PROPOSED LIGHT DUTY ASPHALT
- PROPOSED RIP RAP
- ×50.00 PROPOSED ELEVATION
- ×50.00HP PROPOSED HIGH POINT ELEVATION
- ×50.00S PROPOSED SWALE ELEVATION
- ×50.00BC PROPOSED BOTTOM OF CURB / ASPHALT ELEVATION
- ×50.00TC PROPOSED TOP OF CURB ELEVATION
- ×50.00BW PROPOSED EXPOSED BOTTOM OF RETAINING WALL
- ×50.00TW PROPOSED TOP OF RETAINING WALL
- ×50.00EX MATCH INTO EXISTING ELEVATION
- ×70.19 EXISTING ELEVATION
- PROPOSED OVERLAND MAJOR FLOW ROUTE
- SUB PROPOSED 100mmØ PERFORATED SUBDRAIN
- STM PROPOSED STORM SEWER
- SAN PROPOSED SANITARY SEWER
- WTR PROPOSED WATERMAIN
- STM EXISTING STORM SEWER
- SAN EXISTING SANITARY SEWER
- WTR EXISTING WATERMAIN
- GAS EXISTING GAS LINE
- EXISTING MANHOLE
- EXISTING CATCHBASIN
- PROPOSED CATCHBASIN-MANHOLE/CATCHBASIN
- PROPOSED MANHOLE
- PROPOSED CURB STOP
- PROPOSED PIPE INSULATION
- PROPOSED 100 YEAR HIGH WATER LEVEL
- STORM WATERSHED EXTENT
- WS-XX CONTROLLED / AREA / RUNOFF: WATERSHED NAME; RUNOFF COEFFICIENT; AREA IN HECTARES

DETAILS OF DEVELOPMENT

DATA		REQUIRED	PROVIDED
	ZONING	RG2 (RURAL GENERAL INDUSTRIAL ZONE)	
SETBACKS	FY	15.0m	21.6m
	RY	15.0m	34.2m
	INT.SY	3.0m / 1.5m (MV)	1.5m
	EXT.SY	3.0m	12.4m
NET LOT AREA (sqm)		3000 sqm	
BUILDING COVERAGE		50 % (MAX)	19.7 %
BUILDING HEIGHT		15.0 m (MAX)	10.8 m
GROSS FLOOR AREA		592 sqm	
No. of UNITS		1	
LOADING SPACES		N/A	N/A
PARKING:		5	8
No. OF STOREYS			1
OTHER:			

GENERAL NOTES:

EXISTING SERVICES AND UTILITIES SHOWN ON THESE DRAWINGS ARE TAKEN FROM THE BEST AVAILABLE RECORDS, BUT MAY NOT BE COMPLETE OR TO DATE. CONTRACTOR SHALL VERIFY IN FIELD FOR LOCATION AND ELEVATION OF PIPES AND CHECK WITH THE UTILITY COMPANIES BEFORE DIGGING OR PERFORMING WORK.

CONTRACTOR IS ADVISED TO COLLECT INFORMATION ON SOIL CONDITIONS BEFORE START OF CONSTRUCTION.

THE ENGINEER WAIVES ANY AND ALL RESPONSIBILITY AND LIABILITY FOR PROBLEMS WHICH ARISE FROM FAILURE TO FOLLOW THESE PLANS, SPECIFICATIONS AND THE DESIGN INTENT THEY CONVEY, OR FOR PROBLEMS WHICH ARISE FROM OTHERS' FAILURE TO OBTAIN AND/OR FOLLOW THE ENGINEER'S GUIDANCE WITH RESPECT TO ANY ERRORS, OMISSIONS, INCONSISTENCIES AMBIGUITIES OR CONFLICTS WHICH ARE ALLEGED.

CONTRACTOR TO VERIFY ALL DIMENSIONS AND NOTIFY THE ENGINEER OF ANY DISCREPANCIES BEFORE WORK COMMENCES. DO NOT SCALE DRAWINGS.

5m 2 0 5m

SCALE: 1:200

NOT FOR CONSTRUCTION TENDER OR PERMIT

No.	REVISIONS	BY	DATE
02	ISSUED FOR SITE PLAN CONSTROL	K.H.	XX JUL 2024
01	ISSUED FOR SITE PLAN CONTROL	K.H.	10 OCT 2023

NOT AUTHENTIC UNLESS SIGNED AND DATED

LRL
ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

CLIENT
DUSTIN WILSON

DESIGNED BY: K.H.
DRAWN BY: K.H.
APPROVED BY: M.B.

PROJECT
PROPOSED WAREHOUSE DEVELOPMENT
363 ENTREPRENEUR CRESCENT, OTTAWA

DRAWING TITLE
SITE PLAN

PROJECT NO.
220487

DATE
OCT 2022

C201

SCHEDULE B

Via Email: wellshelpdesk@ontario.ca

December 20, 2023

Our File Ref.: 220487

Well Help Desk,
Environmental Monitoring and Reporting Branch of the
Ministry of the Environment and Climate Change
125 Resources Road
Toronto, Ontario M9P 3V6

Subject: Written Consent Request for Director's Exemptions – Well Producing Mineralized Water 363 Entrepreneur Crescent, Ottawa, Ontario

Dear Respective Respondent of Well Help Desk,

On behalf Entrepreneur Holding Corporation (the 'Client'), LRL Engineering (LRL) has prepared the following formal request for written consent by the Ontario Ministry of the Environmental, Conservation and Parks (MECP) Director for the exemption related to the decommissioning of a recently constructed supply well based on the mineralized water conditions encountered on the property located at 363 Entrepreneur Cresent, in Ottawa, Ontario (herein referred to as the 'Site').

This letter is intended to provide relevant information related to the supply well and mineralized aquifer conditions, the anticipated use of the Site, and rational for the requested decommissioning exemption.

1 SITE DESCRIPTION

The Site is generally undeveloped with exception to a granular base applied across the surface of the Site and is used as a storage yard for the adjacent facility. The Site is set within a rural, low-density commercial and light industrial area of Ottawa, Ontario, southeast of the City's urban extents. The Site is legally described as Part of Block 3 Plan 50M136 Part 3 ON Plan 50R6694; Subject to an Easement in Gross Over Part 9 ON Plan 4R-27830 As in OC1627867; City of Ottawa.

Municipal water supply and sanitary services are not available for the Site. Select neighbouring lands are equipped with private water supply wells, and sewage disposal systems. The potable groundwater supply for the surround area is found in the gravel/shale bedrock layer, at depths between 21.0 m and 30.3 m below ground surface (bgs).

The Client (Entrepreneur Holding Corporation) is the current owner of the Site, and the current owner of the recently constructed supply well on the subject property. The supply well was installed to support a proposed warehouse development, and to facilitate the demands of a hydrogeological assessment requested by the City of Ottawa to support the application of the proposed development.

It is anticipated that one (1) approximately 1,380 m² warehouse will be developed on the subject property, in addition to corresponding parking and circulation area and related components. The proposed development will be serviced by a private water supply well and sewage disposal system, however, it is important to note that the supply well will not be used for human consumption, as discussed in further detail below in Section 3.

2 SUPPLY WELL INSTALLATION

The proposed supply well to facilitate the anticipated development, and requested studies, was constructed on August 23, 2023, by Air Rock Well Drilling (Richmond, Ontario). The well was advanced at the northeastern portion of the Site, being a minimum of 3.0 m from all property lines, and beyond 15 m from potential sources of contamination, such as septic disposal systems (existing and proposed). The well extended to a depth of 48.7 m. Clay was reported to be encountered at ground surface to a depth 26.2 m followed by gravel to 28.0 m bgs. The well was extended into shale bedrock to 48.7 m bgs. Water was found at a depth 46.9 m, with a static water level measured at 2.80 m.

A copy of the well record (Well Tag#A379014) is included in **Attachment A** at the end of this letter.

2.1 Quality

The proposed development of the Site is anticipated to include a warehouse with office space. To support the anticipated development application with the City, a hydrogeological assessment was completed on the Site. The assessment included a supply aquifer evaluation with a focus on demand and quality. To establish the hydraulic properties of the proposed supply aquifer, an eight (8)-hr pump test was conducted on the newly constructed supply well on August 30, 2023, by LRL. The pumping rate throughout the test was set to account for the anticipated demand volumes of the proposed facility, over a common commercial operation period of eight (8)-hours.

Periodic samples collected during the water demand evaluation revealed that the proposed supply aquifer is considered to be mineralized, in accordance with Subsection 1(1) of Wells Regulation 903, that indicates "*water containing in excess of 6,000 mg/L total dissolved solids or 500 mg/L chlorides or 500 mg/L sulphates*" is considered mineralized. The values obtained at the time of the periodic sampling for these parameters indicative of mineralization are as follows:

- Total Dissloved Soilds (TDS) values ranged between 7,880 and 7,950 mg/L; and
- Chloride concentrations ranged between 4,460 and 4,560 mg/L.

Under subsection 21(4) of Ontario Regulation 903, if a well produces mineralized water, the well owner shall immediately abandon the well. However, "*(10) Subsections (4) to (8) do not apply if the well owner has the written consent of the Director (O. Reg. 372/07, s. 20)*" to allow for the continued use of a well which produces mineralized water.

The water quality, and sampling procedures are further discussed in the included Hydrogeological Assessment & Terrian Analysis report (September 2023) included in **Attachment B**.

3 DIRECTOR'S EXEMPTIONS REQUEST – WELL PRODUCING MINERALIZED WATER

As mentioned, the Site is set in a rural industrial setting, with the anticipated use as a warehouse facility with office space. Municipal water supply services are not available for the Site. Future, and existing neighbouring developments are required to obtain their water supply source through natural aquifers. Review of available water well records obtained through MECP water well database, revealed that alternative aquifers are not readily available in the area of the Site. Limitations for alternative water supply sources include the following:

- Overburden soils across the Site consist of clay. Wells which are installed in clayey or silty overburden are often poor yielding due to the hydraulic conductivity characteristics of these materials. A poor yielding well is not acceptable for development according to the local regulatory official and would most likely not be considered acceptable for the proposed development on the Site based on these assumptions. Furthermore, overburden wells are also more susceptible to potential impairment or contamination from on-Site and off-Site operations and features, including septic beds. Although the clay deposits across the Site would act as a confining layer for potential runoff or infiltration of contaminates, due to the light industrial operations in the area of the property, including a snow-dump immediately north, a shallow well is not considered a suitable option for the Site;
- The water well record for the supply well advanced on the Site, included in **Attachment A**, does not indicate an alternative bedrock aquifer, at shallower intervals; and
- According to the O. Reg. 903 licenced well driller retained for the installation services, as well as conversations with neighbouring landowners, deeper conditions are generally considered unacceptable with respect to additional provincial drinking water quality standards and low yields.

As there are no potential alternative water supply sources available for the Site, the client is respectfully requested permission by the Director to maintain the recently installed supply well at 363 Entrepreneur Crescent, Ottawa, Ontario to support the proposed warehouse development.

3.1 Request Rationale

The Client is aware of the potential concerns with respect to plumbing fixture integrity, and potential risks to sensitive populations or persons with health concerns associated with mineralized water. However, there are no alternative aquifers available for the proposed warehouse development, as discussed above.

As a mitigative solution to prevent consumption of the water supply from the well at the proposed facility, the Client will install signage, in accordance with the Ontario Building Code, of the non-potable conditions throughout. Notices of non-potable conditions will be fitted at all fixtures to provide visual awareness that consumption of the supply water emitted from the fixtures is not for consumption. The signage will contain the words "**Non-potable water, Do Not Drink**. The Client will include an alternative source for drinking water through a conventional drinking water dispenser/water cooler, with potable water re-fill containers available through a supplier or retailer.

Although the consumption and use of the supply aquifer at the Site will be restricted, as included in the Hydrogeological Assessment and Terrain Analysis (September 2023), an evaluation of the adjacent properties supply well (357 Entrepreneur Crescent), and existing distribution system was conducted. The intent of the evaluation was to demonstrate through laboratory analysis that the proposed supply aquifer can be treated to concentrations considered generally acceptable in accordance with provincial guidelines, pertaining more so to maintaining the integrity of the distribution system and plumbing fixtures. Based on the information collected with respect to this neighbouring supply well, it is noted that the conditions of the installation are considered similar to those at the Site. The adjacent supply well is advanced to a depth of 28.9 m into the shale stratum, generally where groundwater was encountered. The distribution system which supplies the neighbouring property development includes a water treatment system as follows:

- A water softener that uses salt;
- A series of three (3) carbon filters;
- Iodine dosage; and
- Reverse osmosis.

The pre-treatment system sample (raw water) revealed that the adjacent properties (357 Entrepreneur Crescent) water supply is in fact mineralized, with concentrations of TDS and Chloride of 7,640 and 4,350 mg/L, respectively. Post-treatment concentrations for these parameters were reported as 508 and 302 mg/L, respectively, marginally above the limits considered acceptable for consumption, however, are considered acceptable for general non-consumption use such as hand washing or facility cleaning. The treatment systems are proven to be affective with respect to the parameters of concern. And although the values are marginally above the drinking water quality guidelines, a treatment system specialist could provide modifications, or improvements to the system to further improve quality.

The Site will use a similar water treatment system as that currently in use at the adjacent property (357 Entrepreneur Crescent). The treated water is considered to have a low impact to plumbing fixtures and the distribution system piping system. However, corrosion resistance pluming will be incorporated into the construction of the warehouse as an additional precautionary measure. Furthermore, water treatment units will be maintained at the Site, to support improvements in the water quality. The client is aware that the mineralized water within the well, supply line, and pressure tank prior to treatment may have a reduced operational duration or “life-span”, and may need more frequent replacement.

It is understood that maintaining a mineralized well has risk for further groundwater impairment. Like all wells, a poorly constructed or neglected installation can be a pathway for contaminates entering and impairing aquifers. Proper and regular maintenance is required by the well owner to ensure that its integrity and quality is maintained. The supply well for the Site has been constructed so to limit the potential risk to alternative aquifers and neighbouring wells. The current depth and over-all condition of the well will not be altered, as deepening the well may interfere with deeper aquifers or groundwater supply sources. Furthermore, the seal must be maintained to prevent potential infiltration of the mineralized water into shallow water supply sources. The well was grouted from ground surface to 29.8 m below grade, which corresponds to the depth of the adjacent lands supply well. Groundwater on Site was found at greater depths, reported at 46.9 m below grade. The 29.8 m of seal, including of bentonite slurry and cement grout, is considered adequate to prevent impairment of the mineralized water to alternate aquifers in the area.

With respect to the supporting rational presented above, including:

- The limited alternative water supply sources available for the Site;
- Supporting evidence that the mineralized water can be treated to provide a suitable supply to the building fixtures and distribution system;
- The water will not be used for human consumption, and alternative drinking water sources will be made available by the client; and
- That the construction of the well is acceptable with respect to limiting potential risk or impairment to neighbouring supply aquifers and wells,

It is anticipated that sufficient supporting information has been presented herein to allow the MECP to make an informed decision to which they can agree that the supply well on the Site may be allowed to stay in contravention of Ontario Regulation 903 if the measures mentioned above are in place to eliminate physical hazards to Site occupants.

A copy of the previously prepared Hydrogeological Assessment & Terrain Analysis (September 2023) is included in **Attachment B** to provide the Well Help Desk, Environmental Monitoring and Reporting Branch of the MECP with further technical information related to the Site, proposed supply aquifer, and other pertinent supporting information.

Yours truly,
LRL Associates Ltd.

LICENSED PROFESSIONAL ENGINEER
S. LECLERC
90439027
Dec 20/23
PROVINCE OF ONTARIO

Jessica Arthurs
Environmental Engineering Manager

Stephane Leclerc, P. Eng.
Vice President

Encl.
Cc. Dustin Wilson, Entrepreneur Holding Corporation

ATTACHMENT A

On-Site Supply Well Record

Ontario | Ministry of the Environment, Conservation and Parks

Tag#:A379014 (Print Below)

A379014

Well Record

Regulation 903 Ontario Water Resources Act

Page ____ of ____

Measurements recorded in: ☐ Metric ☒ Imperial

Well Owner's Information

First Name	Last Name/Organization	E-mail Address	☐ Well Constructed by Well Owner
	Dustin Wilson		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
310 Sanctuary Private	Ottawa	ON	K1S 5W1	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
363 Entrepreneur Crescent	Cumberland	23	11

County/District/Municipality	City/Town/Village	Province	Postal Code
Ottawa Carleton	Navan	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	465760	5020936	50R-6694	

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 (ft) From	Depth (ft) To
	Clay			0'	86'
	Gravel			86'	92'
Black	~~Sandstone~~ Shale			92'	154'
Black	~~Sandstone~~ Shale			154'	160'

Annular Space

Depth Set at (ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (ft³)
98'	88'	Neat cement	12.48
88'	0'	Bentonite slurry	21.00

Results of Well Yield Testing

After test of well yield, water was: ☐ Clear and sand free ☐ Other, specify **Not tested**

If pumping discontinued, give reason: X

Pump intake set at (ft): 150

Pumping rate (l/min / GPM): 15

Duration of pumping: 1 hrs + 0 min

Final water level end of pumping (ft): 103.2'

If flowing give rate (l/min/GPM): X

Recommended pump depth (ft): 150'

Recommended pump rate (l/min/GPM): 10

Well production (l/min/GPM): 15

Disinfected? ☒ Yes ☐ No

Draw Down Time (min)	Water Level (ft)	Recovery Time (min)	Water Level (ft)
Static Level	9'2"		103.2"
1	22.4	1	87
2	31.9	2	78.6
3	37.5	3	71.1
4	42.2	4	63.8
5	46.4	5	57.4
10	61.7	10	32.8
15	71.9	15	19.7
20	79.4	20	11.3
25	85.1	25	9.5
30	89.9	30	9.2
40	97	40	9.2
50	100.9	50	9.2
60	103.2	60	9'2"

Method of Construction

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

Well Use

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

Construction Record - Casing

Inside Diameter (in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (in)	Depth (ft) From	To
6 1/4"	Steel	.188"	+2'	98'
6"	Open Hole		98'	160'

Status of Well

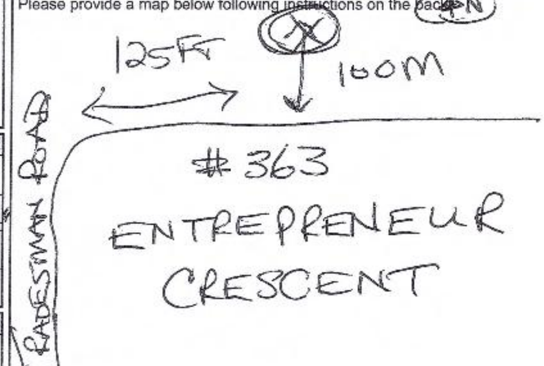
☒ Water Supply ☐ Replacement Well ☐ Test Hole ☐ Recharge Well ☐ Dewatering Well ☐ Observation and/or Monitoring Hole ☐ Alteration (Construction) ☐ Abandoned, Insufficient Supply ☐ Abandoned, Poor Water Quality ☐ Abandoned, other, specify ☐ Other, specify

Construction Record - Screen

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

Map of Well Location

Please provide a map below following instructions on the back.



Water Details

Water found at Depth 154 (ft) ☐ Gas Kind of Water: ☐ Fresh ☒ Untested ☐ Other, specify

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

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

Hole Diameter

Depth (ft) From	To	Diameter (in)
0'	98'	9 3/4"
98'	160'	6"

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Air Rock Drilling Co. Ltd.	C7681

Business Address (Street Number/Name)	Municipality
6659 Franktown Road	Richmond

Province	Postal Code	Business E-mail Address
ON	K0A 2Z0	air-rock@sympatico.ca

Bus.Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
6138382170	Hanna, Jeremy

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
T3632		2023 09 29

Comments: 3/4HP-10GPM Set @ 150 FT

Well owner's information package delivered	Date Package Delivered	Ministry Use Only
☒ Yes ☐ No	2023 08 28	Audit No. Z408138
	Date Work Completed 20230823	Received

ATTACHMENT B

Hydrogeological Assessment & Terrain Analysis

LRL

ENGINEERING | INGÉNIERIE

September 13, 2023

Our File Ref.: 220487

Entrepreneur Holding Corporation
363 Entrepreneur Crescent
Ottawa (Navan), Ontario K4B 1T8

Attention: Dustin Wilson

Subject: Hydrogeological Assessment & Terrain Analysis – Proposed Warehouse Development 363 Entrepreneur Crescent, Ottawa, Ontario

Dear Mr. Wilson,

LRL Engineering (LRL) was retained by Entrepreneur Holding Corporation (the 'Client') to complete a Hydrogeological Assessment & Terrain Analysis for the property located at 363 Entrepreneur Crescent in Ottawa (Navan), Ontario in support of the proposed site development. It is anticipated that one (1) approximately 1,382 m² warehouse will be developed on the subject property, in addition to corresponding parking and circulation area and related components. The proposed development will be serviced by a private water supply well and sewage disposal system.

The assessment was carried out to determine if the proposed development can be adequately and safely supplied with potable water according to the Ontario Drinking Water Standards (ODWS) and *Procedure D-5-5 Technical Guideline for Private Wells: Water Supply Assessment (August 1996)*; and that the proposed development can be serviced with a private septic system. The assessment was also intended to confirm that the construction of the supply well, and proposed construction activities, will be such as to minimize impairment to the regional aquifer and that it meets the current Ontario Regulation 903 requirements.

The assessment was conducted according to Ontario Ministry of the Environment, Conservation and Parks (MECP) "Hydrogeological Technical Information Requirements for Land Development Applications" (April 1995), which include the following guidelines and procedures:

- Guideline D-5 Planning for Sewage and Water Services (August 1996);
- Procedure D-5-4 Technical Guideline for Individual On-site Sewage Systems: Water Quality Impact Risk Assessment (August 1996); and
- Procedure D-5-5 Technical Guideline for Private Wells: Water Supply Assessment (August 1996).

The City of Ottawa Hydrogeological and Terrain Analysis Guidelines, March 2021, was also referenced to support the completion of this study.

The assessment involved a desktop review of available information on the geology and hydrogeology of the site and adjacent lands in addition to intrusive investigative work, supply aquifer demand evaluations and water quality sampling and analysis. Based on our review of available information, and results of our field investigations, it is determined that the proposed development can be supplied with a sufficient quantity and quality of readily treatable water, and that the site conditions are suitable for an on-site sewage disposal system.

1 SCOPE OF INVESTIGATION

LRL was retained by Entrepreneur Holding Corporation to complete a Hydrogeological Assessment & Terrain Analysis for the property located at 363 Entrepreneur Crescent in Ottawa (Navan), Ontario (herein referred to as the 'Site'). This assessment was requested in support of the proposed development of the Site, and associated application submission to the City of Ottawa. It is understood that one (1) approximately 1,382 m² warehouse will be constructed on the Site. Further details pertaining to the anticipated development are included in Section 3.

LRLs scope for this investigation was in general accordance with current applicable provincial guidelines, in addition to the City of Ottawa Hydrogeological and Terrain Analysis Guideline, dated March 2021. Prior to the initiation of the scope of this investigation, a virtual meeting was held with the Hydrogeologist of the City of Ottawa to review the project, discuss the possible concerns related to the natural features of the area, and how this can be addressed through the pumping test of the supply well and neighbouring aquifer supply sampling. LRLs scope for this Hydrogeological Assessment & Terrain Analysis was generally as follows:

- Conduct a search of available well information for neighbouring properties through the MECP water well records database;
- Perform a desk top review of available geological maps and local well records to obtain information pertaining to the quantity supply aquifer of the subject Site;
- Collect a water sample, representative of pre- and post-treatment supply aquifer conditions, from the neighbouring property to the west (357 Entrepreneur Cres.) to obtain information of the respective aquifer characteristics;
- Provide support during the construction of the test well, including a grouting inspection to verify the installation corresponds to applicable requirements and regulations;
- Conduct one (1) – eight (8) hour pumping test on the newly constructed test well on the Site by using a submersible pump and powered by a portable generator.
    - Based on the proposed Site use and development footprint, and as per the Ontario Building Code, an estimated daily demand of 7,600 L/day is anticipated for the Site. To account for this daily volume, the well would be pumped at a rate of between 16 – 20 L/minute to represent peak demand over eight (8) hours;
    - Manual water levels were collected from the supply well during the pumping test to analyse the hydrogeological characteristics of the aquifer on-Site;
    - Collect and submit water samples from the supply well periodically during the pumping test, four (4)-hours and eight (8)-hours of pumping, for laboratory analysis under the subdivision package, and volatile organic compounds; and
    - Following the pumping test, record water levels for up to 24 hours or until 95% recovery has occurred.
- Collect and compile relevant sub-surface details related to the underlying subsurface

conditions through collaboration with additional sub-surface investigation field work (i.e. Phase Two Environmental Site Assessment, and Geotechnical Investigation);

- Compare the laboratory analysis results, from the supply well, to the applicable Ontario Drinking Water Standard (ODWS) and MECP D-5-5 Treatability Limits; and
- Prepare a summary regarding the quality and the quantity of the supply aquifer and comparison to D-5-5 compliance requirements set forth by the City of Ottawa Technical Authority. Summarize the findings to confirm that the property size and soil conditions are suitable to attenuate the impacts of the septic system effluent.

2 SITE AND AREA DESCRIPTION

The Site is generally undeveloped with exception to a granular base applied across the majority of the surface of the Site and is used as a storage yard for the adjacent YSB Hoisting Equipment & YSB Carpentry facility. The Site is set within a rural, low-density commercial and light industrial area of Ottawa, Ontario, southeast of the City's urban extents. The Site is legally described as Part of Block 3 Plan 50M136 Part 3 ON Plan 50R6694; Subject to an Easement in Gross Over Part 9 ON Plan 4R-27830 As in OC1627867; City of Ottawa.

The Site is located approximately 310 m northeast of the Boundary Road and Entrepreneur Crescent intersection, as presented in **Figure 1**. The Site is a rectangular shape, with a total area of approximately 3,000 m² or 0.75 acre as shown in **Figure 2**. Historically, the Site was used as agricultural lands, since at least the mid-1960's (1965). Thereafter, the Site remained undeveloped and densely wooded until approximately 2017, when the vegetation was cleared. Neighbouring lands include commercial and light industrial developments since at least the early 1990's. The Site is zoned as Rural General Industrial Zone (RG2), according to the City of Ottawa interactive mapping system (geoOttawa).

Municipal water supply and sanitary services are not available for the Site. Select neighbouring lands are equipped with private water supply wells, and sewage disposal systems. The potable groundwater is found in the gravel/shale bedrock layer, at depths between 21.0 m and 30.3 m below ground surface (bgs).

2.1 Topography

The topography of the Site and vicinity are generally flat. The subject Site and the neighbouring lands have a common topographic elevation of 78 m above mean sea level (amsl) according to *The Atlas of Canada – Toporama*. More specifically, the Site has a slight slope to the southern and western perimeters with elevations ranging between 76.74 and 77.22 m amsl. A ditch boarders the northern extent of the Site with bank height of approximately 1.0 m. Elevations along the southern extent of the Site range between 103.7 and 102.5 m amsl.

These detailed elevations are presented in the Annis, O'Sullivan, Vollebekk Ltd. Topographic Survey plan, dated December 14, 2022, and included in **Attachment A**.

2.2 Existing Development Features

The Site is generally undeveloped with exception to a granular base applied across the majority of the surface and is used as a storage yard for the adjacent YSB Hoisting Equipment & YSB Carpentry facility.

2.3 Aerial Imagery

Aerial imagery was access through the City of Ottawa on-line interactive mapping portal, geoOttawa. The available historical imagery for the Site dates back to the mid 1960's (1965) when the Site and neighbouring lands appear to be used for agriculture purposes (fields or pastures). An agricultural related development is present approximately 170 m west of the Site. No significant changes were observed in the subsequent aerial imagery until the early 1990's (1991) when the Site appears to be un-developed and forested, with a clearing at the southern portion of the property, and the neighbouring lands were observed to include low-density commercial developments to the south, east and west of the Site.

In the available 2014 aerial imagery, the neighbouring lands to the east, north and south are developed. North of the Site appears to be operated as a mineral extraction facility. As of the 2021 aerial imagery, the Site appears to be occupied for it's current use as a storage yard for the adjacent land to the east.

2.4 Neighbouring Properties and Land Uses

According to the City of Ottawa's Zoning information, available through the City of Ottawa's on-line interactive mapping portal, geoOttawa, the neighbouring lands are zoned as follows:

- The neighbouring lands to the east and west are zoned as Rural General Industrial Zone (RG2); and
- The neighbouring lands to the north and the south are zoned as Rural Heavy Industrial (RH).

The neighbouring land uses generally include the following:

- North: Mineral-Aggregate extraction facility and seasonal snow dump;
- South: Entrepreneur Crescent followed by an un-known commercial/light industrial operation with various storage containers and vehicles;
- East: Industrial - YSB Hoisting Equipment & YSB Carpentry facility (carpentry company and hoist equipment rentals facility), followed by vacant; and
- West Construction company yard (Galaxy Construction) followed by vehicle storage yard.

2.5 Hydrology

The Site is generally flat with a gentle slope south and west. Locally, the inferred groundwater flow direction is north-west towards the Bear Brook, located approximately 2.2 km to the northwest of the Site, however neighbouring ditches are identified to flow easterly according to *The Atlas of Canada – Toporama* interactive mapping system. A ditch is present along the northern perimeter of Site, however the flow direction was not confirmed at the time of this assessment. According to an Environmental Impact Statement[1] dated June 23, 2023, and prepared by others, the ditch was also observed to have '*lack of any flows observed*' at the time of their June 12, 2023, Site visit.

[1] Environmental Impact Statement – Zoning By-Law Amendment for 363 Entrepreneur Crescent, prepared by Kilgour & Associates Ltd., June 23, 2023.

The ditch was described in the Environmental Impact Statement as having high water chemistry measurements related to salt, likely associated with the adjacent snow dumping facility. The Environmental Impact Statement indicated that these conditions would likely result in fish, which could enter the ditch during high seasonal water level conditions from neighbouring sources, to perish. The Environmental Impact Statement concluded that the ditch has no natural heritage values. However, it was recommended that to prevent surface runoff from the Site into the ditch, a 'raised berm' would be constructed to the north of the proposed warehouse development, which would divert runoff into the Sites strategic stormwater management system. A formal stormwater management plan has been prepared to support the development of the Site. The plan will be submitted to the City under a separate cover.

A Phase Two Environmental Site Assessment was completed for the Site to address potential environmental concerns raised with respect to adjacent or neighbouring land uses, and on-Site activities. As part of this assessment, a total of four (4) groundwater monitoring wells were constructed on the property to facilitate groundwater sample collection, and to further address the hydrogeological characteristics of the upper / shallow overburden groundwater. Groundwater was measured in each monitoring well at depths of between 0.20 and 0.55 m below grade. Based on these measurements, in conjunction with groundsurface elevations, the upper / shallow overburden groundwater flow direction is found to be towards the southeast.

The variance between locally inferred groundwater flow directions, and measured groundwater elevations may be attributed to infrastructure including utility trenches, structures, and ditches or swales. A municipal ditch is presented along the southern extent of the Site.

2.6 Natural Heritage Features

Based on available databases and records reviewed, the following with respect to Natural Heritage Features, are revealed for the Site:

- The Site is not part of a provincial park or conservation area;
- The Site is not within any Areas of Natural and Scientific Interest (ANSI) identified by the Ministry of Natural Resources (MNR) as having provincial significance;
- The Site does not include any area identified as Provincial Significance Wetland (PSW) by MNR,
- The Site does not include any area designated as environmental significant in municipal official plans;
- The Site does not include any area designated as an escarpment natural area by Niagara Escarpment Plan;
- The Site does not include any area which is a habitat of endangered species;
- The Site does not include any Oak Ridges Moraine Conservation area; and,
- The Site does not include any area designated as a wilderness area.

As discussed above in Section 2.5, a ditch is present along the northern perimeter of Site, however the flow direction was not confirmed at the time of this assessment. According to an Environmental Impact Statement prepared by others, the ditch was also observed to have '*lack of any flows observed*' at the time of their Site visit. The Environmental Impact Statement concluded that the ditch has no natural heritage values. It is understood that the findings of this Environmental Impact Statement report were confirmed by the Ontario Ministry of the Environment, Parks and Conservations as being accurate and reliable.

2.7 Geology & Hydrogeology

2.7.1 Geological Mapping

Surficial soil deposit mapping[2] indicates that the surficial geology is Offshore Marine Deposits: clay, silty clay, and silt, commonly calcareous and fossiliferous; locally overlain by thin sand. Bedrock mapping[3] indicates that the bedrock is described as the Carlsbad Formation: grey shale, sandy shale, and some dolomitic layers.

According to the Brunton, F.R. and Dodge, J.E.P. Karst map of Southern Ontario, including Manitoulin Island; Ontario Geological Survey, Groundwater Resource Study 5, 2008, known areas to potential areas of karst geology is present in the vicinity of the Site, namely to the south. The Site and adjacent land to the east and west are identified as "Unknown or no observed evidence of karstification due to the character of bedrock, lack of outcrop and/or relative thickness of overburden."

2.7.2 Hydrogeologically Sensitive Areas

The Site is not considered Hydrogeologically Sensitive in regard to shallow soils or bedrock outcrops. Review of geological mapping and additional supporting documents, including MECP water well records, have revealed a deposit of overburden greater than 1.5 m in thickness. This was further confirmed through the advancement of boreholes across the Site at the time of additional sub-surface investigation fieldwork completed by LRL, in support of the proposed development application. These additional investigations included a Geotechnical Investigation and a Phase Two Environmental Site Assessment. No bedrock outcrops were encountered at the time of LRLs Site visits associated with the corresponding investigations and assessments.

Subsurface conditions encountered during these studies are summarized as follows, although greater detail is available in the corresponding reporting documents completed for the respective investigations. Copies of the borehole logs from the Phase Two Environmental Site Assessment and Geotechnical Investigation are included in **Attachment B**, and further detail pertaining to each summary, including chemical analysis and conclusions are provided in Section 4.1.

2.7.3 Geotechnical Investigation (February 2023):

Fill material consisting of a crushed stone granular material was encountered at the surface of all boring locations and extended to depths ranging between 0.60 and 1.07 m bgs. The recorded SPT "N" values of this deposit varied from 30 to 36, indicating the deposit is dense. The natural moisture contents were found to be 9 and 11%. Underlying the fill material at all boring locations, a layer of brown silty sand was encountered and extended to a depth of 1.45 m bgs. The recorded SPT "N" values of this deposit varied from 14 to 19, indicating the deposit is compact. The natural moisture contents were found to be 22 and 24%.

Below the silty sand in all boring locations, a layer of clayey silty was encountered and extended to a depth of 4.12 m bgs. This material contained trace sand, grey and wet. The SPT "N" values were found to range between 0 (weight of hammer (WH)) and 4, indicating the material is soft to very soft. The natural moisture contents were determined to range between 37 and 87%.

Refusal using the DCP test was encountered on the Site at a depth of 24.50 m bgs. This was encountered over a large boulder within till material or over possible bedrock.

---

[2] St-Onge, D.A., Surficial Geology, Lower Ottawa Valley, Ontario, Map 2140A, Geological Survey of Canada, 2009.
[3] Harrison, J.E., 1976, Generalized Bedrock Geology, Ottawa-Hull, Ontario and Quebec, Geological Survey of Canada, Map 1508A, Scale 1:125,000.

As part of the investigation, select soil samples were submitted for laboratory gradation analyses. The results of these analysis are summarized in the following **Table A**.

Table A: Gradation Analysis Summary

Sample Location	Depth (m)	Percent for Each Soil Gradation					Estimated Hydraulic Conductivity K (m/s)
		Sand			Silt (%)	Clay (%)	
		Coarse (%)	Medium (%)	Fine (%)			
BH1	1.52 – 2.13	0.4	0.8	4.1	59.3	35.4	5×10^{-8}
BH2	6.10 – 6.71	0.0	0.0	0.6	31.0	68.4	5×10^{-8}

Atterberg limits and moisture contents were conducted on two (2) split spoon soil samples. A summary of these values is provided below in **Table B**.

Table B: Summary of Atterberg Limits and Water Contents

Sample Location	Parameter					
	Depth (m)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Water Content (%)	USCS Group Symbol
BH3	4.57 – 5.18	61	23	38	90	CH
BH4	1.52 – 2.13	67	25	42	77	CH

The laboratory reports can be found in **Attachment C** of this report.

A piezometer was installed in one (1) borehole location to measure the static groundwater level. The piezometer consisted of a 19 mm diameter PVC pipe with a slotted bottom to allow for groundwater infiltration, backfilled with silica sand, and sealed with bentonite. The water was measured on December 6, 2022, and found to be at 0.5 m bgs.

The locations of the boreholes are presented in **Figure 4**.

2.7.4 Phase Two Environmental Site Assessment (January 2023)

Subsurface conditions across the Site generally included a layer of sand and gravel fill extending from surface to 0.85 m bgs. Underlying the fill material was a layer of brown silty sand which extended from the bottom of the fill layer to 1.2 m bgs followed by silty clay to a depth of 6.0 m bgs where the boreholes were terminated. Refusal over inferred bedrock was not encountered in any of the boreholes.

The locations of the borehole are presented in **Figure 4**.

2.7.5 Potential Sources of Contamination

To support the proposed development application, a Phase One Environmental Site Assessment was completed for the Site. This assessment was conducted to identify potential environmental concerns or liabilities related to the past and present operations conducted on the property and the adjacent lands. A historical records review of the Site was conducted, as well as contact with relevant regulatory agencies, a walk-through Site inspection of the property and interviews with those knowledgeable of the Site.

This review was completed with general reference to Ontario Regulation 153/04, which is the provincial regulation which is most often referenced when considering the environmental conditions of a Site. The regulation outlines possible Potential Contaminating Activities (PCA) which can be associated with impairment or impacts to the quality of the subject property conditions. The review revealed the following potential sources of contamination, and the corresponding PCA as set out by Ontario Regulation 153/04.

O. Reg 153/04 Schedule D PCA	Location of PCA	Description and Source Information	Contribution to an APEC
PCA 32: Iron and Steel Manufacturing and Processing	On-Site	The adjacent property hoist equipment manufacturing and rental company (YSB Hoisting equipment facility), is identified as an industrial use which involves assembling, processing, storing, warehousing, or distributing hoisting equipment. Associated material and equipment are stored on the Site. This was observed through aerial photography and Site visit.	The PCA is located on the Site and is therefore automatically considered to contribute to an on-Site APEC.
PCA 30: Importation of Fill Materials of Unknown Quality	On-Site	Identified through aerial imagery and confirmed by the interview with the Site owner.	The PCA is located on the Site and is therefore automatically considered to contribute to an on-site APEC.
PCA 32: Iron and Steel Manufacturing and Processing	357 Entrepreneur Crescent, immediately east of the Site.	Adjacent property immediately east of the Site occupied by a hoist equipment rental company (YSB Hoisting Equipment & YSB Carpentry facility). Industrial use which involves assembling, processing, storing, warehousing, or distributing hoisting equipment. Observed through aerial photography and Site visit.	Due to the type of the activity and location being along the eastern perimeter of the Site, this record is considered to represent an APEC to the eastern portion of the Site.
PCA Other: Construction company workshop and storage yard	371 Entrepreneur Crescent, immediately west of the Site.	Construction company workshop and storage yard. Observed through aerial photography and Site visit	Due to the type of the activity and location being along the western perimeter of the Site, this record is considered to represent an APEC to the western portion of the Site.
PCA 56: Treatment of Sewage equal to or greater than 10,000 litres per day	336 Entrepreneur Crescent, approximately 100 m south-east of the Site (up-gradient)	Identified as having an ECA for industrial sewage disposal.	Due to the type of the activity and location being to the south-east of the Site, this record is considered to represent an APEC to the southern and eastern portion of the Site.

O. Reg 153/04 Schedule D PCA	Location of PCA	Description and Source Information	Contribution to an APEC
PCA 58: Waste Disposal and Waste Management, including thermal treatment, landfilling and transfer of waste, other than use of biosoils as soil conditioners	336 Entrepreneur Crescent, approximately 100 m south-east of the Site (up-gradient)	Listed as waste disposal site with approval of ECA-Waste Disposal Sites issued in March 2012, November 2012, October 2016, and March 2020.	Due to the type of the activity and location being to the south-east of the Site, this record is considered to represent an APEC to the southern and eastern portion of the Site.
PCA 58: Waste Disposal and Waste Management, including thermal treatment, landfilling and transfer of waste, other than use of biosoils as soil conditioners	Cumberland Con. 10 Dump, approximately 150 m east of the Site (up-gradient).	Identified through HLUI as a landfill.	Due to the type of the activity and location being to the east of the Site, this record is considered to represent an APEC to the eastern portion of the Site.
PCA 58: Waste Disposal and Waste Management, including thermal treatment, landfilling and transfer of waste, other than use of biosoils as soil conditioners	Unnamed Waste Disposal Site, approximately 110 m south of the Site (up-gradient)	Identified through HLUI as a landfill.	Due to the type of the activity and location being to the south of the Site, this record is considered to represent an APEC to the eastern portion of the Site.
PCA Other: Spill	336 Entrepreneur Crescent, approximately 100 m south-east of the Site (up-gradient)	In March 2019, an incident was reported to the MECP for the property. The incident was summarized as non-compliance with FA re-evaluation required.	Due to the type of the activity and location being to the south-east of the Site, this record is considered to represent an APEC to the southern and eastern portion of the Site.

Based on the findings of the Phase One ESA, it is recommended that a Phase Two ESA be conducted on the Site to confirm the presence/absence of impacts in the areas of potential environmental concern identified. The findings of the Phase Two Environmental Site Assessment are discussed below in Section 4.1.

2.8 Ontario Water Well Records

A search was conducted of the well records from the MECP Water Well Record (WWR) department. The search by UTM coordinates covered a 750 m radius from the Site. The search returned 30 WWRs, however, several of which did not have any details available related to the construction or subsurface conditions encountered. Nine (9) of the WWR retrieved was for a test well. A copy of those WWRs which included relevant details related to the hydrogeological and subsurface features are included in **Attachment D** and their approximately locations are presented in **Figure 4**.

The records of the wells within 750 m of the Site, where details were available, revealed that the wells include both drilled and shallow overburden wells. The drilled wells, seven (7) of which, were reported to extend to depths of between 28.9 and 61.0 m. Only one (1) shallow overburden/dug supply well was reported, which extended to a depth of between 7.0 m. The remaining overburden well reported were test holes/monitoring wells.

The well records show that that the geological conditions within 750 m are generally similar and consist of clay to depths between 21.0 and 44.8 m followed by a thin layer of gravel, over shale or limestone bedrock. A thin layer of sand was reported in select wells over the clay, and glacial till was reported over bedrock in the supply well located approximately 640 m northwest of the Site. The water type was reported as sulphur in two (2) of the test well locations.

On August 23, 2023, the proposed supply well for the anticipated development was constructed at the northeastern portion of the Site. The well was advanced to a depth of 48.7 m. Clay was reported to be encountered at ground surface to a depth 26.2 m followed by gravel to 28.0 m bgs. The well was extended into shale bedrock to 48.7 m bgs. Water was found at a depth 46.9 m, with a static water level measured at 2.80 m.

Inferred subsurface profiles cross sections are presented in **Figure 5A** through **Figure 5B** and include select wells in the vicinity of the cross-section segments as shown in **Figure 4**. The general overburden conditions encountered in the wells, where details were available, within 750 m of the Site are as follows:

MECP Well Number	Distance and Direction from Site (m)	Depth (m)	Overburden Details			Bedrock Details	Groundwater Encountered (m)	Static Water Level (m)	Type of water
			Sand/Till (m)	Clay (m)	Gravel (m)	Bedrock (m)			
A379014 (Tag)	On-Site	48.7	--	0 – 26.2	26.2 – 28.0	28.0 - 48.7	46.9	2.8	Not Tested
7320860	Directly east	28.9	--	0 – 21.3	21.3 – 22.6	22.6 – 28.9 (Shale)	27	9.6	--
7043396	225 SW	32.4	--	0 – 30.3	30.3 – 31.5	31.5 – 32.4 (Shale)	31.5	2.9	Sulphur
7266180	368 SW	7.0	0 – 0.2 (Topsoil)	0.2 – 7.0	--	--	--	--	Fresh
7201225	*440 E*	*31.4*	--	*0 – 31.4*	--	--	--	--	--
7201224	*500 S*	*44.8*	--	*0 – 44.8*	--	--	--	--	--
7201724	*553 NE*	*1.5*	*0 – 1.5 (Sand)*	--	--	--	--	--	--
7201737	*555 NE*	*6.4*	*0 – 1.5 (Sand)*	*1.5 – 6.4*	--	--	--	--	--
1525164	640 NW	30.5	0 – 0.6 (Sand) 21.3 – 23.5 (Till)	0.6 – 21.3	--	23.5 – 30.5 (Limestone)	29.0	1.8	Sulphur
7212030	*650 SW*	*6.4*	*0.3 – 2.4 (Sand)*	*2.4 – 6.4*	*0 – 0.3*	--	--	--	--
7212029	*652 SW*	*6.4*	*0.3 – 2.4 (Sand)*	*2.4 – 6.4*	*0 – 0.3*	--	--	--	--
7322574	670 NE	42.4	0 – 2.1 (Sand)	2.1 – 24.2	24.2 – 26.1	26.1 – 42.4 (Limestone)	7.9	2.1	Salty
1534876	670 W	33.5	0 – 1.5 (Sand)	1.5 – 29.0	29.0 – 33.2	33.2 – 33.5	33.5	2.6	Salty
7310678	695 NW	61.0	--	0 – 1.8 (Clay Fill with gravel) 1.8 – 21.0	21.0 – 22.3	22.3 – 61.0 (Shale)	27.0 52.0	3.8	--
7200942	*705 S*	*1.5*	*0 – 0.9 (Sand)*	*0.9 – 1.5*	--	--	--	--	--
7201226	*745 SE*	*43.6*	--	*0 – 43.6*	--	--	--	--	--
7200943	*745 SE*	*6.4*	*0 -0.9 (Sand)*	*0.9 – 6.4*	--	--	--	--	--

Notes:

Italics Test Hole/ Monitoring Well Record

-- Not Data/Not Tested

2.8.1 Water Well Record Summary

Based on the details of the well records obtained in the area (within 750 m of the Site) the aquifer can yield a sufficient amount to supply the proposed development on the Site in the long term. For example, pumping test results from select neighbouring wells within 750 m of the Site, indicate the bedrock - Limestone aquifer being able achieve a rate of 54 L/min over 60 minutes utilizing approximately 0.3% of the available drawdown. The neighbouring property, located immediately east of the Site, was reported to be advanced into the bedrock – shale stratum, which was able to achieve a rate of 13 L/min over 60 minutes utilizing 41.4% of the available drawdown.

Based on the proposed development and anticipated daily demand of 7,600 L/day, or 15.8 L/min over an eight (8) hour period, as described in greater detail in Section 3, these conditions are considered suitable to sustain the anticipated Site development and corresponding activities. A summary of the quantity of water of select neighboring wells within a 750 m radius of the Site is as follows:

MECP Well Number	Distance and Direction from Site	Depth (m)	Pump Test Details					
			Pump Rate (L/min)	Duration (min)	Drawdown (m)	Specific Capacity (L/Sec/m)	Recovery (%)	Recommended Pump Rate (L/min)
7320860	**Directly east**	**28.9**	**13**	**60**	**11.99**	**0.0180**	**100**	**15**
7043396	**225 SW**	**32.4**	**58.5**	**60**	**0.15**	**6.5**	**100**	**45.5**
7266180	*368 SW*	*7.0*	--	--	--	--	--	--
1525164	*640 NW*	*30.5*	*113*	*60*	*11.12*	*0.1693*	*--*	*113*
7322574	*670 NE*	*42.4*	*54*	*60*	*0.13*	*6.9230*	*100*	*56*
1534876	670 W	33.5	42	60	0.17	4.1176	100	50
7310678	**695 NW**	**61.0**	**42**	**60**	**1.92**	**0.3645**	**100**	**66**

Notes:

--	No Data is Available/Not Reported
BOLD	Supply well advanced into Shale Bedrock
Italics	Supply well advanced into the Limestone Bedrock
xxx	Dug/Shallow Supply Well

2.9 Shallow Overburden Groundwater Monitoring Wells

Entrepreneur Holding Corporation retained LRL to complete a Phase Two Environmental Site Assessment on the Site in the context of property redevelopment. The assessment was completed to determine if recognized potential environmental concerns have negatively impacted soil and groundwater quality of the subject Site. The potential environmental concerns identified that requires investigation includes:

- **PCA 32**: Iron and Steel Manufacturing and Processing. The adjacent property hoist equipment manufacturing and rental company (YSB Hoisting equipment facility), is identified as an industrial use which involves assembling, processing, storing, warehousing, or distributing hoisting equipment. Associated material and equipment are stored on the Site since at least mid of 2022;
- **PCA 30**: Importation of Fill Material of Unknown Quality. Based on available information obtained, a layer of granular crushed stone was applied across the surface of the subject property in 2022 (est.). The source and quality of the material is unknown, therefore its conditions, in addition to the underlying materials, should be investigated;

- **PCA 32**: Iron and Steel Manufacturing and Processing. 357 Entrepreneur Crescent, immediately east of the Site, occupied by a hoist equipment rental company (YSB Hoisting Equipment & YSB Carpentry facility), industrial use which involves assembling, processing, storing, warehousing, or distributing hoisting equipment;
- **PCA Other**: Construction company workshop and storage yard. 371 Entrepreneur Crescent, immediately west of the Site, occupied by Galaxy Construction - workshop and storage yard;
- **PCA 56**: Treatment of Sewage equal to or greater than 10,000 litres per day. 954192 Ontario Ltd at 336 Entrepreneur Crescent, approximately 100 m south-east of the Site, issued an environmental compliance approval for industrial sewage works and treatment of Sewage equal to or greater than 10,000 litres per day;
- **PCA 58**: Waste Disposal and Waste Management, including thermal treatment, landfilling and transfer of waste, other than use of biosoils as soil conditioners. 954192 Ontario Ltd at 336 Entrepreneur Crescent, approximately 100 m south-east of the Site, listed as waste disposal site with approval of ECA-Waste Disposal Sites issued in March 2012, November 2012, October 2016, and March 2020;
- **PCA 58**: Waste Disposal and Waste Management, including thermal treatment, landfilling and transfer of waste, other than use of biosoils as soil conditioners. Cumberland Con. 10 Dump, approximately 150 m east of the Site listed as a landfill in 1991;
- **PCA 58**: Waste Disposal and Waste Management, including thermal treatment, landfilling and transfer of waste, other than use of biosoils as soil conditioners. Unnamed Waste Disposal Site, approximately 110 m south of the Site listed as a landfill in 1991.
- **PCA Other**: Spill. 954192 Ontario Ltd at 336 Entrepreneur Crescent, approximately 100 m south-east of the Site, reported a spill incident to the MECP in March 2019. The incident was summarized as non-compliance with FA re-evaluation required.

To address these concerns, an intrusive investigation was carried out between March 13 and March 16, 2023, by LRL. Further details pertaining to the findings of the Phase Two Environmental Site Assessment, namely concentrations of contaminates encountered, contamination plumes, and recommendations are described below in Section 4.1. This section pertains solely to the geological and hydrogeological characteristics across the Site.

A total of ten (10) boreholes were advanced across the Site. The subsurface soil conditions in the area investigated on the Site generally consist of included a layer of sand and gravel fill extending from surface to 0.85 m bgs. Underlying the fill material was a layer of brown silty sand which extended from the bottom of the fill layer to 1.2 m bgs followed by silty clay to a depth of 6.0 m bgs where the boreholes were terminated. Refusal over inferred bedrock was not encountered in any of the boreholes.

Four (4) boreholes were completed as monitoring wells: BH23-2, BH23-3, BH23-4 and BH23-5 (herein referred to as MW23-2, MW22-3, MW23-4, and MW23-5). Monitoring wells were constructed within the 203 mm diameter boreholes with a 51 mm slotted PVC piezometer. The top of the screen was extended to the ground surface using a solid riser pipe. Annular space around the slotted portion of the piezometer was backfilled with pre-washed and graded silica sand up to 300 mm above the top of the screen. A bentonite seal was placed above the sand pack and bentonite was used to fill the remainder of the hole to the surface. Monitoring wells were finished at the surface with a flush-mount aluminum casing.

The locations of the monitoring wells are described as follows:

Monitoring Well Identification	Location
MW23-2	West-central portion of the Site.
MW23-3	South-central portion of the Site.
MW23-4	Southeastern portion of the Site.
MW23-5	North-central portion of the Site.

The borehole and monitoring well locations are presented in **Figure 3**, and a copy of the borehole logs are included in **Attachment B**. Static groundwater elevations were measured at each monitoring well prior to the respective sampling activities and are summarized as follows.

Monitoring Well	Ground Surface Elevation (m)	Reference Elevation (m)	Depth to Water Table (m)		Groundwater Elevation (m)
			Reference Point	Ground Surface	
MW23-2	99.90	99.83	0.20	0.27	99.63
MW23-3	99.88	99.80	0.39	0.47	99.41
MW23-4	99.87	99.79	0.47	0.55	99.32
MW23-5	99.89	99.78	0.09	0.20	99.69

Groundwater depth measurements were between 0.20 and 0.55 m below grade, which corresponded to elevations between 99.32 and 99.69 m, with respect to an arbitrary benchmark established and assigned an elevation of 100.00 m.

The groundwater elevations and interpreted flow contours are shown in **Figure 6**. Based on these elevations the groundwater flow direction on the Site is towards the southeast.

3 PROPOSED DEVELOPMENT

It is anticipated that one (1) approximately 1,382 m² warehouse will be developed on the subject property, in addition to corresponding parking and circulation area and related components. The proposed development will be serviced by a private water supply well and sewage disposal system. The location and dimensions of the proposed features are presented in **Figure 7**.

The warehouse is anticipated to include a slab-on grade level (ground floor), with a partial second-floor mezzanine. The ground floor portion of the building is anticipated to include open warehouse space, meeting and collaboration space, a lunchroom/kitchen area, washroom and shower facilities and one (1) set of laundry units (washer and dryer). The mezzanine is anticipated to be used for general storage as well as to house mechanical components and equipment related to overall serviceability of the development (i.e. heating components and water treatment system).

To facilitate the development of the Site, excavation of the overburden materials to accommodate the foundation structural components (footings) are anticipated to extend to between 1.5 and 1.8 m below grade. The excavated areas, and underside of footings will be backfilled with non-frost susceptible backfill material, as outlined in the corresponding Geotechnical Investigation report prepared by LRL, dated February 2023.

The septic system will be designed by a competent individual and submitted for approval with the Ottawa Septic System Office (OSSO). On April 20, 2023, a formal submission was made to the OSSO, however it is understood that based on subsequent alterations to the proposed Site layout, a revised application will need to be submitted which depicts the updated proposed location. For the purposes of this report, the April 20, 2023, OSSO submission details are considered warranted as the overall proposed design, daily flow rates and treatment will not be altered. The actual proposed location for the installation of the system will be at the southwestern extent of the Site, between the warehouse and the southern property boundary as presented in **Figure 7** and the initial OSSO submission package is included in **Attachment E**. The proposed septic details are as follows:

- The septic system will be a new construction, encompassing an approximate area of 68 m²;
- The sewage design flow for the Site will be 1,310 L/day;
- The proposed system will be a Class IV 'Eljen' partially raised system;
- The tank will have a capacity of 5,509 L and will be equipped with a Polytek effluent filter; and
- The total capacity of the system will be 6,903 L.

In support of this hydrogeological assessment, a supply well has been constructed on the Site in the location presented in **Figure 7**. The well was advanced to a depth of 48.7 m. Clay was reported to be encountered at ground surface to a depth 26.2 m followed by gravel to 28.0 m bgs. The well was extended into shale bedrock to 48.7 m bgs. Water was found at a depth 46.9 m, with a static water level measured at 2.80 m.

4 PREVIOUSLY PREPARED REPORTS

4.1 Phase Two Environmental Site Assessment, 363 Entrepreneur Crescent, Ottawa, Ontario, September 5, 2023

Entrepreneur Holding Corporation has retained LRL Engineering to complete a Phase Two Environmental Site Assessment on the properties located at 363 Entrepreneur Crescent, Ottawa, Ontario. A Phase Two ESA was completed to address the presence or absence of one or more contaminants at the Site as determined in the Phase One ESA and to assess the quality of the soil and ground water. The findings of the corresponding Phase One ESA should be read in conjunction with the Phase Two ESA presented herein. The Phase One ESA identified nine (9) individual potential contaminating activities (PCA). The PCAs that affect the Phase Two ESA are detailed above in Section 2.9, and are generally summarized as follows:

- **PCA 32**: Iron and Steel Manufacturing and Processing;
- **PCA 30**: Importation of Fill Material of Unknown Quality;
- **PCA 32**: Iron and Steel Manufacturing and Processing;
- **PCA Other**: Construction company workshop and storage yard;
- **PCA 56**: Treatment of Sewage equal to or greater than 10,000 litres per day;
- **PCA 58**: Waste Disposal and Waste Management, including thermal treatment, landfilling and transfer of waste, other than use of biosoils as soil conditioners; and
- **PCA Other**: Spill.

The contaminants of potential concern (CPCs) in soil and groundwater for the Site were based on the APECs identified at the Site during Phase One Environmental Site Assessment and observations at the time of the drilling program. The following CPCs for the Site were suspected to be associated with the identified APECs:

- Petroleum Hydrocarbons ranges F1-F4 (PHCs);
- Volatile Organic Compounds (VOCs);
- Polycyclic Aromatic Hydrocarbons (PAHs);
- Polychlorinated Biphenyls (PCBs); and
- Metals, Metal hydrides, and General Inorganics.

An assessment of the CPCs for the Site was completed as part of the Phase Two ESA analytical submission program. Soil and groundwater samples were submitted for a combination of the CPCs dependant on borehole and monitoring well locations with respect to the APECs. Based on the analytical results for the CPCs at the Site, generally the soils were found to meet the applicable provincial site condition standards (SCS) with two (2) exceptions, which included the following:

- Lead was reported above the SCS of 120 µg/g, with a value of 284 µg/g in the borehole advanced at the southwestern extent of the Site (BH23-7), from depths extended between 0.0 and 1.05 m below grade. A secondary soil sample collected from this borehole was submitted for metals analysis, which revealed that lead concentrations at depths between 1.20 and 1.95 m below grade were significantly below the SCS wit ha value of 7.5 µg/g; and
- Conductivity was marginally above the SCS of 1400 µg/g with a value of 1460 µg/g in a sample collected from the north-central portion of the property (BH23-5) at depths between 0 – 1.0 m. A duplicate sample representative of this parent sample was found to

have lower concentrations of conductivity with a value of 1250 µg/g. Therefore, it is possible that the elevated conductivity encountered may be limited or an anomaly.

Groundwater samples collected at the Site on March 16, 2023, revealed that only one (1) of the four (4) sample locations was found to have elevated concentrations of select parameters of concern. Based on the concentration reported, and in comparison, to the applicable SCS, exceedances to select PAH parameters were encountered in monitoring well MW23-3, located at the southeastern portion of the Site. More specifically for the following parameters:

- Benzo [a] pyrene;
- Benzo [b] fluoranthene;
- Benzo [k] fluoranthene;
- Chrysene; and
- Fluoranthene.

Vanadium, commonly elevated in clay deposits across the region, was also detected above the appliable SCS in MW23-3.

LRL returned to the Site to confirm if the concentrations of PAH and metals encountered, as since these parameters were found to be notably lower in the soil samples collected from the Site, and no further exceedances were detected on the Site in the groundwater. A re-sample was collected on April 17, 2023, by LRL. The results of the additional sampling returned lower concentrations of all parameters previously reported above the SCS. Of which, Benzo [a] pyrene remained above the appliable SCS with concentrations of 0.07 µg/L.

4.1.1 Additional Consideration

It was recommended in the Phase Two ESA report that remediation work to address the elevated lead concentrations in the soil be completed during the construction efforts. Remediation efforts, when performed using conventional ‘dig-and-dump’ methodology requires confirmatory sampling of excavation limits. This methodology, including additional confirmatory sampling for lead parameters, will be completed to address the impacted soil encountered, and confirm that the conditions of the Site are in accordance with applicable provincial SCS. Impacted soils with contaminates require special attention and handling requirements for disposal.

The impacted groundwater is also anticipated to be addressed at the time of development. As the PAH impacts appear to be limited to the southeastern portion of the Site, it may be attributed by localised impacted soil. The removal of soil in the vicinity of the monitoring well of concern will be completed during construction, and subsequent groundwater sampling will take place (either from the salvaged monitoring well, or a newly constructed monitoring well). If elevated concentrations of parameters of concern, namely PAH, continue to be elevated, numerous effective treatment technologies are available.

For the same rationale described in Section 8, the impacts resulting from this overburden groundwater impairment to the proposed supply aquifer is unlikely based on the limited travel time through the thick clay confining layer.

4.2 Geotechnical Investigation, Proposed Warehouse, 363 Entrepreneur Crescent, Ottawa, Ontario, February 2023

LRL was retained by Entrepreneur Holding Corporation to perform a Geotechnical Investigation for a proposed warehouse development on the Site. The purpose of the investigation was to identify the subsurface conditions across the Site by the completion of a limited borehole drilling program. The fieldwork for this investigation was carried out on November 17, 2022, by LRL. A total of four (4) boreholes, labelled BH1 through BH4, as presented in **Figure 3**, were drilled across the Site to get a general understanding of the underlying soil conditions.

Sampling of the overburden materials encountered in the boreholes was carried out at regular depth intervals using a 50.8 mm diameter drive open conventional spoon sampler in conjunction with standard penetration testing (SPT) "N" values. In-situ field vane shear testing using a tapered vane was carried out in the soft to very soft cohesive soils. The boreholes were augered and sampled to a depth of 7.00 m below ground surface (bgs). A Dynamic Cone Penetration (DCP) test was carried out in BH2 until refusal (24.50 m bgs) to determine the overburden thickness. Upon completion, the boreholes were backfilled using the overburden cuttings.

The underlying soil conditions encountered across the Site generally included the following:

- Fill material consisting of a crushed stone granular material was encountered at the surface of all boring locations, and extended to depths ranging between 0.60 and 1.07 m bgs. The recorded SPT "N" values of this deposit varied from 30 to 36, indicating the deposit is dense. The natural moisture contents were found to be 9 and 11%;
- Underlying the fill material at all boring locations, a layer of brown silty sand was encountered and extended to a depth of 1.45 m bgs. The recorded SPT "N" values of this deposit varied from 14 to 19, indicating the deposit is compact. The natural moisture contents were found to be 22 and 24%;
- Below the silty sand in all boring locations, a layer of clayey silty was encountered and extended to a depth of 4.12 m bgs. This material contained trace sand, grey and wet. The SPT "N" values were found to range between 0 (weight of hammer (WH)) and 4, indicating the material is soft to very soft. The natural moisture contents were determined to range between 37 and 87%;
- Underlying the clayey silt in all boring locations, a layer of silty clay was encountered and extended to the end of sampling at a depth of 7.00 m bgs. This was found to be grey, and wet. The SPT "N" values of this layer were WH, indicating the material is very soft. The natural moisture contents were determined to be 76 and 90%; and
- Inferred glacial till was encountered in BH2 by way of the DCP test. This was found to be in a compact to very dense state of packing.

Two (2) soil samples were collected for laboratory gradation analyses. The gradation analyses comprised of sieve and hydrometer. Based on the analytical results collected, the estimated hydraulic conductivity was 5×10^{-8} with a plasticity index range between 38 and 42%, and a liquid limit range of between 61 and 67%.

A piezometer was installed in BH3 to measure the static groundwater level. The piezometer consisted of a 19 mm diameter PVC pipe with a slotted bottom to allow for groundwater infiltration, backfilled with silica sand, and sealed with bentonite. The water was measured on December 6, 2022, and found to be at 0.5 m bgs.

5 WATER QUALITY AND QUANTITY ASSESSMENT

5.1 Initial Water Quality Evaluation – 357 Entrepreneur Cresent

During our initial technical pre-consultation with the City of Ottawa Hydrogeologist, it was indicated that elevated concentrations of various parameters may be encountered in the bedrock aquifer in the area. Therefore, it was anticipated that by verifying the conditions of a neighbouring supply well, pre- ad post- treatment, and interviewing occupants of the building may provide insight on future recommendations for the anticipated development on Site and viable treatment system options for the water supply. LRL was granted permission to collect a representative sample of the neighbouring supply well of 357 Entrepreneur Crescent. A copy of the well record for this property (Well No. 7320860) is included in **Attachment D**.

LRL visited the property immediately east of the Site, on April 7, 2023, to collect two (2) samples of the supply water distribution system. One (1) sample was collected directly from the pressure tank, prior to treatment (pre-), and the second sample was collected from a washroom tap post-treatment (post-). The water samples were collected using laboratory prepared bottles and were submitted to an accredited laboratory (Parcel Laboratories Ltd. of Ottawa, Ontario) for analysis of a standard "subdivision" package. Each location was dis-infected prior to sampling with a distilled water/bleach solution and the fixture was allowed to run for a duration of at least 10-minutes prior to sampling. The aerator on the washroom tap was removed prior to disinfection and sampling. The sample containers were labelled with exclusive identification details and stored in a cooler with pre-chilled ice packs during transportation to the laboratory.

Our interview with the property owner at the time of the sampling revealed the following pertinent information related to the water supply and distribution system:

- The property is serviced by a drilled well located on the west side of the building. The well was installed in 2018 and was initially extended to 115 m. However, the water quality was not considered suitable and well was modified to intercept a shallower aquifer being approximately 28 m in depth;
- The distribution system which supplies the building with water includes a water treatment system. The system includes:
  - A smaller pressure tank is used in conjunction with a submersible pump to direct water into the building. The water is then emptied into a larger pressure tank;
  - From the larger capacity pressure tank, the water is passed through the following sequence of treatment systems:
    - a water softener that uses salt;
    - a series of three (3) carbon filters;
    - Iodine dosage; and
    - Reverse osmosis.
  - The water is then stored in a 1,000 L capacity container available for supply.
- The system is maintained twice annually by a plumbing and treatment specialist which includes sampling to confirm the components are in superior working order;
- At the time of the installation (2018), the system start-up cost was approximately $25,000. For commercial/light industrial purposes, this is considered feasible to initiate and operate.

The analytical results from the pre- and post- treatment samples are presented in the included **Table 1**. Exceedances to the Ontario Drinking Water Standards (ODWS), and MECP D-5-5 guideline – maximum concentration considered reasonably treatable, were encountered in the pre- treatment sample for the following parameters:

- Alkalinity with a value of 605 mg/L, above the ODWS operation guideline (OG) of between 30 – 500 mg/L;
- Hardness with a value of 1,050 mg/L, above the ODWS OG of between 80 – 100 mg/L;
- Total Dissolved Solids (TDS) aesthetic objective (AO) of 500 mg/L, with a value of 7,640 mg/L;
- Turbidity was elevated with a value of 12 NTU, above the ODWS AO of 5 NTU, and the maximum allowable concentration (MAC) if treatment is required of 1 NTU;
- Chloride was reported with a value of 4,350 mg/L, above the AO of 250 mg/L;
- Iron was above the AO of 0.3 mg/L with a value of 1.3 mg/L; and
- Sodium was reported with a concentration of 2,010 mg/L, above the AO of 200 mg/L.

Post- treatment, the samples were found to improve significantly, however select parameters remain above the ODWS. These parameters include the following:

- Alkalinity with a value of 16 mg/L, below the ODWS OG acceptable range of between 30 and 500 mg/L;
- Hardness with a value of 0.00 mg/L, below the ODWS OG acceptable range of between 80 – 100 mg/L;
- Marginally above the TDS AO of 500 mg/L, with a value of 508 mg/L; and
- Chloride was reported with a value of 302 mg/L, above the AO of 250 mg/L.

Sodium, although was reported below the ODWS AO of 200 mg/L, was above the 20 mg/L limit which the local medical officer should be notified, with a value of 152 mg/L. It is our opinion that these remaining exceedances to the ODWS can be accounted for through adjustments to the existing system including possible media replacement, or dosing adjustments. The water is considered to be reasonably treatable with respect to the proposed use and development plan of the Site.

A copy of the laboratory certificate of analysis is included in **Attachment H**.

5.2 Proposed Supply Well – 363 Entrepreneur Cresent

The proposed supply well to facilitate the anticipated development was constructed on August 23, 2023, by Air Rock Well Drilling (Richmond, Ontario). The well was advanced at the northeastern portion of the Site, being a minimum of 3.0 m from all property lines, and beyond 15 m from potential sources of contamination, such as septic disposal systems (existing and proposed). The well extended to a depth of 48.7 m. Clay was reported to be encountered at ground surface to a depth 26.2 m followed by gravel to 28.0 m bgs. The well was extended into shale bedrock to 48.7 m bgs. Water was found at a depth 46.9 m, with a static water level measured at 2.80 m.

A copy of the well record (Well Tag#A379014) is included in **Attachment D**.

The previously prepared EIS, as mentioned above in Section 2.6, has identified the ditch which traverses along the northern perimeter, as being likely impacted by the adjacent snow dump, and is likely impaired by elevated concentrations of sodium/chloride.

"Development within the site is unlikely to alter the hydrology, riparian functions, or terrestrial or aquatic habitat functions of the ditch adjacent to the site. The HDFA (Appendix C) determined that the Ditch, has extremely high salinity and is acting as a trough instead of water flowing through it. While the Ditch may have marginal connection to downstream features during the spring freshet, which could provide a limited and temporary entry point for fish, any fish entering the feature would certainly perish from the extreme environment. As such, the Ditch does not hold natural heritage value. A setback to protect feature is not required."

It is understood that Regulation 903 indicates that a supply well should not be placed within 15 m of a potential contamination source, and that the ditch is considered a possible contamination source by the City of Ottawa resulting from the neighbouring snow dump. The proposed supply well location is positioned approximately 7 m from the extents of the ditch, and is considered acceptable due to the proposed development details, and general site conditions as rationalized as follows:

- The proposed supply well has been constructed as a drilled well, extending to a depth of approximately 48.7 m below grade, comparable to that of the neighbouring supply well at 357 Entrepreneur Crescent. The clay deposit encountered during well construction was reported to be 26.2 m thick, which a confining layer between potential ditch infiltration and the supply aquifer. In addition to the clay layer, the well was also include a cement grout and bentonite slurry seal of at least 29.8 m, to further prevent surficial infiltration into the supply aquifer;
- The proposed supply well has constructed as per O. Reg. 903 with a minimum casing stickup of 40 cm, water proof cap. The immediate area will be graded such that will divert surface water from the installation. These actions would prevent possible impairment to the groundwater through infiltration into the water well;
- As a conservative approach to further mitigate possible impacts to the Site from the neighbouring land, a 5 m naturalized berm is to be constructed along the norther extent of the site. The berm is intended to prevent surface runoff from the adjacent property on the site, and towards the proposed well;
- After completing an initial water quality analysis of the neighbouring supply well, it was found that chloride and sodium are elevated in the groundwater, likely naturally. Samples were collected from pre- and post- treatment and it was found that through the use of various treatment units, including RO, carbon filtration, water softening and iodine dosing, the quality of the supply aquifer can be improved significantly; and
- The client will be utilizing a comparable treatment system for the development, therefore, the should the bedrock aquifer be impaired (although unlikely) by the neighbouring facility and ditch, adequate treatment will be in place to address the contaminates of concern.

Although the well is constructed so that the casing extends above ground surface, it is further recommended that the casing be extended/confirmed to be at least 400 mm above ground surface following final grading and surfacing.

5.3 Quantity

The proposed development of the Site is anticipated to include a warehouse with office space. The required aquifer yield has been derived from the City of Ottawa Water Distribution Guidelines, July 2010, as amended, including the August 18, 2021 Technical Bulletin specified alterations, and the MECP's Design Guidelines for Drinking-Water Systems, 2008.

An application to construct a new sewage disposal system on the Site was submitted by a qualified designer on April 20, 2023, to the OSSO. The application submitted, although will required alterations and a re-submission based on new proposed placement and overall lot confirmation, is included in the **Attachment E**. The proposed daily sewage flow has been calculated to be 1,310 L/day with a fixture count of 42. The proposed septic tank size was identified to be much greater, to accommodate dosing, with a capacity of 5,509 L as discussed above in Section 3.

In support of the aquifer demand and supply evaluation (pumping test), as a conservative estimate, following as per Table 8.2.1.3.B of the Ontario Building Code, 2012, the total daily demand was calculated for this assessment is approximately 7,600 L/day. This is considered acceptable to account for the proposed Site development plans, as well as possible future occupants of the property although significantly greater than the actual daily consumption estimation. Therefore, based on the conservative value of 7,600 L/day, over an eight (8)-hour period as 15.8 L/min.

5.3.1 Pumping Test

To establish the hydraulic properties of the proposed supply aquifer, an eight (8)-hr pump test was conducted on the newly constructed supply well on August 30, 2023. The pumping rate was to account for the anticipated demand volumes, over a common commercial operation period of eight (8)-hours.

The well was pumped at a constant flow rate (±5%) of approximately 22 L/min over eight (8)-hr period using a temporary submersible pump lowered into the well. Drawdown was measured manually during the pumping and recovery periods using an electronic water level tape. Following the pump's cessation, the supply well water level recovery was measured. Data collected in the field for the pumping test which includes the flow rate, water levels and measurement intervals, are presented in **Attachment F.**

The initial static water level was measured as 2.61 m below top of casing (btc), and test well depth was measured as approximately 49.1 m btc. The pump was set at approximately 45 m btc at the time of the test. The drawdown after eight (8)-hr of pumping was 3.64 m. This represents only approximately 8.1% of the available drawdown in the well, assuming the set pump depth of 45 m is the maximum drawdown which can be reached. The specific capacity of the well after eight (8)-hr of pumping was calculated to be 0.101 L/sec/m with a long-term availability of 82.4 m^3 per day. The calculation is presented in **Table 2**.

The recovery was commenced at the end of the eight (8)-hr pumping duration. The submersible pump remained in the well throughout this time so not to alter the recovery test process and measurements. After one (1) hour of recovery, the well returned to 90.0% of the initial water level. LRL returned after approximately 16 hours and again after 24 hours of recovery to verify the water level. The well was recorded to have reached 92.8% and 91.7% recovery, respectively. Marginally below the D-5-5 guideline requirement of 95% within 24 hours. Further discussion is included below.

5.3.2 Aquifer Characteristics

Following the completion of the constant rate pumping test, the data was analysed using the Aquifer Test software package, by Waterloo Hydrogeologic. The data underwent Theis and Agarwal-Theis Recovery analysis, the results of which are shown in the table below. Graphical analyses of the drawdown are provided for reference purposes in **Attachment G**.

Based on the information gathered from the pump test, the wells' transmissivity and coefficient of storage were calculated using the average of the Theis logarithmic approximation for the drawdown and Agarwal/Theis for the recovery. The specific yield of the well was calculated using the information obtained from the pump test, the transmissivity and coefficient of storage. The yield takes into account a minimum safety factor of 3. The characteristics of the well are summarized in the table below. The yield was calculated using the safety factor; therefore, the theoretical yields can be higher.

Parameter	**Supply Well**
	8 Hour Test
	Theis
Transmissivity (m^2/sec)	7.59 x 10^{-5}
Coefficient of Storage	4.51 x 10^{-3}
Pumping Rate (L/min)	22
Available Drawdown (m) – assuming pump set at 45 m (as per pumping test)	42.4
Maximum Drawdown (m)	3.64
% Drawdown	8.1%
Specific Yield (L/sec/m)	0.101
Maximum Pumping Rate (L/min)	57.2
Long Term Availability (m^3/day)	82.4

Based on the observed drawdown/recovery relationship, it is concluded that the long-term yield of the test well is in excess of minimum daily demand of 7,600 L (7.6 m^3/day) with a projected value of 82.4 m^3/day and is found to be able to meet a maximum pumping rate of 57.2 L/minute. This is considered in excess and adequate to supply the inferred peak hourly flow demands of 15.8 L/min.

5.4 Quality

5.4.1 Field Measurements

Throughout the pumping tests the following field parameters were measured and recorded:

- Turbidity, chlorine and colour using a Lamotte TC-3000 Trimeter; and
- Conductivity, total dissolved solids (TDS) and pH using a portable meter (Hanna Instruments).

A summary of the field measurements collected throughout the duration of the pumping test are included in **Attachment F**.

The machine detection limits of the Lamotte TC-3000 Trimeter are as follows:

- Turbidity of 0.01 NTC, with an accuracy of +/- 0.05 (or 2%, whichever is greater);
- Colour of 0.1 CU, with an accuracy of +/- 0.5 (or 2%, whichever is greater); and
- Chlorine of 0.01 ppm, with an accuracy of +/-0.02 (or 2%, whichever is greater).

For the purposes of this report, values read as less than the corresponding limits will be reported as <0.01, or <0.1.

The following calibration, or zeroing techniques performed as part of this assessment, during the filed investigations is summarized as follows:

Parameter	Equipment Used	Calibration and Zeroing Techniques
Turbidity	Lamotte TC-3000 Trimeter	Prior to use, the equipment was calibrated using the ‘two-point’ method, following manufacturer instructions. Standard calibration solutions of 0.0 NTU and a 1.0 NTU were used to calibrate the machine. The solutions were pre-made by a supplier.
Colour	Lamotte TC-3000 Trimeter	Prior to the use of the equipment, and periodically during the pumping test, colour measurements were first zeroed by following the manufacturer’s instructions and using Deionized Water (prepared and supplied by Hanna Instruments – HI7040-2).
Chlorine	Lamotte TC-3000 Trimeter	Prior to each chlorine reading, a blank sample, including Deionized Water (prepared and supplied by Hanna Instruments – HI7040-2) was screened to zero the machine.
Conductivity	HI98129 Hanna Instruments	Prior to each event, where the meter is used (typically daily), the instrument was calibrated using the Hanna Instrument prepared 1413 µs/cm conductivity solution (HI7031).
pH	HI98129 Hanna Instruments	Prior to each event, where the meter is used (typically daily), the instrument was calibrated using the ‘two-point’ method, following manufactures specifications. As the pH readings are anticipated to be within the neutral to slightly acid range based on our knowledge of the area and past experience, solutions of 7.01 pH Units (Hanna Instruments HI7007) and 4.01 pH Units (Hanna Instruments HI7004) were used.

5.4.2 Groundwater Sampling

Groundwater samples were collected for laboratory analysis during the pumping tests to assess the quality of the proposed supply aquifer. The water samples were collected after four (4) and eight (8)-hours of pumping. The water samples were collected directly into laboratory prepared bottles. The water samples were submitted to the laboratory for analysis of a “subdivision” package.

The groundwater analytical results are discussed in Section 5.4.3. The laboratory Certificate of Analysis from Paracel Laboratories Ltd. (Ottawa, Ontario) is included in **Attachment H**.

5.4.2.1 Chlorine Residual

Procedure D-5-5 specifies, "T*he chlorine residual must be zero before any bacteriological sample can be taken*." At the start of the eight (8)-hour pumping test, the chlorine residual was measured at 0.03 mg/L and fluctuated throughout the duration of the test with values of 0.02 mg/L at both the four (4) and eight (8) - hours pumping durations.

Chlorine residual at the time of the sample collection was thought to be a result of seasonal conditions influencing the field equipment and the sample matrix. It has been noted historically that during hot seasonal conditions, the glass vials used for the field measurement becoming cloudy from condensation, which is thought to disrupt the light exchange used for the measurement.

Further research into this matter ("chlorine residual without the well being chlorinated") has found the following which may be attributed to the residual levels detected:

- In-field measurements can be influenced by sunlight. Sunlight can react with the indicator tablets used for the collecting the measurements, resulting in false positives. It is found that the 3-minute reaction time for the tablets in the sample matrix is needed to be kept outside of sunlight. It is likely that during the sample collection, the vials were exposed to the sunlight which returned false positives; and
- It was also retrieved that most common interferent with chlorine residual reading is oxidized manganese. Manganese was detected in the samples collected therefore this is a possible explanation for the slight detection of chlorine.

According to the equipment manual for the Lamotte TC-3000e, chlorine measurement accuracy is 0.02 ppm (mg/L) or 2%, which ever is greater. Therefore, based on the accuracy of the equipment, the chlorine residual measurements can be in the range of 0.00 and 0.04 mg/L in the four (4) hour and eight (8) hour samples collected. According to this, it is possible that based simply on the machine accuracy range, the samples are likely free of chlorine residual.

5.4.3 Supply Aquifer Quality – Proposed Supply Well

The groundwater chemistry of the proposed supply aquifer for the development was obtained by collecting water samples from the newly constructed proposed supply well located at the northeastern portion of the Site. The well was installed within the upper bedrock shale formation common of the area.

To represent the long-term water quality of the well, samples were collected during different stages of the pump test and well development (after four (4) and eight (8)-hours of pumping). The water samples were collected using laboratory prepared bottles and were submitted to an accredited laboratory (Parcel Laboratories Ltd. of Ottawa, Ontario) for analysis of a standard "subdivision" package, trace metals and volatile organic compounds (VOCs). The laboratory certificates of analysis are included in **Attachment H**.

Table 3A through **Table 3C** summarizes the water analysis and also includes the relative ODWS (O. Reg. 169/03) for the parameters tested. The water samples were found to be very comparable to that of the initial water sample collected from the neighbouring property as discussed in Section 5.1. The majority of the parameters analysed meet the ODWS parameters tested except for the following:

- Alkalinity was reported to have values of 703 and 705 mg/L at 4- and 8-hour, respectively. These values are above the ODWS OG limit of 500 mg/L. Alkalinity can be reduced through the use of a water softener; however the use of sodium chloride as a regenerant for the resins can increase the sodium content of the water. This poses a lower risk to the subject site based on it's anticipated use, although it should be noted that for individuals with sodium restricted diets, potassium chloride can be substituted for sodium in the ion exchange system to lower the hardness in the water supply;

- Hardness was found to be 1020 and 1030 mg/L at 4- and 8-hours, respectively, above the ODWS OG limit of 100 mg/L. High levels of hardness can lead to scale deposits and excessive utilization of regular soaps. Hardness can be reduced through the use of a water softener; however as mentioned above, the use of sodium chloride as a regenerant for the resins can increase the sodium content of the water;
    - The Langelier Saturation Index (LSI) is used to determine the calcium carbonate stability of water and the pH at which water is saturated with calcium carbonate (pHs). The LSI calculation is used to establish the level of saturation. The Ryznar Stability Index (RI) is used to determine the aggressiveness of water which can indicate the scale and corrosion potential. The calculations for RI and LSI are shown in **Table 4**. Using a water temperature of 10°C (typical of an interior distribution system circulating through a building), the LSI was calculated for the 8-hour sample of 1.78 which indicate the water is scale forming but non-corrosive. The RI was calculated to be 4.72 at the 8-hour sample which indicates heavy scaling.
- TDS values were found to be 7950 and 7880 mg/L in the 4- and 8-hour samples, respectively, above the AO of 500 mg/L. TDS can be reduced through the use of a water softener; however the use of sodium chloride as a regenerant for the resins can increase the sodium content of the water. For individuals with sodium restricted diets, potassium chloride can be substituted for sodium in the ion exchange system to lower the TDS in the water supply;
- Turbidity was measured to have a level of 3.8 NTU in the 4-hour sample, and 3.5 NTU in the 8-hour sample. Both of which are above the ODWS OG of 1 NTU if the treatment system is required to provide filtration, however, are below the AO of 5 NTU and the D-5-5 level considered reasonably treatable of 5 NTU. If the water is to be disinfected using an ultra-violet filter, it is recommended that the water be pre-treated with a 5 um filter;
- Dissolved Organic Carbon (DOC) with a level of 9.4 and 8.5 mg/L, at the 4- and 8-hour sample, respectively, above the AO of 5 mg/L but below the D-5-5 level considered reasonably treatable of 10 mg/L. DOC can cause taste, odour, and colour. DOC can be reduced through the use of an activated carbon (AC) filter;
- Colour with a level of 8 TCU in both samples collected, above the AO of 5 TCU and the D-5-5 level considered reasonably treatable of 7 TCU. The colour can be attributed to the levels of organic materials (tannin and lignin) encountered, which imparts a yellow/brown tinge to the water. The color can be reduced by use of an activated carbon filter or a water softener.
- Chloride concentrations exceeded the ODWS AO of 250 mg/L with a value of 4560 mg/L after 4-hours of pumping, and 4460 mg/L after 8-hours of pumping. Chloride levels also exceeded the D-5-5 level of 250 mg/L. Chloride is found in nature in various forms such as in sodium (NaCl), potassium (KCl) and calcium ($CaCl^2$) salts. A reverse osmosis treatment system can be used to lower level of chloride in drinking water;
- Barium concentrations exceeded the ODWS of 1 mg/L with values of 4.17 and 4.22 mg/L. Barium is a naturally occurring element that is found in various minerals.

Barium in drinking water is often related to dissolved compounds which migrate through rocks and soil deposits and enter into the supply aquifer. Barium can be treated through the use of an ion exchange system, however caution related to excess soil should be exercised as discussed above; and

- Sodium with a level of 2670 mg/L at 4-hours, and 2,620 mg/L at 8-hours, which is above the AO and the D-5-5 level considered reasonably treatable of 200 mg/L. It is also above the 20 mg/L warning level notification limit for those on a sodium restricted diet. The local Medical Officer of Health should be notified of these levels so that this information may be communicated to local physicians with regards to homeowners who follow a sodium-restricted diet. The levels of sodium can be reduced through reverse osmosis system.

VOC parameters were not detected in the samples submitted for analysis, and bacteria levels were either non-detected, or within the acceptable limit. Total Coliforms were detected with counts of 2 and 1 CFU/100 mL in the four (4)- and eight (8)-hours samples. Although these counts are less than the ODWS MAC, it is advisable to include an ultra-violet treatment system as a precautionary measure.

Select parameters were encountered in excess of the regulation D-5-5 levels which are considered reasonably treatable, our findings from the initial water quality evaluation of the neighbouring well, the concentrations of alkalinity, hardness, TDS, chloride and sodium have been proven to be treatable through the use of generally considered conventional treatment units. A water quality treatment specialist should be consulted to recommend the proper units, specifications and maintenance frequency, it is considered acceptable to assume the following system can be applied to the proposed development to support suitable drinking water supply to occupants:

- a water softener that uses potassium chloride as sodium is found to be elevated;
- Carbon filtration;
- Iodine dosage;
- Reverse osmosis;
- Ultra-violet (UV) light unit with a 5 μm filtration membrane to do reduce turbidity of the water and ensure effectiveness of the UV unit.

As the property will be used for commercial/light industrial purposes, it is considered feasible for such a system series to be supplied and maintained on a regular basis.

6 WATER SUPPLY ASSESSMENT

Based on the Site geology and hydrogeology the recommended potential supply aquifer for the Site, is the shale aquifer. The proposed supply well installed on the Site currently intercepts this aquifer, and it is our understanding that the proposed development of the Site will utilize this newly constructed well. The selection of this aquifer is supported by the following:

- The risk to impairment of the on-Site water supply, as well as the possible pathway for contaminates in the shallow soils is considered too great of a risk to explore this as a potential supply aquifer, in addition to clay overburden is not considered a reliable or suitable stratum to obtain an adequate water supply.
- Only one (1) record of neighbouring shallow supply well was returned which suggests it may not be a suitable source.
- The City of Ottawa, at the time of the technical pre-construction reiterated comments from an initial project overview consultation that indicated the thick marine clay deposit identified in local well records may not be a suitable aquifer material for a shallow well. Furthermore, it was indicated that as per Section 5.2.3 of the City of Ottawa Hydrogeological and Terrain Analysis guidelines "*Site Plans will normally not be approved based on dug wells, unless it can be demonstrated, to the satisfaction of the City, that a drilled well is likely to produce unacceptable water quality or quantity.*"
- The thick confining clay later, above the bedrock, is considered a suitable barrier to prevent possible impartment to the supply aquifer and regional supply aquifer from the site proposed activities.
- Discussions with the neighbouring landowner indicated that the deeper bedrock aquifer was of poor quality, and not considered a suitable source to supply their establishment. They, much like other neighbouring lands, intercept the shale bedrock aquifer for supply.

6.1.1 Demand

The average daily water demand for the proposed building is 15.8 L/min. The assessment was completed at a higher rate of 22 L/min over eight (8) - hours. The results of the test have revealed that the proposed supply aquifer was only marginally impacted by the demand resulting in only 8.1% drawdown of the available water column, assuming a pump depth of 45 m. This demonstrates that the aquifer was not stressed during the duration of the pumping test and would likely have not influenced any neighbouring property supply wells. The well was found to reach drawdown stabilization after approximately 2 hours. Although the aquifer did not return to ≥95% after 24-hours, the overall drawdown was marginal of the potential availability (even with a greater demand utilized for the test), and the aquifer did not demonstrate stressed conditions, which supports that it is suitable for the anticipated development.

As previously mentioned, the pumping test was highly conservative with an inferred demand of more than 5 times the actual proposed daily demand. Should the actual anticipated daily demand of 1,310 L/day would have been implemented during the test, a flow rate of slightly less than 3 L/minute. As the well stabilized rapidly at the higher rate (stabilization in 2 hours at a rate of 22 L/minute), and the over drawdown was marginal, it is inferred that a 3 L/minute demand would result in the recharge of the well exceeding the demand, resulting in little to no fluctuation in the water level of the well, or neighbouring lands.

7 TERRAIN ANALYSIS

The terrain analysis was conducted to demonstrate that the unconsolidated material on the Site is appropriate for the construction of an on-Site subsurface sewage disposal system on the Site. The subject property is currently developed with a sewage disposal system, however, to support the re-development and Site up-grades, a new structure and associated components will be constructed in accordance with the Ontario Building Code, 2012. The proposed location of the sewage disposal system is presented in **Figure 7**.

The septic system will be designed by a competent individual and submitted for approval with the Ottawa Septic System Office (OSSO). On April 20, 2023, a formal submission was made to the OSSO, however it is understood that based on subsequent alterations to the proposed Site layout, a revised application will need to be submitted which depicts the updated proposed location. For the purposes of this report, the April 20, 2023, OSSO submission details are considered warranted as the overall proposed design, daily flow rates and treatment will not be altered. The actual proposed location for the installation of the system will be at the southwestern extent of the Site, between the warehouse and the southern property boundary. The initial OSSO submission package is included in **Attachment E**. The proposed septic details are as follows:

- The septic system will be a new construction, encompassing an approximate area of 68 m²;
- The sewage design flow for the Site will be 1,310 L/day;
- The proposed system will be a Class IV 'Eljen' partially raised system;
- The tank will have a capacity of 5,509 L and will be equipped with a Polytek effluent filter; and
- The total capacity of the system will be 6,903 L.

The Site is not considered Hydrogeologically Sensitive in regard to geological formations. Review of geological mapping and additional supporting documents, including MECP water well records, have revealed a deposit of overburden greater than 20 m thickness. This was further confirmed through the advancement of boreholes across the Site at the time of additional sub-surface investigation fieldwork completed by LRL, in support of the proposed development application. These additional investigations included a Geotechnical Investigation and a Phase Two Environmental Site Assessment. No bedrock outcrops were encountered at the time of LRLs Site visits associated with the corresponding investigations and assessments.

Subsurface conditions encountered during these studies are summarized as follows, although greater detail is available in the corresponding reporting documents completed for the respective investigations. Copies of the borehole logs from the Phase Two Environmental Site Assessment and Geotechnical Investigation are included in **Attachment B**.

As part of the Geotechnical Investigation, select soil samples were submitted for laboratory gradation analyses. The results of these analysis are summarized as follows:

Sample Location	Depth (m)	Percent for Each Soil Gradation					Estimated Hydraulic Conductivity K (m/s)
		Sand			Silt (%)	Clay (%)	
		Coarse (%)	Medium (%)	Fine (%)			
BH1	1.52 – 2.13	0.4	0.8	4.1	59.3	35.4	5×10^{-8}
BH2	6.10 – 6.71	0.0	0.0	0.6	31.0	68.4	5×10^{-8}

The subsurface conditions indicated for the Site are considered suitable for a Class IV septic sewage disposal system with a partially to fully raised leaching bed depending on the Site-specific soil and groundwater conditions at the actual location of the proposed septic system leaching bed. The leaching bed should be constructed to conform to the specifications set out in the Ontario Building Code (OBC).

According to the design submitted by others, the overall septic system would require an area of 68.04 m² for the dispersion bed, along with an additional approximate 30 m² for the pump station, tank, dosing chamber and secondary pump station. This equates to a total surface area of 98.04 m². Assuming a replacement area of 70 m², an area of approximately 168 m² would be required for the placement of the sewage disposal system.

The proposed grassed area assigned for the septic system at the southwestern extent of the Site has a surface area of 175 m², which is considered suitable for the placement of the septic. This location is more than 15 m from the location of the proposed supply well on the Site, and the existing supply wells on neighbouring lands.

8 GROUNDWATER IMPACT ASSESSMENT

The groundwater impact assessment addresses the ability of the land to attenuate the sewage effluent created by the development. Three (3) methods for conducting the assessment are outlined in Procedure D-5-4:

- *Lot Size Consideration* for lot greater than 10 000 m^2;
- *System Isolation Consideration* for areas where the septic system is hydrogeologically isolated from the potable water source; and
- *Contaminate Attenuation Consideration* for sites that do not meet the above two points.

The System Isolation Consideration was used to determine the impact of the individual on-Site septic systems at the boundary of the lots.

Based on the review of the available information and observations collected at the time of our Site visit, the Site is not obviously hydrogeologically sensitive (i.e. karstic areas, areas of fractured bedrock at the surface, areas of thin soil over highly permeable soils). As mentioned above, the Site has a surface area 3,000 m², with approximately 175 m² available for the installation of the proposed septic system at the southwestern portion of the Site, including a 70 m² septic system replacement area. The proposed septic system layouts are shown in the proposed Site development plan in **Figure 7**, and the configuration of the individual septic components are included in **Attachment E**.

Due to the lot size and soil conditions, “***System Isolation***” was considered as part of this terrain analysis.

8.1 System Isolation Determination

“***System Isolation***” is the most appropriate consideration, as the area is confirmed to have a thick clay deposit, extending between approximately 20 and 30 m in depth in the area, and an estimated 17 - 26 m on the Site, based on the findings of a previously prepared Geotechnical Investigation, and the conditions encountered in the installation of the proposed supply well on the Site.

Although seven (7) supply wells have been identified within 750 m of the Site, of which three (3) are within 500 m of the Site. All but one (1) of the supply wells are advanced into the underlying bedrock (shale or limestone). The neighbouring supply well to the east extends 21.3 m into the clay overburden, which is then followed by gravel to 22.6 m where bedrock was encountered. The well was constructed into the shale bedrock to 28.9 m below grade. A secondary well, approximately 225 m southwest of the Site is reported to have a similar construction with 30.3 m of clay encountered, followed by gravel to 31.5 m where bedrock was encountered. The well was constructed into the shale bedrock to a depth of 32.4 m below grade. No details of the newly constructed supply well on the Site have been retrieved at this time, other than that the well extended to an overall depth of 48.7 m with 30.4 m of casing. Bedrock was encountered at 28.0 m below grade.

A shallow/dug supply well has been identified approximately 360 m southwest of the Site. The well is reported to extend into the clay to a maximum depth of 7.0 m.

The clay layer encountered is considered to act as a physical boundary between the groundwater anticipated to be the receiving groundwater of the sewage, and the supply aquifer for the identified wells in the area. The overburden conditions (clay) are not considered a suitable potential aquifer for possible future development in the vicinity of the Site.

On April 17, 2023, LRL performed a visually assessment of the neighbouring properties for the presence of dug/shallow wells, which may not have been registered with the MECP. LRL walked Entrepreneur Crescent, and from readily accessible locations and vantage points, observations were made for the presence of supply well evidence. Based on these efforts, no evidence of dug/shallow wells were encountered in within approximately 100 m of the Site, in each direction.

i. Vertical Contamination Travel Time

The vertical groundwater velocity is calculated using the following equation:

$$v = \frac{Kdh}{n_e dl}$$

Where:

K = hydraulic conductivity (m/s)

dh/dl = hydraulic gradient (m/m)

n_e = effective porosity

During the borehole advancement on the subject Site at the time of the Geotechnical Investigation in February 2023, fill material consisting of a crushed stone granular material was encountered at the surface of all boring locations and extended to depths ranging between 0.60 and 1.07 m bgs. The recorded SPT "N" values of this deposit varied from 30 to 36, indicating the deposit is dense. The natural moisture contents were found to be 9 and 11%. Underlying the fill material at all boring locations, a layer of brown silty sand was encountered and extended to a depth of 1.45 m bgs. The recorded SPT "N" values of this deposit varied from 14 to 19, indicating the deposit is compact. The natural moisture contents were found to be 22 and 24%.

Below the silty sand in all boring locations, a layer of clayey silty was encountered and extended to a depth of 4.12 m bgs. This material contained trace sand, grey and wet. The SPT "N" values were found to range between 0 (weight of hammer (WH)) and 4, indicating the material is soft to very soft. The natural moisture contents were determined to range between 37 and 87%.

Static water levels and observations during borehole drilling revealed that the shallow groundwater in generally located in the clay stratum and is the most probable groundwater receiver for sewage effluent, although, there is a thick confining layer of clay encountered from the surface to the water table.

As detailed above, select soil samples were submitted for gradation analysis as part of the previous Geotechnical Investigation. The results of this analysis has confirmed that overburden material, at depth of between 1.5 and 2.1 m, as well as between 6.1 and 6.7 m, has an estimated hydraulic conductivity of 5×10^{-8} m/s. A n_e value of 0.55 is considered representative of the clay soils identified across the Site. This is according to the Total and Effective Porosity values (*data from Enviro Wiki Contributors, 2019*) presented in Hydrogeological Properties of Earth Materials and Principles of Groundwater Flow reference document prepared by The Groundwater Project (*https://books.gw-project.org*).

The vertical gradient of 0.0045 m/m was calculated using the difference between the water elevations in the groundwater monitoring wells collected from the Phase Two ESA, as presented in **Figure 6**, and the distance between the groundwater monitoring wells. The distance between MW23-3 and MW23-5 is 60.9 m. This is the furthest distance from available monitoring wells on Site. The difference in groundwater elevations between these two (2) locations is 0.28 m.

The vertical groundwater velocity is as follows:

	dh/dl (m/m)	**K (m/s)**	**v (m/year)**
Vertical	0.0045	5.0×10^{-8}	0.013

Using these values, the vertical travel time through the overburden conditions on the Site, was calculated to be approximately 0.012 m/year. Assuming that the proposed supply aquifer of the Site and neighbouring lands within 100 m of the Site is that of the gravel and shallow bedrock (shale) aquifer, confined by between approximately 17 and 30 m of clay, it is estimated that the effluent impacts could take more than 500 years to travel the vertical distance through the confining clay later, to the groundwater table. This is considered suitable time for the dilution and natural attenuation of the nitrates.

Based on the findings, the proposed development, and the construction of a new sewage disposal system is considered as low risk to groundwater impairment. It has been demonstrated that the sewage effluent is hydrogeologically isolated from possible existing or potential supply aquifers. The likely risk to surface water bodies in the vicinity of the Site is considered low due to the approximately distance from the natural features and proposed development envelope.

9 SUMMARY AND CONCLUSIONS

Based on the results of this investigation the following summary and conclusions are provided.

- The Site set within a low-density commercial and light industrial area of Ottawa, Ontario, southeast of the City's urban extents. The Site is legally described as Part of block 3 Plan 50M136 Part 3 ON Plan 50R6694; Subject to an Easement in Gross Over Part 9 ON Plan 4R-27830 As in OC1627867; City of Ottawa.
- The Site is generally undeveloped with exception to a granular base applied across the majority of the surface of the Site and is used as a storage yard for the adjacent YSB Hoisting Equipment & YSB Carpentry facility.
- The Site is a rectangular shape, with a total area of approximately 3,000 m² or 0.75 acre. The topography of the Site and vicinity are generally flat with a slight slope to the southern and western perimeters with elevations across the Site.
- Historically, the Site was used agricultural lands, since at least the mid-1960's (1965). Thereafter, the Site remained undeveloped and densely wooded until approximately 2017, when the vegetation was cleared. Neighbouring lands include commercial and light industrial developments since at least the early 1990's.
- The Hydrogeological Assessment & Terrain Analysis was completed in support of the proposed Site development which is anticipated to include one (1) approximately 1,382 m² warehouse, in addition to corresponding parking and circulation area and related components. The proposed development will be serviced by a private water supply well and sewage disposal system.
- The inferred groundwater flow direction is north-west towards the Bear Brook, located approximately 2.2 km to the northwest of the Site, however neighbouring ditches are identified to flow easterly according to *The Atlas of Canada – Toporama* interactive mapping system.
- A ditch is present along the northern perimeter of Site. According to an Environmental Impact Statement dated June 23, 2023, and prepared by others, the ditch was described as having high water chemistry measurements related to salt, likely associated with the adjacent snow dumping facility. The Environmental Impact Statement indicated that these conditions would likely result in fish, which could enter the ditch during high seasonal water level conditions from neighbouring sources, to perish. The Environmental Impact Statement concluded that the ditch has no natural heritage values. However, it was recommended that to prevent surface runoff from the Site into the ditch, a 'raised berm' would be constructed to the north of the proposed warehouse development, which would divert runoff into the Sites strategic stormwater management system.
- Surficial soil deposit mapping indicates that the surficial geology is Offshore Marine Deposits: clay, silty clay, and silt, commonly calcareous and fossiliferous; locally overlain by thin sand. Bedrock mapping indicates that the bedrock is described as the Carlsbad Formation: grey shale, sandy shale, and some dolomitic layers.
- The Site is not considered Hydrogeologically Sensitive in regard to shallow soils or bedrock outcrops.
- A search was conducted of the well records from the MECP WWR department. The search by UTM coordinates covered a 750 m radius from the Site. The search returned 30 WWRs, however, several of which did not have any details available related to the construction or subsurface conditions encountered. Nine (9) of the WWR retrieved was

for a test well. The records of the wells within 750 m of the Site, where details were available, revealed that the wells include both drilled and shallow overburden wells. The drilled wells, seven (7) of which, were reported to extend to depths of between 28.9 and 61.0 m. Only one (1) shallow overburden/dug supply well was reported, which extended to a depth of between 7.0 m. The well records show that that the geological conditions within 750 m are generally similar and consist of clay to depths between 21.0 and 44.8 m followed by a thin layer of gravel, over shale or limestone bedrock. A thin layer of sand was reported in select wells over the clay, and glacial till was reported over bedrock in the supply well located approximately 640 m northwest of the Site. The water type was reported as sulphur in two (2) of the test well locations.

- On August 23, 2023, the proposed supply well for the anticipated development was constructed at the northeastern portion of the Site. The well was advanced to a depth of 48.7 m. Clay was reported to be encountered at ground surface to a depth 26.2 m followed by gravel to 28.0 m bgs. The well was extended into shale bedrock to 48.7 m bgs. Water was found at a depth 46.9 m, with a static water level measured at 2.80 m.
- Entrepreneur Holding Corporation retained LRL to complete a Phase Two Environmental Site Assessment on the Site in the context of property redevelopment. The assessment was completed to determine if recognized potential environmental concerns have negatively impacted soil and groundwater quality of the subject Site. A total of ten (10) boreholes were advanced across the Site to address the potential environmental concerns identified. The subsurface soil conditions in the area investigated on the Site generally consist of included a layer of sand and gravel fill extending from surface to 0.85 m bgs. Underlying the fill material was a layer of brown silty sand which extended from the bottom of the fill layer to 1.2 m bgs followed by silty clay to a depth of 6.0 m bgs where the boreholes were terminated. Refusal over inferred bedrock was not encountered in any of the boreholes.
- Four (4) groundwater monitoring wells were constructed on the Site as part of a Phase Two Environmental Site Assessment. Groundwater depth measurements in the monitoring wells were between 0.20 and 0.55 m below grade, which corresponded to elevations between 99.32 and 99.69 m, with respect to an arbitrary benchmark established and assigned an elevation of 100.00 m. Based on these elevations the groundwater flow direction on the Site is towards the southeast.
- Based on the findings of the Phase Two Environmental Site Assessment, remediation work to address the elevated lead concentrations encountered in the soil be completed during the construction efforts associated with the Site development. The impacted groundwater is also anticipated to be addressed at the time of development.
- To establish the hydraulic properties of the proposed supply aquifer, an eight (8)-hr pump test was conducted on the newly constructed supply well on August 30, 2023. The pumping rate was to account for the anticipated demand volumes, over a common commercial operation period of eight (8)-hours. The well was pumped at a constant flow rate (±5%) of approximately 22 L/min over eight (8)-hr period using a temporary submersible pump lowered into the well.
- The initial static water level was measured as 2.61 m below top of casing (btc), and test well depth was measured as approximately 48.7 m btc. The pump was set at approximately 45 m btc at the time of the test. The drawdown after eight (8)-hr of pumping was 3.64 m. This represents only approximately 8.1% of the available drawdown in the well, assuming the set pump depth of 45 m is the maximum drawdown

which can be reached. The specific capacity of the well after eight (8)-hr of pumping was calculated to be 0.101 L/sec/m with a long-term availability of 82.4 m³ per day.

- The average daily water demand for the proposed building is 15.8 L/min. The assessment was completed at a higher rate of 22 L/min over eight (8) - hours. The results of the test have revealed that the proposed supply aquifer was only marginally impacted by the demand resulting in only 8.1% drawdown of the available water column, assuming a pump depth of 45 m. This demonstrates that the aquifer was not stressed during the duration of the pumping test and would likely have not influenced any neighbouring property supply wells. The well was found to reach drawdown stabilization after approximately 2 hours. Although the aquifer did not return to >95% after 24-hours, the overall drawdown was marginal of the potential availability (even with a greater demand utilized for the test), and the aquifer did not demonstrate stressed conditions, which supports that it is suitable for the anticipated development.
- As previously mentioned, the pumping test was highly conservative with an inferred demand of more than 5 times the actual proposed daily demand. Should the actual anticipated daily demand of 1,310 L/day would have been implemented during the test, a flow rate of slightly less than 3 L/minute. As the well stabilized rapidly at the higher rate (stabilization in 2 hours at a rate of 22 L/minute), and the over drawdown was marginal, it is inferred that a 3 L/minute demand would result in the recharge of the well exceeding the demand, resulting in little to no fluctuation in the water level of the well, or neighbouring lands.
- To represent the long-term water quality of the well, samples were collected during different stages of the pump test (after four (4) and eight (8)-hours of pumping), and shortly thereafter. The majority of the parameters analysed meet the ODWS parameters tested except for the following:
    - Alkalinity was reported to have values of 703 and 705 mg/L at 4- and 8-hour, respectively. These values are above the ODWS OG limit of 500 mg/L;
    - Hardness was found to be 1020 and 1030 mg/L at 4- and 8-hours, respectively, above the ODWS OG limit of 100 mg/L;
    - TDS values were found to be 7950 and 7880 mg/L in the 4- and 8-hour samples, respectively, above the AO of 500 mg/L
    - Turbidity was measured to have a level of 3.8 NTU in the 4-hour sample, and 3.5 NTU in the 8-hour sample;
    - DOC with a level of 9.4 and 8.5 mg/L, at the 4- and 8-hour sample, respectively, above the AO of 5 mg/L but below the D-5-5 level considered reasonably treatable of 10 mg/L;
    - Colour with a level of 8 TCU in both samples collected, above the AO of 5 TCU and the D-5-5 level considered reasonably treatable of 7 TCU;.
    - Chloride concentrations exceeded the ODWS AO of 250 mg/L with a value of 4560 mg/L after 4-hours of pumping, and 4460 mg/L after 8-hours of pumping. Chloride levels also exceeded the D-5-5 level of 250 mg/L;
    - Barium concentrations exceeded the ODWS of 1 mg/L with values of 4.17 and 4.22 mg/L; and
    - Sodium with a level of 2670 mg/L at 4-hours, and 2,620 mg/L at 8-hours, which is above the AO and the D-5-5 level considered reasonably treatable of 200 mg/L.

- Although select parameters were encountered in excess of the regulation D-5-5 levels which are considered reasonably treatable, our findings of an initial water quality evaluation of the neighbouring well, the concentrations of alkalinity, hardness, TDS, chloride and sodium have been proven to be treatable through the use of generally considered conventional treatment units.
- The water samples meet the ODWS parameters tested except for the following:
    - Hardness was found to be 204 and 219 mg/L at 3- and 6-hours, respectively, above the ODWS OG limit of 100 mg/L;
    - Turbidity was measured to have a level of 4.2 NTU in the 3-hour sample, and 8.8 NTU in the 6-hour sample. Both of which are above the ODWS OG of 1 NTU if the treatment system is required to provide filtration and, the 6-hour sample is above the AO of 5 NTU;
    - All trace metal parameters analysed were below the respective OWDS, with the exception to Manganese which was reported with a value of 0.07 mg/L, above the ODWS of 0.05 mg/L;
    - Sulphide concentrations were reported as 0.12 mg/L after 6-hours of pumping, above the 0.05 mg/L ODWS AO. Sulphide can be reduced through aeration, which oxidizes it to sulphate, or an activated carbon filter;
    - Total Coliforms were detected in the samples collected at 3-hours and 6-hours of pumping, with values of 4 and 2 CFU/100 mL, respectively. Microbial impacts can be treated through the use of an ultraviolet disinfection system; and
    - Iron levels were measured to be 0.4 and 0.9 mg/L, above the ODWS AO of 0.3 mg/L. This level is below the D-5-5 treatability limit of 10 mg/L. Iron can be reduced through the use of a water softener.
- According to the design submitted by others, the overall septic system would require an area of 68.04 m² for the dispersion bed, along with an additional approximate 30 m² for the pump station, tank, dosing chamber and secondary pump station. This equates to a total surface area of 98.04 m². Assuming a replacement area of 70 m², an area of approximately 168 m² would be required for the placement of the sewage disposal system. The proposed grassed area assigned for the septic system at the southwestern extent of the Site has a surface area of 175 m², which is considered suitable for the placement of the septic. This location is more than 15 m from the location of the proposed supply well on the Site, and the existing supply wells on neighbouring lands.
- "***System Isolation***" is the most appropriate consideration, as the area is confirmed to have a thick clay deposit, extending between approximately 20 and 30 m in depth in the area, and an estimated 17 and 26 m on the Site. Although seven (7) supply wells have been identified within 750 m of the Site, of which three (3) are within 500 m of the Site. All but one (1) of the supply wells are advanced into the underlying bedrock (shale or limestone). The neighbouring supply well to the east extends 21.3 m into the clay overburden, which is then followed by gravel to 22.6 m where bedrock was encountered. The well was constructed into the shale bedrock to 28.9 m below grade. A secondary well, approximately 225 m southwest of the Site is reported to have a similar construction with 30.3 m of clay encountered, followed by gravel to 31.5 m where bedrock was encountered. The well was constructed into the shale bedrock to a depth of 32.4 m below grade. No details of the newly constructed supply well on the Site have been retrieved at this time, other than that the well extended to an overall depth of 48.7 m with 30.4 m of

casing. Bedrock was encountered at 28.0 m below grade.

- Assuming that the proposed supply aquifer of the Site and neighbouring lands within 100 m of the Site is that of the gravel and shallow bedrock (shale) aquifer, confined by between approximately 17 and 30 m of clay, it is estimated that the effluent impacts could take more than 500 years to travel the vertical distance through the confining clay later, to the groundwater table. This is considered suitable time for the dilution and natural attenuation of the nitrates.

10 RECOMMENDATIONS

Based on the results of this investigation the following recommendations are provided:

1. It is recommended that the recently constructed proposed supply well at the Site be utilized as a water supply for the proposed development features of the Site. The well is found to generally have acceptable groundwater supply for the proposed Site activities and with conventional treatment applied. Furthermore, the well will be able to meet the daily supply demands, as determined through the 8-hour pumping test initiated.
2. The casing of the well should also be extended to 400 mm above final grade after construction.
3. Additional consideration with respect to maintaining the condition of the supply well, and the corresponding supply aquifer include the following:
   a. Snow should not be piled in the area of the well so as not to potentially damage the supply well; and
   b. The Site, post- development, should be graded such that surface run-off and drainage be diverted away from the supply well.
4. The water quality of the proposed supply well is found to be in general accordance with the ODWS. The following exceptions were encountered:

- Alkalinity was reported to have values of 703 and 705 mg/L at 4- and 8-hour, respectively. These values are above the ODWS OG limit of 500 mg/L. Alkalinity can be reduced through the use of a water softener; however the use of sodium chloride as a regenerant for the resins can increase the sodium content of the water. This poses a lower risk to the subject site based on it's anticipated use, although it should be noted that for individuals with sodium restricted diets, potassium chloride can be substituted for sodium in the ion exchange system to lower the hardness in the water supply;
- Hardness was found to be 1020 and 1030 mg/L at 4- and 8-hours, respectively, above the ODWS OG limit of 100 mg/L. High levels of hardness can lead to scale deposits and excessive utilization of regular soaps. Hardness can be reduced through the use of a water softener; however as mentioned above, the use of sodium chloride as a regenerant for the resins can increase the sodium content of the water;
  - The Langelier Saturation Index (LSI) is used to determine the calcium carbonate stability of water and the pH at which water is saturated with calcium carbonate (pHs). The LSI calculation is used to establish the level of saturation. The Ryznar Stability Index (RI) is used to determine the aggressiveness of water which can indicate the scale and corrosion potential. The calculations for RI and LSI are shown in **Table 4**. Using a water temperature of 10°C (typical of an interior distribution system circulating

through a building), the LSI was calculated for the 8-hour sample of 1.78 which indicate the water is scale forming but non-corrosive. The RI was calculated to be 4.72 at the 8-hour sample which indicates heavy scaling.

- TDS values were found to be 7950 and 7880 mg/L in the 4- and 8-hour samples, respectively, above the AO of 500 mg/L. TDS can be reduced through the use of a water softener; however the use of sodium chloride as a regenerant for the resins can increase the sodium content of the water. For individuals with sodium restricted diets, potassium chloride can be substituted for sodium in the ion exchange system to lower the TDS in the water supply;
- Turbidity was measured to have a level of 3.8 NTU in the 4-hour sample, and 3.5 NTU in the 8-hour sample. Both of which are above the ODWS OG of 1 NTU if the treatment system is required to provide filtration, however, are below the AO of 5 NTU and the D-5-5 level considered reasonably treatable of 5 NTU. If the water is to be disinfected using an ultra-violet filter, it is recommended that the water be pre-treated with a 5 um filter;
- Dissolved Organic Carbon (DOC) with a level of 9.4 and 8.5 mg/L, at the 4- and 8-hour sample, respectively, above the AO of 5 mg/L but below the D-5-5 level considered reasonably treatable of 10 mg/L. DOC can cause taste, odour, and colour. DOC can be reduced through the use of an activated carbon (AC) filter;
- Colour with a level of 8 TCU in both samples collected, above the AO of 5 TCU and the D-5-5 level considered reasonably treatable of 7 TCU. The colour can be attributed to the levels of organic materials (tannin and lignin) encountered, which imparts a yellow/brown tinge to the water. The color can be reduced by use of an activated carbon filter or a water softener.
- Chloride concentrations exceeded the ODWS AO of 250 mg/L with a value of 4560 mg/L after 4-hours of pumping, and 4460 mg/L after 8-hours of pumping. Chloride levels also exceeded the D-5-5 level of 250 mg/L. Chloride is found in nature in various forms such as in sodium (NaCl), potassium (KCl) and calcium ($CaCl^2$) salts. A reverse osmosis treatment system can be used to lower level of chloride in drinking water;
- Barium concentrations exceeded the ODWS of 1 mg/L with values of 4.17 and 4.22 mg/L. Barium is a naturally occurring element that is found in various minerals. Barium in drinking water is often related to dissolved compounds which migrate through rocks and soil deposits and enter into the supply aquifer. Barium can be treated through the use of an ion exchange system, however caution related to excess soil should be exercised as discussed above; and
- Sodium with a level of 2670 mg/L at 4-hours, and 2,620 mg/L at 8-hours, which is above the AO and the D-5-5 level considered reasonably treatable of 200 mg/L. It is also above the 20 mg/L warning level notification limit for those on a sodium restricted diet. The local Medical Officer of Health should be notified of these levels so that this information may be communicated to local physicians with regards to homeowners who follow a sodium-restricted diet. The levels of sodium can be reduced through reverse osmosis system.

VOC parameters were not detected in the samples submitted for analysis, and bacteria levels were either non-detected, or within the acceptable limit. Total Coliforms were detected with counts of 2 and 1 CFU/100 mL in the 4- and 8-hours samples. Although these counts are less than the ODWS MAC, it is advisable to include an ultra-violet treatment system as a precautionary measure.

Although select parameters were encountered in excess of the regulation D-5-5 levels which are considered reasonably treatable, our findings from the initial water quality evaluation of the neighbouring well, the concentrations of alkalinity, hardness, TDS, chloride and sodium have been proven to be treatable through the use of generally considered conventional treatment units.

A water quality treatment specialist should be consulted to recommend the proper units, specifications and maintenance frequency, it is considered acceptable to assume the following system can be applied to the proposed development to support suitable drinking water supply to occupants:

- a water softener that uses potassium chloride as sodium is found to be elevated;
- Carbon filtration;
- Iodine dosage;
- Reverse osmosis;
- Ultra-violet (UV) light unit with a 5 μm filtration membrane to do reduce turbidity of the water and ensure effectiveness of the UV unit.

As the property will be used for commercial/light industrial purposes, it is considered feasible for such a system series to be supplied, and maintained on a regular basis.

5. Water Treatment options should be considered on an individual basis. Any water treatment system should be maintained on a regular basis in accordance with the manufacturer's recommendations to ensure that it is properly functioning and providing a safe drinking water.
6. The owner should maintain their well as outlined in the Ontario Ministry of Agricultural and Rural Affairs Best Management Series – Water Wells.
7. The subsurface conditions indicated for the Site are considered suitable for a Class IV septic sewage disposal system with a partially to fully raised leaching bed depending on the specific soil and groundwater conditions at the actual leaching bed locations. Sewage system designs shall be based on specific investigations to evaluate the suitability of local conditions on each lot. The system should be designed using the percolation time of the native and imported sand and according to the Ontario Building Code (OBC). The leaching beds should be constructed to conform to the specifications set out in the OBC. The septic systems shall be constructed above the groundwater table over the native soil once all organic soils have been stripped from is footprint.
8. Prior to installation of the septic disposal system, an updated application must be filed and approved by the Ontario Septic System Office (OSSO).
9. The septic system should be placed at least 15 m from any drilled supply wells, 30 m from any shallow/dug wells, and at least 3 m from the property boundary limits.
10. It is recommended that the water table be surveyed prior to installation of the sewage disposal systems.

11 LIMITATIONS

The findings contained in this report are based on data and information collected during the Hydrogeological Assessment & Terrain Analysis of the subject property conducted by LRL Engineering. The conclusions and recommendations are based solely on-Site conditions encountered at the time of our fieldwork between April 17 and August 31, 2023, supplemented by historical information and data obtained as described in this report. The information presented in this report represents the groundwater conditions at the locations sampled. Due to natural variations in geological conditions, no inference is made to the soil or groundwater conditions between sampling points. No assurance is made regarding changes in conditions subsequent to the time of this investigation. If additional information is discovered or obtained, LRL Engineering should be requested to re-evaluate the conclusions presented in this report and to provide amendments as required.

In evaluating the subject property, LRL Engineering has relied in good faith on information provided by individuals as noted in this report. We assume that the information provided is factual and accurate. We accept no responsibility for any deficiencies, misstatements or inaccuracies contained in this report as a result of omissions, misinterpretation or fraudulent acts of the persons contacted.

Yours truly,

LRL Associates Ltd.

LICENSED PROFESSIONAL ENGINEER
K. MOHAMMADI
100172155
Sep. 12, 2023
PROVINCE OF ONTARIO

Jessica Arthurs

k. Mohamadi

Jessica Arthurs
Environmental Engineering Manager

Kourosh Mohammadi, Ph. D., P. Eng.
Hydrogeological Engineer

W:\FILES 2022\220487\04 Environmental\04 Hydrogeology\05 Reports\2023.09.13.LRL220487.Report.HydrogeologicalAssessment.363EntreneurCresOttawa.docx

FIGURES

ENGINEERING | INGÉNIERIE

5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

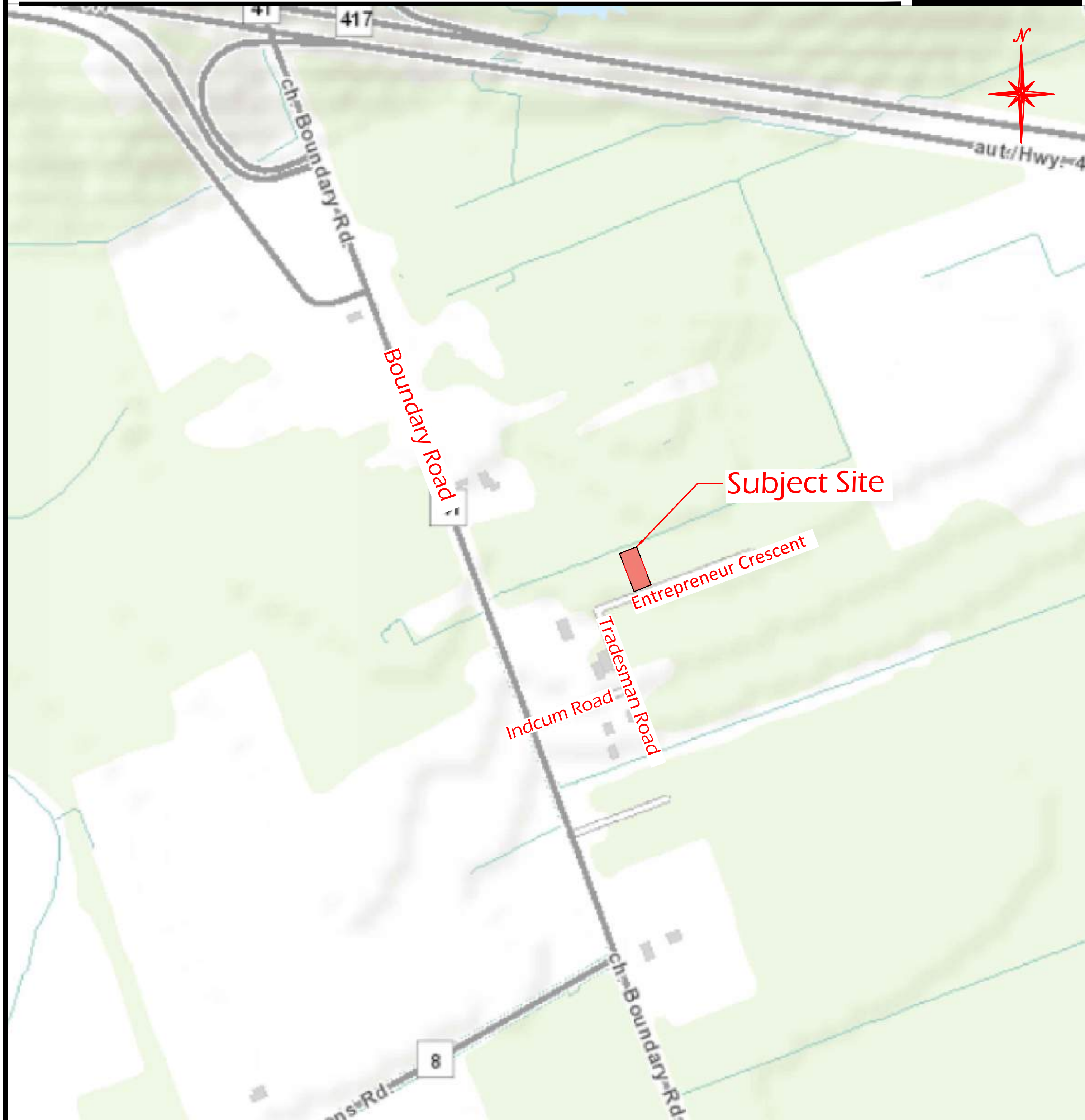
PROJECT

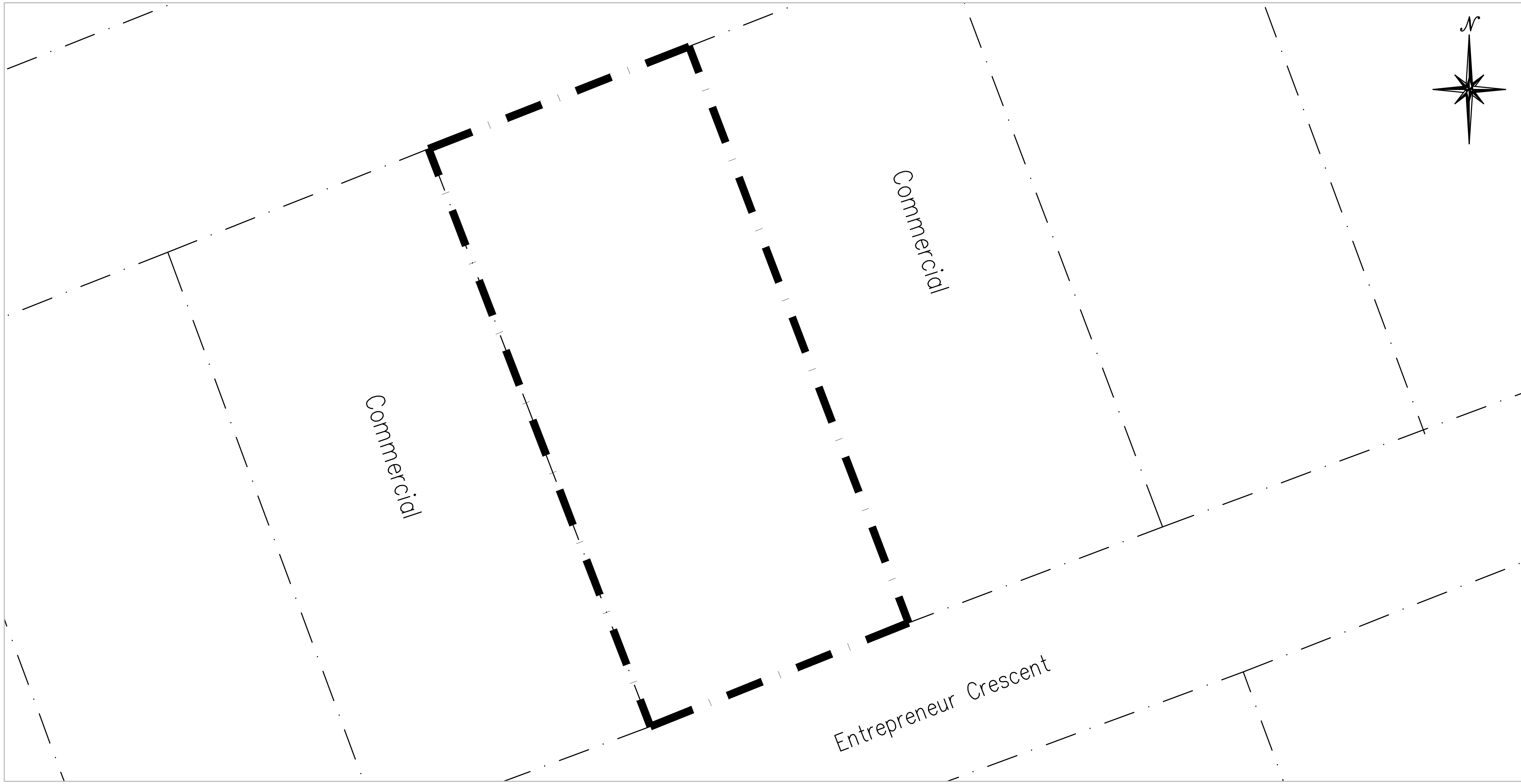
HYDROGEOLOGICAL ASSESSMENT & TERRAIN ANALYSIS
PROPOSED WAREHOUSE DEVELOPMENT
363 ENTREPRENEUR CRESCENT
OTTAWA, ONTARIO

DRAWING TITLE

SITE LOCATION
(NOT TO SCALE)
SOURCE: GEOOTTAWA

CLIENT	DATE	PROJECT	
ENTREPRENEUR HOLDING CORPORATION	SEPTEMBER 2023	220487	FIGURE1





LEGEND

Property Line – Subject Site (363 Entrepreneur Crescent)

Neighbouring Property Boundaries

15m 0 30 60m

SCALE: 1:1250

No.	REVISIONS	BY	DATE
01	ISSUED FOR REVIEW	C.C.	04/09/2023

LRL
ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

CLIENT
ENTREPRENEUR HOLDING CORPORATION

DESIGNED BY: C.C.
DRAWN BY: C.C.
APPROVED BY: J.A.

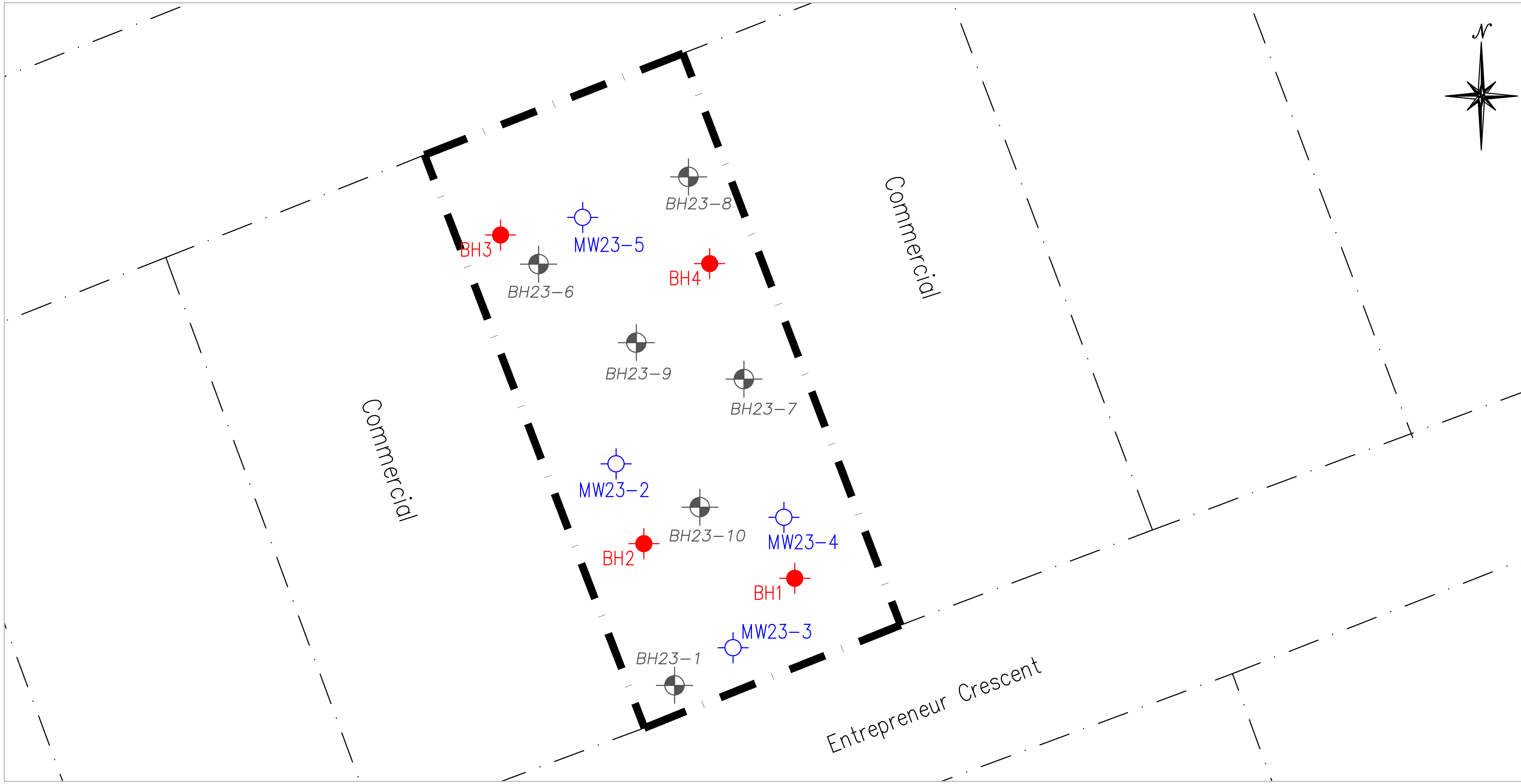
PROJECT
HYDROGEOLOGICAL ASSESSMENT & TERRAIN ANALYSIS
PROPOSED WAREHOUSE DEVELOPMENT
363 ENTREPRENEUR CRESCENT
OTTAWA, ONTARIO

DRAWING TITLE
SITE PLAN

PROJECT NO.
220487

DATE
SEPTEMBER 2023

FIGURE2



LEGEND

Property Line – Subject Site (363 Entrepreneur Crescent)	
Neighbouring Property Boundaries	
BH–X	Borehole (Phase Two ESA)
MW23–X	Monitoring Well (Phase Two ESA)
BHX	Borehole (Geotechnical Investigation)

15m 0 30 60m

SCALE: 1:1250

No.	REVISIONS	BY	DATE
01	ISSUED FOR REVIEW	C.C.	04/09/2023

LRL

ENGINEERING | INGÉNIERIE

5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

CLIENT
ENTREPRENEUR HOLDING CORPORATION

DESIGNED BY:	DRAWN BY:	APPROVED BY:
C.C.	C.C.	J.A.

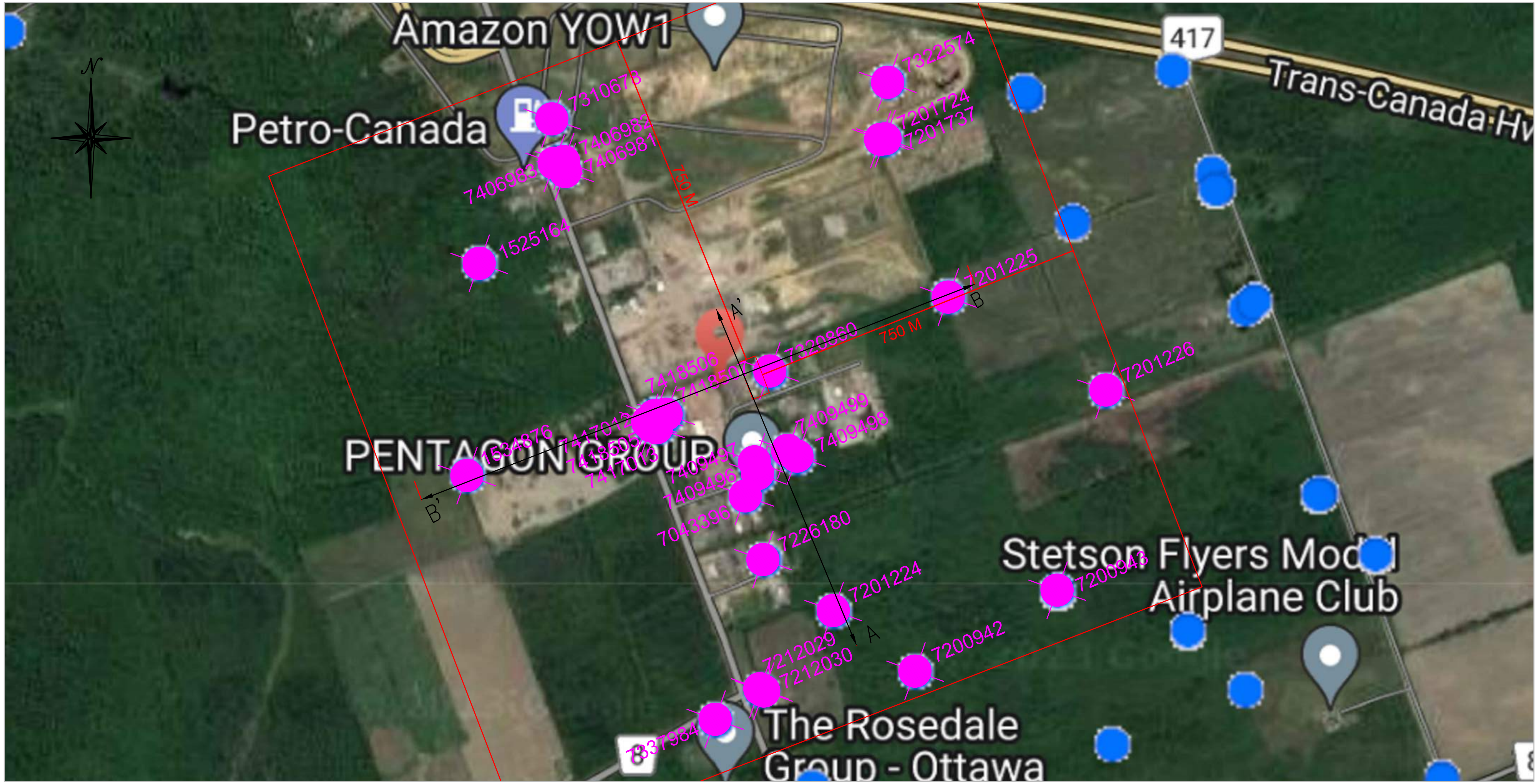
PROJECT
HYDROGEOLOGICAL ASSESSMENT & TERRAIN ANALYSIS
PROPOSED WAREHOUSE DEVELOPMENT
363 ENTREPRENEUR CRESCENT
OTTAWA, ONTARIO

DRAWING TITLE
PREVIOUS INVESTIGATION - BOREHOLE AND MONITORING WELL LOCATIONS

PROJECT NO.
220487

DATE
SEPTEMBER 2023

FIGURE3



Legend

(red line)	Property Line – Subject Site (363 Entrepreneur Crescent)
xxxx	Wells within 500 m of the Site
BH-X	Borehole
MW23-X	Monitoring Well

15m 0 30 60m

SCALE: 1:1250

No.	REVISIONS	BY	DATE
01	ISSUED FOR REVIEW	C.C.	12/09/2023

LRL

ENGINEERING | INGÉNIERIE

5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

CLIENT
ENTREPRENEUR HOLDING CORPORATION

DESIGNED BY:	DRAWN BY:	APPROVED BY:
C.C.	C.C.	J.A.

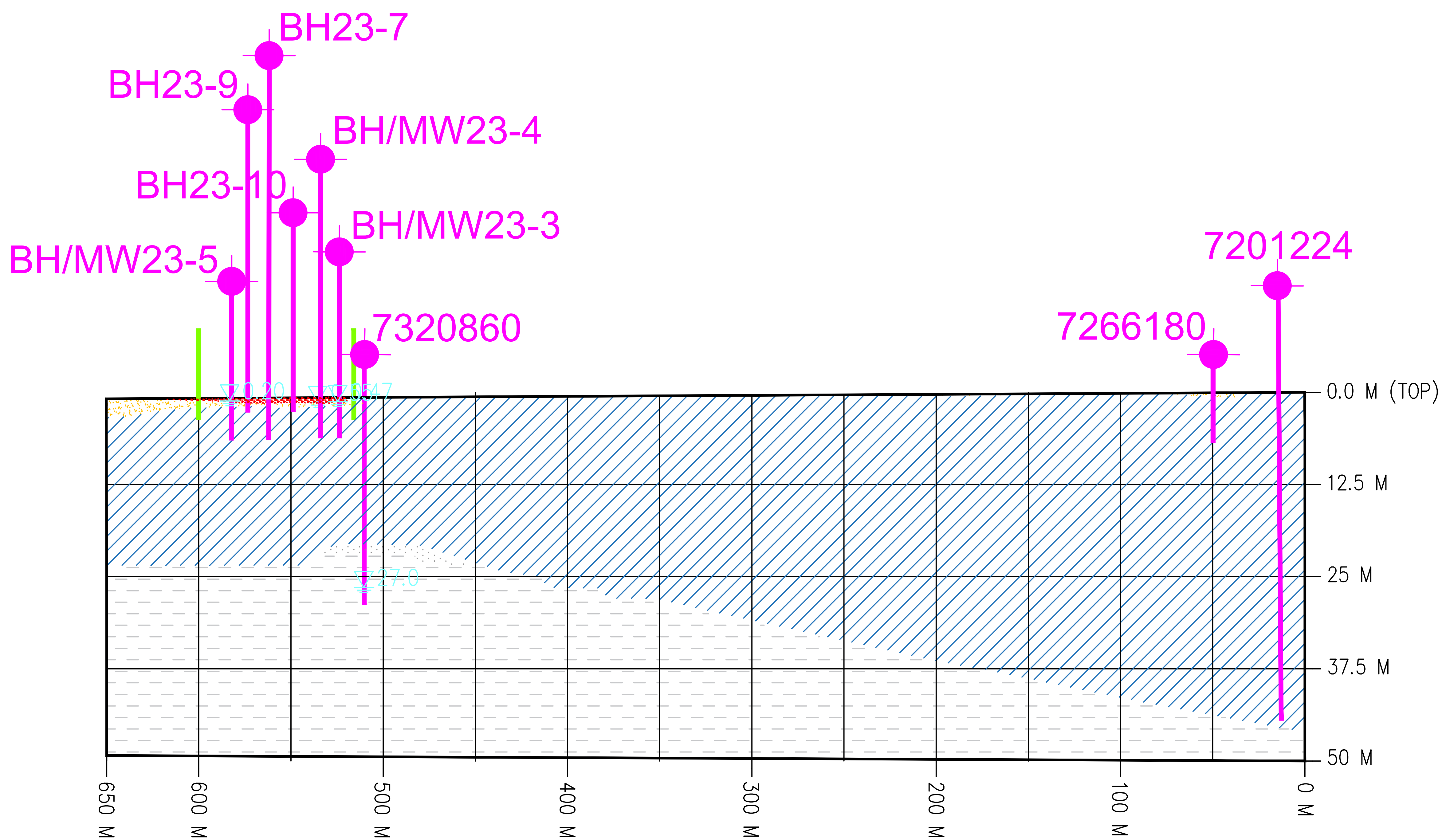
PROJECT
HYDROGEOLOGICAL ASSESSMENT & TERRAIN ANALYSIS
PROPOSED WAREHOUSE DEVELOPMENT
363 ENTREPRENEUR CRESCENT
OTTAWA, ONTARIO

DRAWING TITLE
WELLS WITHIN 750 m OF THE SITE (SOURCE & BASE LAYER: MECP WELL RECORD DATABASE)

PROJECT NO.
220487

DATE
SEPTEMBER 2023

FIGURE4



NORTH A' CROSS SECTION A' – A A SOUTH

LEGEND

- Supply Well
- Subject Site Property Extents
- 99.9 Groundwater Found
- Sand (Sand, Gravel, Boulders)
- Clay
- Gravel
- Bedrock
- Fill

15m 0 30 60m

SCALE: 1:1250

No.	REVISIONS	BY	DATE
01	ISSUED FOR REVIEW	C.C.	05/09/2023

LRL ENGINEERING I INGÉNIERIE
5430 Canotek Road I Ottawa, ON, K1J 9G2
www.lrl.ca I (613) 842-3434

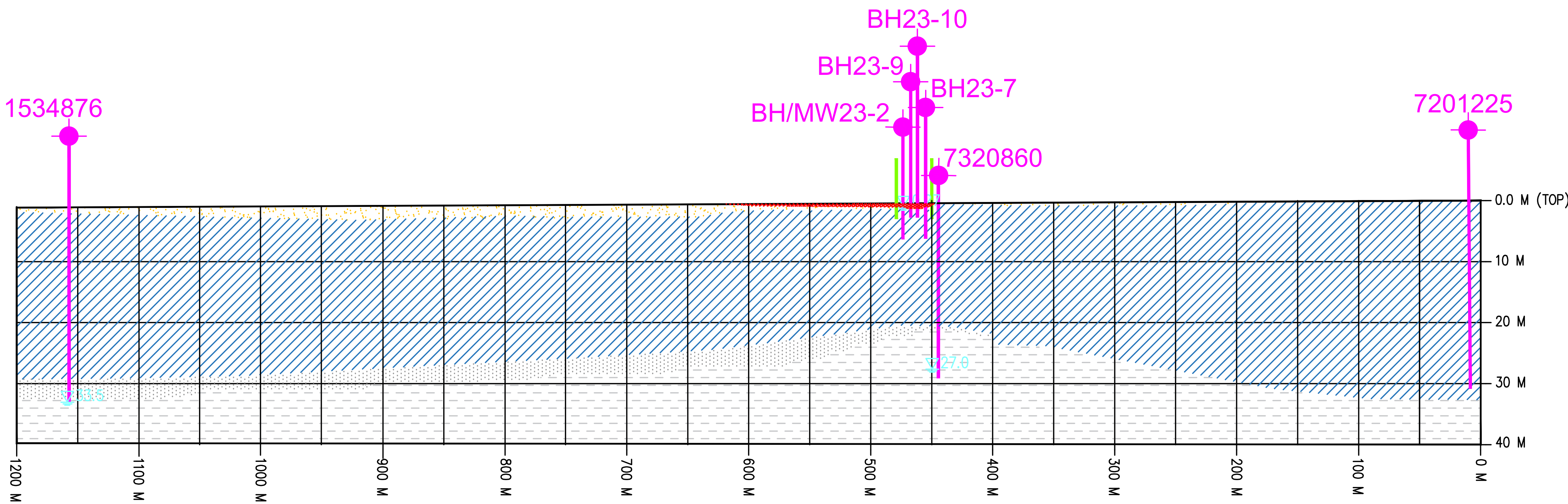
CLIENT
ENTREPRENEUR HOLDING CORPORATION

DESIGNED BY:	DRAWN BY:	APPROVED BY:
C.C.	C.C.	J.A.

PROJECT
HYDROGEOLOGICAL ASSESSMENT & TERRAIN ANALYSIS
PROPOSED COMMERCIAL DEVELOPMENT
363 ENTREPRENEUR CRESCENT
OTTAWA, ONTARIO

DRAWING TITLE
CROSS SECTION A' - A

FIGURE5A



WEST B' CROSS SECTION B' – B B EAST

LEGEND

- Supply Well
- Subject Site Property Extents
- 99.9 Groundwater Found
- Sand (Sand, Gravel, Boulders)
- Clay
- Gravel
- Bedrock
- Fill

15m 0 30 60m

SCALE: 1:1250

No.	REVISIONS	BY	DATE
01	ISSUED FOR REVIEW	C.C.	05/09/2023

LRL ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

CLIENT
ENTREPRENEUR HOLDING CORPORATION

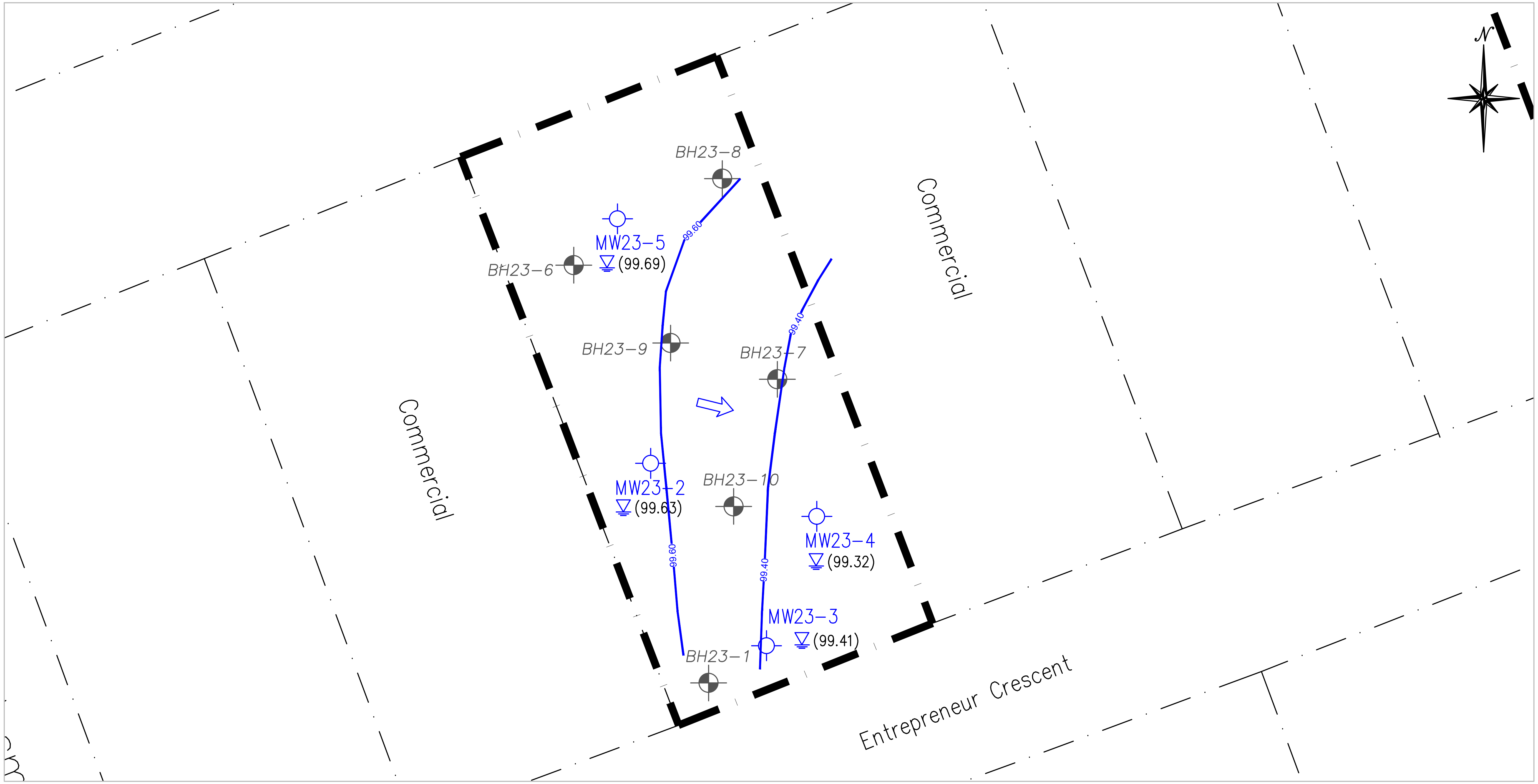
DESIGNED BY:	DRAWN BY:	APPROVED BY:
C.C.	C.C.	J.A.

PROJECT
HYDROGEOLOGICAL ASSESSMENT & TERRAIN ANALYSIS
PROPOSED COMMERCIAL DEVELOPMENT
363 ENTREPRENEUR CRESCENT
OTTAWA, ONTARIO

DRAWING TITLE

CROSS SECTION B' - B

FIGURE5B



LEGEND

Property Line – Subject Site (363 Entrepreneur Crescent)

Neighbouring Property Boundaries

BH-X Borehole

MW23-X Monitoring Well

Inferred Groundwater Flow Direction

99.99 Groundwater Elevation

Groundwater Elevation Contour

15m 0 30 60m

SCALE: 1:1250

No.	REVISIONS	BY	DATE
01	ISSUED FOR REVIEW	C.C.	04/09/2023

LRL ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

CLIENT
ENTREPRENEUR HOLDING CORPORATION

DESIGNED BY:	DRAWN BY:	APPROVED BY:
C.C.	C.C.	J.A.

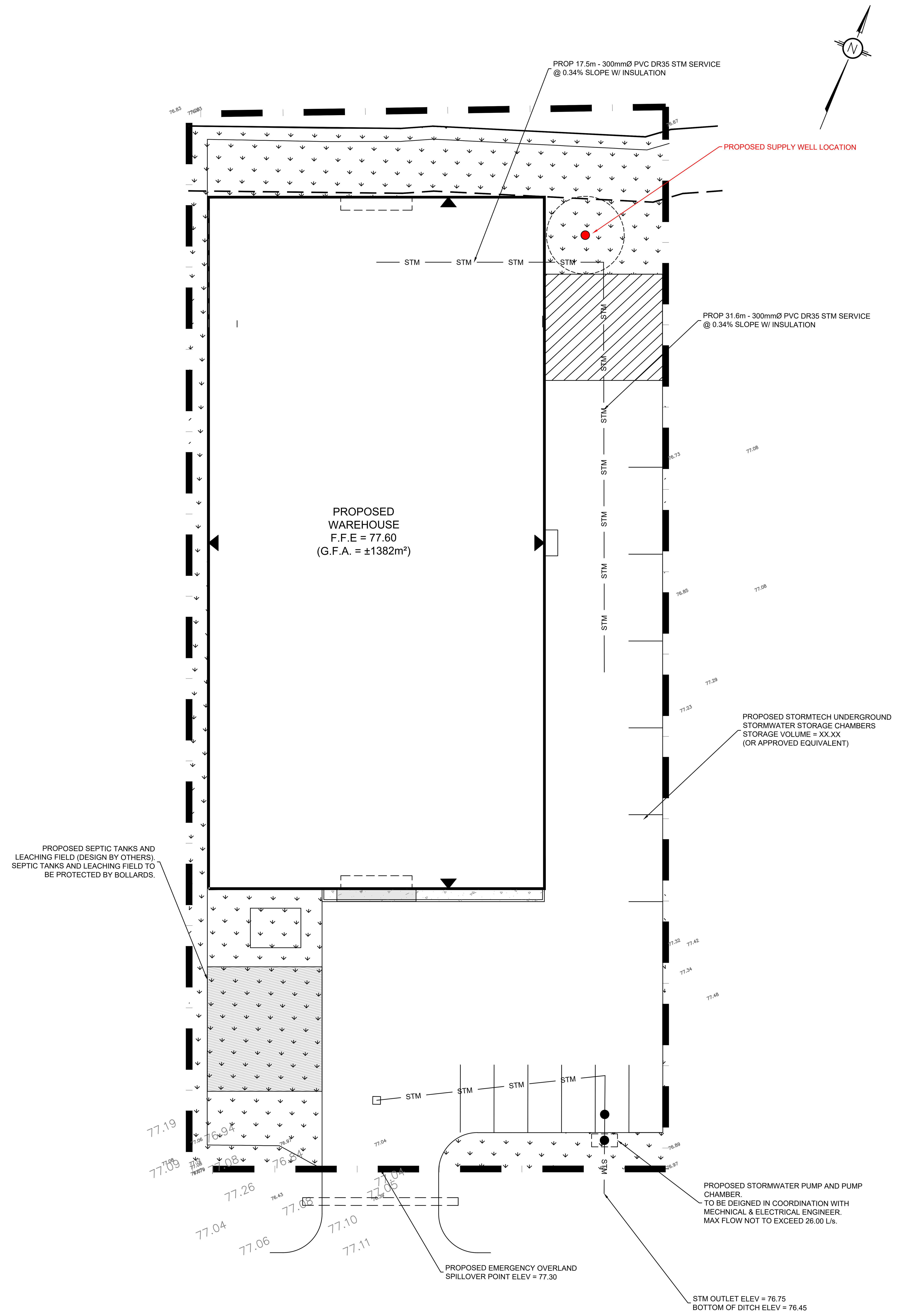
PROJECT
HYDROGEOLOGICAL ASSESSMENT & TERRAIN ANALYSIS
PROPOSED WAREHOUSE DEVELOPMENT
363 ENTREPRENEUR CRESCENT
OTTAWA, ONTARIO

DRAWING TITLE
GROUNDWATER ELEVATIONS AND CONTOURS (MARCH 16, 2023)

PROJECT NO.
220487

DATE
SEPTEMBER 2023

FIGURE 6



LEGEND:

- EXISTING PROPERTY LINE TO REMAIN
- PROPOSED CURB
- PROPOSED DEPRESSED CURB
- PROPOSED TERRACING (3:1 MIN.)
- PROPOSED SILT FENCE AS PER OPSD 219.110
- PROPOSED FENCE
- PROPOSED DOOR ENTRANCE/EXIT
- PROPOSED GRASS AREA (100mm TOP SOIL & SOD)
- PROPOSED CONCRETE FEATURES/SLAB
- PROPOSED GRAVEL
- PROPOSED RIP RAP
- ×50.00 PROPOSED ELEVATION
- ×50.00HP PROPOSED HIGH POINT ELEVATION
- ×50.00S PROPOSED SWALE ELEVATION
- ×50.00BC PROPOSED BOTTOM OF CURB / ASPHALT ELEVATION
- ×50.00TC PROPOSED TOP OF CURB ELEVATION
- ×50.00BW PROPOSED EXPOSED BOTTOM OF RETAINING WALL
- ×50.00TW PROPOSED TOP OF RETAINING WALL
- ×50.00EX MATCH INTO EXISTING ELEVATION
- ×70.19 EXISTING ELEVATION
- PROPOSED OVERLAND MAJOR FLOW ROUTE
- SUB PROPOSED 100mmØ PERFORATED SUBDRAIN
- STM PROPOSED STORM SEWER
- SAN PROPOSED SANITARY SEWER
- WTR PROPOSED WATERMAIN
- STM EXISTING STORM SEWER
- SAN EXISTING SANITARY SEWER
- WTR EXISTING WATERMAIN
- GAS EXISTING GAS LINE
- EXISTING MANHOLE
- EXISTING CATCHBASIN
- PROPOSED CATCHBASIN-MANHOLE/CATCHBASIN
- PROPOSED MANHOLE
- PROPOSED CURB STOP
- PROPOSED PIPE INSULATION
- PROPOSED 100 YEAR HIGH WATER LEVEL
- STORM WATERSHED EXTENT
- WS-XX / CONTROLLED / AREA / RUNOFF: WATERSHED NAME; RUNOFF COEFFICIENT; AREA IN HECTARES

USE AND INTERPRETATION OF DRAWINGS

GENERAL CONDITIONS OF THE CONTRACT FOR CONSTRUCTION ARE PART OF THE CONTRACT DOCUMENTS AND DESCRIBE USE AND INTENT OF THE DRAWING. THE CONTRACT DOCUMENTS INCLUDE NOT ONLY THE DRAWINGS, BUT ALSO THE OWNER-CONTRACTOR AGREEMENTS, CONDITIONS OF THE CONTRACT, THE SPECIFICATIONS, ADDENDA, AND MODIFICATIONS ISSUED AFTER EXECUTION OF THE CONTRACT. THESE CONTRACT DOCUMENTS ARE COMPLEMENTARY, AND WHAT IS REQUIRED BY ANY ONE SHALL BE BINDING AS IF REQUIRED BY ALL. WORK NOT COMPLETELY DELINEATED HEREON SHALL BE CONSTRUCTED OF THE SAME MATERIALS AND DETAILED SIMILARLY AS WORK SHOWN MORE COMPLETELY ELSEWHERE IN THE CONTRACT DOCUMENTS.

BY USE OF THE DRAWINGS FOR CONSTRUCTION OF THE PROJECT, THE OWNER CONFIRMS THAT HE HAS REVIEWED AND APPROVED THE DRAWINGS. THE CONTRACTOR CONFIRMS THAT HE HAS VISITED THE SITE, FAMILIARIZED HIMSELF WITH THE LOCAL CONDITIONS, VERIFIED FIELD DIMENSIONS AND CORRELATED HIS OBSERVATIONS WITH THE REQUIREMENTS OF THE CONTRACT DOCUMENTS.

AS INSTRUMENTS OF SERVICE, ALL DRAWINGS, SPECIFICATIONS, CADD FILES OR OTHER ELECTRONIC MEDIA AND COPIED THERE OF FURNISHED BY THE ENGINEER ARE HIS PROPERTY. THEY ARE TO BE USED ONLY FOR THIS PROJECT AND ARE NOT TO BE USED ON ANY OTHER PROJECT, INCLUDING REPEATS OF THE PROJECT. CHANGES TO THE DRAWINGS MAY ONLY BE MADE BY THE ENGINEER.

UNLESS THE REVISION TITLE IS "ISSUED FOR CONSTRUCTION", THESE DRAWINGS SHALL BE CONSIDERED PRELIMINARY AND SHALL NOT BE USED AS A CONSTRUCTION DOCUMENT.

THESE DRAWINGS ILLUSTRATES THE WORK TO BE DONE. THE ENGINEER IS NOT RESPONSIBLE FOR THE MEANS, METHODS, TECHNIQUES, SEQUENCES, AND PROCEDURES USED TO DO THE WORK, OR THE SAFETY ASPECTS OF CONSTRUCTION, AND NOTHING ON THESE DRAWINGS EXPRESSED OR IMPLIED CHANGES THIS CONDITION. CONTRACTOR SHALL DETERMINE ALL CONDITIONS AT THE SITE AND SHALL BE RESPONSIBLE FOR KNOWING HOW THEY AFFECT THE WORK. SUBMITTAL OF A BID TO PERFORM THIS WORK IS ACKNOWLEDGEMENT OF THE RESPONSIBILITIES, AND THAT THEY HAVE BEEN FULLY CONSIDERED IN PLANNING OF THE WORK, AND THE BID PRICE. NO CLAIMS FOR EXTRA CHARGES DUE TO THESE CONDITIONS WILL BE FORTHCOMING.

UNAUTHORIZED CHANGES:

IN THE EVENT THE CLIENT, THE CLIENT'S CONTRACTORS OR SUBCONTRACTORS, OR ANYONE FOR WHOM THE CLIENT IS LEGALLY LIABLE MAKES OR PERMITS TO BE MADE ANY CHANGES TO ANY REPORTS, PLANS, SPECIFICATIONS OR OTHER CONSTRUCTION DOCUMENTS PREPARED BY LRL ASSOCIATES LTD. (LRL) WITHOUT OBTAINING LRL'S PRIOR WRITTEN CONSENT, THE CLIENT SHALL ASSUME FULL RESPONSIBILITY FOR THE RESULTS OF SUCH CHANGES. THEREFORE THE CLIENT AGREES TO WAIVE ANY CLAIM AGAINST LRL AND TO RELEASE LRL FROM ANY LIABILITY ARISING DIRECTLY OR INDIRECTLY FROM SUCH UNAUTHORIZED CHANGES.

IN ADDITION, THE CLIENT AGREES, TO THE FULLEST EXTENT PERMITTED BY LAW, TO INDEMNIFY AND HOLD HARMLESS LRL FROM ANY DAMAGES, LIABILITIES OR COST, INCLUDING REASONABLE ATTORNEY'S FEES AND COST OF DEFENSE, ARISING FROM SUCH CHANGES.

IN ADDITION, THE CLIENT AGREES TO INCLUDE IN ANY CONTRACTS FOR CONSTRUCTION APPROPRIATE LANGUAGE THAT PROHIBITS THE CONTRACTOR OR ANY SUBCONTRACTORS OF ANY TIER FROM MAKING ANY CHANGES OR MODIFICATIONS TO LRL'S CONSTRUCTION DOCUMENTS WITHOUT THE PRIOR WRITTEN APPROVAL OF LRL AND THAT FURTHER REQUIRES THE CONTRACTOR TO INDEMNIFY BOTH LRL AND THE CLIENT FROM ANY LIABILITY OR COST ARISING FROM SUCH CHANGES MADE WITHOUT SUCH PROPER AUTHORIZATION.

GENERAL NOTES:

EXISTING SERVICES AND UTILITIES SHOWN ON THESE DRAWINGS ARE TAKEN FROM THE BEST AVAILABLE RECORDS, BUT MAY NOT BE COMPLETE OR TO DATE. CONTRACTOR SHALL VERIFY IN FIELD FOR LOCATION AND ELEVATION OF PIPES AND CHECK WITH THE UTILITY COMPANIES BEFORE DIGGING OR PERFORMING WORK.

CONTRACTOR IS ADVISED TO COLLECT INFORMATION ON SOIL CONDITIONS BEFORE START OF CONSTRUCTION.

THE ENGINEER WAIVES ANY AND ALL RESPONSIBILITY AND LIABILITY FOR PROBLEMS WHICH ARISE FROM FAILURE TO FOLLOW THESE PLANS, SPECIFICATIONS AND THE DESIGN INTENT THEY CONVEY, OR FOR PROBLEMS WHICH ARISE FROM OTHERS' FAILURE TO OBTAIN AND/OR FOLLOW THE ENGINEER'S GUIDANCE WITH RESPECT TO ANY ERRORS, OMISSIONS, INCONSISTENCIES AMBIGUITIES OR CONFLICTS WHICH ARE ALLEGED.

CONTRACTOR TO VERIFY ALL DIMENSIONS AND NOTIFY THE ENGINEER OF ANY DISCREPANCIES BEFORE WORK COMMENCES. DO NOT SCALE DRAWINGS.

5m 2 0 5m

SCALE: 1:200

NOT FOR CONSTRUCTION TENDER OR PERMIT

No.	REVISIONS	BY	DATE
01	ISSUED FOR SITE PLAN CONTROL	K.H.	XX MAR 2023

NOT AUTHENTIC UNLESS SIGNED AND DATED

LRL
ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

CLIENT
ENTREPRENEUR HOLDING CORP.

DESIGNED BY:	DRAWN BY:	APPROVED BY:
K.H.	K.H.	M.B.

PROJECT
HYDROGEOLOGICAL ASSESSMENT & TERRAIN ANALYSIS
PROPOSED WAREHOUSE DEVELOPMENT
363 ENTREPRENEUR CRESCENT, OTTAWA

DRAWING TITLE
GENERAL PROPOSED DEVELOPMENT PLAN

PROJECT NO.
220487

DATE
OCT 2022

FIGURE7

TABLES

Table 1
Summary of Analysis of Water Sample Collected from the Neighbouring Supply Wells - 357 Entrepreneur Crescent
Hydrogeological Assessment and Terrain Analysis
Proposed Warehouse Development - 363 Entrepreneur Crescent, Ottawa, Ontario
LRL File: 220487

Parameter	Units	MRL	Ontario Drinking Water Standards: Standard	Ontario Drinking Water Standards: Type	MECP D-5-5[5]	Sample: 357 Entrepreneur - Pre	Sample: 357 Entrepreneur - Post
Sample Date (d/m/y)						**17-Apr-23**	**17-Apr-23**
Microbiological Parameters							
E. Coli	CFU/100 mL	1	0	MAC		<1	<1
Fecal Coliforms	CFU/100 mL	1	0 [1]	MAC		<1	<1
Heterotrophic Plate Count	CFU/ml	10	--			<10	150
Total Coliforms	CFU/100 mL	1	0/5[1]	MAC		<1	<1
General Inorganics							
Alkalinity, total	mg/L	5	30 - 500	OG		**605**	**16**
Ammonia as N	mg/L	0.01	--			3.28	0.46
Dissolved Organic Carbon	mg/L	0.5	5	AO	10	7.8	<0.5
Colour	TCU	2	5	AO	7	5	<2
Conductivity	uS/cm	5	--			13100	1050
Hardness	mg/L	1	80 - 100	OG		**1050**	**0.00**
pH	pH Units	0.05	6.5 - 8.5	OG		8.2	7.0
Phenolics	mg/L	0.001	--			<0.001	<0.001
Total Dissolved Solids	mg/L	10	500	AO		**7640**	**508**
Sulphide	mg/L	0.02	0.05	AO		0.24	<0.02
Tannin & Lignin	mg/L	0.1	--			0.7	<0.1
Total Kjeldahl Nitrogen	mg/L	0.1	--			3.4	0.5
Organic Nitrogen	mg/L		0.15	OG		0.12	0.04
Turbidity	NTU	0.1	1/5[2]	MAC/AO	5	***12.0***	<0.1
Anions							
Chloride	mg/L	1	250	AO	250	***4350***	**302**
Fluoride	mg/L	0.1	1.5[3]/2.4	MAC		0.7	<0.1
Nitrate as N	mg/L	0.1	10	MAC		<0.1	<0.1
Nitrite as N	mg/L	0.05	1	MAC		<0.50	<0.05
Sulphate	mg/L	1	500	AO	500	13	<1
Metals							
Calcium	mg/L	0.1	--			97.8	<0.1
Iron	mg/L	0.1	0.3	AO	5	**1.3**	<0.1
Magnesium	mg/L	0.2	--			196	<0.2
Manganese	mg/L	0.005	0.05	AO	1	0.03	<0.005
Potassium	mg/L	0.1	--			91.4	1.9
Sodium	mg/L	0.2	20[4]/200	AO	200	***2010***	*152*

NOTES

MRL	Minimum Reportable Limit	**ODWS**	Ontario Drinking Water Standards (2006)
MAC	Maximum Acceptable Concentration	**NA**	Not Analysed
AO	Aesthetic Objective	**UNDERLINE**	Parameter level above ODWS
OG	Operational Guideline	*Italics*	Notify Medical Officer of Health
		BOLD	Parameter level above D-5-5 maximum treatability limits

[1] As per Table 1 of MECP's technical guideline "*D-5-5 Private Wells: Water Supply Assessment*"
[2] 1.0 NTU MAC if treatment system required to provide filtration for disinfection. 5.0 NTU AO for all points of consumption
[3] Where supplies of naturally occuring flouride at levels above 1.5 mg/L but below 2.4 mg/L the Ministry of Health recommends notification of local board of health of levels to avoid excesses exposure from other sources.
[4] Limit at which Local Medical Officer of Health should be notified of Levels.
[5] MECP D-5-5 guideline, maximum concentration considered reasonably treatable

Table 2
Specific Capacity and Longterm Availability
Hydrogeological Assessment & Terrain Analysis
Proposed Warehouse Development - 363 Entrepreneur Crescent, Ottawa, Ontario
LRL File: 220487

Well	Cs - Static mTOC	EOH mTOC	Cp - Pump* mTOC	Cp - Cs	Drawdown (m)	Pumping Rate L/min	*Sc* - Specific Capacity L/sec/m	Qsc -Maximum Pumping Rate L/min	Long Term Availability m^3/day	Qsc GPM (US)	Qsc GPM (IMP)
Proposed Supply Well	2.61	6.25	45.00	42.4	3.64	22.0	0.101	57.2	82.4	15.1	12.6

Notes:

$$Qsc = 0.67\frac{(C_p - C_s)S_c}{SF}$$

Qsc	Pumping rate with safety factor (SF) of 3 (L/min);
$C_p - C_s$	Difference between pump level and static water level (m);
S_c	Specific capacity (L/min/m); and
0.67	Is a factor that compensates for the variation of the static water level due to seasonal variations as well as to drawdown from nearby wells
SF	3
Minimum Demand	1.35 m^3
*	Depth of pump at the time of the pumping test - measured in field
	Greater than Minimum Demand
	Less than Minimum Demand

Table 3A
Summary of Analysis of Water Sample Collected - 363 Entrepreneur Crescent
Hydrogeological Assessment and Terrain Analysis
Proposed Warehouse Development - 363 Entrepreneur Crescent , Ottawa, Ontario
LRL File: 220487

Parameter	Units	MRL	Ontario Drinking Water Standards: Standard	Ontario Drinking Water Standards: Type	MECP D-5-5[5]	Sample: 363 Entrepreneur Crescent Supply - 4 Hour	Sample: 363 Entrepreneur Crescent Supply - 8 Hour
Sample Date (d/m/y)						**30-Aug-23**	**30-Aug-23**
Microbiological Parameters							
E. Coli	CFU/100 mL	1	0	MAC		<1	<1
Fecal Coliforms	CFU/100 mL	1	0 [1]	MAC		<1	<1
Heterotrophic Plate Count	CFU/ml	10	--			90	40
Total Coliforms	CFU/100 mL	1	0/5[1]	MAC		2	1
General Inorganics							
Alkalinity, total	mg/L	5	30 - 500	OG		**703**	**705**
Ammonia as N	mg/L	0.01	--			4.72	4.71
Dissolved Organic Carbon	mg/L	0.5	5	AO	10	**9.4**	**8.5**
Colour	TCU	2	5	AO	7	**8**	**8**
Conductivity	uS/cm	5	--			14300	14200
Hardness	mg/L	1	80 - 100	OG		**1020**	**1030**
pH	pH Units	0.05	6.5 - 8.5	OG		8.2	8.3
Phenolics	mg/L	0.001	--			<0.001	<0.001
Total Dissolved Solids	mg/L	10	500	AO		**7950**	**7880**
Sulphide	mg/L	0.02	0.05	AO		0.23	0.23
Tannin & Lignin	mg/L	0.1	--			0.7	0.7
Total Kjeldahl Nitrogen	mg/L	0.1	--			4.7	4.7
Organic Nitrogen	mg/L		0.15	OG		-0.02	-0.01
Turbidity	NTU	0.1	1/5[2]	OG/AO	5	**3.8**	**3.5**
Anions							
Chloride	mg/L	1	250	AO	250	***4560***	***4460***
Fluoride	mg/L	0.1	1.5[3]/2.4	MAC		0.2	0.2
Nitrate as N	mg/L	0.1	10	MAC		<0.1	<0.1
Nitrite as N	mg/L	0.05	1	MAC		<0.25	<0.25
Sulphate	mg/L	1	500	AO	500	3	4

NOTES

MRL	Minimum Reportable Limit	**ODWS**	Ontario Drinking Water Standards (2006)
MAC	Maximum Acceptable Concentration	**NA**	Not Analysed
AO	Aesthetic Objective	**UNDERLINE**	Parameter level above ODWS
OG	Operational Guideline	*Italics*	Notify Medical Officer of Health
		BOLD	Parameter level above D-5-5 maximum treatability limits

[1] As per Table 1 of MECP's technical guideline "*D-5-5 Private Wells: Water Supply Assessment*"
[2] 1.0 NTU MAC if treatment system required to provide filtration for disinfection. 5.0 NTU AO for all points of consumption
[3] Where supplies of naturally occuring flouride at levels above 1.5 mg/L but below 2.4 mg/L the Ministry of Health recommends notification of local board of health of levels to avoid excesses exposure from other sources.
[4] Limit at which Local Medical Officer of Health should be notified of Levels.
[5] MECP D-5-5 guideline, maximum concentration considered reasonably treatable

Table 3B
Summary of Analysis of Water Sample Collected (Metals) - 363 Entrepreneur Crescent
Hydrogeological Assessment and Terrain Analysis
Proposed Warehouse Development - 363 Entrepreneur Crescent , Ottawa, Ontario
LRL File: 220487

Parameter	Units	MRL	Ontario Drinking Water Standards: Standard	Ontario Drinking Water Standards: Type	MECP D-5-5[5]	Sample: 363 Entrepreneur Crescent Supply - 4 Hour	Sample: 363 Entrepreneur Crescent Supply - 8 Hour
Sample Date (d/m/y)						**30-Aug-23**	**30-Aug-23**
Metals							
Aluminum	mg/L	0.001	0.1	AO		0.025	0.018
Antimony	mg/L	0.0005	0.006	MAC		<0.0005	<0.0005
Arsenic	mg/L	0.001	0.01	MAC		<0.001	<0.001
Barium	mg/L	0.001	1	MAC		**4.17**	**4.22**
Beryllium	mg/L	0.0005				<0.0005	<0.0005
Boron	mg/L	0.01	5	MAC		0.79	0.76
Cadmium	mg/L	0.0001	0.005	MAC		<0.0001	<0.0001
Calcium	mg/L	0.1				48.3	49.0
Chromium	mg/L	0.001	0.05			<0.001	<0.001
Cobalt	mg/L	0.0005				<0.0005	ND (0.0005)
Copper	mg/L	0.0005	1	AO		<0.0005	ND (0.0005)
Iron	mg/L	0.1	0.3	AO	5	0.3	0.3
Lead	mg/L	0.0001	0.01	MAC		<0.0001	ND (0.0001)
Magnesium	mg/L	0.2				218	220
Manganese	mg/L	0.005	0.05	AO	1	0.009	0.007
Molybdenum	mg/L	0.0005				<0.0005	ND (0.0005)
Nickel	mg/L	0.001				<0.001	ND (0.001)
Potassium	mg/L	0.1				61.3	63.3
Selenium	mg/L	0.001	0.05	MAC		<0.001	ND (0.001)
Silver	mg/L	0.0001				<0.0001	ND (0.0001)
Sodium	mg/L	0.2	20/200	MAC/AO	200	***2670***	***2620***
Strontium	mg/L	0.01				5.71	5.71
Thallium	mg/L	0.001				ND (0.001)	ND (0.001)
Tin	mg/L	0.01				ND (0.01)	ND (0.01)
Titanium	mg/L	0.005				ND (0.005)	ND (0.005)
Tungsten	mg/L	0.01				ND (0.01)	ND (0.01)
Uranium	mg/L	0.0001	0.02	MAC		ND (0.0001)	ND (0.0001)
Vanadium	mg/L	0.0005				ND (0.0005)	ND (0.0005)
Zinc	mg/L	0.005	5	AO		ND (0.005)	ND (0.005)

NOTES

MRL	Minimum Reportable Limit	**ODWS**	Ontario Drinking Water Standards (2006)
MAC	Maximum Acceptable Concentration	**NA**	Not Analysed
AO	Aesthetic Objective	**UNDERLINE**	Parameter level above ODWS
OG	Operational Guideline	*Italics*	Notify Medical Officer of Health
		BOLD	Parameter level above D-5-5 maximum treatability limits

[1] As per Table 1 of MECP's technical guideline "*D-5-5 Private Wells: Water Supply Assessment*"

[2] 1.0 NTU MAC if treatment system required to provide filtration for disinfection. 5.0 NTU AO for all points of consumption

[3] Where supplies of naturally occuring flouride at levels above 1.5 mg/L but below 2.4 mg/L the Ministry of Health recommends notification of local board of health of levels to avoid excesses exposure from other sources.

[4] Limit at which Local Medical Officer of Health should be notified of Levels.

[5] MOECC D-5-5 guideline, maximum concentration considered reasonably treatable

Table 3C
Summary of Analysis of Water Sample Collected (VOC) - 363 Entrepreneur Crescent
Hydrogeological Assessment and Terrain Analysis
Proposed Warehouse Development - 363 Entrepreneur Crescent , Ottawa, Ontario
LRL File: 220487

Parameter	Units	MRL	Sample 363 Entrepreneur Crescent Supply - 4 Hour	363 Entrepreneur Crescent Supply - 8 Hour
Sample Date (d/m/y)			**30-Aug-23**	**30-Aug-23**
Volatile Organic Compounds (VOCs)				
Acetone	mg/L	0.0050	<0.0050	<0.0050
Benzene	mg/L	0.0005	<0.0005	<0.0005
Bromodichloromethane	mg/L	0.0005	<0.0005	<0.0005
Bromoform	mg/L	0.0005	<0.0005	<0.0005
Bromomethane	mg/L	0.0005	<0.0005	<0.0005
Carbon Tetrachloride	mg/L	0.0002	<0.0002	<0.0002
Chlorobenzene	mg/L	0.0005	<0.0005	<0.0005
Chloroethane	mg/L	0.0010	<0.0010	<0.0010
Chloroform	mg/L	0.0005	<0.0005	<0.0005
Dibromochloromethane	mg/L	0.0005	<0.0005	<0.0005
Dichlorodifluoromethane	mg/L	0.0010	<0.0010	<0.0010
Ethylene dibromide (dibromoethane, 1,2-)	mg/L	0.0002	<0.0002	<0.0002
1,2-Dichlorobenzene	mg/L	0.0005	<0.0005	<0.0005
1,3-Dichlorobenzene	mg/L	0.0005	<0.0005	<0.0005
1,4-Dichlorobenzene	mg/L	0.0005	<0.0005	<0.0005
1,1-Dichloroethane	mg/L	0.0005	<0.0005	<0.0005
1,2-Dichloroethane	mg/L	0.0005	<0.0005	<0.0005
1,1-Dichloroethylene	mg/L	0.0005	<0.0005	<0.0005
cis-1,2-Dichloroethylene	mg/L	0.0005	<0.0005	<0.0005
trans-1,2-Dichloroethylene	mg/L	0.0005	<0.0005	<0.0005
1,2-Dichloroethylene, total	mg/L	0.0005	<0.0005	<0.0005
1,2-Dichloropropane	mg/L	0.0005	<0.0005	<0.0005
cis-1,3-Dichloropropylene	mg/L	0.0005	<0.0005	<0.0005
trans-1,3-Dichloropropylene	mg/L	0.0005	<0.0005	<0.0005
1,3-Dichloropropene, total	mg/L	0.0005	<0.0005	<0.0005
Ethylbenzene	mg/L	0.0005	<0.0005	<0.0005
Hexane	mg/L	0.0010	<0.0010	<0.0010
Methyl Ethyl Ketone (2-Butanone)	mg/L	0.0050	<0.0050	<0.0050
Methyl Isobutyl Ketone	mg/L	0.0050	<0.0050	<0.0050
Methyl tert-butyl ether	mg/L	0.0020	<0.0020	<0.0020
Methylene Chloride	mg/L	0.0050	<0.0050	<0.0050
Styrene	mg/L	0.0005	<0.0005	<0.0005
1,1,1,2-Tetrachloroethane	mg/L	0.0005	<0.0005	<0.0005
1,1,2,2-Tetrachloroethane	mg/L	0.0005	<0.0005	<0.0005
Tetrachloroethylene	mg/L	0.0005	<0.0005	<0.0005
Toluene	mg/L	0.0005	<0.0005	<0.0005
1,1,1-Trichloroethane	mg/L	0.0005	<0.0005	<0.0005
1,1,2-Trichloroethane	mg/L	0.0005	<0.0005	<0.0005
Trichloroethylene	mg/L	0.0005	<0.0005	<0.0005
Trichlorofluoromethane	mg/L	0.0010	<0.0010	<0.0010
Vinyl Chloride	mg/L	0.0002	<0.0002	<0.0002
m/p-Xylene	mg/L	0.0005	<0.0005	<0.0005
o-Xylene	mg/L	0.0005	<0.0005	<0.0005
Xylenes, total	mg/L	0.0005	<0.0005	<0.0005

Table 4
Langelier and Ryznar Calculations
Hydrogeological Assessment & Terrain Analysis
Proposed Warehouse Development - 363 Entrepreneur Crescent , Ottawa, Ontario
LRL File: 220487

Analyzed Parameters

TDS (mg/L)	7880
Hardness(mg/L)	1030
alkalinity(mg/L)	705
pH (pH units)	8.3
Temperature °C	10

Langelier

LSI = pH - pHs

pHs = (9.3 +A+B) - (C+D)	Where	A= (Log10(TDS)-1)/10	=	0.2896526
		B= (-13.12*Log10(T°C+273)+34.55	=	2.382562
		C= Log10(Hardness)-0.4	=	2.6128372
		D= Log10(Alkalinity)	=	2.8481891

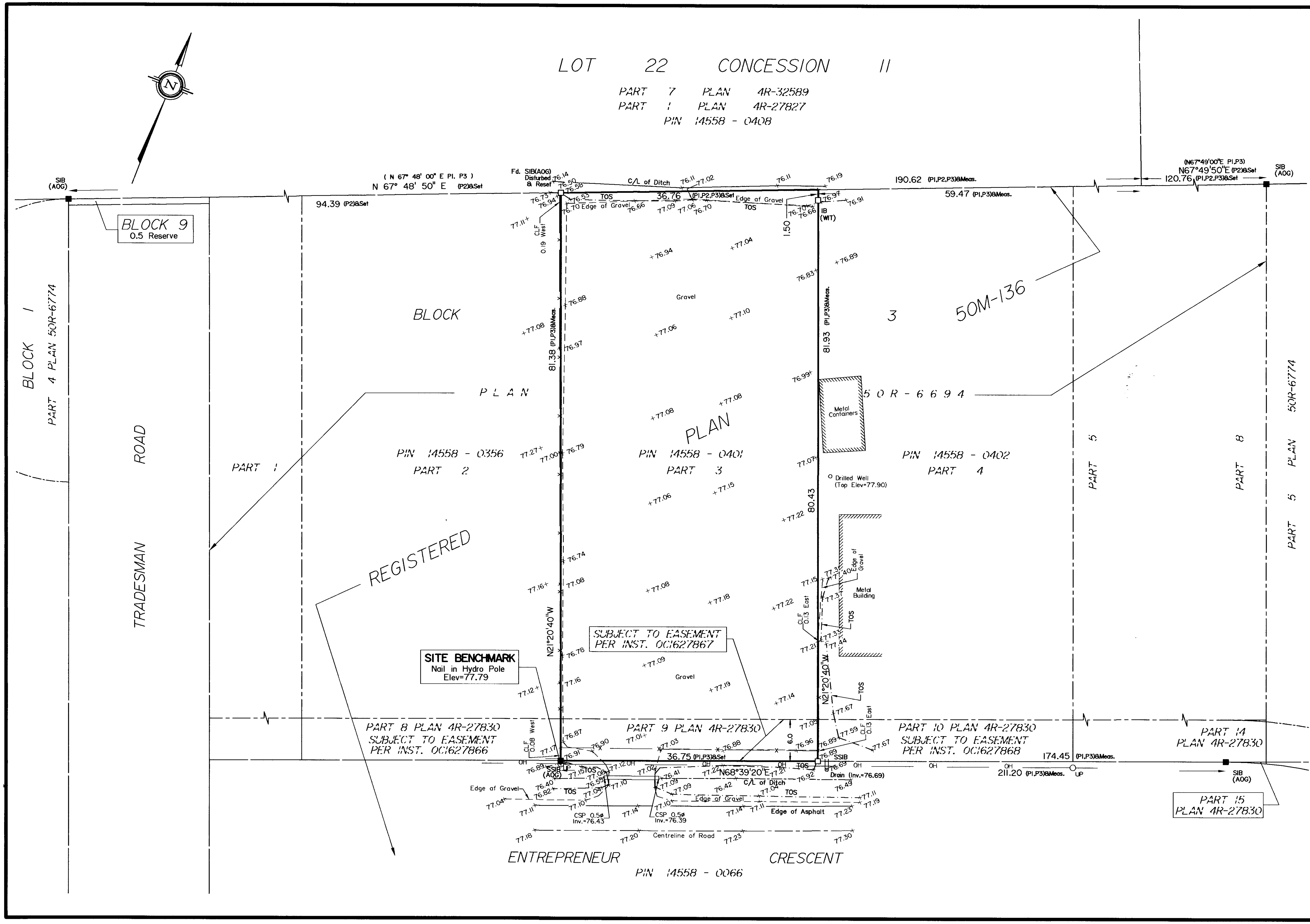
Ryznar

RI=2pHs-pH

pHs=	6.511188
LSI=	1.788812
RI=	4.722376

ATTACHMENT A

Topographic Map



TOPOGRAPHICAL PLAN OF SURVEY OF

PART OF BLOCK 3
REGISTERED PLAN 50M-136
CITY OF OTTAWA

Surveyed by Annis, O'Sullivan, Vollebekk Ltd.

Scale 1 : 400

16 12 8 4 0 8 16 Metres

Metric

DISTANCES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048

Surveyor's Certificate

I CERTIFY THAT :

1. This survey and plan are correct and in accordance with the Surveys Act, the Surveyors Act and the regulations made under them.
2. The survey was completed on December 8, 2022.

Dec 14/22
Date

Tyler J. Allison
Ontario Land Surveyor

ASSOCIATION OF ONTARIO LAND SURVEYORS
PLAN SUBMISSION FORM
V-33900

THIS PLAN IS NOT VALID UNLESS IT IS AN EMBOSSED ORIGINAL COPY ISSUED BY THE SURVEYOR IN ACCORDANCE WITH Regulation 1026, Section 29 (3)

Notes & Legend

—□—	Denotes	Survey Monument Planted
—■—	"	Survey Monument Found
SIB	"	Standard Iron Bar
SSIB	"	Short Standard Iron Bar
IB	"	Iron Bar
(WIT)	"	Witness
Meas.	"	Measured
(P1)	"	Plan 4R-27830
(P2)	"	Plan 4R-32589
(P3)	"	Plan 50R-6694
(AOG)	"	Annis, O'Sullivan, Vollebekk Ltd.
—OH—	"	Overhead Wires
UP	"	Utility Pole
CSP	"	Corrugated Steel Pipe
Inv.	"	Invert
CLF	"	Chain Link Fence
TOS	"	Top of Slope
+ 65.00	"	Location of Elevations
C/L	"	Centreline

Bearings are grid, derived and are referred to the Central Meridian of MTM Zone 9 (76°30' West Longitude) NAD-83 (original).

ELEVATION NOTES

1. Elevations shown are geodetic and are referred to the CGVD28 geodetic datum.
2. It is the responsibility of the user of this information to verify that the job benchmark has not been altered or disturbed and that it's relative elevation and description agrees with the information shown on this drawing.

UTILITY NOTES

1. This drawing cannot be accepted as acknowledging all of the utilities and it will be the responsibility of the user to contact the respective utility authorities for confirmation.
2. Only visible surface utilities were located.
3. A field location of underground plant by the pertinent utility authority is mandatory before any work involving breaking ground, probing, excavating etc.

ANNIS, O'SULLIVAN, VOLLEBEKK LTD.
165 Bay Street
Embrun, Ont. K0A 1W1
Phone: (613) 443-3364
Email: Embrun@aovltd.com
Ontario Land Surveyors

Job No. E-2488-22

BIN

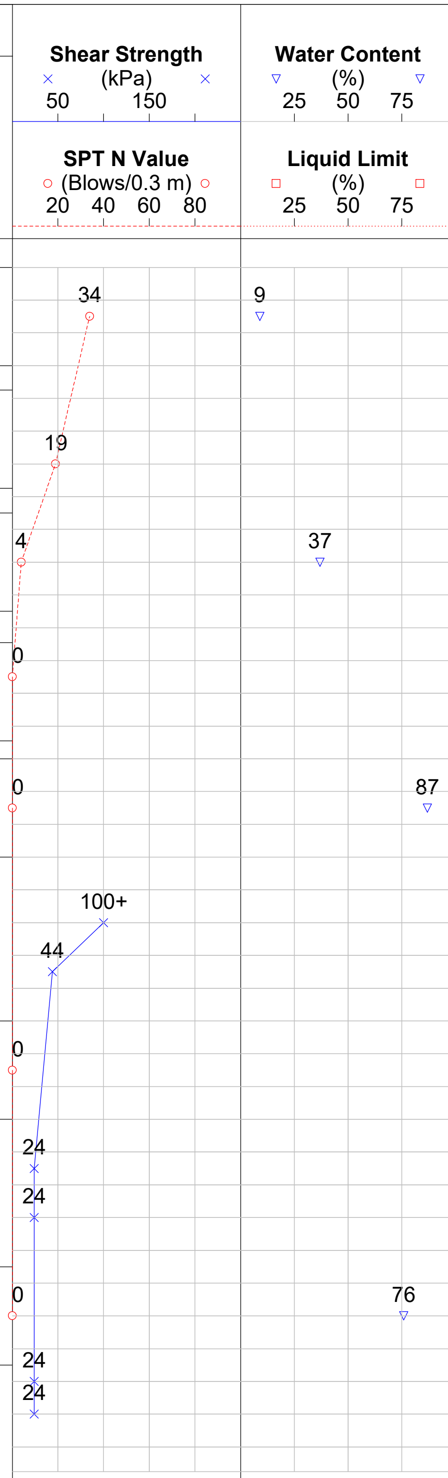
ATTACHMENT B

Borehole Logs – Previous Investigations

Borehole Log: BH1

Project No.: 220487
Project: Proposed Warehouse
Client: Entrepreneur Holding Corp.
Location: 363 Entrepreneur Cres. Vars ON
Date: November 17, 2022
Field Personnel: BJ
Driller: CCC Geotech and Enviro Drilling
Drilling Equipment: Track Mount CME 75
Drilling Method: Hollow Stew Auger

SUBSURFACE PROFILE		SAMPLE DATA				
Depth	Soil Description	Elev./Depth (m)	Type	Sample Number	N or RQD	Recovery (%)
0 ft / 0 m	Ground Surface	100.28				
	FILL MATERIAL crushed stone, grey, moist, dense.	0.00		SS1	34	42
				SS2	19	58
	SILTY SAND brown, moist, compact.	99.22 / 1.07				
	CLAYEY SILT trace sand, grey, firm to very soft, wet.	98.83 / 1.45		SS3	4	50
				SS4	WH	100
				SS5	WH	100
	SILTY CLAY grey, very soft, wet.	96.16 / 4.12				
				SS6	WH	100
				SS7	WH	100
	End of Borehole	93.28 / 7.00				



Monitoring Well Details

Easting: 465773 m
Northing: 5020883 m

Site Datum: TBM - Top of Culvert located at Southwest of Driveway entrance. (100.00 m)

Groundsurface Elevation: 100.285 m
Top of Riser Elev.: NA

Hole Diameter: 200 mm
Monitoring Well Diameter: N/A

NOTES:

Borehole Log: BH2

Project No.: 220487 **Project:** Proposed Warehouse

Client: Entrepreneur Holding Corp. **Location:** 363 Entrepreneur Cres. Vars ON

Date: November 17, 2022 **Field Personnel:** BJ

Driller: CCC Geotech and Enviro Drilling **Drilling Equipment:** Track Mount CME 75 **Drilling Method:** Hollow Stew Auger

SUBSURFACE PROFILE		SAMPLE DATA							
Depth	Soil Description	Elev./Depth (m)	Type	Sample Number	N or RQD	Recovery (%)	SPT N Value (Blows/0.3 m)	Water Content (%)	Monitoring Well Details
0 ft / 0 m	Ground Surface	100.17							
	FILL MATERIAL crushed stone, grey, moist, dense.	0.00		SS1	30	42	30		
		99.57							
	SILTY SAND brown, moist, compact.	0.60		SS2	15	50	15	22	
		98.72							
	CLAYEY SILT trace sand, grey, firm to very soft, wet.	1.45		SS3	1	50	1		
				SS4	WH	58	0	65	
				SS5	WH	75	0		
		96.05							
	SILTY CLAY grey, very soft, wet.	4.12		SS6	WH	100	0		

Shear Strength (kPa):

Depth (approx.)	Shear Strength (kPa)
~13 ft	20
~14 ft	30
~18 ft	24
~19 ft	30

Easting: 465762 m **Northing:** 5020885 m

Site Datum: TBM - Top of Culvert located at Southwest of Driveway entrance. (100.00 m)

Groundsurface Elevation: 100.165 m **Top of Riser Elev.:** NA

Hole Diameter: 200 mm **Monitoring Well Diameter:** N/A

NOTES:

Borehole Log (continued): BH2

Project No.: 220487

Project: Proposed Warehouse

Client: Entrepreneur Holding Corp.

Location: 363 Entrepreneur Cres. Vars ON

Date: November 17, 2022

Field Personnel: BJ

Driller: CCC Geotech and Enviro Drilling

Drilling Equipment: Track Mount CME 75

Drilling Method: Hollow Stew Auger

SUBSURFACE PROFILE		SAMPLE DATA							
Depth	Soil Description	Elev./Depth (m)	Type	Sample Number	N or RQD	Recovery (%)	Shear Strength (kPa) × 50 150 / SPT N Value (Blows/0.3 m) ○ 20 40 60 80	Water Content (%) ▿ 25 50 75 / Liquid Limit (%) □ 25 50 75	Monitoring Well Details
20–22				SS7	WH	100	SPT N: 0	Water Content: 85	
22–23							Shear Strength: 24; 24		
24–39							SPT N: 0; 0; 0; 0; 0; 0; 0; 0; 0; 0; 0; 0; 0; 0; 0; 0		

Depth scale: 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39 (secondary scale: 7, 8, 9, 10, 11)

NOTES

Borehole Log (continued): BH2

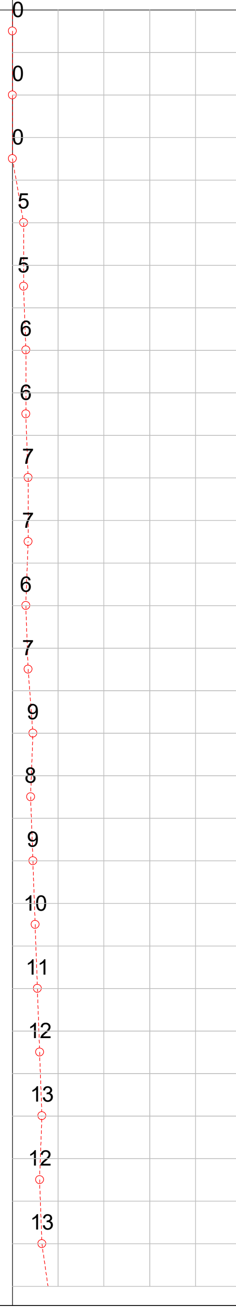
Project No.: 220487 | **Project:** Proposed Warehouse

Client: Entrepreneur Holding Corp. | **Location:** 363 Entrepreneur Cres. Vars ON

Date: November 17, 2022 | **Field Personnel:** BJ

Driller: CCC Geotech and Enviro Drilling | **Drilling Equipment:** Track Mount CME 75 | **Drilling Method:** Hollow Stew Auger

SUBSURFACE PROFILE		SAMPLE DATA							
Depth	Soil Description	Elev./Depth (m)	Type	Sample Number	N or RQD	Recovery (%)	Shear Strength (kPa) 50 150 / SPT N Value (Blows/0.3 m) 20 40 60 80	Water Content (%) 25 50 75 / Liquid Limit (%) 25 50 75	Monitoring Well Details
40									
41									
42									
13 / 43									
44									
45									
14 / 46									
47									
48									
49 / 15									
50									
51									
52 / 16									
53									
54									
55 / 17									
56									
57									
58									
59									

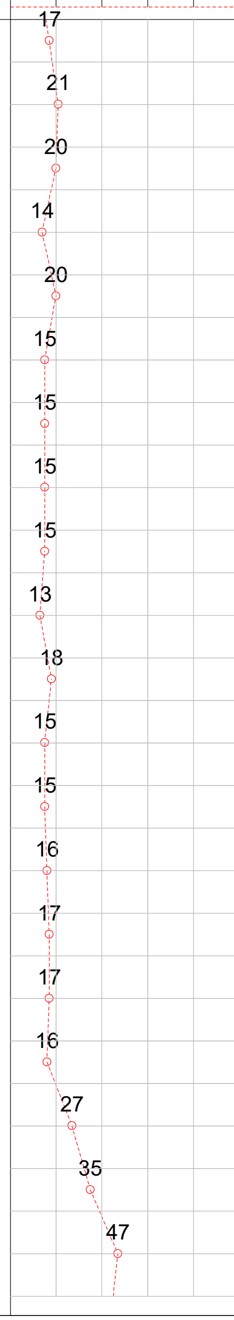


NOTES

Borehole Log (continued): BH2

Project No.: 220487
Project: Proposed Warehouse
Client: Entrepreneur Holding Corp.
Location: 363 Entrepreneur Cres. Vars ON
Date: November 17, 2022
Field Personnel: BJ
Driller: CCC Geotech and Enviro Drilling
Drilling Equipment: Track Mount CME 75
Drilling Method: Hollow Stew Auger

SUBSURFACE PROFILE		SAMPLE DATA					Shear Strength (kPa) 50 150 / SPT N Value (Blows/0.3 m) 20 40 60 80	Water Content (%) 25 50 75 / Liquid Limit (%) 25 50 75	Monitoring Well Details
Depth	Soil Description	Elev./Depth (m)	Type	Sample Number	N or RQD	Recovery (%)			
60 ft									
61 ft	INFERRED GLACIAL TILL	81.56 / 18.60							
62 ft / 19 m									
63–78 ft / 20–23 m									



NOTES

Borehole Log (continued): BH2

Project No.: 220487
Project: Proposed Warehouse
Client: Entrepreneur Holding Corp.
Location: 363 Entrepreneur Cres. Vars ON
Date: November 17, 2022
Field Personnel: BJ
Driller: CCC Geotech and Enviro Drilling
Drilling Equipment: Track Mount CME 75
Drilling Method: Hollow Stew Auger

SUBSURFACE PROFILE		SAMPLE DATA							
Depth	Soil Description	Elev./Depth (m)	Type	Sample Number	N or RQD	Recovery (%)	Shear Strength (kPa) 50 150 / SPT N Value (Blows/0.3 m) 20 40 60 80	Water Content (%) 25 50 75 / Liquid Limit (%) 25 50 75	Monitoring Well Details
79							44		
80		75.67 24.50					50		
81	End of Borehole								
82 / 25									
83									
84									
85 / 26									
86									
87									
88 / 27									
89									
90									
91									
92 / 28									
93									
94									
95 / 29									
96									
97									
98									

NOTES

Borehole Log: BH3

Project No.: 220487
Project: Proposed Warehouse
Client: Entrepreneur Holding Corp.
Location: 363 Entrepreneur Cres. Vars ON
Date: November 17, 2022
Field Personnel: BJ

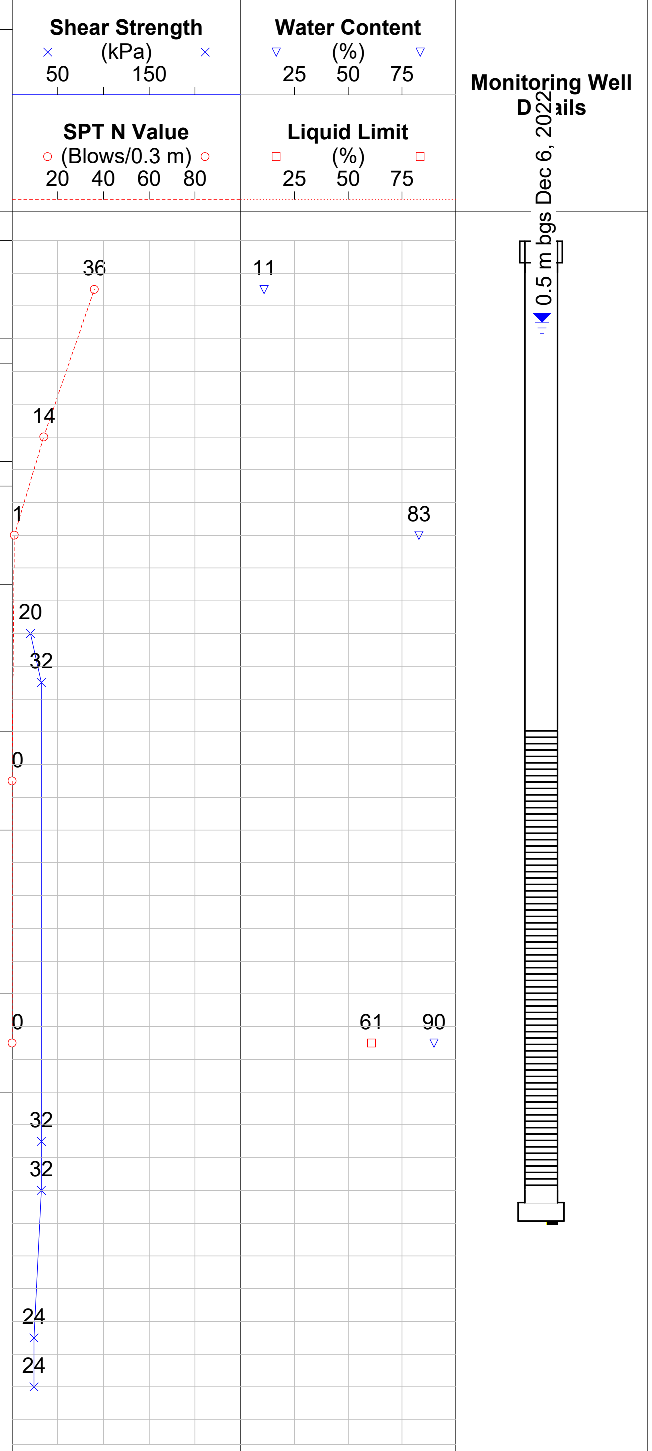
Driller: CCC Geotech and Enviro Drilling
Drilling Equipment: Track Mount CME 75
Drilling Method: Hollow Stew Auger

SUBSURFACE PROFILE

Depth (m)	Soil Description	Elev./Depth (m)
0	Ground Surface	100.18
0.00	**FILL MATERIAL** crushed stone, grey, moist, dense.	100.18 / 0.00
0.69	**SILTY SAND** brown, moist, compact.	99.49 / 0.69
1.45	**CLAYEY SILT** trace sand, grey, very soft, wet. -Sand seam at about 3.65 m bgs	98.73 / 1.45
4.12	**SILTY CLAY** grey, very soft, wet.	96.06 / 4.12
7.00	End of Borehole	93.18 / 7.00

SAMPLE DATA

Sample Number	N or RQD	Recovery (%)	SPT N Value (Blows/0.3 m)	Water Content (%)	Liquid Limit (%)
SS1	36	50	36	11	
SS2	14	50	14		
SS3	1	100	1	83	
SS4	WH	100	0		
SS5	WH	100	0	90	61



Easting: 465745 m
Northing: 5020920 m

Site Datum: TBM - Top of Culvert located at Southwest of Driveway entrance. (100.00 m)

Groundsurface Elevation: 100.180 m
Top of Riser Elev.: NA

Hole Diameter: 200 mm
Monitoring Well Diameter: 19 mm

NOTES:

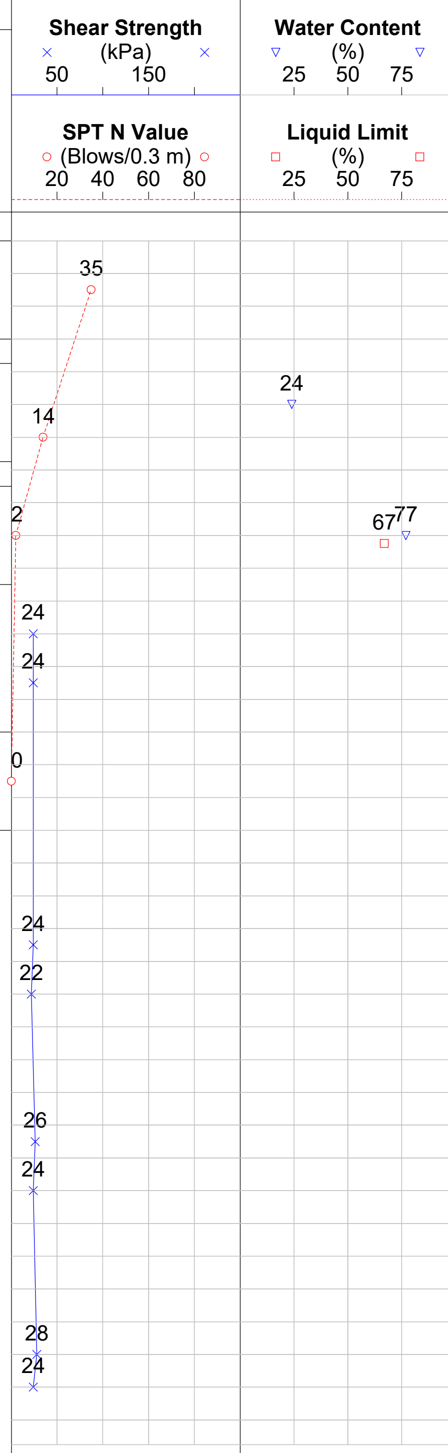
Borehole Log: BH4

Project No.: 220487
Project: Proposed Warehouse
Client: Entrepreneur Holding Corp.
Location: 363 Entrepreneur Cres. Vars ON
Date: November 17, 2022
Field Personnel: BJ

Driller: CCC Geotech and Enviro Drilling
Drilling Equipment: Track Mount CME 75
Drilling Method: Hollow Stew Auger

SUBSURFACE PROFILE / SAMPLE DATA

Depth (m)	Soil Description	Elev./Depth (m)	Type	Sample Number	N or RQD	Recovery (%)
0	Ground Surface	100.22				
0.00–0.60	**FILL MATERIAL** crushed stone, grey, moist, dense.	100.22 / 0.00		SS1	35	33
0.60–1.45	**SILTY SAND** brown, moist, compact.	99.63 / 0.60		SS2	14	50
1.45–4.12	**CLAYEY SILT** trace sand, grey, firm to very soft, wet.	98.77 / 1.45		SS3	2	100
				SS4	WH	100
4.12–7.00	**SILTY CLAY** grey, very soft, wet.	96.10 / 4.12				
7.00	End of Borehole	93.22 / 7.00				



Monitoring Well Details

Easting: 465770 m
Northing: 5020920 m

Site Datum: TBM - Top of Culvert located at Southwest of Driveway entrance. (100.00 m)

Groundsurface Elevation: 100.225 m
Top of Riser Elev.: NA

Hole Diameter: 200 mm
Monitoring Well Diameter: N/A

NOTES:

BOREHOLE LOG: BH23-1

LRL ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

PROJECT NO.: 220487
CLIENT: ENTREPRENEUR HOLDING CORPORATION
DATE: MARCH 14, 2023
PROJECT: PHASE II ENVIRONMENTAL SITE ASSESSMENT
LOCATION: 363 ENTREPRENEUR CRESCENT, OTTAWA, ONTARIO
FIELD PERSONNEL: ABDUL KADER

DRILLER: GEORGE DOWNING ESTATE DRILLING LTD. **DRILLING EQUIPMENT:** TRACK MOUNTED GEO-PROBE **DRILLING METHOD:** DIRECT PUSH

SOIL DESCRIPTION	ELEV./DEPTH (m)
FILL: Sand and gravel, grey, loose, moist, saturated at (0.0 - 0.2 m bgs).	99.88 / 0.00 – 99.03
SAND: Silty, brown, moist becoming saturated with depth.	0.85 – 98.68
CLAY: Silty at (1.20 - 1.95 m bgs) and at (3.65 - 4.50 m bgs), grey, brown at (1.20 - 1.95 m bgs), saturated.	1.20 – 93.88
End of Borehole	6.0

SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS	Combustible Soil Vapours (ppm)
SS1 (SS50)		100	PHC, VOC, Metals & General Inorganics	0.1
SS2				<0.1
SS3		100	PHC & VOC	<0.1
SS4			PAH & PCB	<0.1
SS5		100		<0.1
SS6				<0.1
SS7		100		<0.1
SS8				<0.1
SS9		100		<0.1
SS10				<0.1

Combustible Soil Vapours (ppm): 10, 30, 50, 70, 90
ISOBUTYLENE (ppm): 200, 600, 1000, 1400, 1800

MONITORING WELL DETAILS

EASTING: 18T 0465761 **NORTHING:** 5020902

SITE DATUM: Elevations measured from temporary benchmark established at the top surface of the Entrepreneur Crescent Centerline opposite the the Site entrance (100.00 m).

GROUNDSURFACE ELEVATION: 99.88 m **TOP OF RISER ELEVATION:** N/A
HOLE DIAMETER: 91 mm **MONITORING WELL DIAMETER:** N/A

NOTES:
bgs: Below Ground Surface
VOC: Volatile Organic Compounds
PHC: Petroleum Hydrocarbons
PAH: Polycyclic Aromatic Hydrocarbons
PCB: Polychlorinated Biphenyls
N/A: Not applicable

BOREHOLE LOG: BH/MW23-2

LRL
ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

PROJECT NO.: 220487
PROJECT: PHASE II ENVIRONMENTAL SITE ASSESSMENT
CLIENT: ENTREPRENEUR HOLDING CORPORATION
LOCATION: 363 ENTREPRENEUR CRESCENT, OTTAWA, ONTARIO
DATE: MARCH 14, 2023
FIELD PERSONNEL: ABDUL KADER

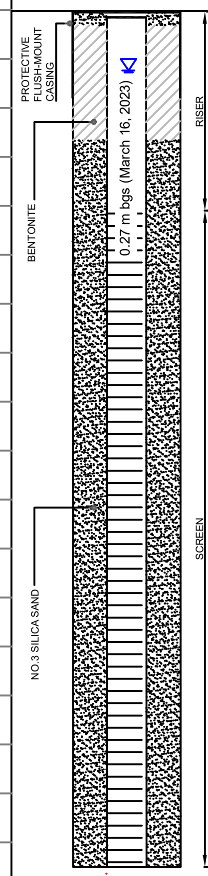
DRILLER: GEORGE DOWNING ESTATE DRILLING LTD.
DRILLING EQUIPMENT: TRACK MOUNTED GEO-PROBE
DRILLING METHOD: DIRECT PUSH

DEPTH (M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS	Combustible Soil Vapours (ppm)
0.0	**FILL:** Sand and gravel, grey, loose, moist, saturated at (0.0 - 0.2 m bgs).	99.90 / 0.00	SS1 (SS40)		100	PHC, VOC, Metals & General Inorganics	0.2
	SAND: Silty, brown, moist.	99.05 / 0.85	SS2				<0.1
	CLAY: Silty at (1.20 - 1.95 m bgs) and at (3.60 - 4.80 m bgs), brown becoming grey at (1.95 m bgs), saturated.	98.70 / 1.20	SS3		100		<0.1
			SS4				<0.1
			SS5		100		<0.1
			SS6				<0.1
			SS7		100		<0.1
			SS8				<0.1
			SS9		100		<0.1
			SS10				<0.1
6.0	End of Borehole	93.90 / 6.0					

Depth scale: FT 0.0 – 20.0; M 0.0 – 6.0

Combustible Soil Vapours (ppm): 10, 30, 50, 70, 90
ISOBUTYLENE (ppm): 200, 600, 1000, 1400, 1800

MONITORING WELL DETAILS



Groundwater samples collected March 16, 2023 were submitted for laboratory analysis of VOC, PHC, PAH, Metals, Metals hydrides, and General Inorganics.

EASTING: 18T 0465753
NORTHING: 5020904
SITE DATUM: Elevations measured from temporary benchmark established at the top surface of the Entrepreneur Crescent Centerline opposite the the Site entrance (100.00 m).
GROUNDSURFACE ELEVATION: 99.90 m
TOP OF RISER ELEVATION: N/A
HOLE DIAMETER: 91 mm
MONITORING WELL DIAMETER: N/A

NOTES:
bgs: Below Ground Surface
VOC: Volatile Organic Compounds
PHC: Petroleum Hydrocarbons
PAH: Polycyclic Aromatic Hydrocarbons
PCB: Polychlorinated Biphenyls
N/A: Not applicable

BOREHOLE LOG: BH/MW23-3

LRL
ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

PROJECT NO.: 220487
PROJECT: PHASE II ENVIRONMENTAL SITE ASSESSMENT
CLIENT: ENTREPRENEUR HOLDING CORPORATION
LOCATION: 363 ENTREPRENEUR CRESCENT, OTTAWA, ONTARIO
DATE: MARCH 14, 2023
FIELD PERSONNEL: ABDUL KADER

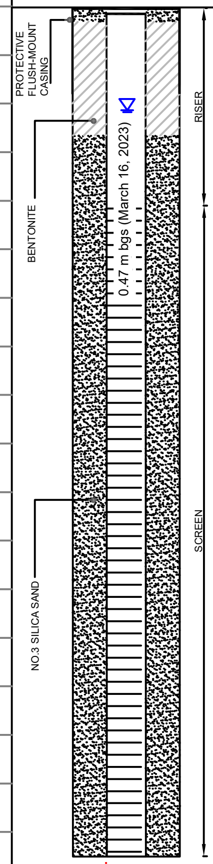
DRILLER: GEORGE DOWNING ESTATE DRILLING LTD.
DRILLING EQUIPMENT: TRACK MOUNTED GEO-PROBE
DRILLING METHOD: DIRECT PUSH

DEPTH	SOIL DESCRIPTION	ELEV./DEPTH (m)	LITHOLOGY
0.0 ft / 0.0 m		99.88 0.00	
0.0 – 0.85 m	**FILL:** Sand and gravel, grey, loose, moist, saturated at (0.0 - 0.2 m bgs).	99.03 0.85	Fill
0.85 – 1.20 m	**SAND:** Silty, green, moist.	98.68 1.20	Sand
1.20 – 6.0 m	**CLAY:** Silty at (1.20 - 1.95 m bgs) and at (3.60 - 4.25 m bgs), brown becoming grey at (1.95 m bgs), some red at (1.95 - 2.4 m bgs) and at (4.25 - 4.8 m bgs), saturated.	93.88 6.0	Clay
6.0 m (20.0 ft)	End of Borehole		

SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS	Combustible Soil Vapours (ppm)
SS1		69	PHC, VOC, Metals & General Inorganics	0.1
SS2			PHC & VOC	<0.1
SS3		100	Metals & General Inorganics	<0.1
SS4			PAH & PCB	<0.1
SS5		100		<0.1
SS6				<0.1
SS7		100		<0.1
SS8				<0.1
SS9		100		<0.1
SS10				<0.1

Combustible Soil Vapours (ppm): 10, 30, 50, 70, 90
ISOBUTYLENE (ppm): 200, 600, 1000, 1400, 1800

MONITORING WELL DETAILS



Groundwater samples collected March 16, 2023 were submitted for laboratory analysis of VOC, PHC, PAH, Metals, Metals hydrides, and General Inorganics.

EASTING: 18T 0465763
NORTHING: 5020877
SITE DATUM: Elevations measured from temporary benchmark established at the top surface of the Entrepreneur Crescent Centerline opposite the the Site entrance (100.00 m).
GROUNDSURFACE ELEVATION: 99.88 m
TOP OF RISER ELEVATION: N/A
HOLE DIAMETER: 91 mm
MONITORING WELL DIAMETER: N/A

NOTES:
bgs: Below Ground Surface
VOC: Volatile Organic Compounds
PHC: Petroleum Hydrocarbons
PAH: Polycyclic Aromatic Hydrocarbons
PCB: Polychlorinated Biphenyls
N/A: Not applicable

BOREHOLE LOG: BH/MW23-4

ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

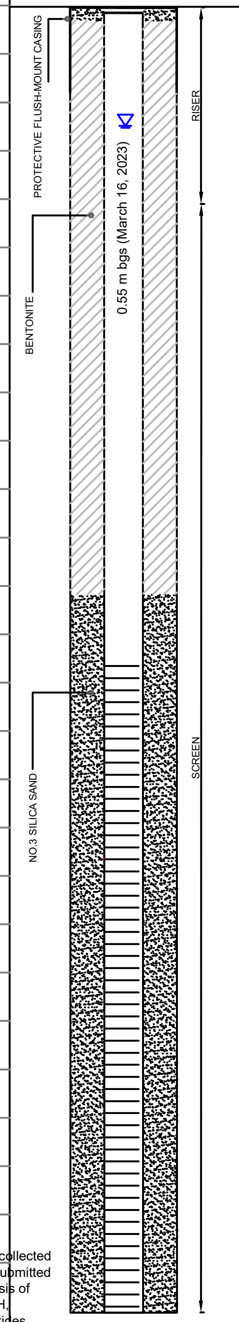
PROJECT NO.: 220487
PROJECT: PHASE II ENVIRONMENTAL SITE ASSESSMENT
CLIENT: ENTREPRENEUR HOLDING CORPORATION
LOCATION: 363 ENTREPRENEUR CRESCENT, OTTAWA, ONTARIO
DATE: MARCH 13, 2023
FIELD PERSONNEL: ABDUL KADER

DRILLER: GEORGE DOWNING ESTATE DRILLING LTD.
DRILLING EQUIPMENT: TRACK MOUNTED GEO-PROBE
DRILLING METHOD: DIRECT PUSH

DEPTH (M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS	Combustible Soil Vapours (ppm)
0.0 – 1.0	**FILL:** Sand and gravel, grey, loose, moist, saturated at (0.0 - 0.2 m bgs).	99.87 / 0.00	SS1		65	Metals & General Inorganics	0.1
1.0 – 1.20	**SAND:** Silty, brown, moist.	98.87 / 1.0	SS2			PHC & Metals	<0.1
1.20 – 6.0	**CLAY:** Silty sandy at (1.20 - 2.0 m bgs), silty at (3.60 - 4.25 m bgs), brown becoming grey at (2.0 m bgs), saturated.	98.67 / 1.20	SS3		100	Metals & General Inorganics	<0.1
			SS4			PAH & PCB	<0.1
			SS5		100		<0.1
			SS6				<0.1
			SS7		100		<0.1
			SS8				<0.1
			SS9		100		<0.1
			SS10				<0.1
6.0	End of Borehole	93.87 / 6.0					

Combustible Soil Vapours (ppm): 10, 30, 50, 70, 90
ISOBUTYLENE (ppm): 200, 600, 1000, 1400, 1800

MONITORING WELL DETAILS



Groundwater samples collected March 16, 2023 were submitted for laboratory analysis of VOC, PHC, PAH, Metals, Metals hydrides, and General Inorganics.

EASTING: 18T 0465769
NORTHING: 5020895
SITE DATUM: Elevations measured from temporary benchmark established at the top surface of the Entrepreneur Crescent Centerline opposite the the Site entrance (100.00 m).
GROUNDSURFACE ELEVATION: 99.87 m
TOP OF RISER ELEVATION: N/A
HOLE DIAMETER: 91 mm
MONITORING WELL DIAMETER: N/A

NOTES:
bgs: Below Ground Surface
VOC: Volatile Organic Compounds
PHC: Petroleum Hydrocarbons
PAH: Polycyclic Aromatic Hydrocarbons
PCB: Polychlorinated Biphenyls
N/A: Not applicable

BOREHOLE LOG: BH/MW23-5

LRL
ENGINEERING | INGENIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

PROJECT NO.: 220487
PROJECT: PHASE II ENVIRONMENTAL SITE ASSESSMENT
CLIENT: ENTREPRENEUR HOLDING CORPORATION
LOCATION: 363 ENTREPRENEUR CRESCENT, OTTAWA, ONTARIO
DATE: MARCH 13, 2023
FIELD PERSONNEL: ABDUL KADER

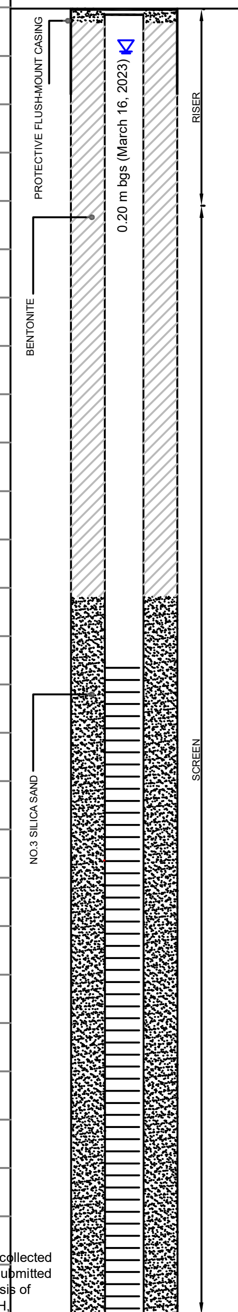
DRILLER: GEORGE DOWNING ESTATE DRILLING LTD.
DRILLING EQUIPMENT: TRACK MOUNTED GEO-PROBE
DRILLING METHOD: DIRECT PUSH

DEPTH (M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	LITHOLOGY	TYPE	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS	Combustible Soil Vapours (ppm) / ISOBUTYLENE (ppm)
0.0 – 1.0	**FILL:** Sand and gravel, brown at (0.0 - 0.2 m bgs) followed by grey to (0.9 m bgs) followed by red stone to (1.0 m bgs), moist.	99.89 / 0.00 – 98.89			SS2 (SS20)		75	PHC, VOC, Metals & General Inorganics	0.3
1.0 – 1.20	**SAND:** Silty, brown, moist.	98.89 / 1.0 – 98.69			SS2				0.2
1.20 – 6.0	**CLAY:** Silty at (1.20 - 1.75 m bgs), brown becoming grey at (1.75 m bgs), some red, saturated.	98.69 / 1.20			SS3		100	PHC, VOC, & Metals	0.1
					SS4				<0.1
					SS5		100		<0.1
					SS6				<0.1
					SS7		100		<0.1
					SS8				<0.1
					SS9		100		<0.1
					SS10				<0.1
6.0	End of Borehole	93.89 / 6.0							

Combustible Soil Vapours (ppm): 10, 30, 50, 70, 90
ISOBUTYLENE (ppm): 200, 600, 1000, 1400, 1800

Depth scale: FT 0.0 – 20.0; M 0.0 – 6.0

MONITORING WELL DETAILS



Groundwater samples collected March 16, 2023 were submitted for laboratory analysis of VOC, PHC, PAH, Metals, Metals hydrides, and General Inorganics.

EASTING: 18T 0465749
NORTHING: 5020933
SITE DATUM: Elevations measured from temporary benchmark established at the top surface of the Entrepreneur Crescent Centerline opposite the the Site entrance (100.00 m).
GROUNDSURFACE ELEVATION: 99.89 m
TOP OF RISER ELEVATION: N/A
HOLE DIAMETER: 91 mm
MONITORING WELL DIAMETER: N/A

NOTES:
bgs: Below Ground Surface
VOC: Volatile Organic Compounds
PHC: Petroleum Hydrocarbons
PAH: Polycyclic Aromatic Hydrocarbons
PCB: Polychlorinated Biphenyls
N/A: Not applicable

BOREHOLE LOG: BH23-6

LRL ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

PROJECT NO.: 220487
PROJECT: PHASE II ENVIRONMENTAL SITE ASSESSMENT
CLIENT: ENTREPRENEUR HOLDING CORPORATION
LOCATION: 363 ENTREPRENEUR CRESCENT, OTTAWA, ONTARIO
DATE: MARCH 13, 2023
FIELD PERSONNEL: ABDUL KADER

DRILLER: GEORGE DOWNING ESTATE DRILLING LTD.
DRILLING EQUIPMENT: TRACK MOUNTED GEO-PROBE
DRILLING METHOD: DIRECT PUSH

DEPTH (FT / M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	LITHOLOGY	TYPE	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS	Combustible Soil Vapours (ppm) / ISOBUTYLENE (ppm)	MONITORING WELL DETAILS
0.0 ft / 0.0 m		99.90								
0.0 – 2.8 ft / 0.0 – 0.85 m	**FILL:** Sand and gravel, brown at (0.0 - 0.35 m bgs) followed by grey to (0.85 m bgs), dry, loose.	0.00			SS1		100		0.1	
2.8 – 3.9 ft / 0.85 – 1.20 m	**SAND:** Silty, brown, moist.	99.05 / 0.85			SS2			PHC, VOC, Metals & General Inorganics	0.1	
3.9 – 19.7 ft / 1.20 – 6.0 m	**CLAY:** Silty sandy at (1.20 - 1.9 m bgs), silty at (4.8 - 6.0 m bgs), brown becoming grey with depth, saturated, the sampling tube was empty at (3.6 - 4.8 m bgs) due to high water content.	98.70 / 1.20			SS3		100		<0.1	
					SS4				<0.1	
					SS5		100		<0.1	
					SS6				<0.1	
					SS7		100		<0.1	
					SS8				<0.1	
19.7 ft / 6.0 m	End of Borehole	93.90 / 6.0								

Combustible Soil Vapours (ppm) scale: 10, 30, 50, 70, 90
ISOBUTYLENE (ppm) scale: 200, 600, 1000, 1400, 1800

EASTING: 18T 0465743
NORTHING: 5020927
SITE DATUM: Elevations measured from temporary benchmark established at the top surface of the Entrepreneur Crescent Centerline opposite the the Site entrance (100.00 m).
GROUNDSURFACE ELEVATION: 99.90 m
TOP OF RISER ELEVATION: N/A
HOLE DIAMETER: 91 mm
MONITORING WELL DIAMETER: N/A

NOTES:
bgs: Below Ground Surface
VOC: Volatile Organic Compounds
PHC: Petroleum Hydrocarbons
PAH: Polycyclic Aromatic Hydrocarbons
PCB: Polychlorinated Biphenyls
N/A: Not applicable

BOREHOLE LOG: BH23-7

LRL ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

PROJECT NO.: 220487
CLIENT: ENTREPRENEUR HOLDING CORPORATION
DATE: MARCH 14, 2023

PROJECT: PHASE II ENVIRONMENTAL SITE ASSESSMENT
LOCATION: 363 ENTREPRENEUR CRESCENT, OTTAWA, ONTARIO
FIELD PERSONNEL: ABDUL KADER

DRILLER: GEORGE DOWNING ESTATE DRILLING LTD. **DRILLING EQUIPMENT:** TRACK MOUNTED GEO-PROBE **DRILLING METHOD:** DIRECT PUSH

Depth scale: FT 0.0 – 20.0; M 0.0 – 6.0

SOIL DESCRIPTION	ELEV./DEPTH (m)	LITHOLOGY	TYPE	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS	Combustible Soil Vapours (ppm)
	99.89 / 0.00							
FILL: Sand and gravel, grey, dry, moist at (0.0 - 0.1 m bgs).	98.89 / 1.0	Fill		SS1		71	PHC, VOC, Metals & General Inorganics	0.3
SAND: Silty, brown, moist.	98.69 / 1.20	Sand		SS2		71		<0.1
CLAY: Silty at (1.20 - 1.95 m bgs) and at (3.6 - 4.20 m bgs), grey, brown at (1.20 - 1.95 m bgs), some red at (1.20 - 2.4 m bgs) and at (4.8 - 6.0 m bgs), saturated.		Clay		SS3		100	Metals	<0.1
				SS4		100		<0.1
				SS5		100		<0.1
				SS6		100		<0.1
				SS7		100		<0.1
				SS8		100		<0.1
				SS9		100		<0.1
	93.89 / 6.0			SS10		100		<0.1
End of Borehole								

Combustible Soil Vapours (ppm): 10, 30, 50, 70, 90
ISOBUTYLENE (ppm): 200, 600, 1000, 1400, 1800

MONITORING WELL DETAILS

EASTING: 18T 0465765 **NORTHING:** 5020919

SITE DATUM: Elevations measured from temporary benchmark established at the top surface of the Entrepreneur Crescent Centerline opposite the the Site entrance (100.00 m).

GROUNDSURFACE ELEVATION: 99.89 m **TOP OF RISER ELEVATION:** N/A
HOLE DIAMETER: 91 mm **MONITORING WELL DIAMETER:** N/A

NOTES:
bgs: Below Ground Surface
VOC: Volatile Organic Compounds
PHC: Petroleum Hydrocarbons
PAH: Polycyclic Aromatic Hydrocarbons
PCB: Polychlorinated Biphenyls
N/A: Not applicable

BOREHOLE LOG: BH23-8

LRL ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

PROJECT NO.: 220487
PROJECT: PHASE II ENVIRONMENTAL SITE ASSESSMENT
CLIENT: ENTREPRENEUR HOLDING CORPORATION
LOCATION: 363 ENTREPRENEUR CRESCENT, OTTAWA, ONTARIO
DATE: MARCH 13, 2023
FIELD PERSONNEL: ABDUL KADER

DRILLER: GEORGE DOWNING ESTATE DRILLING LTD. **DRILLING EQUIPMENT:** TRACK MOUNTED GEO-PROBE **DRILLING METHOD:** DIRECT PUSH

DEPTH (M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS	Combustible Soil Vapours (ppm)	MONITORING WELL DETAILS
0.0		99.87 / 0.00						
0.0 – 0.80	**FILL:** Sand and gravel, grey, moist.	98.07 / 0.80	SS1		92		0.1	
0.80 – 1.20	**SAND:** Silty to (1.10 m bgs). followed by silty clayey, brown with some red spots, wet.	98.67 / 1.20	SS2			PHC, VOC, Metals & General Inorganics	<0.1	
1.20 – 6.0	**CLAY:** Silty at (1.20 - 1.95 m bgs), grey, grey-brown at (1.20 - 1.95 m bgs), some red at (1.95 - 2.4 m bgs), saturated.	93.87 / 6.0	SS3		100	Metals	<0.1	
			SS4				<0.1	
			SS5		100		<0.1	
			SS6				<0.1	
			SS7		100		<0.1	
			SS8				<0.1	
			SS9		100		<0.1	
			SS10				<0.1	
6.0	End of Borehole							

Combustible Soil Vapours (ppm): 10, 30, 50, 70, 90
ISOBUTYLENE (ppm): 200, 600, 1000, 1400, 1800

EASTING: 18T 0465756 **NORTHING:** 5020940

SITE DATUM: Elevations measured from temporary benchmark established at the top surface of the Entrepreneur Crescent Centerline opposite the the Site entrance (100.00 m).

GROUNDSURFACE ELEVATION: 99.87 m **TOP OF RISER ELEVATION:** N/A
HOLE DIAMETER: 91 mm **MONITORING WELL DIAMETER:** N/A

NOTES:
bgs: Below Ground Surface
VOC: Volatile Organic Compounds
PHC: Petroleum Hydrocarbons
PAH: Polycyclic Aromatic Hydrocarbons
PCB: Polychlorinated Biphenyls
N/A: Not applicable

BOREHOLE LOG: BH23-9

LRL ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

PROJECT NO.: 220487
PROJECT: PHASE II ENVIRONMENTAL SITE ASSESSMENT
CLIENT: ENTREPRENEUR HOLDING CORPORATION
LOCATION: 363 ENTREPRENEUR CRESCENT, OTTAWA, ONTARIO
DATE: MARCH 14, 2023
FIELD PERSONNEL: ABDUL KADER

DRILLER: GEORGE DOWNING ESTATE DRILLING LTD.
DRILLING EQUIPMENT: TRACK MOUNTED GEO-PROBE
DRILLING METHOD: DIRECT PUSH

DEPTH (M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	LITHOLOGY	TYPE	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS	Combustible Soil Vapours (ppm) / ISOBUTYLENE (ppm)	MONITORING WELL DETAILS
0.0	**FILL:** Sand and gravel, grey, dry, moist at (0.0 - 0.1 m bgs).	99.89 / 0.00			SS1		92	PHC, VOC, Metals & General Inorganics	<0.1	
1.0	**SAND:** Silty, brown, moist.	98.89 / 1.0			SS2				<0.1	
1.20	**CLAY:** Silty at (1.20 - 1.85 m bgs), grey-brown with some red at (1.20 - 1.85 m bgs) followed by grey at (1.85 - 2.4 m bgs), saturated.	98.69 / 1.20			SS3		100		<0.1	
					SS4				<0.1	
2.4	End of Borehole	97.49 / 2.4								

Combustible Soil Vapours (ppm) scale: 10, 30, 50, 70, 90
ISOBUTYLENE (ppm) scale: 200, 600, 1000, 1400, 1800

Depth scale: FT 0.0–20.0; M 0.0–6.0

EASTING: 18T 0465765
NORTHING: 5020921
SITE DATUM: Elevations measured from temporary benchmark established at the top surface of the Entrepreneur Crescent Centerline opposite the the Site entrance (100.00 m).
GROUNDSURFACE ELEVATION: 99.89 m
TOP OF RISER ELEVATION: N/A
HOLE DIAMETER: 91 mm
MONITORING WELL DIAMETER: N/A

NOTES:
bgs: Below Ground Surface
VOC: Volatile Organic Compounds
PHC: Petroleum Hydrocarbons
PAH: Polycyclic Aromatic Hydrocarbons
PCB: Polychlorinated Biphenyls
N/A: Not applicable

BOREHOLE LOG: BH23-10

LRL ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

PROJECT NO.: 220487
PROJECT: PHASE II ENVIRONMENTAL SITE ASSESSMENT
CLIENT: ENTREPRENEUR HOLDING CORPORATION
LOCATION: 363 ENTREPRENEUR CRESCENT, OTTAWA, ONTARIO
DATE: MARCH 14, 2023
FIELD PERSONNEL: ABDUL KADER
DRILLER: GEORGE DOWNING ESTATE DRILLING LTD.
DRILLING EQUIPMENT: TRACK MOUNTED GEO-PROBE
DRILLING METHOD: DIRECT PUSH

DEPTH (FT / M)	SOIL DESCRIPTION	ELEV./DEPTH (m)	LITHOLOGY	TYPE	SAMPLE NUMBER	N OR RQD (%)	RECOVERY (%)	LABORATORY ANALYSIS	Combustible Soil Vapours (ppm) / ISOBUTYLENE (ppm)	MONITORING WELL DETAILS
0.0 ft / 0.0 m	**FILL:** Sand and gravel, grey, dry, moist at (0.0 - 0.1 m bgs).	99.88 / 0.00			SS1		90	PHC, VOC, Metals & General Inorganics	<0.1	
	SAND: Silty, brown, moist.	99.03 / 0.85			SS2			Metals	<0.1	
	CLAY: Silty at (1.20 - 1.9 m bgs), grey-brown with some red at (1.20 - 1.9 m bgs), followed by grey with red at (1.9 - 2.4 m bgs), saturated.	98.68 / 1.20			SS3		100		<0.1	
					SS4				<0.1	
	End of Borehole	97.48 / 2.4								

Combustible Soil Vapours (ppm) scale: 10, 30, 50, 70, 90
ISOBUTYLENE (ppm) scale: 200, 600, 1000, 1400, 1800

Depth scale: FT 0.0 – 20.0; M 0.0 – 6.0

EASTING: 18T 0465761
NORTHING: 5020893
SITE DATUM: Elevations measured from temporary benchmark established at the top surface of the Entrepreneur Crescent Centerline opposite the the Site entrance (100.00 m).
GROUNDSURFACE ELEVATION: 99.88 m
TOP OF RISER ELEVATION: N/A
HOLE DIAMETER: 91 mm
MONITORING WELL DIAMETER: N/A

NOTES:
bgs: Below Ground Surface
VOC: Volatile Organic Compounds
PHC: Petroleum Hydrocarbons
PAH: Polycyclic Aromatic Hydrocarbons
PCB: Polychlorinated Biphenyls
N/A: Not applicable

Symbols and Terms Used on Borehole and Test Pit Logs

The following explains the data presented in the borehole and test pit logs.

1. Soil Description

The soil descriptions presented in this report are based on commonly accepted methods of classification and identification employed in geotechnical practice. Classification and identification of soil involves some judgement and LRL Associates Ltd. does not guarantee descriptions as exact, but infers accuracy to the extent that is common in current geotechnical practice. Boundaries between zones on the logs are often not distinct but transitional and were interpreted.

a. Proportion

The proportion of each constituent part, as defined by the grain size distribution, is denoted by the following terms:

Term	Proportions
"trace"	1% to 10%
"some"	10% to 20%
prefix (i.e. "sandy" silt)	20% to 35%
"and" (i.e. sand "and" gravel)	35% to 50%

b. Compactness and Consistency

The state of compactness of granular soils is defined on the basis of the Standard Penetration Test. See Section 2c for more details. The consistency of clayey or cohesive soils is based on the shear strength of the soil, as determined by field vane tests and by a visual and tactile assessment of the soil strength.

The state of compactness of granular soils is defined by the following terms:

State of Compactness Granular Soils	Standard Penetration Number "N"
Very loose	0 – 4
Loose	4 – 10
Compact or medium	10 - 30
Dense	30 - 50
Very dense	over - 50

The consistency of cohesive soils is defined by the following terms:

Consistency Cohesive Soils	Undrained Shear Strength (Cu) (kPa)
Very soft	under 10
Soft	10 - 25
Medium or firm	25 - 50
Stiff	50 - 100
Very stiff	100 - 200
Hard	over - 200

2. Sample Data

a. Elevation depth

This is a reference to the geodesic elevation of the soil or to a benchmark of an arbitrary elevation at the location of the borehole or test pit. The depth of geological boundaries is measured from ground surface.

b. Type

Symbol	Type	Letter Code
	Auger	AU
	Split spoon	SS
	Shelby tube	ST
	Rock Core	RC

c. Sample Number

Each sample taken from the borehole is numbered in the field as shown in this column.

LETTER CODE (as above) – Sample Number

d. Blows (N) or RQD

This column indicates the Standard Penetration Number (N) as per ASTM D-1586. This is used to determine the state of compactness of the soil sampled. It corresponds to the number of blows required to drive 300 mm of the split spoon sampler using a 622 kg*m/s^2 hammer falling freely from a height of 760 mm. For a 600 mm long split spoon, the blow counts are recorded for every 150 mm. The "N" index is obtained by adding the number of blows from the 2nd and 3rd count. Technical refusal indicates a number of blows greater than 50.

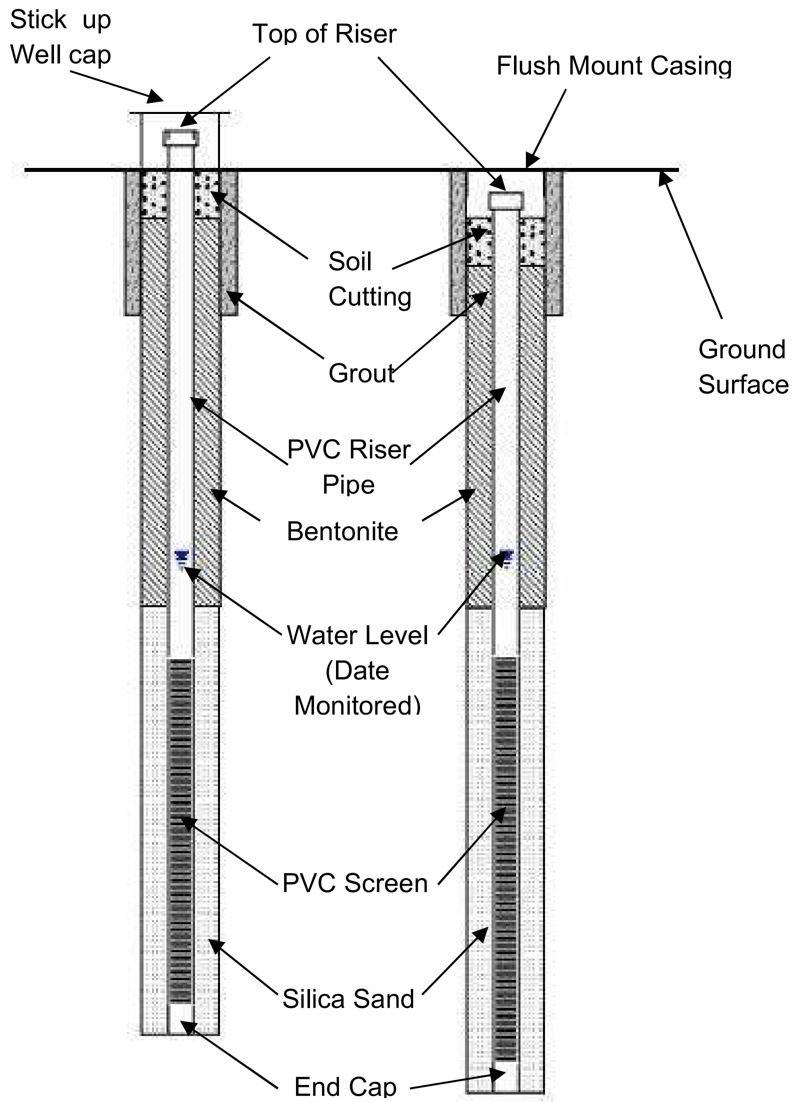
In the case of rock, this column presents the Rock Quality Designation (RQD). The RQD is calculated as the cumulative length of rock pieces recovered having lengths of 10 cm or more divided by the length of coring. The qualitative description of the bedrock based on RQD is given below.

Rock Quality Designation (RQD) (%)	Description of Rock Quality
0 –25	very poor
25 – 50	poor
50 – 75	fair
75 – 90	good
90 – 100	excellent

e. Recovery (%)

For soil samples this is the percentage of the recovered sample obtained versus the length sampled. In the case of rock, the percentage is the length of rock core recovered compared to the length of the drill run.

3. General Monitoring Well Data



ATTACHMENT C

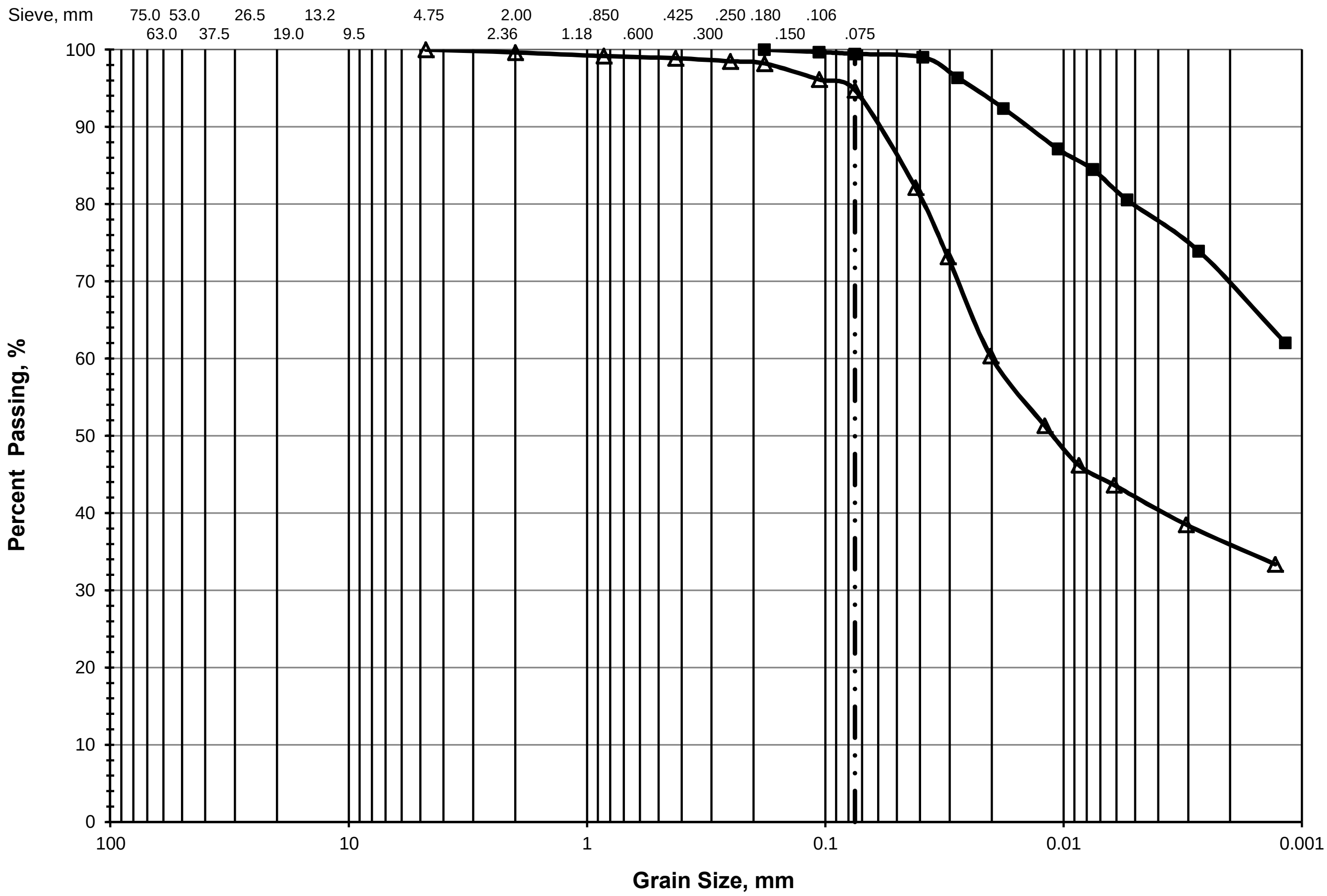
Gradation Analytical Report

LRL Associates Ltd.

PARTICLE SIZE ANALYSIS

ASTM D 422 / LS-702

Client:	Entrepreneur Holding Corporation	**File No.:**	220487
Project:	Geotechnical Investigation	**Report No.:**	2
Location:	363 Entrepreneur Crescent, Navan, ON.	**Date:**	November 17, 2022



Unified Soil Classification System

> 75 mm	% GRAVEL		% SAND			% FINES	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
△ 0.0	0.0	0.0	0.4	0.8	4.1	59.3	35.4
■ 0.0	0.0	0.0	0.0	0.0	0.6	31.0	68.4

	Location	Sample	Depth, m	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
△	BH 1	SS-3	1.52 - 2.13	0.0199	0.0111					
■	BH 2	SS-7	6.10 - 6.71							

ATTACHMENT D

MECP Water Well Records

Ontario Ministry of the Environment, Conservation and Parks

Tag#:A379014 (Print Below)

A379014

Well Record

Regulation 903 Ontario Water Resources Act

Page ____ of ____

Measurements recorded in: ☐ Metric ☒ Imperial

Well Owner's Information

First Name	Last Name/Organization	E-mail Address	☐ Well Constructed by Well Owner
	Dustin Wilson		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
310 Sanctuary Private	Ottawa	ON	K1S 5W1	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
363 Entrepreneur Crescent	Cumberland	23	11

County/District/Municipality	City/Town/Village	Province	Postal Code
Ottawa Carleton	Navan	Ontario	

UTM Coordinates NAD	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
83	18	465760	5020936	50R-6694	

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	To
	Clay			0'	86'
	Gravel			86'	92'
Black	~~Sandstone~~ Shale			92'	154'
Black	~~Sandstone~~ Shale			154'	160'

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
98'	88'	Neat cement	12.48
88'	0'	Bentonite slurry	21.00

Results of Well Yield Testing

After test of well yield, water was: ☐ Clear and sand free ☐ Other, specify **Not tested**

If pumping discontinued, give reason: X

Pump intake set at (m/ft): 150

Pumping rate (l/min / GPM): 15

Duration of pumping: 1 hrs + 0 min

Final water level end of pumping (m/ft): 103.2'

If flowing give rate (l/min/GPM): X

Recommended pump depth (m/ft): 150'

Recommended pump rate (l/min/GPM): 10

Well production (l/min/GPM): 15

Disinfected? ☒ Yes ☐ No

Draw Down Time (min)	Water Level (m/ft)	Recovery Time (min)	Water Level (m/ft)
Static Level	9'2"		103.2"
1	22.4	1	87
2	31.9	2	78.6
3	37.5	3	71.1
4	42.2	4	63.8
5	46.4	5	57.4
10	61.7	10	32.8
15	71.9	15	19.7
20	79.4	20	11.3
25	85.1	25	9.5
30	89.9	30	9.2
40	97	40	9.2
50	100.9	50	9.2
60	103.2	60	9'2"

Method of Construction

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

Well Use

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

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	To
6 1/4"	Steel	.188"	+2'	98'
6"	Open Hole		98'	160'

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

Construction Record - Screen

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

Water Details

Water found at Depth 154 (m/ft) ☐ Gas | Kind of Water: ☐ Fresh ☒ Untested ☐ Other, specify

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

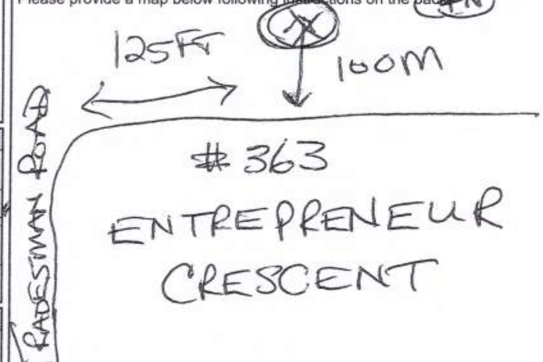
Water found at Depth (m/ft) ☐ Gas | Kind of Water: ☐ Fresh ☐ Untested ☐ Other, specify

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0'	98'	9 3/4"
98'	160'	6"

Map of Well Location

Please provide a map below following instructions on the back. N



Comments: 3/4HP-10GPM Set @ 150 FT

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Air Rock Drilling Co. Ltd.	7681

Business Address (Street Number/Name)	Municipality
6659 Franktown Road	Richmond

Province	Postal Code	Business E-mail Address
ON	K0A 2Z0	air-rock@sympatico.ca

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
6138382170	Hanna, Jeremy

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
T3632		2023 09 29

Well owner's information package delivered ☒ Yes ☐ No | Date Package Delivered 2023 08 28 / 20230823

Ministry Use Only — Audit No. Z408138 — Received

Ontario Ministry of the Environment

Measurements recorded in: ☐ Metric ☑ Imperial

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

A111208 1

12-04-?

Well Record

Regulation 903 Ontario Water Resources Act

Page ______ of ______

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
~~Golder~~	Capital Region Resource	—	

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. *(inc. area code)*
708-225 Metcalfe St	Ottawa	ON	K2P1P9	6134545581

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
570 FRONTIER RD	Ottawa		

County/District/Municipality	City/Town/Village	Province	Postal Code
Ottawa	Ottawa	Ontario	K0A3H0

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 8 3	18T	466522	5020872		

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	To
GRAY	CLAY	SAND · TILL-ROCK	SAND TO CLAY TO TILL then ROCK	0	143
					VSP

6

Annular Space

Depth Set at *(m/ft)* From	To	Type of Sealant Used *(Material and Type)*	Volume Placed *(m^3/ft^3)*
		COATED BENTONITES	
		bentonite chips	
		bentonite GROUT	

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	To
2"	PLASTIC	1/4		

Construction Record - Screen

Outside Diameter *(cm/in)*	Material (Plastic, Galvanized, Steel)	Slot No.	Depth *(m/ft)* From	To

Status of Well

☐ Water Supply ☐ Replacement Well ☐ Test Hole ☐ Recharge Well ☐ Dewatering Well ☐ Observation and/or Monitoring Hole ☐ Alteration (Construction) ☐ Abandoned, Insufficient Supply ☐ Abandoned, Poor Water Quality ☐ Abandoned, other, *specify* ☐ Other, *specify*

Water Details

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

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

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

Hole Diameter

Depth *(m/ft)* From	To	Diameter *(cm/in)*

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)*

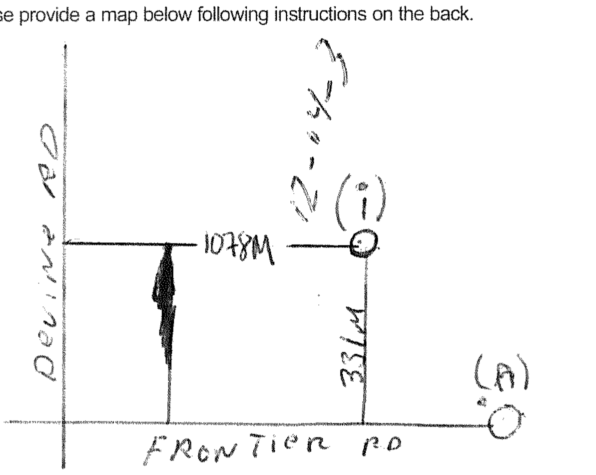
Well production *(l/min / GPM)*

Disinfected? ☐ Yes ☐ No

Draw Down Time *(min)*	Water Level *(m/ft)*	Recovery Time *(min)*	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	

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.
Marathon Drilling Co. Ltd	6894

Business Address (Street Number/Name)	Municipality
6847 Hiram DR	Greely

Province	Postal Code	Business E-mail Address
ON	K4P1A2	mwelsh@marathondrilling.ca

Bus.Telephone No. *(inc. area code)*	Name of Well Technician (Last Name, First Name)
6138220571	Welsh, Matthew

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3279	[signature]	20130425

Well owner's information package delivered ☐ Yes ☐ No

Date Package Delivered Y Y Y Y M M D D

Date Work Completed Y Y Y Y M M D D

Ministry Use Only

Audit No. Z 82629

MAY 06 2013

Received

0506E (12/2007) **Ministry's Copy** © Queen's Printer for Ontario, 2007

Ontario — Ministry of the Environment and Climate Change

Measurements recorded in: ☐ Metric ☒ Imperial

Well Tag No. *(Place Sticker and/or Print Below)*: N/A

Well Record

Regulation 903 Ontario Water Resources Act

Page ______ of ______

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
2030470	ONTARIO LIMITED	C/O Rosedale	

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. *(inc. area code)*
Transport Group, 6845 Invader Cres,	Mississauga	Ont	L5T 2B7	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
#9460 MITCH OWENS ROAD	OSGOODE	Pt L1	11

County/District/Municipality	City/Town/Village	Province	Postal Code
OTTAWA-CARLETON	EDWARDS	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	465655	5020146	RP-5R-13558 Part 2	

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	To
	6" Drilled Well Abandonment			0'	85'

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used *(Material and Type)*	Volume Placed *(m³/ft³)*
85'	5'	3/8 Hole Plug	24 Bags
5'	0'	Backfill	

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)*	Water Level *(m/ft)*	Recovery Time *(min)*	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	To

Status of Well

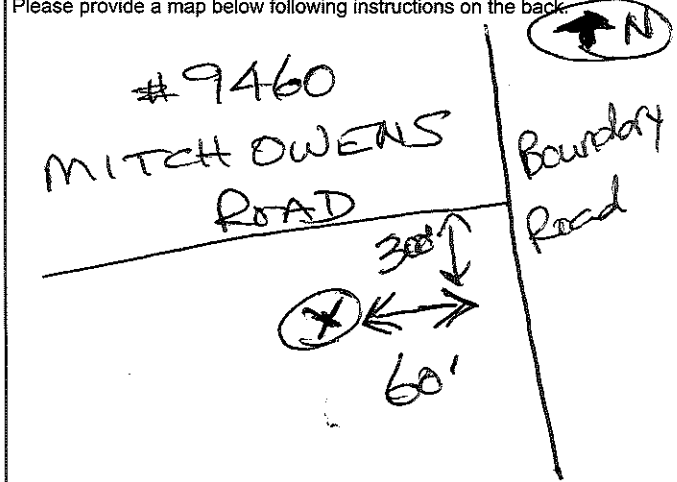
☐ Water Supply ☐ Replacement Well ☐ Test Hole ☐ Recharge Well ☐ Dewatering Well ☐ Observation and/or Monitoring Hole ☐ Alteration (Construction) ☐ Abandoned, Insufficient Supply ☐ Abandoned, Poor Water Quality ☒ Abandoned, other, *specify* New Construction ☐ Other, *specify*

Construction Record - Screen

Outside Diameter *(cm/in)*	Material (Plastic, Galvanized, Steel)	Slot No.	Depth *(m/ft)* From	To

Map of Well Location

Please provide a map below following instructions on the back.



Water Details

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

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

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

Hole Diameter

Depth *(m/ft)* From	To	Diameter *(cm/in)*

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
AIR ROCK DRILLING Co LTD	C-7681

Business Address (Street Number/Name)	Municipality
6659 Franktown Road	Richmond

Province	Postal Code	Business E-mail Address
Ont	K0A 2Z0	

Bus.Telephone No. *(inc. area code)*	Name of Well Technician (Last Name, First Name)
6138382170	HANNA JEREMY

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
T3632	[signature]	20190628

Comments:

Well owner's information package delivered	Date Package Delivered	Date Work Completed
☐ Yes ☒ No		20190626

Ministry Use Only

Audit No. Z302260

Received JUL 25 2019

0506E (2014/11)

Ministry's Copy

Ontario — Ministry of the Environment and Climate Change

Measurements recorded in: ☑ Metric ☐ Imperial

Well Tag N Tag#: A244754

A244754

Well Record

Regulation 903 Ontario Water Resources Act

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
Amazon	Ottawa		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
5371 Boundary, Rd	Cumberland.	ON	K4B1P6	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
5371 Boundary, Road	Cumberland.	21	11

County/District/Municipality	City/Town/Village	Province	Postal Code
OTTAWA City	NAVAN	Ontario	K4B1P6

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	466045	5021560		

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	To
Brown	Sand.		Soft	0	2.12
Bleu	Clay		Soft	2.12	24.24
Grey	Gravel		Soft	24.24	26.06
Grey	Limestone		Hard.	26.06	42.42

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	6.06	Quik Grout	4 Bag.

Method of Construction

☐ Cable Tool ☐ Diamond ☐ Rotary (Conventional) ☐ Jetting ☑ Rotary (Reverse) Air ☐ 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	To
15.55	Steel	0.48	+0.90	26.06

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

Construction Record - Screen

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

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): 24.24

Pumping rate (l/min / GPM): 54:00

Duration of pumping: 1 hrs + 00 min

Final water level end of pumping (m/ft): 2.25

If flowing give rate (l/min / GPM):

Recommended pump depth (m/ft): 24.24

Recommended pump rate (l/min / GPM): 56:00

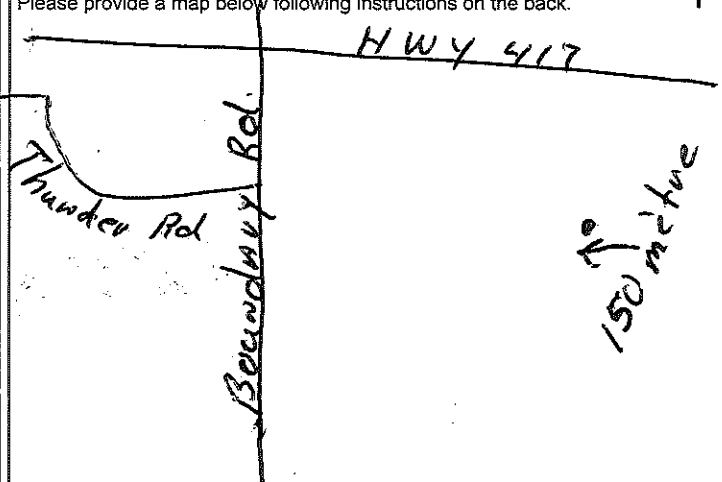
Well production (l/min / GPM): 90:00

Disinfected? ☑ Yes ☐ No

Draw Down Time (min)	Water Level (m/ft)	Recovery Time (min)	Water Level (m/ft)
Static Level	2.12		2.25
1	2.14	1	2.18
2	2.16	2	2.16
3	2.18	3	2.12
4	2.20	4	2.12
5	2.21	5	2.12
10	2.23	10	2.12
15	2.24	15	2.12
20	2.25	20	2.12
25	2.25	25	2.12
30	2.25	30	2.12
40	2.25	40	2.12
50	2.25	50	2.12
60	2.25	60	2.12

Map of Well Location

Please provide a map below following instructions on the back.



Water Details

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

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	6.06	25.40
0	42.42	15.55

Well Contractor and Well Technician Information

Business Name of Well Contractor: DXR-WATER-well-Drilling

Well Contractor's Licence No.: 7526

Business Address (Street Number/Name): 1763 - Route 900 west

Municipality: Nation

Province: ON

Postal Code: K0A3C0

Business E-mail Address:

Bus. Telephone No. (inc. area code): 6139877558

Name of Well Technician (Last Name, First Name): Mowette Karl

Well Technician's Licence No.: 3773

Signature of Technician and/or Contractor: Karl Mowette

Date Submitted: 20180924

Comments: Mitch Owens, Rd County Rd 8

Well owner's information package delivered: ☑ Yes ☐ No

Date Package Delivered: 20180924

Date Work Completed: 20180911

Ministry Use Only

Audit No. Z280974

Received NOV 2 2 2018

0506E (2014/11) Ministry's Copy

Ontario

Ministry of the Environment and Climate Change

Well Tag No. Tag#: A249297

A249297

Well Record

Regulation 903 Ontario Water Resources Act

Page ____ of ____

Measurements recorded in: ☒ Metric ☐ Imperial

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
	VSB Carpentry Inc.	N/A	

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
357 Entrepreneur Crescent	Navan	On.	K4B1T8	6138291925

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
357 Entrepreneur Crescent	City of Ottawa	23	11

County/District/Municipality	City/Town/Village	Province	Postal Code
Cumberland		Ontario	K4B1T8

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	465777	50209116	50R-6694 Part 4	

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	clay	Silt, Stone	Hard	0	3.7
Grey	clay	silt	Soft	3.7	21.3
Grey	gravel	Medium Sand	packed	21.3	22.6
Grey	Shale		layered	22.6	28.9

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	12.1	cement grout	.3 m³

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): 22

Pumping rate (l/min / GPM): 13

Duration of pumping: 1 hrs + ____ min

Final water level end of pumping (m/ft): 21.61

If flowing give rate (l/min / GPM):

Recommended pump depth (m/ft): 22

Recommended pump rate (l/min / GPM): 15

Well production (l/min / GPM): 20

Disinfected? ☒ Yes ☐ No

Draw Down Time (min)	Water Level (m/ft)	Recovery Time (min)	Water Level (m/ft)
Static Level	9.62		21.61
1	10.49	1	20.79
2	10.73	2	19.58
3	11.15	3	19.27
4	11.53	4	19.07
5	11.71	5	18.50
10	13.38	10	16.91
15	14.71	15	14.99
20	15.88	20	13.21
25	16.87	25	12.83
30	17.77	30	10.99
40	19.40	40	9.74
50	20.65	50	9.69
60	21.61	60	9.62

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	To
15.55	Steel	.48	+.6	23.1
15.32	Open Hole		23.1	28.9

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

Construction Record - Screen

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

Water Details

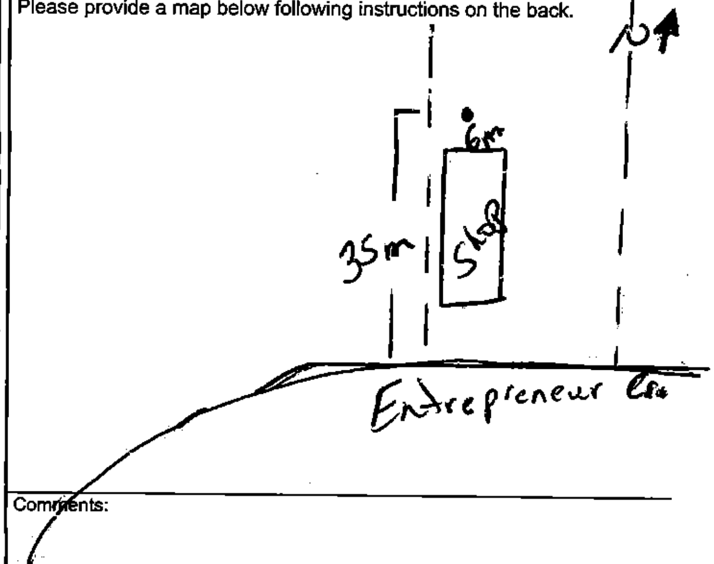
Water found at Depth	Kind of Water
27 (m/ft) ☐ Gas	☐ Fresh ☒ Untested ☐ Other, specify
(m/ft) ☐ Gas	☐ Fresh ☐ Untested ☐ Other, specify
(m/ft) ☐ Gas	☐ Fresh ☐ Untested ☐ Other, specify

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	12.1	24.9
12.1	28.9	15.32

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.
Bourgeois Well Drilling Ltd	7417

Business Address (Street Number/Name)	Municipality
14245 Conc. 10-11	Crysler

Province	Postal Code	Business E-mail Address
On.	K0A1R0	N/A

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
6139875291	GENIER, MICHAEL

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3493		20181010

Well owner's information package delivered: ☒ Yes ☐ No

Date Package Delivered: 20181010

Date Work Completed: 20181005

Ministry Use Only

Audit No. Z300222

Received OCT 25 2018

0506E (2014/11) **Ministry's Copy**

Ontario — Ministry of the Environment and Climate Change

Measurements recorded in: ☒ Metric ☐ Imperial

Well Tag No. Tag#:A236242 — A 236242

Well Record

Regulation 903 Ontario Water Resources Act

Page ____ of ____

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
Boundry Road Development Inc.		N/A	

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
16766 Transcanadienne Suite 500	Kirland	QC.	H9H4M7	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
5371 Boundry Road	Cumberland	21	11

County/District/Municipality	City/Town/Village	Province	Postal Code
Ottawa	Carlsbad Spring	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	465300	5021483		

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	To
Brown	Fill	clay, Stone	Hard	0	1.8
Brown	clay	Silt	Hard	1.8	3.9
Grey	clay		SoST	3.9	21.0
Grey	gravel	Silt, Sand	packed	21.0	~~60.96~~ 22.25
Grey	shale		layered	22.25	60.96

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	24.99	ciment grout	1.5 m³

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	To
15.55	Steel	.48	+.6	24.99
15.32	Open Hole		24.99	60.96

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

Construction Record - Screen

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

Results of Well Yield Testing

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

If pumping discontinued, give reason:

Pump intake set at (m/ft): 60

Pumping rate (l/min / GPM): 42

Duration of pumping: 1 hrs + ____ min

Final water level end of pumping (m/ft): 5.75

If flowing give rate (l/min / GPM):

Recommended pump depth (m/ft): 58

Recommended pump rate (l/min / GPM): 66

Well production (l/min / GPM): 75

Disinfected? ☒ Yes ☐ No

Draw Down Time (min)	Water Level (m/ft)	Recovery Time (min)	Water Level (m/ft)
Static Level	3.83		5.75
1	4.42	1	4.64
2	4.61	2	4.36
3	4.75	3	4.26
4	4.78	4	4.23
5	4.79	5	4.18
10	4.96	10	4.10
15	5.16	15	4.03
20	5.24	20	3.95
25	5.31	25	3.89
30	5.32	30	3.85
40	5.62	40	3.83
50	5.70	50	3.83
60	5.75	60	3.83

Water Details

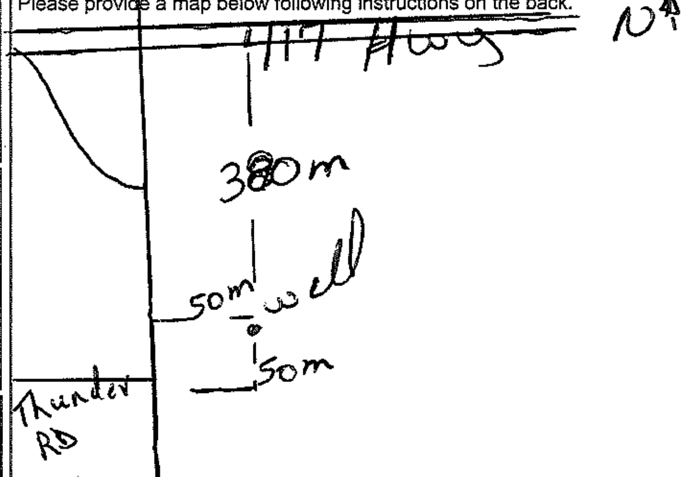
Water found at Depth	Kind of Water
27 (m/ft) ☐ Gas	☐ Fresh ☒ Untested ☐ Other, specify
52 (m/ft) ☐ Gas	☐ Fresh ☒ Untested ☐ Other, specify
(m/ft) ☐ Gas	☐ Fresh ☐ Untested ☐ Other, specify

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	24.99	24.9
24.99	60.9	

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.
Bourgeois Well Drilling Ltd.	7417

Business Address (Street Number/Name)	Municipality
14245 Conc. 10-11	Crysler

Province	Postal Code	Business E-mail Address
On	K0A1R0	N/A

Bus.Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
6139875291	GENIER, MICHAEL

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3493		20180326

Well owner's information package delivered ☒ Yes ☐ No

Date Package Delivered: 20180327

Date Work Completed: 20180323

Ministry Use Only

Audit No. Z276189

MAY 07 2018

Received

0506E (2014/11) Ministry's Copy

Ontario Ministry of the Environment

Measurements recorded in: ☒ Metric ☐ Imperial

Well Tag **Tag#: A131930** A-131930

Well Record

Regulation 903 Ontario Water Resources Act

Page 1 of 1

[redacted]

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
100 Entrepreneur Crescent	Ottawa		

County/District/Municipality	City/Town/Village	Province	Postal Code
Ottawa	Ottawa	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	465599	5020270		

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	To
Brown	topsoil		compacted	0	.20m
Grey	Fissured clay		" "	.20m	2.75m
Grey/Blue	elastic clay.		" "	2.75m	4.0m
BLUE	VERY elastic clay.		" "	4.0m	7.0m

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m^3/ft^3)
0	2.5m	elastic clay	15.0m³

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	To
	P.V.C Schedule 40	.20m	0	7.5m

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To
	geotextile synthetic		0	3.0m

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	Kind of Water
(m/ft) ☐ Gas	☐ Fresh ☐ Untested ☐ Other, specify
(m/ft) ☐ Gas	☐ Fresh ☐ Untested ☐ Other, specify
(m/ft) ☐ Gas	☐ Fresh ☐ Untested ☐ Other, specify

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	3.0m	6.0m
3.0m	5.0m	4.0m
5.0m	7.0m	4.0m

Results of Well Yield Testing

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

If pumping discontinued, give reason: see report attach.

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)

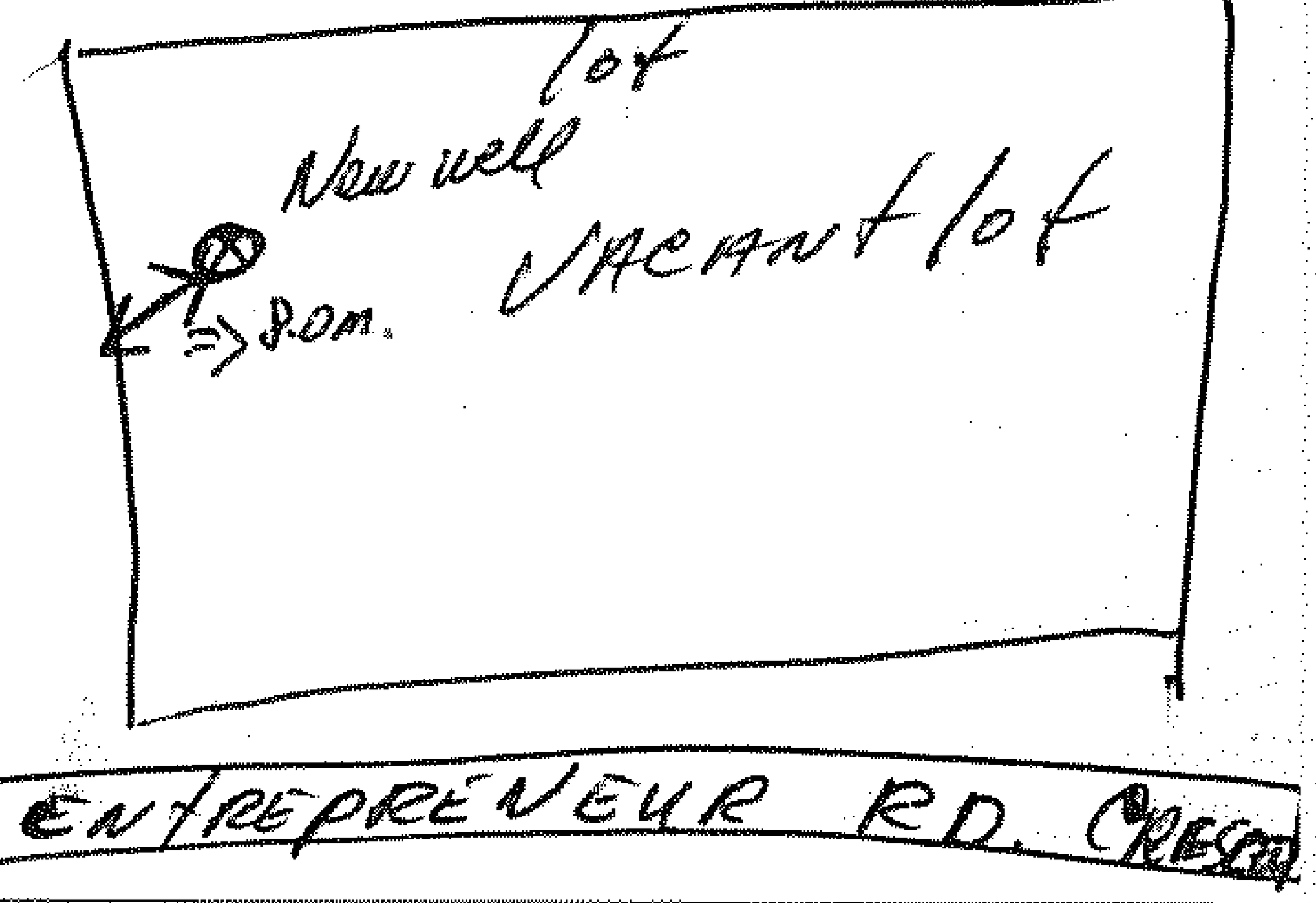
Well production (l/min / GPM)

Disinfected? ☐ Yes ☒ No

Draw Down Time (min)	Water Level (m/ft)	Recovery Time (min)	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	

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.
Leo Sarault & Fils Inc	6667

Business Address (Street Number/Name)	Municipality
4882 County Rd 10 Fournier	Nation

Province	Postal Code	Business E-mail Address
Ontario	K0B1G0	leoSarault@yahoo.com

Bus.Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
6135245449	Gilles Sarault

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
T2124	[signature]	20150323

Well owner's information package delivered ☐ Yes ☐ No

Date Package Delivered 20150323

Date Work Completed 20150323

Ministry Use Only

Audit No Z197003

JUL 11 2016

Received

0506E (2007/12) © Queen's Printer for Ontario, 2007

Ministry's Copy

7212030

S-14748

Ontario Ministry of the Environment

Well Record

Regulation 903 Ontario Water Resources Act

Well Tag No. (Place Sticker and/or Print ...) A154131 Tag#: A154131

Page ______ of ______

Measurements recorded in: ☑ Metric ☐ Imperial

TAGGART MILLER ENVIRONMENTAL SERVICES

[redacted]

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
5775 Boundary Rd			

County/District/Municipality	City/Town/Village	Province	Postal Code
	Ottawa	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	465752	5020214		

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	To
BLK	gravel	sand	loose	0	.31
BRN	sand	silt, clay	soft	.31	2.44
GRY	clay	silt	soft	2.44	6.4

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	.31	concrete/flushmount	
.31	5.18	bentonite	
5.18	6.4	Filter 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)	Water Level (m/ft)	Recovery Time (min)	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 Direct Push

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	To
3.43	PVC	.356	0	5.49

Status of Well

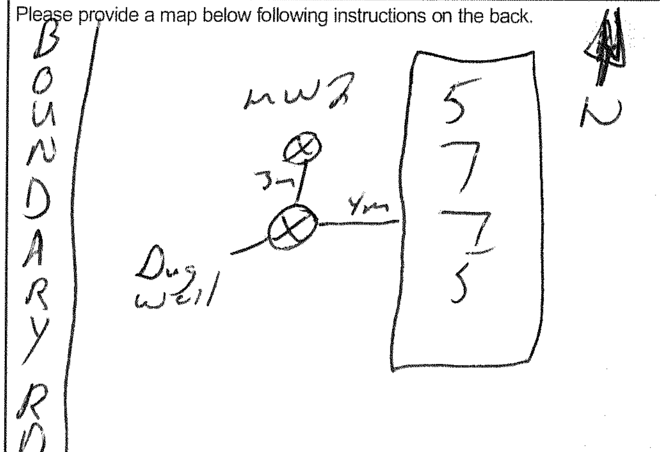
☐ Water Supply ☐ Replacement Well ☑ Test Hole ☐ Recharge Well ☐ Dewatering Well ☑ Observation and/or Monitoring Hole ☐ Alteration (Construction) ☐ Abandoned, Insufficient Supply ☐ Abandoned, Poor Water Quality ☐ Abandoned, other, specify ☐ Other, specify

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To
4.21	PVC	10	5.49	6.4

Map of Well Location

Please provide a map below following instructions on the back.



Water Details

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

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	6.4	8.25

Well Contractor and Well Technician Information

Business Name of Well Contractor: Strata Drilling Group

Well Contractor's Licence No.: 7241

Business Address (Street Number/Name): 147 West Beaver Creek

Municipality: Richmond Hill

Province: ON

Postal Code: L4B1C6

Business E-mail Address: wrecords@stratasoil.com

Bus.Telephone No. (inc. area code): 905 764 9304

Name of Well Technician (Last Name, First Name): McLay, JAMES

Well Technician's Licence No.: 3656

Signature of Technician and/or Contractor

Date Submitted: 2013 11 22

Comments:

Well owner's information package delivered ☐ Yes ☐ No

Date Package Delivered Y Y Y Y M M D D

Date Work Completed 20131028

Ministry Use Only

Audit No. Z 179936

Received NOV 2 8 2013

0506E (2007/12) © Queen's Printer for Ontario, 2007

Ministry's Copy

7212029

S-14748

Ontario Ministry of the Environment

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

A154128 **Tag#: A154128**

Well Record

Regulation 903 Ontario Water Resources Act

Page ______ of ______

Measurements recorded in: ☑ Metric ☐ Imperial

TAGGART MILLER ENVIRONMENTAL SERVICES

[redacted]

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
5775 Boundary Road			

County/District/Municipality	City/Town/Village	Province	Postal Code
	Ottawa	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	465754	5020210		

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
BLK	gravel	sand	loose	0	.31
BRN	sand	silt, clay	soft	.31	2.44
GRY	clay	silt	soft	2.44	6.4

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	.31	concrete/flushmount	
.31	5.88	bentonite	
5.88	6.4	filter 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)	Water Level (m/ft)	Recovery Time (min)	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* Direct Push

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	To
3.25	PVC	.356	0	5.49

Construction Record - Screen

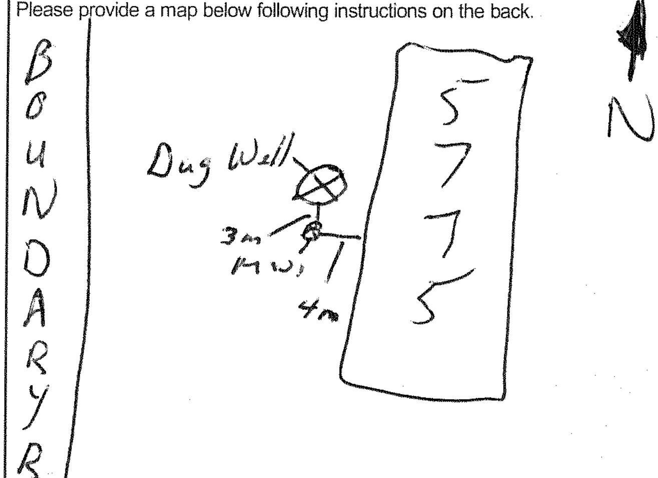
Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To
4.21	PVC	10	5.49	6.4

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*

Map of Well Location

Please provide a map below following instructions on the back.



Comments:

Water Details

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

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	6.4	8.25

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Strata Drilling Group	7241

Business Address (Street Number/Name)	Municipality
147 West Beaver Creek	Richmond Hill

Province	Postal Code	Business E-mail Address
ON	L4B1C6	wrecords@stratasoil.com

Bus.Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
9057649304	McCoy, JAMES

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3656		2013 11 22

Well owner's information package delivered	Date Package Delivered	Date Work Completed
☐ Yes ☐ No	Y Y Y Y M M D D	20131028

Ministry Use Only

Audit No. Z 179935

NOV 2 3 2013
Received

Ministry's Copy

Ontario Ministry of the Environment

Measurements recorded in: ☑ Metric ☐ Imperial

Well Tag No. (Place Sticker and/or Print Below)

Tag#: A145307 A145307

S-13894

Well Record

Regulation 903 Ontario Water Resources Act

Page ____ of ____

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
Capital Region	Resources Recovery Centre		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
708-225 Metcalfe	Ottawa	ON	K2P1P9	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
Boundry Rd			

County/District/Municipality	City/Town/Village	Province	Postal Code
	Ottawa	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	466037	5021430		

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	To
Brn	Sand		Soft wet	0	1.5
Gry	Clay		Soft, wet	1.5	6.4

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	3.96	Holeplug	
3.96	6.4	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)	Water Level (m/ft)	Recovery Time (min)	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 D.P

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	To
3.45	PVC	.56	0	4.88

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

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To
4.21	PVC	10	4.88	6.4

Map of Well Location

Please provide a map below following instructions on the back.

See map "M"

Water Details

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

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

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

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	6.4	11.43

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Strata Drilling Group	7241

Business Address (Street Number/Name)	Municipality
147-2 W. Beaver creek	Ottawa

Province	Postal Code	Business E-mail Address
ON	L4B1C6	wrecords@stratasoil.com

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
9057649304	Beatty Brian

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3616		20130412

Comments:

Well owner's information package delivered ☐ Yes ☐ No

Date Package Delivered YYYYMMDD

Date Work Completed 20130410

Ministry Use Only

Audit No. Z152772

MAY 15 2013 Received

Ministry's Copy

5-13894

12-1125-0045-1000

Boundary Road Site

location I tuesday

C-7241
2152772

MAY 15 2013

Ontario Ministry of the Environment

S-13894

Well Record

Regulation 903 Ontario Water Resources Act

Tag#: A145308

A145308

Measurements recorded in: ☑ Metric ☐ Imperial

Page ____ of ____

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
Capital Region Resources Recovery Centre			

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
708-225 Metcalfe	ottawa	ON	K2P1P9	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
Boundry Rd			

County/District/Municipality	City/Town/Village	Province	Postal Code
	Ottawa	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	466030	5021430		

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	To
Brn	fine Sand		Soft, wet	0	1.5

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	.61	Benseal	
.61	1.5	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)	Water Level (m/ft)	Recovery Time (min)	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 D.P.

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	To
3.45	PVC	.356	0	.61

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

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To
4.21	PVC	10	.61	1.5

Map of Well Location

Please provide a map below following instructions on the back.

See Map "M"

Water Details

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

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

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

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	1.5	11.43

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Strata Drilling Group	7241

Business Address (Street Number/Name)	Municipality
47-2 W. Beaver Creek	Richmondhill

Province	Postal Code	Business E-mail Address
ON	L4B1C6	WRECORDS@STRATASOIL.COM

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
9057649304	BEATTY BRIAN

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3616		20130412

Comments:

Well owner's information package delivered ☐ Yes ☐ No

Date Package Delivered YYYYMMDD

Date Work Completed 20130410

Ministry Use Only

Audit No. Z152773

Received MAY 15 2013

S-13894

12-1125-0045-1000

Boundary Road Site

location I tuesday

C-7241
2152773

MAY 15 2013

13-05-40

Ontario Ministry of the Environment

Measurements recorded in: ☐ Metric ☐ Imperial

Well Tag No. (Place Sticker and/or Print Below)

A111204 W

Well Record

Regulation 903 Ontario Water Resources Act

Page ____ of ____

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
~~Gordon~~	Capital Region Resource	—	

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
708-225 Metcalfe St	Ottawa	ON	K2P1P9	613 4545580

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
5508 Frontier Rd	Ottawa		

County/District/Municipality	City/Town/Village	Province	Postal Code
Ottawa	Ottawa	Ontario	K0A3H0

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	466179	5021081		

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	To
GRAY	CLAY	SAND & Till Rock		0	103''

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
		Benontite Tablets	
		Benotite grout & Portland	
		Benotote Chips	

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)	Water Level (m/ft)	Recovery Time (min)	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
☑ Rotary (Conventional)
☒ Rotary (Reverse)
☐ Boring
☐ Air percussion
☐ Other, specify
☐ Diamond
☐ Jetting
☐ Driving
☐ Digging

Well Use

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

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	To
1''		1/8	0	103''

Status of Well

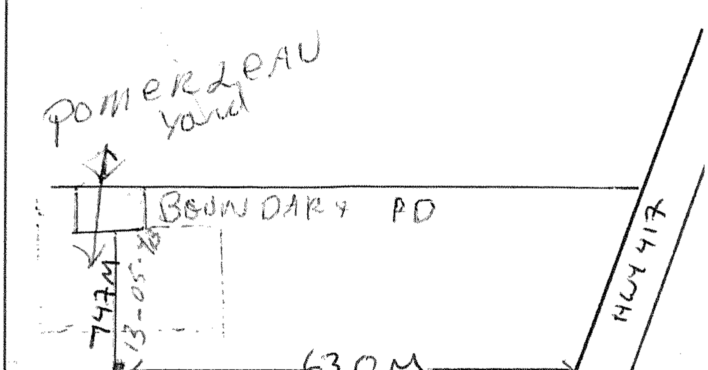
☐ Water Supply
☒ Replacement Well
☑ Test Hole
☐ Recharge Well
☐ Dewatering Well
☐ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, specify
☐ Other, specify

Construction Record - Screen

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

Map of Well Location

Please provide a map below following instructions on the back.



Comments:

Water Details

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

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Marathon Drilling Co Ltd.	6894

Business Address (Street Number/Name)	Municipality
6847 Hiram Dr.	Greely

Province	Postal Code	Business E-mail Address
ON	K4P 1A2	mwells@marathondrilling.ca

Bus.Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
4138220571	Wells, Matthew

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3279	[signature]	20130426

Well owner's information package delivered	Date Package Delivered	Date Work Completed
☐ Yes ☐ No	Y Y Y Y M M D D	Y Y Y Y M M D D

Ministry Use Only

Audit No. Z 82643

MAY 0 6 2013

Received

0506E (12/2007)

Ministry's Copy

Ontario Ministry of the Environment

13-6-3

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

A111206 ✓

Well Record

Regulation 903 Ontario Water Resources Act

Page ______ of ______

Measurements recorded in: ☐ Metric ☐ Imperial

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
Golder	Capital Region Resource	–	

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. *(inc. area code)*
708-225 Metcalfe St	Ottawa	ON	K2P 1P9	6134545580

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
5800 Frontier Rd	Ottawa		

County/District/Municipality	City/Town/Village	Province	Postal Code
Ottawa	Ottawa	Ontario	K0A 3H0.

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	465914	5020386		

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	To
GRAY	CLAY	SAND Till Rock		0	147'10"

Annular Space

Depth Set at *(m/ft)* From	To	Type of Sealant Used *(Material and Type)*	Volume Placed *(m³/ft³)*
		bentonite Tablets	
		bentonite-grout with portland	
		bentonite chips	

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)*	Water Level *(m/ft)*	Recovery Time *(min)*	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	To
2 1/4	plastic	1/8	0	147'10"

Status of Well

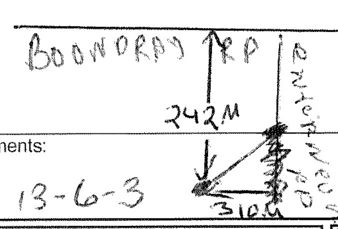
☐ Water Supply
☐ Replacement Well
☑ Test Hole
☐ Recharge Well
☐ Dewatering Well
☐ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, *specify* ______
☐ Other, *specify* ______

Construction Record - Screen

Outside Diameter *(cm/in)*	Material (Plastic, Galvanized, Steel)	Slot No.	Depth *(m/ft)* From	To

Map of Well Location

Please provide a map below following instructions on the back.



Comments:

13-6-3

Water Details

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

Hole Diameter

Depth *(m/ft)* From	To	Diameter *(cm/in)*

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Marathon Drilling Co Ltd	6894

Business Address (Street Number/Name)	Municipality
6847 Hiram Dr	Greely

Province	Postal Code	Business E-mail Address
ON	K4P 1A2	mwebb@marathondrilling.ca

Bus.Telephone No. *(inc. area code)*	Name of Well Technician (Last Name, First Name)
6138220571	Webb Matthew

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3279		2013 03 25

Well owner's information package delivered ☐ Yes ☐ No

Date Package Delivered Y Y Y Y M M D D

Date Work Completed Y Y Y Y M M D D

Ministry Use Only

Audit No. Z 82647

Received MAY 0 8 2013

0506E (12/2007) **Ministry's Copy** © Queen's Printer for Ontario, 2007

Ontario Ministry of the Environment

Measurements recorded in: ☒ Metric ☐ Imperial

Well Tag No. (Place Sticker and/or Print Below)

Tag#: A145268

A145268

S-13834

Well Record

Regulation 903 Ontario Water Resources Act

Page ____ of ____

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
Capital Region	Resources Recovery Centre Ltd		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
708-225 Metcalfe st.	Ottawa	ON	K2P1P9	6134545580

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
Boundary Rd.			

County/District/Municipality	City/Town/Village	Province	Postal Code
	OTTAWA	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	466412	5020426		

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	To
Brown	Sand	organics	soft, loose.	0	.91
Gry	Clay		wet.	.91	6.4

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	3.96	Bonseal	
3.96	6.4	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)	Water Level (m/ft)	Recovery Time (min)	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 Direct push

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	To
3.45	plastic	.356	0	4.88

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

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To
4.21	plastic	10	4.88	6.4

Map of Well Location

Please provide a map below following instructions on the back.

Labelled 13-15-3
P on Map

Water Details

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

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	6.4	11.43

Well Contractor and Well Technician Information

Business Name of Well Contractor: Strata Soil Sampling
Well Contractor's Licence No.: 7241
Business Address (Street Number/Name): 2-147 West Beaver Creek Rd.
Municipality: Richmond Hill
Province: ON
Postal Code: L4B1C6
Business E-mail Address: wrecords@stratasoil.com
Bus.Telephone No. (inc. area code): 9052649304
Name of Well Technician (Last Name, First Name): Parsons Robert
Well Technician's Licence No.: 3722
Signature of Technician and/or Contractor:
Date Submitted: 20130328

Comments:

Well owner's information package delivered ☐ Yes ☐ No

Date Package Delivered: Y Y Y Y M M D D

Date Work Completed: 20130326

Ministry Use Only
Audit No. Z152746
Received APR 30 2013

5-13834

C-7241
2152746

APR 30 2013

S-13834

Ontario Ministry of the Environment

Well Record

Regulation 903 Ontario Water Resources Act

Well Tag No. (Place Sticker and/or Print Below) Tag#: A145269 A145269

Measurements recorded in: ☒ Metric ☐ Imperial

Page ______ of ______

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
Capital Region Resources Recovery Centre Ltd.			

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
708 - 225 Metcalfe St.	Ottawa	ON	K2P1P9	6134545580

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
Frontier Rd.			

County/District/Municipality	City/Town/Village	Province	Postal Code
	OTTAWA	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	466097	5020251		

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	To
Brown	Sand.	organics	Soft, Loose.	0	.91
Grey	Clay		Loose, Soft	.91	1.5

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	.31	Benseal.	
.31	1.5	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)	Water Level (m/ft)	Recovery Time (min)	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 Direct push

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	To
3.45	plastic	.356	0	.5

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

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To
4.21	plastic	10	.5	1.5

Map of Well Location

Please provide a map below following instructions on the back.

Labelled 13-14-3

S on Map

Comments:

Water Details

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

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

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

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	1.5	11.43

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Strata Soil Sampling	7241

Business Address (Street Number/Name)	Municipality
2-147 West Beaver Creek Rd.	Richmond Hill

Province	Postal Code	Business E-mail Address
ON	L4B1C6	wrecords@stratasoil.com

Bus.Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
9057649304	Parsons Robert

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3722	[signature]	20130328

Well owner's information package delivered ☐ Yes ☐ No

Date Package Delivered Y Y Y Y M M D D

Date Work Completed 20130326

Ministry Use Only

Audit No. Z152745

Received APR 30 2013

S13834

C-7241
Z152745

APR 30 2013

Ontario Ministry of the Environment

Well Tag Number (Place sticker and print number below)
A 053936
A053936

Well Record

Regulation 903 Ontario Water Resources Act

Instructions for Completing Form

- For use in the **Province of Ontario** only. This document is a permanent **legal** document. Please retain for future reference.
- All Sections **must** be completed in full to avoid delays in processing. Further instructions and explanations are available on the back of this form.
- Questions regarding completing this application can be directed to the Water Well Help Desk (Toll Free) at 1-888-396-9355.
- **All metre measurements shall be reported to 1/10th of a metre.**
- Please print clearly in blue or black ink only.

Ministry Use Only

MUN	CON	LOT

[redacted]

Address of Well Location (County/District/Municipality)	Township	Lot	Concession
OTTAWA - City	Cumberland	2	11

RR#/Street Number/Name	City/Town/Village	Site/Compartment/Block/Tract etc.
120 Indcum	CARlsbad-ON	50R-6420

GPS Reading	NAD	Zone	Easting	Northing	Unit Make/Model	Mode of Operation
	83	18	465723	5020642	Magellan	UTM ☐ Undifferentiated ☑ Averaged ☐ Differentiated, specify

Log of Overburden and Bedrock Materials (see instructions)

General Colour	Most common material	Other Materials	General Description	Depth Metres From	Depth Metres To
Brown	Clay		Soft	0	0.90
Red	Clay		Soft	0.90	3.63
Grey	Clay		Soft	3.63	30.30
Grey	Gravel		Soft	30.30	31.51
Grey	SHALE		Porous	31.51	32.42

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	7.57	20.32

Water Record

Water found at Metres	Kind of Water
31.51 m	☐ Fresh ☑ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:
m	☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:
m	☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

After test of well yield, water was ☑ Clear and sediment free ☐ Other, specify

Chlorinated ☑ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.55	☑ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	0.48	0	31.51
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
15.55	☑ Open hole		31.51	32.42

Test of Well Yield

Pumping test method	Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Submersible	Static Level	2.89		3.04
Pump intake set at - (metres) 9.09	1	3.20	1	2.89
Pumping rate - (litres/min) 58.50	2	3.17	2	
Duration of pumping 1 hrs + 00 min	3	3.12	3	
Final water level end of pumping 3.04 metres	4	3.10	4	
Recommended pump type. ☑ Shallow ☐ Deep	5	3.10	5	
Recommended pump depth. 9.09 metres	10	3.08	10	
Recommended pump rate. 45.50 (litres/min)	15	3.04	15	
If flowing give rate - (litres/min)	20	3.04	20	
	25	3.04	25	
If pumping discontinued, give reason.	30	3.04	30	
	40	3.04	40	
	50	3.04	50	
	60	3.04	60	

Plugging and Sealing Record

☑ Annular space ☐ Abandonment

Depth set at - Metres From	To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	7.57	Cement Grout	120Kg.

Method of Construction

☐ Cable Tool ☑ Rotary (air) ☐ Diamond ☐ Digging
☐ Rotary (conventional) ☐ Air percussion ☐ Jetting ☐ Other
☐ Rotary (reverse) ☐ Boring ☐ Driving

Water Use

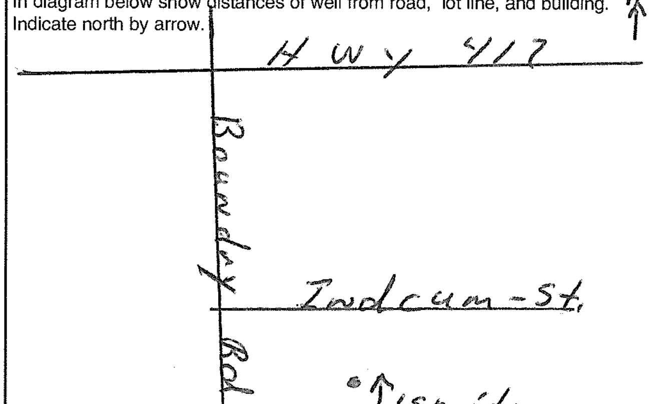
☑ Domestic ☐ Industrial ☐ Public Supply ☐ Other
☐ Stock ☑ Commercial ☐ Not used
☐ Irrigation ☐ Municipal ☐ Cooling & air conditioning

Final Status of Well

☑ Water Supply ☐ Recharge well ☐ Unfinished ☐ Abandoned, (Other)
☐ Observation well ☐ Abandoned, insufficient supply ☐ Dewatering
☐ Test Hole ☐ Abandoned, poor quality ☐ Replacement well

Location of Well

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



Audit No.	Date Well Completed (YYYY MM DD)
Z 71657	2007 04 26

Was the well owner's information package delivered?	Date Delivered (YYYY MM DD)
☑ Yes ☐ No	2007 04 26

Well Contractor/Technician Information

Name of Well Contractor	Well Contractor's Licence No.
DXR-WATER-well-Drilling	6006

Business Address (street name, number, city etc.): CP 98- St-Albert- ON

Name of Well Technician (last name, first name)	Well Technician's Licence No.
Louis Desnoyers	T-625

Signature of Technician/Contractor	Date Submitted (YYYY MM DD)
X [signature]	2007 04 26

Ministry Use Only

Data Source	Contractor 6006
Date Received (YYYY MM DD) MAY 09 2007	Date of Inspection (YYYY MM DD)
Remarks	Well Record Number

Ontario Ministry of the Environment

Well Tag Number (Place sticker and print number below) A012415

A012415

Well Record

Regulation 903 Ontario Water Resources Act

page ___ of ___

Instructions for Completing Form

- For use in the **Province of Ontario** only. This document is a permanent **legal** document. Please retain for future reference.
- All Sections **must** be completed in full to avoid delays in processing. Further instructions and explanations are available on the back of this form.
- Questions regarding completing this application can be directed to the Water Well Management Coordinator at 416-235-6203.
- **All metre measurements shall be reported to 1/10th of a metre.**
- Please print clearly in blue or black ink only.

Ministry Use Only			
MUN 15002	CON OF		LOT 02

Well Owner's Information and Location of Well Information

[redacted]

Plan 50M-136 Pt BLK1 | Cumberland (Ottawa) | Pt 2-3 RP50R26420

RR#/Street Number/Name	City/Town/Village	Site/Compartment/Block/Tract etc.
145 [illegible] Rd. Carlsbad Springs	Carlsbad Spring	

GPS Reading	NAD	Zone	Easting	Northing	Unit Make/Model	Mode of Operation
	83	18	465747	5020692	Magellan	☐ Undifferentiated ☑ Averaged ☐ Differentiated, specify

Log of Overburden and Bedrock Materials (see instructions)

General Colour	Most common material	Other Materials	General Description	Depth (feet / Metres) From	To
Brown	Sandy soil	clay		0	5
grey	clay			5	15
blue	clay			15	95
grey	hard pan	gravel		95	109
grey	rock			109	110

Hole Diameter

Depth Metres From	To	Diameter Centimetres
0	110	6"

Water Record

Water found at Metres	Kind of Water
110 m	☐ Gas ☐ Fresh ☑ Salty ☐ Sulphur ☐ Minerals ☐ Other:
m	☐ Gas ☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Other:
m	☐ Gas ☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Other:

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

Chlorinated ☑ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	To
Casing				
6 1/4	☑ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	188	0	109'
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☐ Open hole			

Test of Well Yield

Pumping test method	Draw Down Time min	Water Level Metres	Recovery Time min	Water Level Metres
Sub.				
Pump intake set at - (metres) 52'	Static Level	2.60		2.77
Pumping rate - (litres/min) 4?	1	2.70	1	2.65
Duration of pumping 1 hrs + ___ min	2	2.70	2	2.64
Final water level end of pumping ___ metres	3	2.70	3	2.63
Recommended pump type. ☐ Shallow ☑ Deep	4	2.72	4	2.62
Recommended pump depth. 50' metres	5	2.72	5	2.61
Recommended pump rate. 50 (litres/min)	10	2.72	10	2.60
	15	2.74	15	2.60
If flowing give rate - C (litres/min)	20	2.74	20	2.60
	25	2.75	25	2.60
If pumping discontinued, give reason.	30	2.75	30	2.60
	40	2.75	40	2.60
	50	2.76	50	2.60
	60	2.77	60	2.60

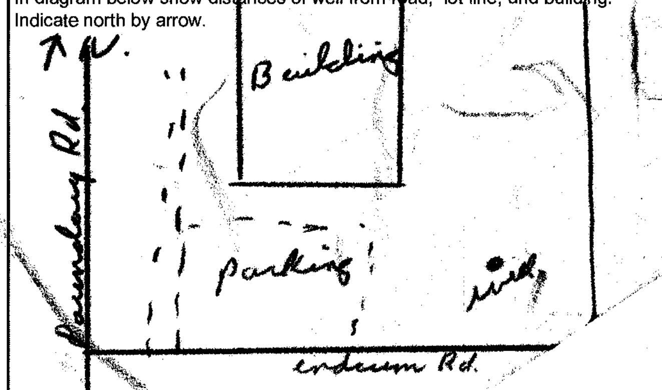
Plugging and Sealing Record

☑ Annular space ☐ Abandonment

Depth set at - Metres From	To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	30'	grout.	3 bag.

Location of Well

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



Method of Construction

☑ Cable Tool ☐ Rotary (air) ☐ Diamond ☐ Digging
☐ Rotary (conventional) ☐ Air percussion ☐ Jetting ☐ Other
☐ Rotary (reverse) ☐ Boring ☐ Driving

Water Use

☑ Domestic ☐ Industrial ☐ Public Supply ☐ Other
☐ Stock ☐ Commercial ☐ Not used
☐ Irrigation ☐ Municipal ☐ Cooling & air conditioning

Final Status of Well

☑ Water Supply ☐ Recharge well ☐ Unfinished ☐ Abandoned, (Other)
☐ Observation well ☐ Abandoned, insufficient supply ☐ Dewatering
☐ Test Hole ☐ Abandoned, poor quality ☐ Replacement well

Well Contractor/Technician Information

Name of Well Contractor	Well Contractor's Licence No.
Maurice Cayer Ltd	1517
Business Address (street name, number, city etc.)	
Carsdane ont	
Name of Well Technician (last name, first name)	Well Technician's Licence No.
Signature of Technician/Contractor	Date Submitted YYYY MM DD
x Maurice Cayer	2004

Audit No.	Date Well Completed YYYY MM DD
Z 12477	2004 05 27
Was the well owner's information package delivered? ☑ Yes ☐ No	Date Delivered YYYY MM DD 2004 05 27

Ministry Use Only	
Data Source	Contractor 1517
Date Received AUG 18 2004	Date of Inspection YYYY MM DD
Remarks	Well Record Number 1534876

0506E (09/03) Contractor's Copy ☐ Ministry's Copy ☐ Well Owner's Copy ☐ Cette formule est disponible en français

Ministry of the Environment

Ontario

OTTAWA - CARLETON

The Ontario Water Resources Act
WATER WELL RECORD

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

11 | 1525164 | MUNICIP. 15002 | CON. CON 09

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
[redacted]	[redacted]cester	9	1

[redacted]lesbad Springs

DATE COMPLETED: DAY 3 MO 5 YR 90

ELEVATION | RC. | BASIN CODE

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	TO
Yellow	Sand	Loam	Loose	0	2
Blue	Clay		Dense	2	70
Grey	Till		Packed	70	77
Grey	Limestone		Layered	77	100

31

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
95	☐ FRESH ☐ SALTY ☒ SULPHUR ☐ MINERALS ☐ GAS
	☐ FRESH ☐ SALTY ☐ SULPHUR ☐ MINERALS ☐ GAS
	☐ FRESH ☐ SALTY ☐ SULPHUR ☐ MINERALS ☐ GAS
	☐ FRESH ☐ SALTY ☐ SULPHUR ☐ MINERALS ☐ GAS
	☐ FRESH ☐ SALTY ☐ SULPHUR ☐ MINERALS ☐ GAS

51 CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	TO
6 1/4	☒ STEEL	188	0	77
6	☒ OPEN HOLE		77	100

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.)
2	77	Clay

71 PUMPING TEST

PUMPING TEST METHOD	PUMPING RATE	DURATION OF PUMPING
☒ PUMP ☐ BAILER	25 GPM	1 HOURS 0 MINS

☒ PUMPING ☐ RECOVERY

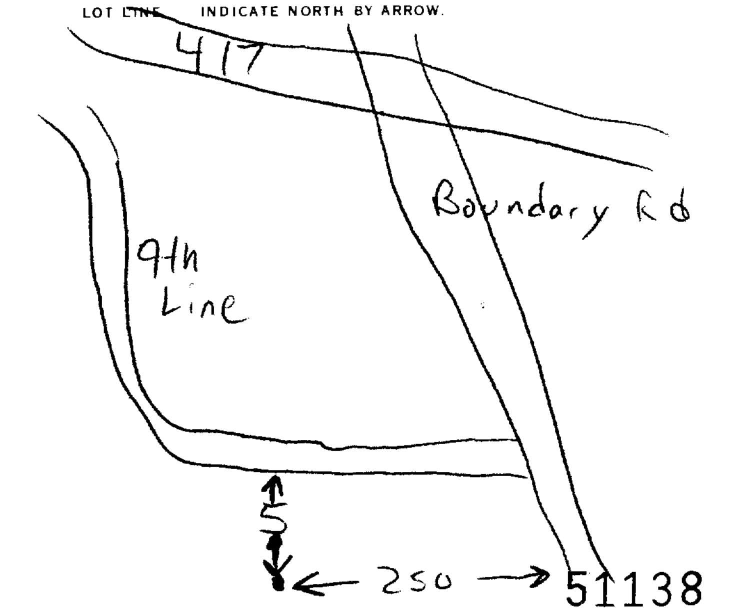
STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
6 FEET	40 FEET	16 FEET	26 FEET	36 FEET	40 FEET

IF FLOWING, GIVE RATE	PUMP INTAKE SET AT	WATER AT END OF TEST
GPM	40 FEET	☐ CLEAR ☒ CLOUDY

RECOMMENDED PUMP TYPE	RECOMMENDED PUMP SETTING	RECOMMENDED PUMPING RATE
☐ SHALLOW ☒ DEEP	40 FEET	25 GPM

LOCATION OF WELL

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



51138

DRILLERS REMARKS

FINAL STATUS OF WELL

☒ WATER SUPPLY ☐ OBSERVATION WELL ☐ TEST HOLE ☐ RECHARGE WELL ☐ ABANDONED, INSUFFICIENT SUPPLY ☐ ABANDONED, POOR QUALITY ☐ UNFINISHED ☐ DEWATERING

WATER USE

☐ DOMESTIC ☐ STOCK ☐ IRRIGATION ☐ INDUSTRIAL ☐ OTHER ☒ COMMERCIAL ☐ MUNICIPAL ☐ PUBLIC SUPPLY ☐ COOLING OR AIR CONDITIONING ☐ NOT USED

METHOD OF CONSTRUCTION

☐ CABLE TOOL ☐ ROTARY (CONVENTIONAL) ☐ ROTARY (REVERSE) ☒ ROTARY (AIR) ☐ AIR PERCUSSION ☐ BORING ☐ DIAMOND ☐ JETTING ☐ DRIVING ☐ DIGGING ☐ OTHER

CONTRACTOR

NAME OF WELL CONTRACTOR: Roy's LBR Ltd | WELL CONTRACTOR'S LICENCE NUMBER: 4609

ADDRESS: Cornwall

NAME OF WELL TECHNICIAN: Roger Roy | WELL TECHNICIAN'S LICENCE NUMBER: T-0330

SIGNATURE OF TECHNICIAN/CONTRACTOR | SUBMISSION DATE DAY ___ MO. ___ YR. ___

OFFICE USE ONLY

DATA SOURCE | CONTRACTOR 4609 | DATE RECEIVED DEC 04 1990

DATE OF INSPECTION | INSPECTOR

REMARKS

MINISTRY OF THE ENVIRONMENT COPY

FORM NO. 0506 (11/86) FORM 9

ATTACHMENT E

OSSO Submission

Application for a Permit to Construct or Demolish

This form is authorized under subsection 8(1.1) of the *Building Code Act,1992*

For use by Principal Authority	
Application number:	Permit number (if different):
Date received:	Roll number:

Application submitted to: OTTAWA SEPTIC SYSTEM OFFICE
(Name of municipality, upper-tier municipality, board of health or conservation authority)

A. Project information

Building number, street name		Unit number	Lot/con.
363 ENTREPRENEUR CRESCENT			
Municipality: NAVAN (CITY OF OTTAWA)	Postal code: K4B 1T8	Plan number/other description	
Project value est. $ 28,000.00		Area of work (m^2) 68.04 m^2	

B. Purpose of application

X New construction | Addition to an existing building | Alteration/repair | Demolition | Conditional Permit

Proposed use of building	Current use of building
WAREHOUSE w/ OFFICE SPACE	VACANT LOT

Description of proposed work

NEW ELJEN SYSTEM FOR WAREHOUSE + OFFICE SPACE.

C. Applicant

Applicant is: Owner or X Authorized agent of owner

Last name	First name	Corporation or partnership	
DECOEUR	MARC-ANDRÉ	ABSOLUTE DRAFTING + DESIGN INC.	
Street address: 1257 MONTÉE DROUIN		Unit number	Lot/con.
Municipality: THE NATION (CASSELMAN)	Postal code: K0A 1M0	Province: ONTARIO	E-mail: INFO@ADND.CA
Telephone number: (613) 434-2844	Fax: ( )		Cell number: (613) 229-0869

D. Owner (if different from applicant)

Last name	First name	Corporation or partnership	
WILSON	DUSTIN	ENTREPRENEUR HOLDING CORPORATION	
Street address: 310 SANCTUARY PVT		Unit number	Lot/con.
Municipality: OTTAWA	Postal code: K1S 5W1	Province: ONTARIO	E-mail: justdustinwilson@gmail.com
Telephone number: ( )	Fax: ( )		Cell number: (613) 700-5262

Application for a Permit to Construct or Demolish – Effective January 1, 2014

E. Builder (optional)				
Last name UNKNOWN @ TIME OF APPLICATION.	First name	Corporation or partnership (if applicable)		
Street address			Unit number	Lot/con.
Municipality	Postal code	Province	E-mail	
Telephone number ( )	Fax ( )		Cell number ( )	

F. Tarion Warranty Corporation (Ontario New Home Warranty Program)		
i. Is proposed construction for a new home as defined in the *Ontario New Home Warranties Plan Act*? If no, go to section G.	Yes	No ✓
ii. Is registration required under the *Ontario New Home Warranties Plan Act*?	Yes	No ✓
iii. If yes to (ii) provide registration number(s): ______________________		

G. Required Schedules
i) Attach Schedule 1 for each individual who reviews and takes responsibility for design activities.
ii) Attach Schedule 2 where application is to construct on-site, install or repair a sewage system.

H. Completeness and compliance with applicable law		
i) This application meets all the requirements of clauses 1.3.1.3 (5) (a) to (d) of Division C of the Building Code (the application is made in the correct form and by the owner or authorized agent, all applicable fields have been completed on the application and required schedules, and all required schedules are submitted).	Yes ✓	No
Payment has been made of all fees that are required, under the applicable by-law, resolution or regulation made under clause 7(1)(c) of the *Building Code Act, 1992*, to be paid when the application is made.	Yes ✓	No
ii) This application is accompanied by the plans and specifications prescribed by the applicable by-law, resolution or regulation made under clause 7(1)(b) of the *Building Code Act, 1992*.	Yes ✓	No
iii) This application is accompanied by the information and documents prescribed by the applicable by-law, resolution or regulation made under clause 7(1)(b) of the *Building Code Act, 1992* which enable the chief building official to determine whether the proposed building, construction or demolition will contravene any applicable law.	Yes ✓	No
iv) The proposed building, construction or demolition will not contravene any applicable law.	Yes ✓	No

I. Declaration of applicant

I MARC-ANDRÉ DECOEUR [ABSOLUTE DRAFTING + DESIGN INC.] declare that:
(print name)

1. The information contained in this application, attached schedules, attached plans and specifications, and other attached documentation is true to the best of my knowledge.
2. If the owner is a corporation or partnership, I have the authority to bind the corporation or partnership.

Date April 19, 2023 Signature of applicant

Personal information contained in this form and schedules is collected under the authority of subsection 8(1.1) of the *Building Code Act, 1992*, and will be used in the administration and enforcement of the *Building Code Act, 1992*. Questions about the collection of personal information may be addressed to: a) the Chief Building Official of the municipality or upper-tier municipality to which this application is being made, or, b) the inspector having the powers and duties of a chief building official in relation to sewage systems or plumbing for an upper-tier municipality, board of health or conservation authority to whom this application is made, or, c) Director, Building and Development Branch, Ministry of Municipal Affairs and Housing 777 Bay St., 2nd Floor. Toronto, M5G 2E5 (416) 585-6666.

Schedule 1: Designer Information

Use one form for each individual who reviews and takes responsibility for design activities with respect to the project.

A. Project Information				
Building number, street name: 363 Entrepreneur Crescent			Unit no.	Lot/con.
Municipality: Navan [Ottawa]	Postal code: K4B 1T8	Plan number/ other description		

B. Individual who reviews and takes responsibility for design activities				
Name: MARC-ANDRE DECOEUR		Firm: ABSOLUTE DRAFTING + DESIGN INC		
Street address: 1257 MONTEE DROUIN			Unit no.	Lot/con.
Municipality: THE NATION	Postal code: K0A 1M0	Province: ONTARIO	E-mail: INFO@ADND.CA	
Telephone number: 613-434-2844 EXT. 1001	Fax number		Cell number: 613-229-0869	

C. Design activities undertaken by individual identified in Section B. [Building Code Table 3.5.2.1. of Division C]

☑ House	☑ HVAC – House	☑ Building Structural
☑ Small Buildings	☑ Building Services	☑ Plumbing – House
☑ Large Buildings	☑ Detection, Lighting and Power	☑ Plumbing – All Buildings
☑ Complex Buildings	☐ Fire Protection	☑ On-site Sewage Systems

Description of designer's work

New Eljen System for Warehouse + Office Space.

D. Declaration of Designer

I MARC-ANDRE DECOEUR (ABSOLUTE DRAFTING + DESIGN INC.) declare that (choose one as appropriate):
(print name)

I review and take responsibility for the design work on behalf of a firm registered under subsection 3.2.4.of Division C, of the Building Code. I am qualified, and the firm is registered, in the appropriate classes/categories.

Individual BCIN: 44555

Firm BCIN: 45254

I review and take responsibility for the design and am qualified in the appropriate category as an "other designer" under subsection 3.2.5.of Division C, of the Building Code.

Individual BCIN: ______

Basis for exemption from registration: ______

The design work is exempt from the registration and qualification requirements of the Building Code.

Basis for exemption from registration and qualification: ______

I certify that:

1. The information contained in this schedule is true to the best of my knowledge.
2. I have submitted this application with the knowledge and consent of the firm.

April 19, 2023
Date

Signature of Designer

NOTE:

1. For the purposes of this form, "individual" means the "person" referred to in Clause 3.2.4.7(1) (c).of Division C, Article 3.2.5.1. of Division C, and all other persons who are exempt from qualification under Subsections 3.2.4. and 3.2.5. of Division C.
2. Schedule 1 is not required to be completed by a holder of a license, temporary license, or a certificate of practice, issued by the Ontario Association of Architects. Schedule 1 is also not required to be completed by a holder of a license to practise, a limited license to practise, or a certificate of authorization, issued by the Association of Professional Engineers of Ontario.

Schedule 2: Sewage System Installer Information

A. Project Information				
Building number, street name 363 ENTREPRENEUR CRESCENT			Unit number	Lot/con.
Municipality NAVAN [OTTAWA]	Postal code K4B 1T8	Plan number/ other description		

B. Sewage system installer

Is the installer of the sewage system engaged in the business of constructing on-site, installing, repairing, servicing, cleaning or emptying sewage systems, in accordance with Building Code Article 3.3.1.1, Division C?

Yes (Continue to Section C) No (Continue to Section E) ✓ Installer unknown at time of application (Continue to Section E)

C. Registered installer information (where answer to B is "Yes")				
Name			BCIN	
Street address			Unit number	Lot/con.
Municipality	Postal code	Province	E-mail	
Telephone number ( )	Fax ( )		Cell number ( )	

D. Qualified supervisor information (where answer to section B is "Yes")	
Name of qualified supervisor(s)	Building Code Identification Number (BCIN)

E. Declaration of Applicant:

I MARC-ANDRÉ DÉCOEUR [ABSOLUTE DRAFTING + DESIGN INC.] declare that:
(print name)

✓ I am the applicant for the permit to construct the sewage system. If the installer is unknown at time of application, I shall submit a new Schedule 2 prior to construction when the installer is known;

OR

I am the holder of the permit to construct the sewage system, and am submitting a new Schedule 2, now that the installer is known.

I certify that:

1. The information contained in this schedule is true to the best of my knowledge.
2. If the owner is a corporation or partnership, I have the authority to bind the corporation or partnership.

Date April 19, 2023 Signature of applicant

Ottawa Septic System Office Bureau des systèmes septiques d'Ottawa

Do Not Complete
Permit # ____________
Revision # ____________
Date ____________

Schedule 4
Proposed Services
Complete Sections 1 thru 7

1. **Engineered**
- ☐ Yes
- ☑ No

2. **Water supply**
- ☑ Proposed
- ☐ Existing

3. **Type of work proposed**
- ☑ New Installation
- ☐ Replacement
- ☐ Alteration

4. **Type of Well**
- ☐ Dug/bored/Sandpoint well
- ☑ Drilled well
- ☐ Municipal
- ☐ Other

5. **Residential** Sewage Design Flow Info.

Bedrooms ____________
House (floor area) ____________ **m²**
People ____________
Total Fixture Units ____________ **(Schedule 8)**
Residential Flow ____________ **L/day**

6. Sewage Design Flow **Other Occupancies**

Design Flow 1310 L/day
Detailed sewage flow calculations:
SEE "FLOW CALCULATION" DRAWING.

- ☑ Class 4 – BMEC Area Bed **(Schedule 11)** → ELJEN
  - ☐ Fully raised
  - ☑ Partially raised
  - ☐ In-ground
- ☐ Class 4 – "Type A" Dispersal **(Schedule 13)**
  - ☐ Fully raised
  - ☐ Partially raised
  - ☐ In-ground
- ☐ Class 4 – "Type B" Dispersal **(Schedule 14)**
  - ☐ Fully raised
  - ☐ Partially raised
  - ☐ In-ground
- ☐ Class 5 – Holding Tank (9000L min)
- ☐ Tank/TreatmentUnit/PumpChamber ONLY
- ☐ Effluent Filter/Risers ONLY

7. **Type of System**
- ☐ Treatment Unit ____________
- ☐ Class 2 – Leaching Pit
- ☐ Class 3 – Cesspool
- ☐ Class 4 – Shallow Buried Trench
- ☐ Class 4 – Trench **(Schedule 9)**
  - ☐ Fully raised
  - ☐ Partially raised
  - ☐ In-ground
- ☐ Class 4 – Filter Media **(Schedule 10)**
  - ☐ Fully raised
  - ☐ Partially raised
  - ☐ In-ground

Ottawa Septic System Office | Bureau des systèmes septiques d'Ottawa

Do Not Complete
Permit No ____________
Revision No ____________
Date ____________

Schedule 5
Sewage System Details

Type of System ELJEN SYSTEM (Schedule 4)
Septic/Holding Tank Size: 5509 Litres Make: LOW-BOY CONCRETE (PROPOSED)
Septic Tank Effluent Filter Make: POLYLOK Model: PL 525 OR EQUIVALENT.

Treatment Unit – Make & Model ELJEN GSF A42 MODULES
Number of Units: 14 Other: ____________
Refer to Typical Drawing # FLOW CALCULATIONS. Pump(s) required YES.
Mantle Information: Pump Rate ____________ L/15min
Native or imported =15m in ______ direction(s)

Note: Alarm required for all pumping systems

8 DOSING PER DAY
@ 163.8 LITER PER DOSING
*SEE SEPTIC SECTION FOR CALCULATION.

Slope subgrade 2% MIN. % slope
NORTH. direction(s)

Site to be Scarified (If clay) YES / NO "SILTY SAND."
Clay Seal Required (If bedrock) YES / NO AS PER LRL "GEOTECH REPORT."

❑ **Trench**
Distribution Pipe Length ______ m
Loading Area ______ m^2
Type of Chamber ______
Length of Chamber ______ m

❑ **Dispersal Bed** $L = \frac{QT}{400}$

☑ **BMEC** ❑ **Type A** ❑ **Type B**
Stone ______ m²
Sand 65.5m² MIN ∴ 68.04 m² PROVIDED
Pipe SEE "FLOW CALCULATION" m
Linear Loading ______ L/m^2

❑ **Shallow Buried Trench**
Pipe Length ______ m

❑ **Filter Media Bed**
Stone ______ m²
Extended Base ______ m²
Pipe ______ m
Weight of Filter Media ______ Kg
Loading Area ______ m

❑ **Tank/Treatment Unit/Pump Chamber Replacement** ONLY
❑ **Effluent Filter & Riser** ONLY

Construction Notes:

Ottawa Septic System Office | Bureau des systèmes septiques d'Ottawa

Do Not Complete
Permit # ______
Revision # ______
Date ______

Schedule 6
Soil and Water Table Information
(Minimum depth of test pit: 2 metres)

Name of Applicant/Agent: MARC-ANDRÉ DÉGREUR. Date: April 19, 2023 Time: ______ Applicant/Agent Signature: [signature]	Inspector: ______ Date: ______ Time: ______ Inspector Signature: ______

Test pit 1

EG (76.94) Soil Description | T

.5m
1.0 m
1.5m
2.0 m

SILTY SAND

ASSUMED HGWT AS PER LRL GEOTECH. REPORT FILE No: 220407 @ BH#3

T: 8 @ 20 FOR SILTY SAND [SB-6]

Test pit 2

EG (……..) Soil Description | T

.5m
1.0 m
1.5m
2.0 m

Test pit 3

EG (……..) Soil Description | T

.5m
1.0 m
1.5m
2.0 m

Test pit 4

EG (……..) Soil Description | T

.5m
1.0 m
1.5m
2.0 m

LEGEND

BR = Bedrock	HGWT = High ground water table	EG = Existing grade
GWT = Ground water table	M = metres	T = percolation rate

Ottawa Septic System Office | Bureau des systèmes septiques d'Ottawa

Do Not Complete
Permit # ____________
Revision # ____________
Date ____________

Scale: 1Block = ________

Schedule 7
Layout Section

N

SEE PROVIDED "SEPTIC LAYOUT"

○Dug Well ●Drilled Well ▲Neighbouring Homes ◊Benchmark ---Tile Drainage —Property Line

Elevations (metric only)
B.M. ____________ m
B.M.Description ________________________
____
Exact Location ________________________

Min. of 5 elevations in proposed system area (in X pattern)

X_1 ____________ X_2 ____________
X_3 ____________ X_4 ____________
X_5 ____________ X_6 (toe) ____________
X_7 X_8

Ottawa Septic System Office | Bureau des systèmes septiques d'Ottawa

Do Not Complete
Permit # ___
Revision # ___
Date ___

Schedule 8
Fixture unit count

Fixtures	# Existing	+	# Proposed	X	unit count	=	Fixture Count
Bathroom Bathroom group (toilet, sink and tub **or** shower) installed in the **same** room		+		X	6	=	
Bathtub with/without overhead shower		+		X	1.5	=	
Shower stall		+	4	X	1.5	=	6
Wash basin (SINK) (1½inch trap)		+	5	X	1.5	=	7.5
Watercloset (TOILET) tank operated		+	5	X	4	=	20
Bidet / URINAL		+	3	X	1	=	3
Kitchen Dishwasher		+	1	X	1	=	1
Sink with/without garbage grinder(s), domestic and other small type single, double or 2 single with a common trap		+	1	X	1.5	=	1.5
Other Domestic washing machine		+	1	X	1.5	=	1.5
Combination sink and laundry tray single or double (Installed on 1½ trap)		+	1	X	1.5	=	1.5
						***Total:**	42

***Insert the TOTAL in section 5 of Schedule 4** (0.Reg 151/13 Table 7.4.9.3)

1. **Sump pumps and floor drains are not to be connected to the sewage system.** Connection of such fixtures to a sewage system may lead to a hydraulic failure of the said system. The above mentioned fixtures should be discharged separately to an approved Class 2 (leaching pit) sewage system.
2. Where laundry waste is not more than 20% of the total daily design sanitary sewage flow, it may discharge to a sewage system (Part 8, OBC, 8.1.3.1(2)).

[signature]
Agent/Owner signature

April 19, 2023
Date

Plan View

Do Not Complete
Permit # ____________
Revision # ____________
Date ____________

Ottawa Septic System Office — Bureau des systèmes septiques d'Ottawa

TYPICAL DRAWING C

BURIED OR RAISED BED - BMEC ELJEN System

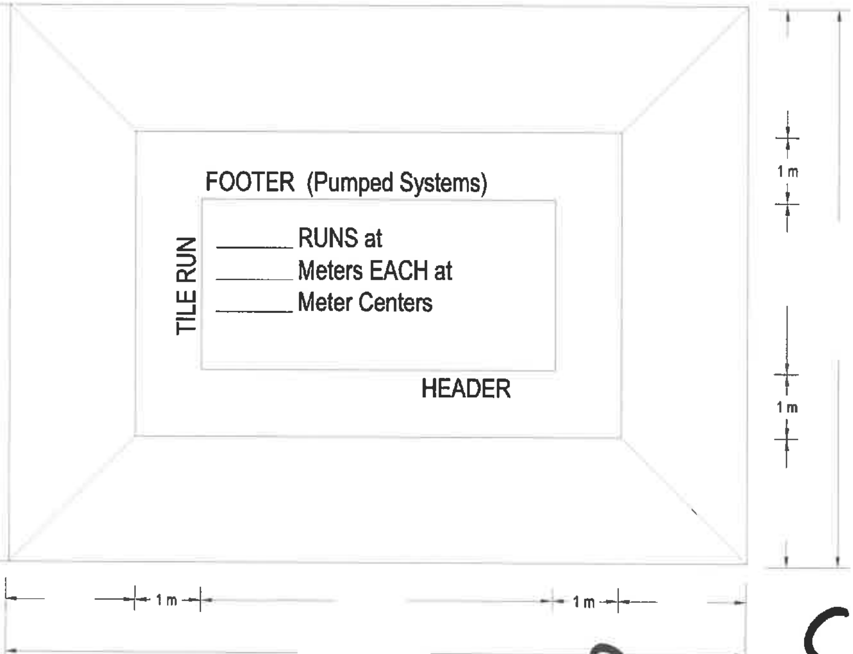
Mantle required: Yes ☐ No ☐

Scarification required: Yes ☐ No ☐

Clay seal required: Yes ☐ No ☐

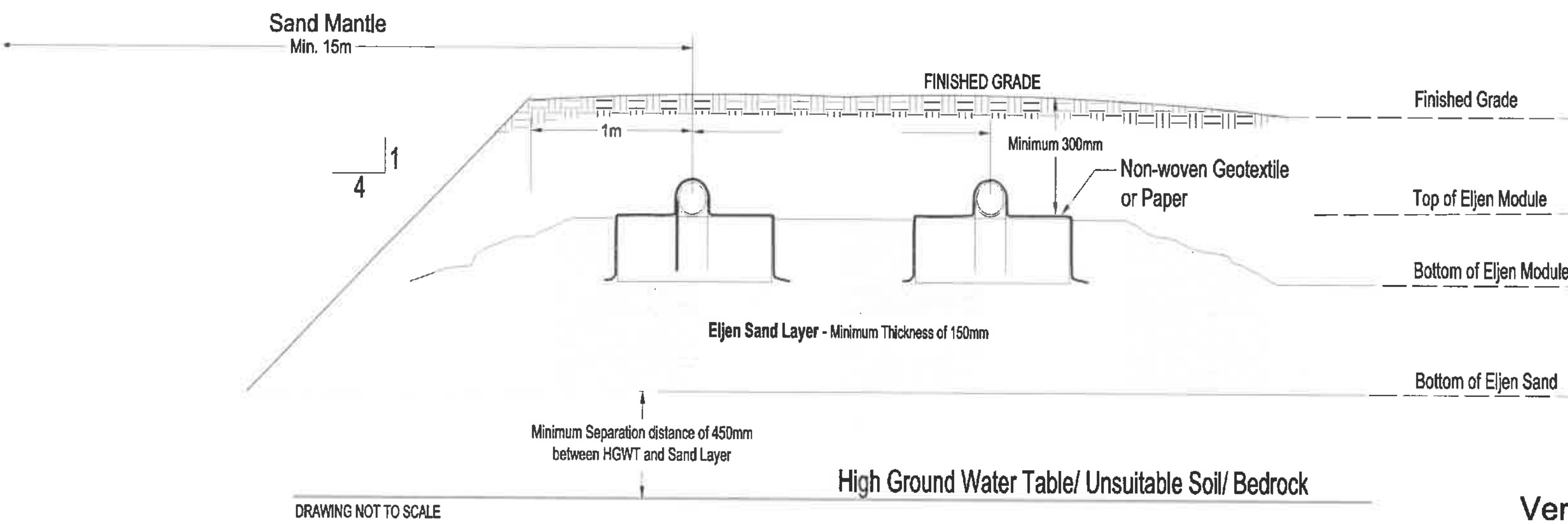
LOADING AREA = ________ m^2

DRAWING NOT TO SCALE



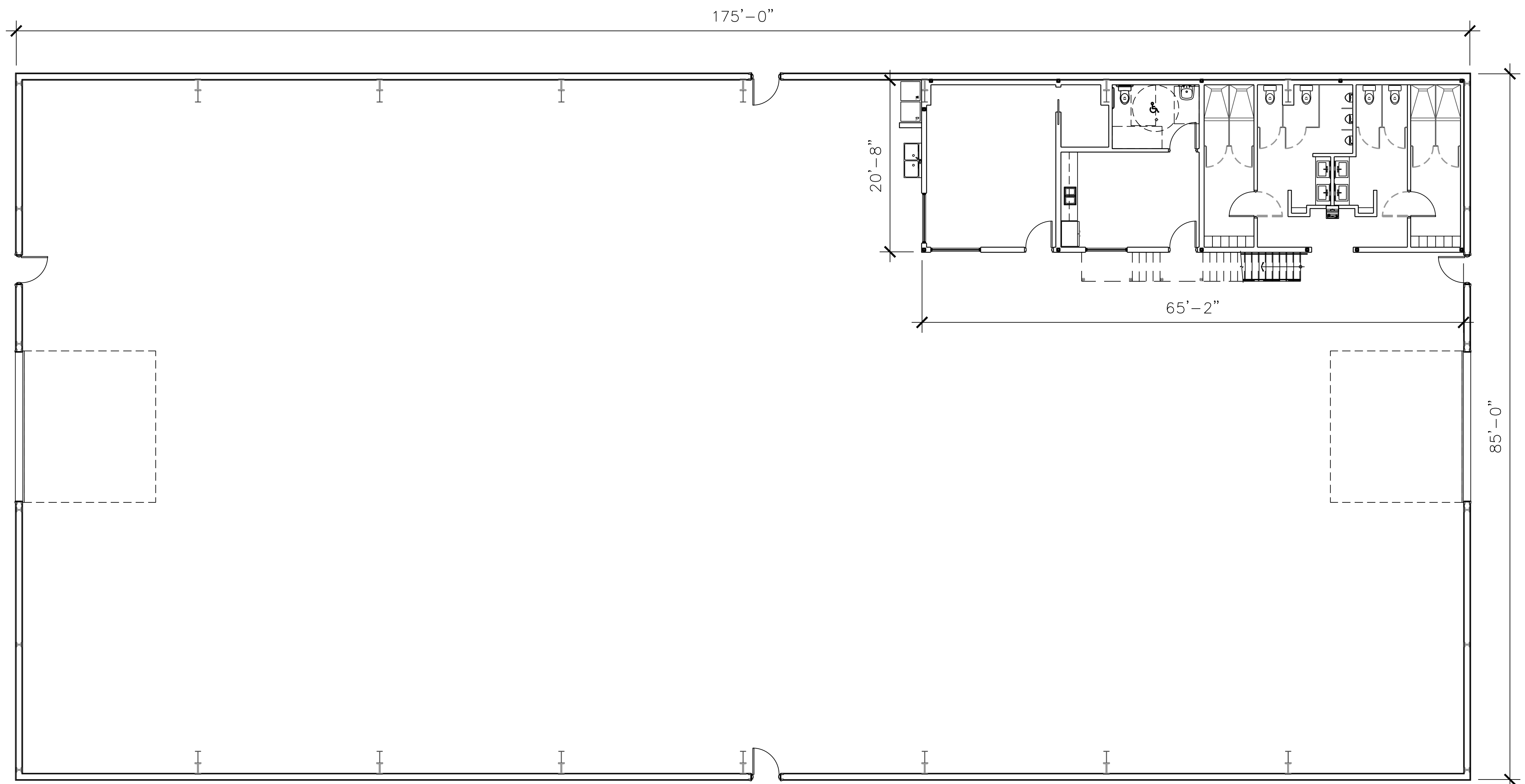
SEE PROVIDED "SEPTIC SECTION"

Cross-Section Profile



Proposed Installation Grades	Approved Installation Grades	Existing Grade

LRL
ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434



GROUND FLOOR PLAN

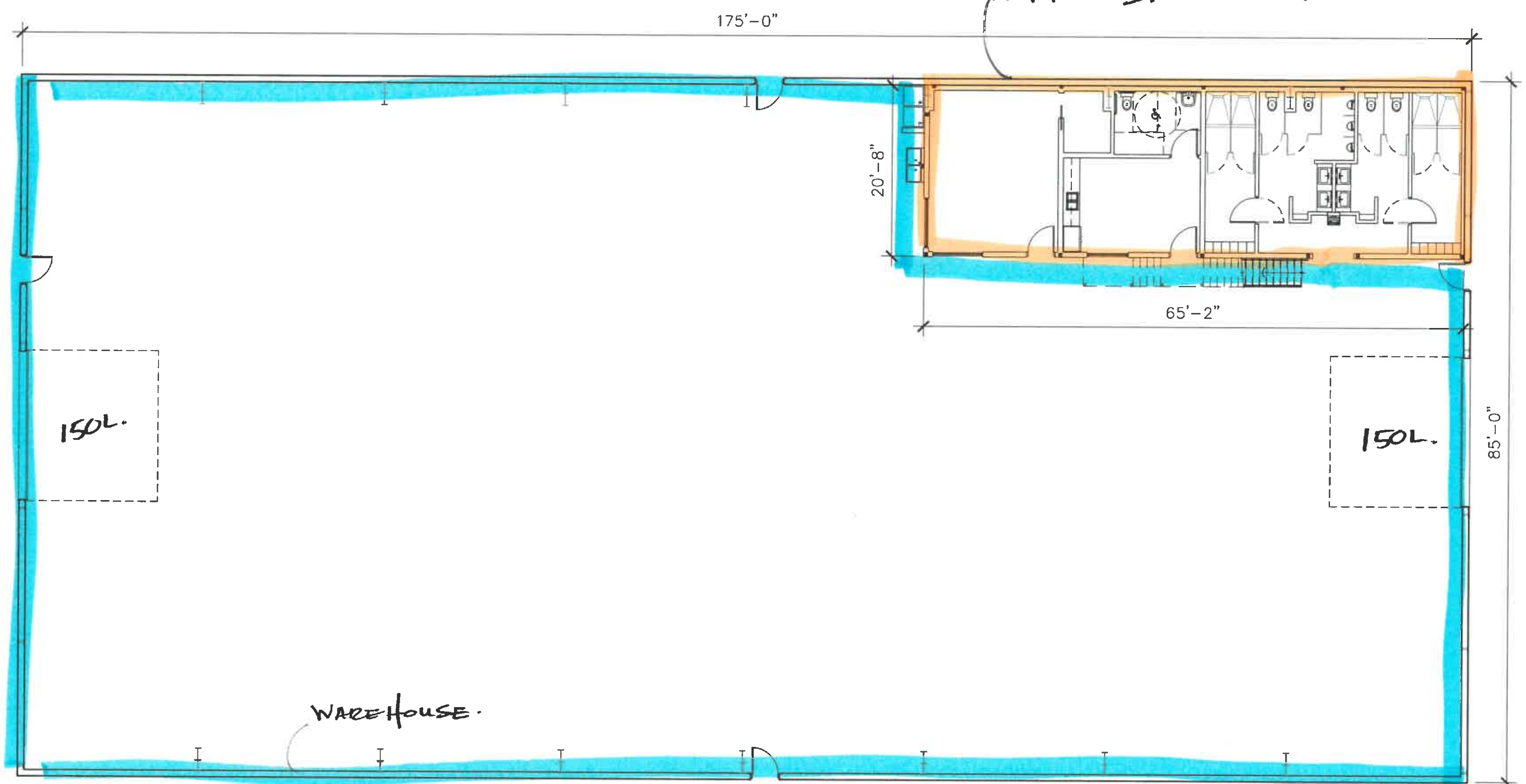
SCALE: 1/16" = 1'–0"

LRL
ENGINEERING | INGÉNIERIE
5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lrl.ca | (613) 842-3434

- WAREHOUSE = 2x LOADING BAY = 2x150L = 300L.
- OFFICE AREA = 75L/9.3m² = 1347 sq.ft. = $\frac{125.12m^2}{9.3m^2}$ = 13.46 x 75L = 1010 L

OR 75L/9.3m²/PERSON
↳ AS PER T.3.1.17 OBC.

300L + 1010L = 1310L/D.
↳ DESIGN FLOW/DAY.



@TEST PIT "BH3"

* HGWT @ 0.5m BELOW EXISTING GRADE [SEE LRL REPORT]

LOADING AREA.
SILTY SAND [SB-6]
$= \frac{QT}{400} = \frac{1310 \times 20}{400}$
= 65.5m² MIN.
PROVIDED = 4.2m x 16.2m
= 68.04m²

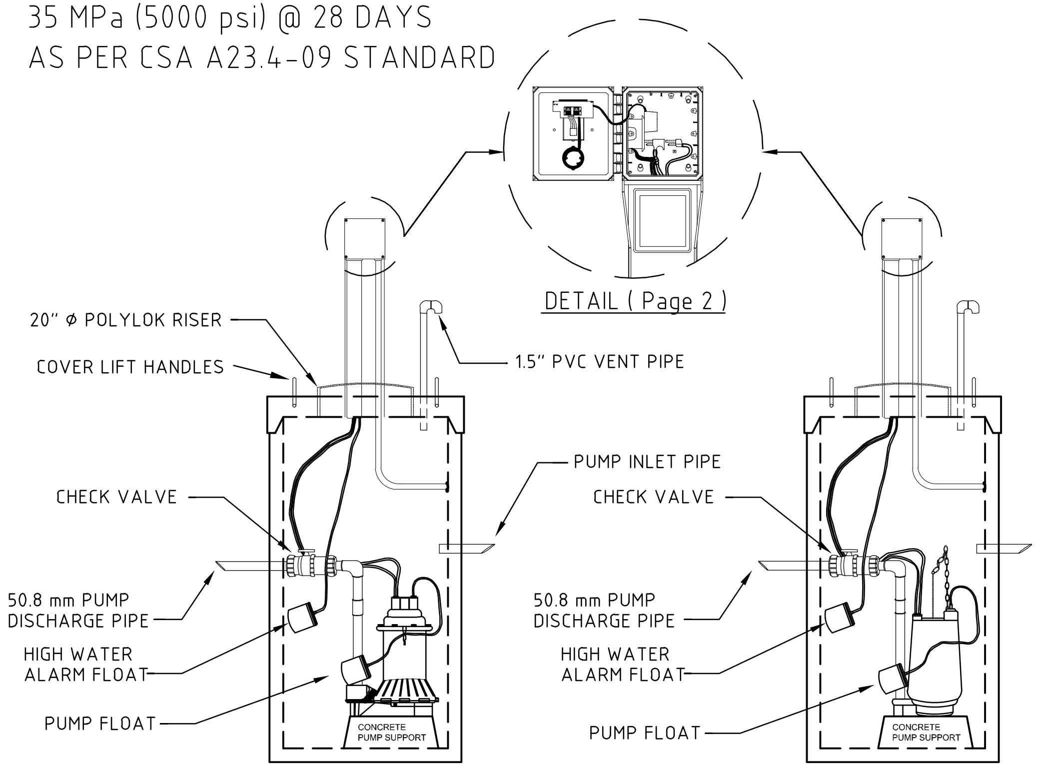
ELJEN SYSTEM.
↳ $\frac{L/D}{95}$
$= \frac{1310}{95} = 13.79$
= 14 MODULES REQ'D.
2 RUNS OF 7 MODULES.

SEPTIC TANK = L/D x 3
= 1310 x 3
= 3930 L MIN. TANK.
↳ PROPOSED 5,509L TANK.

GROUND FLOOR PLAN

SCALE: 1/16" = 1'–0"

6% - 8% AIR ENTRAINED
35 MPa (5000 psi) @ 28 DAYS
AS PER CSA A23.4-09 STANDARD



SRM 4 0.40 HP PUMP SYSTEM

MRG 20 2.0 HP GRINDER PUMP SYSTEM

BOTH PUMP SHOWN ARE 250 GAL / 1135 L PUMP STATIONS, NOT TO SCALE

SIDE VIEW

GENERAL NOTES:

A PUMP STATION IS REQUIRED WHEN A SEPTIC SYSTEM IS UNABLE TO FUNCTION BY GRAVITY.

FROM 8.6.1.3. (3) OF THE O.B.C. 2006, WHERE 2 OR MORE PUMPS ARE EMPLOYED WITHIN A DOSING TANK, THE PUMPS SHALL BE DESIGNED SUCH THAT THE PUMPS ALTERNATE DOSING, AND DOSING SHALL CONTINUE IN THE EVENT THAT ONE OF THE PUMP FAILS.

FROM 8.6.1.3. (4) OF THE O.B.C. 2006, WHERE A PUMP OR SIPHON IS REQUIRED, THE PUMP OR SIPHON SHALL BE DESIGNED TO DISCHARGE A DOSE OF AT LEAST 75% OF THE INTERNAL VOLUME OF THE DISTRIBUTION PIPE WITHIN A TIME PERIOD NOT EXCEEDING 15 MINUTES.

A PUMP STATION SHALL HAVE A WORKING VOLUME OF A THIRD OF THE DAILY FLOW OF THE SEPTIC SYSTEM IT IS DESIGNED FOR.

PUMP STATION ARE AVAILABLE IN MULTIPLE SIZES, AND MULTIPLE PUMP SIZES ALSO AVAILABLE.
DUAL PUMP STATION ALSO AVAILABLE, SEE LIST BELOW,
VOLUME INDICATED IS MAXIMUM WORKING VOLUME:

175 GAL / 800 LITERS : 3 FEET ø - 4 FEET WELL TILE
250 GAL / 1135 LITERS : 3 FEET ø - 6 FEET WELL TILE
450 GAL / 2045 LITERS : 4 FEET ø - 6 FEET WELL TILE
DUAL - 760 GAL / 3450 LITERS : NORMAL 800 GAL / 3630 L TANK
DUAL - 1175 GAL / 5340 LITERS : NORMAL 1210 GAL / 5509 L TANK

ALARMS, ELECTRICAL BOXES AND CHECK VALVES MAY DIFFERS FROM ONE PUMP STATION SYSTEMS TO ANOTHER. SIMPLEX AND DUPLEX TIME DOSING CONTROL PANEL AVAILABLE.

16525 SIXTH RD, MOOSE CREEK, ON
KOC 1W0
PHONE : (613)-538-2381
FAX : (613)-538-4870

MOOSE CREEK CEMENT PRODUCTS (2006) LIMITED
PUMP STATION SIDE VIEW (Page 1 / 2)

SCALE	NOT TO SCALE	DATE	JULY 2011

MOOSE CREEK CEMENT PRODUCTS (2006) LIMITED 538-2381

TECHNICAL BROCHURE

B3872 R1

WW05 Series Model 3872

SUBMERSIBLE SEWAGE PUMPS

GOULDS
WATER TECHNOLOGY
a xylem brand

FEATURES

Impeller: Glass-filled thermoplastic Full-Vortex design with pump out vanes for mechanical seal protection.

Casing and Base: Rugged glass-filled thermoplastic design provides superior strength and corrosion resistance.

Motor Housing: Cast iron for efficient heat transfer, strength, and durability.

Motor Cover: Thermoplastic cover with integral handle and float switch attachment points.

Bearings: Upper and lower heavy duty ball bearing construction.

Power Cable: Severe duty rated oil and water resistant.

O-ring: Provides positive sealing. Easily replaced during maintenance.

Stainless steel fasteners

AGENCY LISTINGS

By Canadian Standards Association

APPLICATIONS

Specifically designed for the following uses:

- Residential sewage systems
- Dewatering
- Water transfer

Anywhere waste or drainage must be disposed of quickly, quietly and efficiently.

SPECIFICATIONS

Pump:

- Solids handling capability: 2" maximum
- Capacities: up to 75 GPM
- Total heads: up to 18 feet
- Discharge size: 2" NPT
- Mechanical seal: carbon-rotary/ceramic-stationary, BUNA-N elastomers
- Temperature:
  104° F (40° C) continuous
  140° F (60° C) intermittent
- Class B Insulation
- Fasteners: 300 series stainless steel
- Capable of running dry without damage to components.

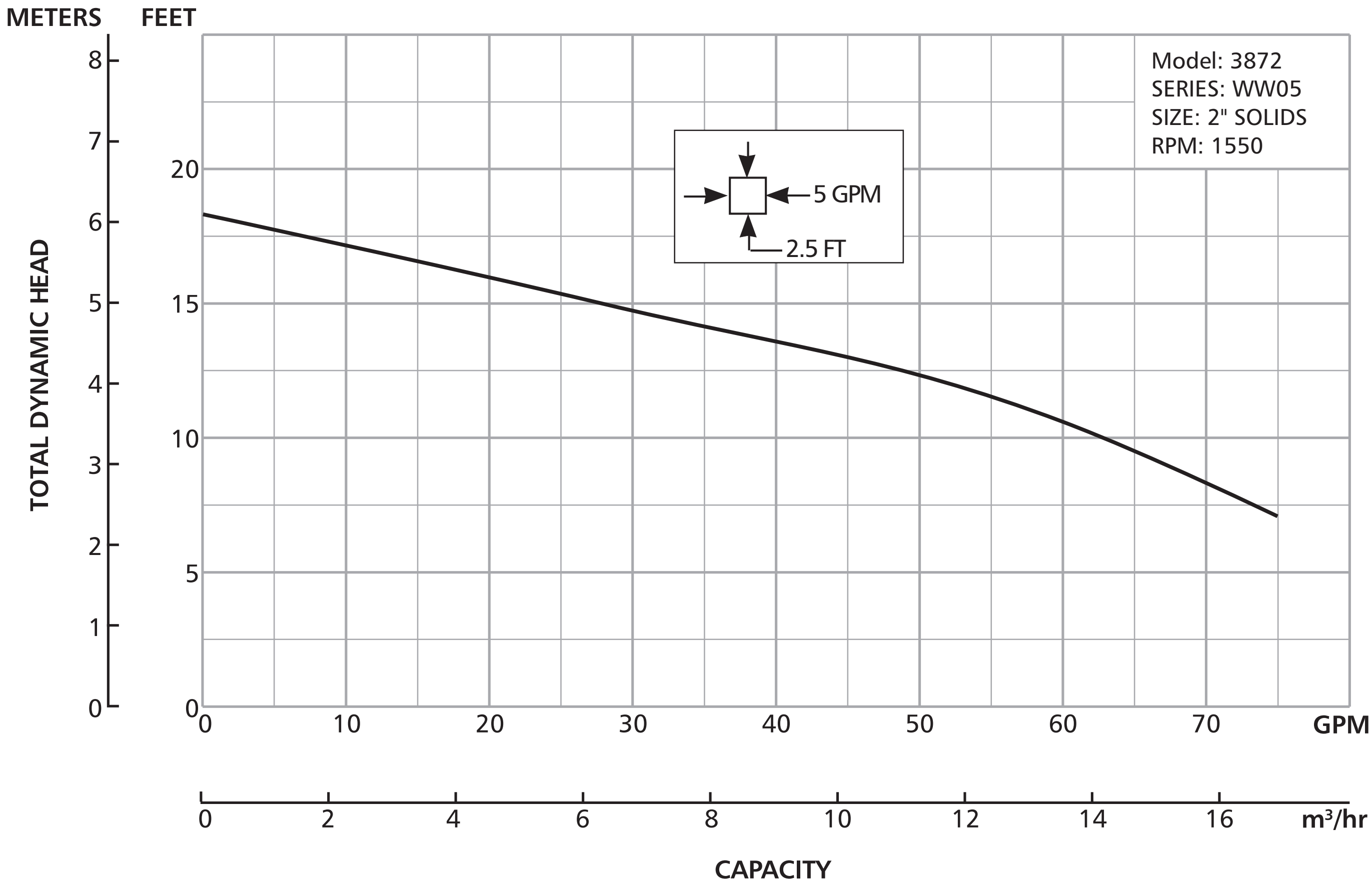
Motor

- Single phase: ½ HP, 115 or 230 V, 60 Hz, 1550 RPM, built in overload with automatic reset.
- Power cord: 10 foot standard length, 16/3 SJTW with three prong grounding plug. Optional 20 foot length, 16/3 SJTW with three prong grounding plug.
- Fully submerged in high grade turbine oil for lubrication and efficient heat transfer.

Available for automatic and manual operation. Automatic models include Mechanical Float Switch assembled and preset at the factory.

MODEL INFORMATION

<table>
<tr><th>Order No.</th><th>HP</th><th>Volts</th><th>Amps</th><th>Minimum Circuit Breaker</th><th>Phase</th><th>Float Switch Style</th><th>Cord Length</th><th>Discharge Connection</th><th>Minimum On Level</th><th>Minimum Off Level</th><th>Minimum Basin Diameter</th><th>Maximum Solids Size</th><th>Shipping Weight lbs/kg</th></tr>
<tr><td>WW0511</td><td rowspan="6">.5</td><td rowspan="4">115</td><td rowspan="4">13</td><td rowspan="4">20</td><td rowspan="6">1</td><td>Plug / No Switch</td><td>10'</td><td>2"</td><td>Manual</td><td>Manual</td><td>18"</td><td rowspan="6">2"</td><td>22 / 10</td></tr>
<tr><td>WW0511A</td><td>Piggyback / Wide-Angle</td><td>10'</td><td>2"</td><td>15"</td><td>9"</td><td>18"</td><td>23 / 10.4</td></tr>
<tr><td>WW0511F</td><td>Plug / No Switch</td><td>20'</td><td>2"</td><td>Manual</td><td>Manual</td><td>18"</td><td>22 / 10</td></tr>
<tr><td>WW0511AC</td><td>Piggyback / Wide-Angle</td><td>20'</td><td>2"</td><td>15"</td><td>9"</td><td>18"</td><td>23 / 10.4</td></tr>
<tr><td>WW0512</td><td rowspan="2">230</td><td rowspan="2">6.5</td><td rowspan="2">10</td><td>Plug / No Switch</td><td>10'</td><td>2"</td><td>Manual</td><td>Manual</td><td>18"</td><td>22 / 10</td></tr>
<tr><td>WW0512F</td><td>Plug / No Switch</td><td>20'</td><td>2"</td><td>Manual</td><td>Manual</td><td>18"</td><td>22 / 10</td></tr>
</table>



PERFORMANCE CHARTS

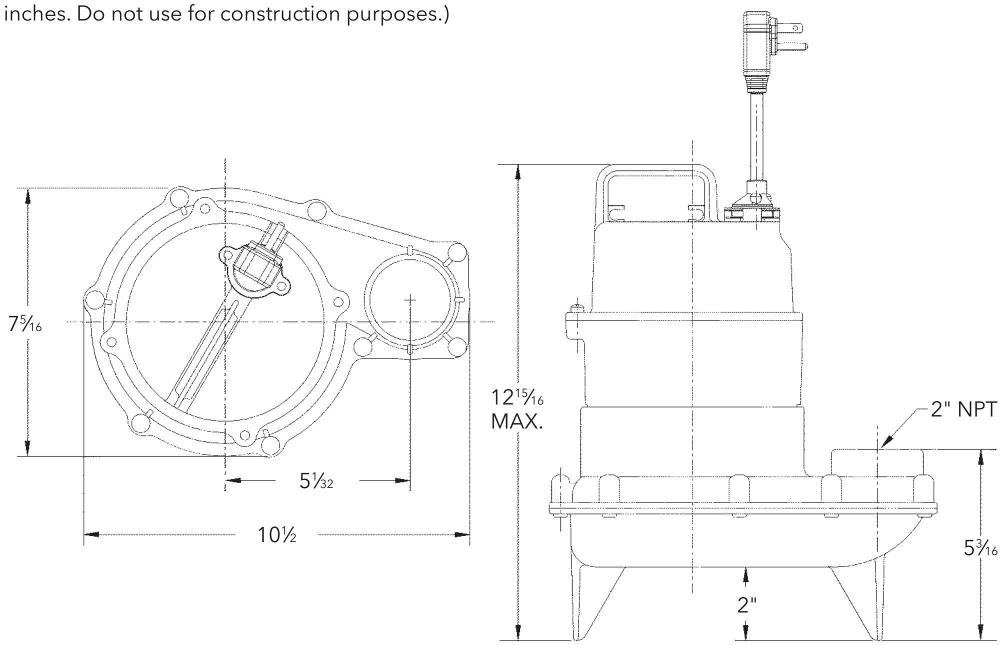
These charts show actual system performance with friction loss factored in for various discharge pipe lengths. Calculations and performance based on a system with 2" PVC, schedule 40 plastic pipe (C150), (4) 90° elbows, (1) check valve and (1) shut-off valve. Wastewater requires a minimum scouring velocity of 21 gpm for 2" pipe. Shaded areas do not provide min. scouring velocity - use only for gray water with no solids.

WW05 (3872)

	4	6	8	10	12	14	16
25	75	68	62	52	40	27	13
50	67	61	54	45	35	24	12
75	61	55	48	40	32	22	11
100	56	50	44	37	29	21	11
150	48	43	38	32	26	18	10
200	43	39	34	29	23	17	10
250	39	35	31	26	21	15	10
300	35	32	29	24	20	14	10

DIMENSIONS

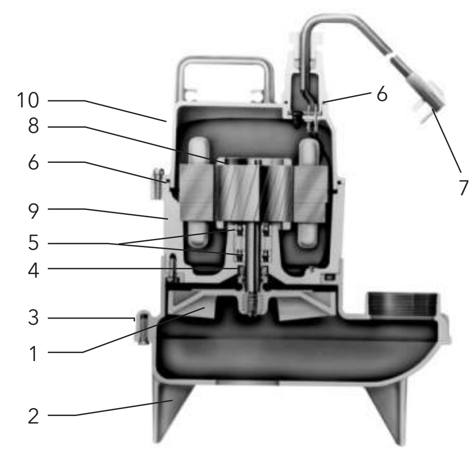
(All dimensions are in inches. Do not use for construction purposes.)



COMPONENTS *(for reference only)*

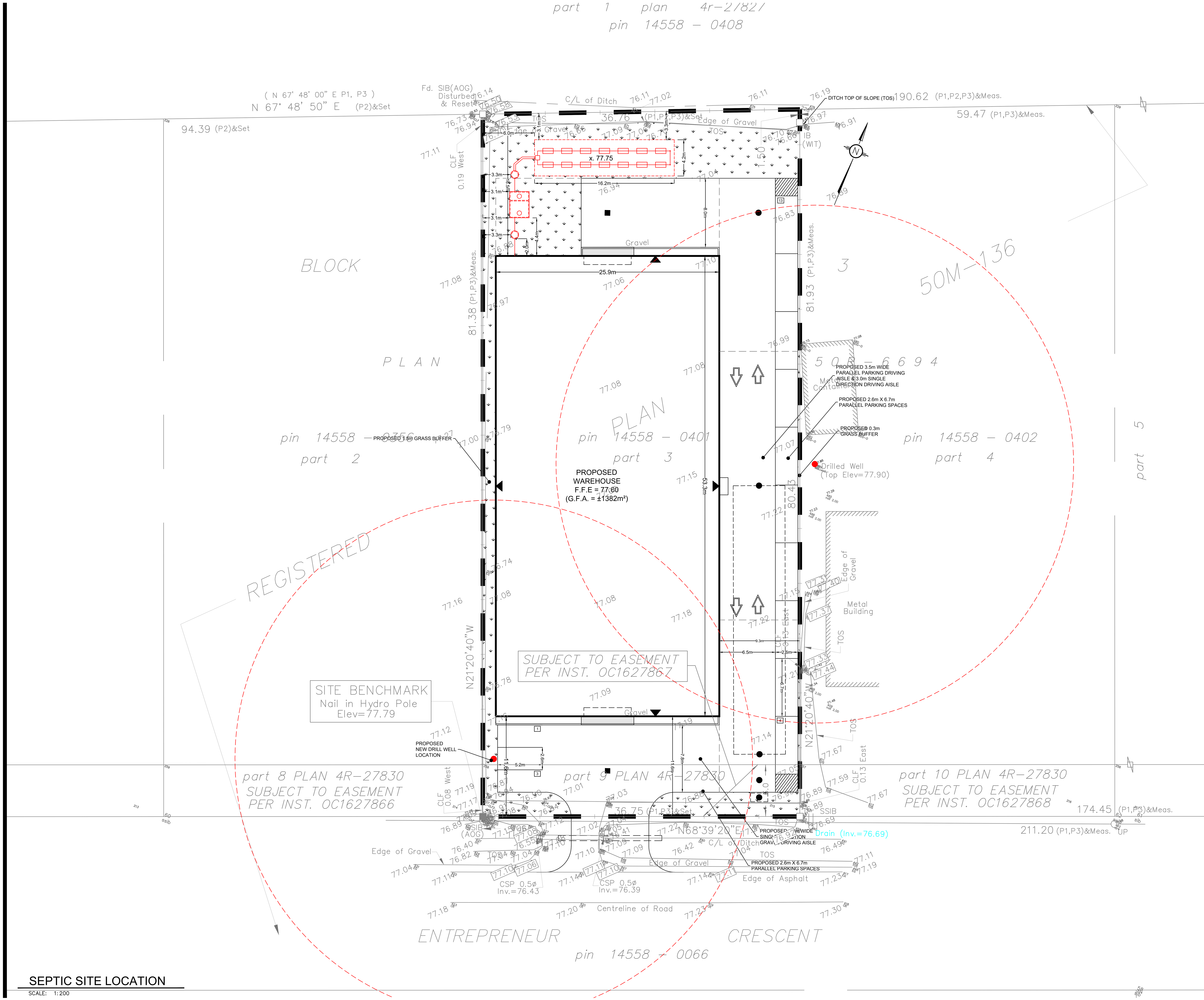
Item No.	Description
1	Impeller
2	Rugged thermoplastic base
3	Rugged thermoplastic pump casing
4	Mechanical seal
5	Ball bearings
6	O-rings
7	Power cord
8	Oil filled motor
9	Cast iron motor housing/stator assembly
10	Thermoplastic motor cover

* Parts available on repair parts selection chart.



xylem
Let's Solve Water

Xylem, Inc.
2881 East Bayard Street Ext., Suite A
Seneca Falls, NY 13148
Phone: (866) 325-4210
Fax: (888) 322-5877
www.gouldswatertechnology.com



ABSOLUTE DRAFTING + DESIGN INC.

ALL CONTRACTORS SHALL PERFORM THEIR WORK WHETHER DESCRIBED OR NOT, ACCORDING TO THE APPLICABLE BUILDING CODE REQUIREMENTS AND MUNICIPAL REGULATIONS.

THE GENERAL CONTRACTOR SHALL CHECK AND VERIFY ALL DIMENSIONS AND REPORT ERRORS AND OMISSIONS TO THE DESIGN CONSULTANT.

NO DIMENSION SHOULD BE SCALED ON DRAWINGS.

THE GENERAL CONTRACTOR OR SUB-CONTRACTORS WILL BE HELD RESPONSIBLE FOR ALL WORK DONE ON THE CONSTRUCTION SITE. IN NO EVENT WILL THE DESIGNER BE HELD RESPONSIBLE BEFORE, DURING AND AFTER THE PROJECT.

SCALE: 1:200

DATE: 2023.04.19.

ISSUED FOR PERMIT

PROJECT: 23A011-REV01

ABSOLUTE DRAFTING + DESIGN INC.
PERS. BCIN #44555
FIRM. BCIN #45254

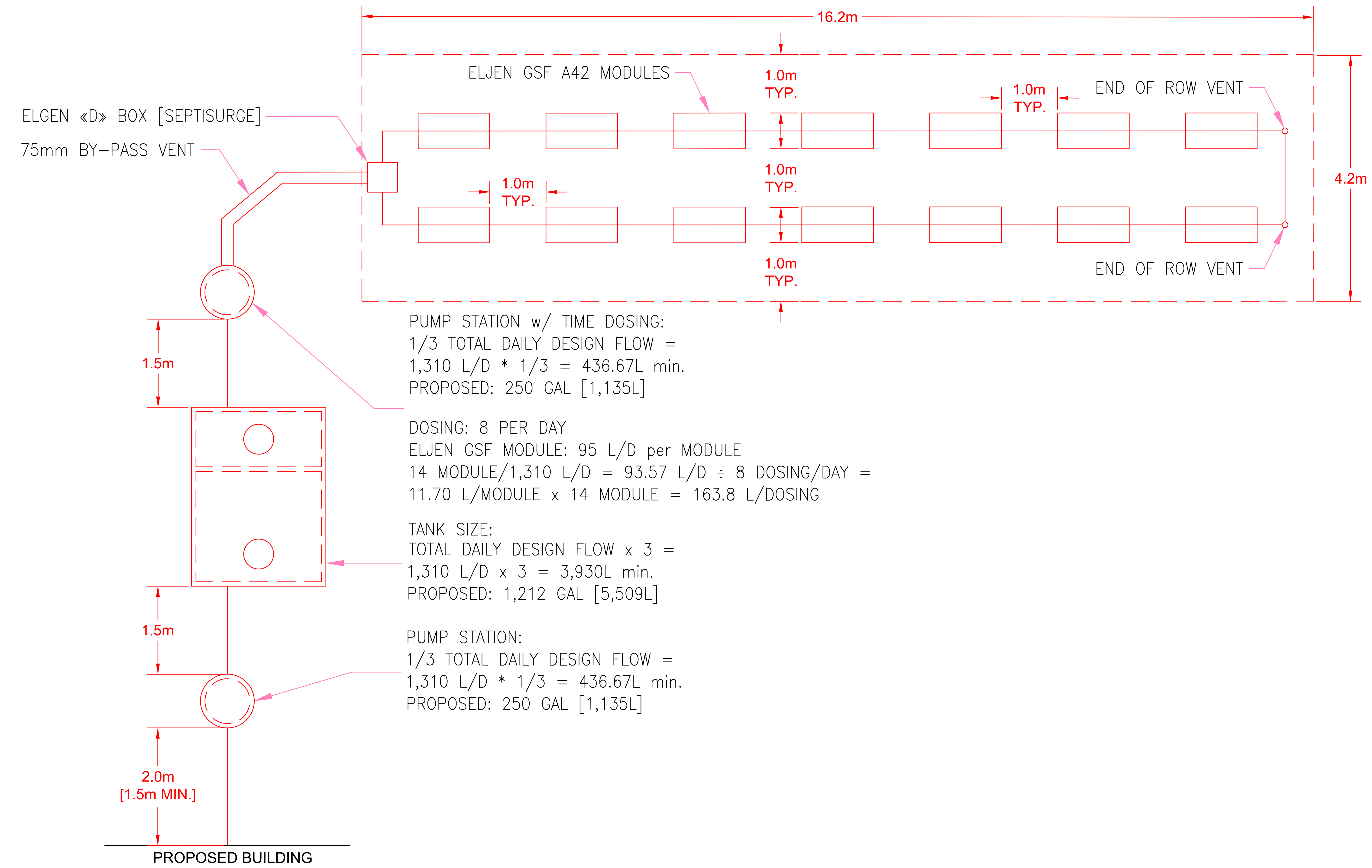
I, ABSOLUTE DRAFTING + DESIGN INC., HAVE REVIEWED THE FOLLOWING DOCUMENTS AND TAKE RESPONSIBILITY FOR THE DESIGN ACTIVITIES.

DESSIN/DRAWING
SEPTIC LOCATION

PROJET/PROJECT
WAREHOUSE DEVELOPMENT
363 ENTREPRENEUR CR., OTTAWA

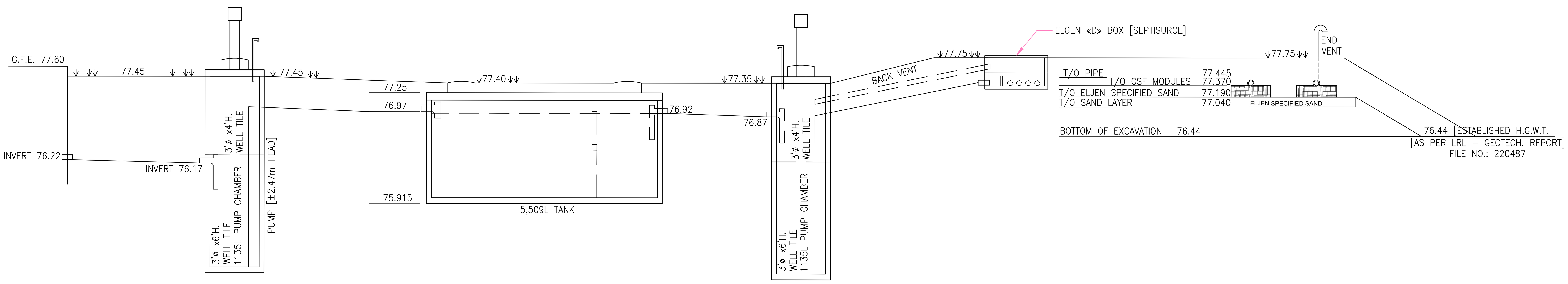
CLIENT
DUSTIN WILSON

S-101 of S-102



SEPTIC LAYOUT

SCALE: 1:50



SEPTIC SECTION

SCALE: 1:35

ABSOLUTE DRAFTING + DESIGN INC.

ALL CONTRACTORS SHALL PERFORM THEIR WORK WHETHER DESCRIBED OR NOT, ACCORDING TO THE APPLICABLE BUILDING CODE REQUIREMENTS AND MUNICIPAL REGULATIONS.

THE GENERAL CONTRACTOR SHALL CHECK AND VERIFY ALL DIMENSIONS AND REPORT ERRORS AND OMISSIONS TO THE DESIGN CONSULTANT.

NO DIMENSION SHOULD BE SCALED ON DRAWINGS.

THE GENERAL CONTRACTOR OR SUB–CONTRACTORS WILL BE HELD RESPONSIBLE FOR ALL WORK DONE ON THE CONSTRUCTION SITE. IN NO EVENT WILL THE DESIGNER BE HELD RESPONSIBLE BEFORE, DURING AND AFTER THE PROJECT.

SCALE:
AS INDICATED

DATE:
2023.04.19.

ISSUED FOR PERMIT

PROJECT:
23A011–REV01

ABSOLUTE
DRAFTING + DESIGN INC.
PERS. BCIN #44555
FIRM. BCIN #45254

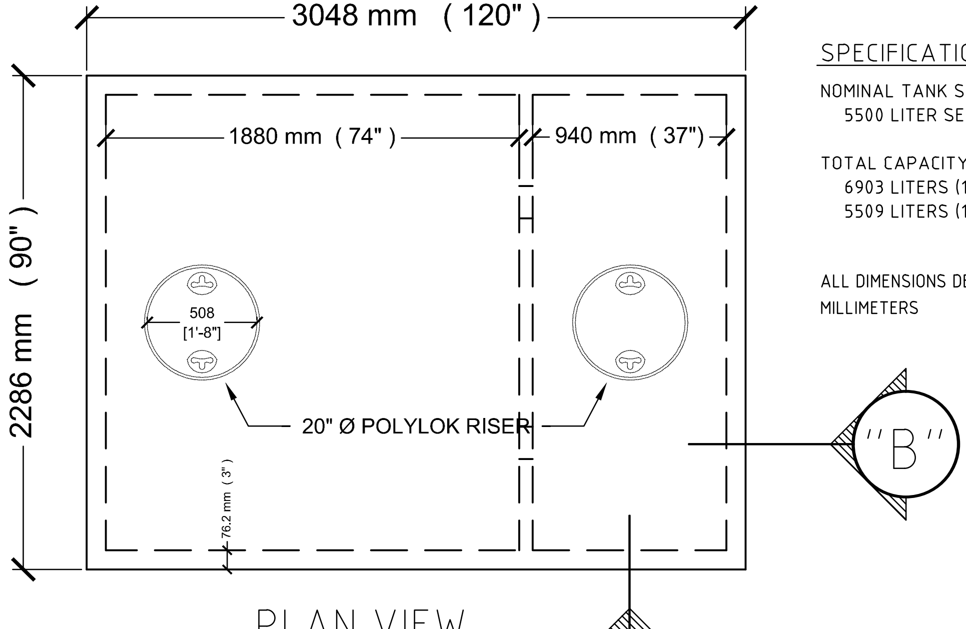
I, ABSOLUTE DRAFTING + DESIGN INC., HAVE REVIEWED THE FOLLOWING DOCUMENTS AND TAKE RESPONSIBILITY FOR THE DESIGN ACTIVITIES.

DESSIN/DRAWING
SEPTIC LAYOUT + SPEC'S

PROJET/PROJECT
WAREHOUSE DEVELOPMENT
363 ENTREPRENEUR CR., OTTAWA

CLIENT
DUSTIN WILSON

S-102 of S-102



PLAN VIEW

SPECIFICATIONS:

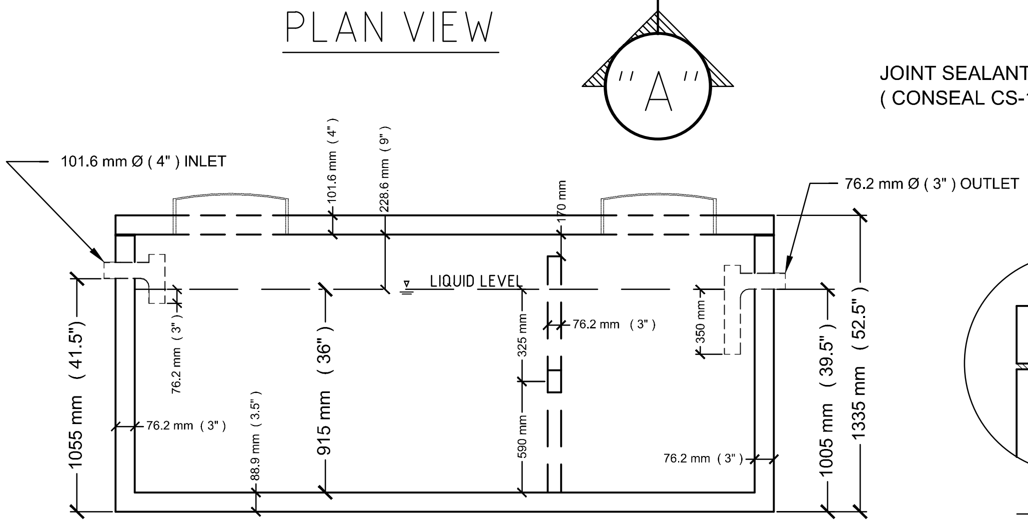
NOMINAL TANK SIZE
5500 LITER SEPTIC TANK

TOTAL CAPACITY
6903 LITERS (1518 GAL)
5509 LITERS (1212 GAL) TO OUTLET

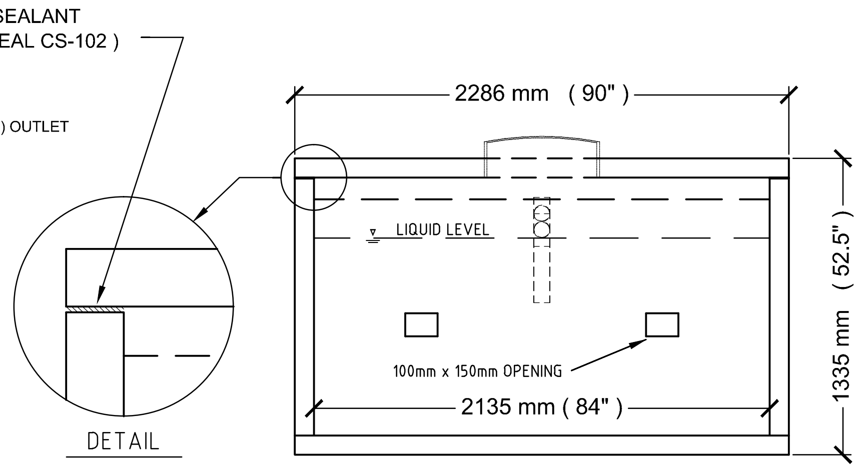
ALL DIMENSIONS DEFAULT TO MILLIMETERS $\frac{mm}{[in]}$

GENERAL NOTES:

1) CONCRETE TO BE 30 MPa @ 28 DAYS WITH 5-8% AIR ENTRAINMENT
2) CONCRETE MIX IS NON-SULPHATE RESISTANT
3) REINFORCEMENT TO CONFORM TO G30.15 AND CAN/CSA G30.18
4) REINFORCEMENT: TOP SLAB REINFORCEMENT
   -10M REBAR EQUALLY SPACED IN BOTH DIRECTION
   BOTTOM SLAB REINFORCEMENT
   -10M REBAR EQUALLY SPACED IN BOTH DIRECTION
   WALL REINFORCEMENT
   -FIBERGLASS MESH ADDED IN CONCRETE MIX
5) MINIMUM CONCRETE COVER OVER REINFORCEMENT IS 25.4mm / 1"
6) CERTIFIED MINIMUM BURIAL DEPTH: 0.6M (24")
7) WEIGHT OF TOP SLAB = 1635 KG / 3605 LBS
8) WEIGHT OF TANK SECTION = 4113 KG / 9068 LBS
9) ASSEMBLED WEIGHT = 5748 KG / 12672 LBS
10) CHAMBER DIVIDER IS CAST SEPARATELY
11) NO CENTER JOINT IN TANKS
12) 100mmØ INLET AND 75mmØ OUTLET PVC PIPE STUB
13) TOP OF OUTLET FITTING EXTENDS TO AT LEAST THE HEIGHT OF CHAMBER DIVIDER WITH 25mm MINIMUM AIR SPACE
14) PRODUCT IS FACTORY ASSEMBLED AND AS PER CSA A23.4-09 STANDARD AND CSA B 66-00 STANDARD



CROSS SECTION A



DETAIL

CROSS SECTION B

16525 SIXTH RD, MOOSE CREEK, ON
KOC 1W0
PHONE : (613)-538-2381
FAX : (613)-538-4870

MOOSE CREEK CEMENT PRODUCTS (2006) LIMITED
LOW-BOY CONCRETE 1212 GALLON / 5509 LITER SEPTIC TANK

SCALE	NOT TO SCALE	DATE	JULY 2011

ATTACHMENT F

Pumping Test – Field Data

Pump Test Data
Hydrogeological Assessment & Terrain Analysis
Proposed Warehouse Development - 363 Entrepreneur Crescent, Ottawa, Ontario
LRL File No. 220487

Date:	**30/07/2023**	**Technician:**	E. Lavergne
Well Number:	**Tag A37901**	**Pump Depth (m BTC):**	45.7
Depth of Well (m BTC):	49.10	**Start Time:**	8:15 AM
Ground Surface Elev. (m):	--	**End Time:**	4:30 PM
Top of Casing Elev. (m):	--	**Average Pump Rate (L/min):**	22.0
Water Level before Pump In (m BTC)	2.75		
Water Level after Pump In (m BTC)	2.61		

Time[1] (min)	Water Level (Pump In) (m BTC)	Drawdown (m)	Flow Rate (L/min)	Turbidity (NTU)	Field Parameters: Residual Chlorine (mg/L)	Field Parameters: Colour (TCU)	Field Parameters: pH	Field Parameters: Conductivity (µs)	Field Parameters: Total Dissolved (mg/L)
0.0	2.61	0.00							
0.5	3.01	0.40	22.0						
1.0	3.75	1.14	22.0						
1.5	4.01	1.40	22.0						
2.0	4.26	1.65	22.0						
2.5	4.50	1.89	22.0						
3.0	4.71	2.10	22.0						
3.5	4.95	2.34	22.0						
4.0	5.13	2.52	22.0						
4.5	5.23	2.62	22.0						
5.0	5.30	2.69	22.0						
6.0	5.38	2.77	22.0						
7.0	5.52	2.91	22.0						
8.0	5.59	2.98	22.0						
9.0	5.67	3.06	22.0						
10.0	5.73	3.12	22.0						
15.0	5.88	3.27	22.0						
20.0	5.97	3.36	22.0						
25.0	6.03	3.42	22.0						
30.0	6.06	3.45	22.0						
40.0	6.11	3.50	22.0						
50.0	6.13	3.52	22.0						
60.0	6.18	3.57	22.0	3.58	0.03	92	7.90	3999+	2000+
90.0	6.19	3.58	22.0						
120.0	6.20	3.59	22.0	2.31	0.05	52	7.92	3999+	2000+
150.0	6.21	3.60	22.0						
180.0	6.20	3.59	22.0	2.04	0.06	13	8.05	3999+	2000+
240.0	6.22	3.61	22.0	2.54	0.02	66	8.40	3999+	2000+
300.0	6.23	3.62	22.0	2.12	0.02	33	8.05	3999+	2000+
360.0	6.21	3.60	22.0	2.23	0.06	12	8.10	3999+	2000+
420.0	6.24	3.63	22.0	2.16	0.02	21	8.12	3999+	2000+
480.0	6.25	3.64	22.0	2.54	0.02	34	8.10	3999+	2000+
495.0	6.23	3.62	22.0						
Recovery				**% Recovery**					
0 (2.95)	6.23	3.62		0.0					
0.5	4.30	1.69		53.3					
1.0	4.19	1.58		56.4					
1.5	4.11	1.50		58.6					
2.0	4.05	1.44		60.2					
2.5	3.94	1.33		63.3					
3.0	3.81	1.20		66.9					
3.5	3.68	1.07		70.4					
4.0	3.56	0.95		73.8					
4.5	3.51	0.90		75.1					
5.0	3.45	0.84		76.8					
6.0	3.38	0.77		78.7					
7.0	3.32	0.71		80.4					
8.0	3.28	0.67		81.5					
9.0	3.26	0.65		82.0					
10.0	3.22	0.61		83.1					
15.0	3.14	0.53		85.4					
20.0	3.09	0.48		86.7					
25.0	3.05	0.44		87.8					
30.0	3.03	0.42		88.4					
40.0	2.99	0.38		89.5					
50.0	2.98	0.37		89.8					
60.0	2.97	0.36		90.1					
960.0	2.87	0.26		92.8					
1440.0	2.93	0.32		91.2					

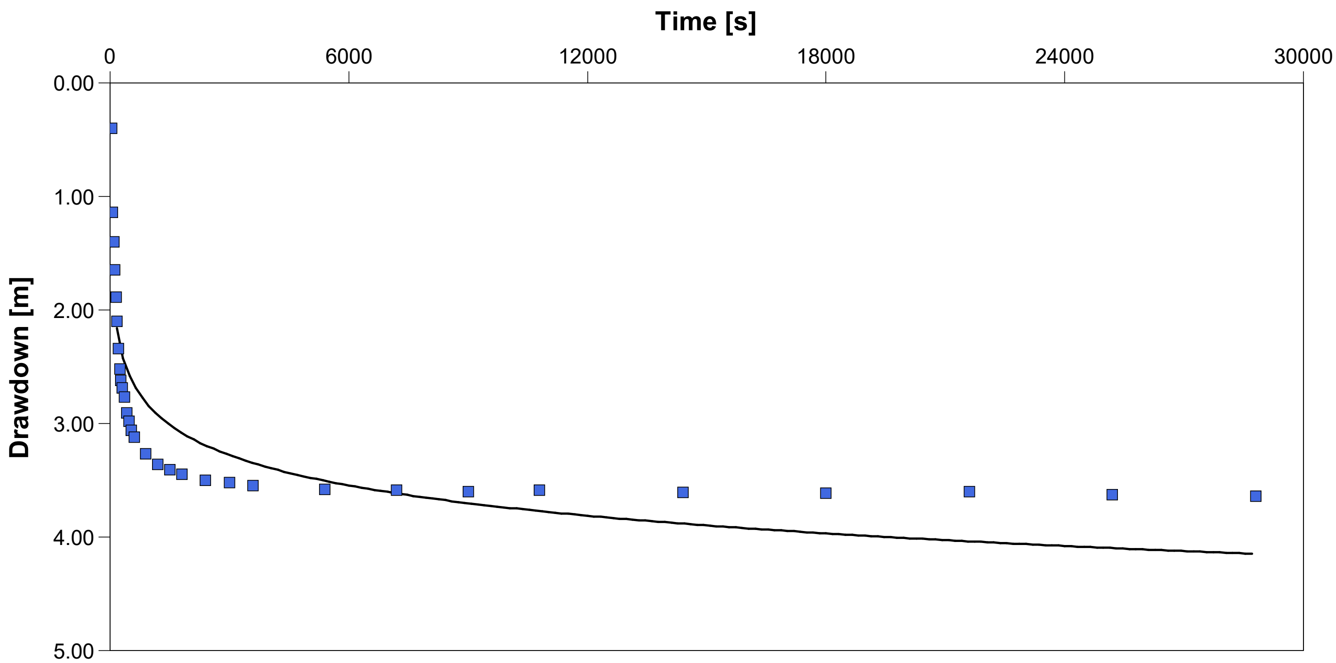
1 Time elapse from pump turning on or off.
BTC: Below Top of Casing

ATTACHMENT G

Aquifer Test – Theis Analysis

LRL Associates Ltd. 5430 Canotek Road Ottawa, Ontario	**Pumping Test Analysis Report**
	Project: 363 Entrepreneur Cresent
	Number: 220487
	Client: Entrepreneur Holding

Location: 363 Entrepreneur Cresent	Pumping Test: Pumping Test 1	Pumping Well: Well 1
Test Conducted by: LRL Engineering		Test Date: 2023-08-30
Analysis Performed by: LRL Engineering	Draw Down - August 30 2023	Analysis Date: 2023-09-07
Aquifer Thickness:	Discharge Rate: 0.022 [m³/min]	



Calculation using Theis

Observation Well	Transmissivity [m²/s]	Storage coefficient	Radial Distance to PW [m]	
Well 1	7.59×10^{-5}	4.51×10^{-3}	0.15	

ATTACHMENT H

Laboratory Certificate of Analysis

PARACEL LABORATORIES LTD. | TRUSTED. RESPONSIVE. RELIABLE.

300 - 2319 St. Laurent Blvd
Ottawa, ON, K1G 4J8
1-800-749-1947
www.paracellabs.com

Certificate of Analysis

LRL Associates Ltd.

5430 Canotek Road
Ottawa, ON K1J 9G2
Attn: Jessica Arthurs

Client PO:
Project: 220487
Custody: 18167

Report Date: 25-Apr-2023
Order Date: 17-Apr-2023

Order #: 2316079

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

Paracel ID	Client ID
2316079-01	357 Entrepreneur-Pre
2316079-02	357 Entrepreneur-Post

Approved By:

Mark Foto, M.Sc.
Lab Supervisor

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Alkalinity, total to pH 4.5	EPA 310.1 - Titration to pH 4.5	18-Apr-23	18-Apr-23
Ammonia, as N	EPA 351.2 - Auto Colour	19-Apr-23	19-Apr-23
Anions	EPA 300.1 - IC	18-Apr-23	18-Apr-23
Colour	SM2120 - Spectrophotometric	18-Apr-23	18-Apr-23
Conductivity	EPA 9050A- probe @25 °C	18-Apr-23	18-Apr-23
Dissolved Organic Carbon	MOE 3247B - Combustion IR	20-Apr-23	20-Apr-23
E. coli	MOE E3407	18-Apr-23	18-Apr-23
Fecal Coliform	SM 9222D	18-Apr-23	18-Apr-23
Heterotrophic Plate Count	SM 9215C	18-Apr-23	18-Apr-23
Metals, ICP-MS	EPA 200.8 - ICP-MS	18-Apr-23	18-Apr-23
pH	EPA 150.1 - pH probe @25 °C	18-Apr-23	18-Apr-23
Phenolics	EPA 420.2 - Auto Colour, 4AAP	19-Apr-23	19-Apr-23
Hardness	Hardness as CaCO3	18-Apr-23	18-Apr-23
Sulphide	SM 4500SE - Colourimetric	21-Apr-23	21-Apr-23
Tannin/Lignin	SM 5550B - Colourimetric	20-Apr-23	20-Apr-23
Total Coliform	MOE E3407	18-Apr-23	18-Apr-23
Total Dissolved Solids	SM 2540C - gravimetric, filtration	18-Apr-23	19-Apr-23
Total Kjeldahl Nitrogen	EPA 351.2 - Auto Colour, digestion	18-Apr-23	18-Apr-23
Turbidity	SM 2130B - Turbidity meter	19-Apr-23	19-Apr-23

Certificate of Analysis

Client: **LRL Associates Ltd.**

Client PO:

Report Date: 25-Apr-2023

Order Date: 17-Apr-2023

Project Description: 220487

	Client ID:	357 Entrepreneur-Pre	357 Entrepreneur-Post	-	-
	Sample Date:	17-Apr-23 11:15	17-Apr-23 11:35	-	-
	Sample ID:	2316079-01	2316079-02	-	-
	MDL/Units	Drinking Water	Drinking Water	-	-
Microbiological Parameters					
E. coli	1 CFU/100mL	ND	ND [1]	-	-
Fecal Coliforms	1 CFU/100mL	ND	ND	-	-
Total Coliforms	1 CFU/100mL	ND	ND [1]	-	-
Heterotrophic Plate Count	10 CFU/mL	<10	150	-	-
General Inorganics					
Alkalinity, total	5 mg/L	605	16	-	-
Ammonia as N	0.01 mg/L	3.28	0.46	-	-
Dissolved Organic Carbon	0.5 mg/L	7.8	<0.5	-	-
Colour	2 TCU	5	<2	-	-
Conductivity	5 uS/cm	13100	1050	-	-
Hardness	mg/L	1050	0.00	-	-
pH	0.1 pH Units	8.2	7.0	-	-
Phenolics	0.001 mg/L	<0.001	<0.001	-	-
Total Dissolved Solids	10 mg/L	7640	508	-	-
Sulphide	0.02 mg/L	0.24	<0.02	-	-
Tannin & Lignin	0.1 mg/L	0.7	<0.1	-	-
Total Kjeldahl Nitrogen	0.1 mg/L	3.4	0.5	-	-
Turbidity	0.1 NTU	12.0	<0.1	-	-
Anions					
Chloride	1 mg/L	4350	302	-	-
Fluoride	0.1 mg/L	0.7	<0.1	-	-
Nitrate as N	0.1 mg/L	<0.1	<0.1	-	-
Nitrite as N	0.05 mg/L	<0.50 [2]	<0.05	-	-
Sulphate	1 mg/L	13	<1	-	-
Metals					
Calcium	0.1 mg/L	97.8	<0.1	-	-
Iron	0.1 mg/L	1.3	<0.1	-	-
Magnesium	0.2 mg/L	196	<0.2	-	-
Manganese	0.005 mg/L	0.030	<0.005	-	-
Potassium	0.1 mg/L	91.4	1.9	-	-
Sodium	0.2 mg/L	2010	152	-	-

Certificate of Analysis

Client: LRL Associates Ltd.

Client PO:

Report Date: 25-Apr-2023

Order Date: 17-Apr-2023

Project Description: 220487

Method Quality Control: Blank

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

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	157	1	mg/L	158			0.1	20	
Fluoride	ND	0.1	mg/L	ND			NC	20	
Nitrate as N	ND	0.1	mg/L	ND			NC	20	
Nitrite as N	ND	0.05	mg/L	ND			NC	20	
Sulphate	32.4	1	mg/L	32.6			0.7	20	
General Inorganics									
Alkalinity, total	15.2	5	mg/L	16.2			6.2	14	
Ammonia as N	0.150	0.01	mg/L	0.151			1.0	17.7	
Dissolved Organic Carbon	ND	0.5	mg/L	ND			NC	37	
Colour	5	2	TCU	5			0.0	12	
Conductivity	1000	5	uS/cm	1050			4.0	5	
pH	7.0	0.1	pH Units	7.0			0.6	3.3	
Phenolics	ND	0.001	mg/L	ND			NC	10	
Total Dissolved Solids	7550	10	mg/L	7640			1.2	10	
Sulphide	ND	0.02	mg/L	ND			NC	10	
Tannin & Lignin	0.2	0.1	mg/L	0.2			4.5	11	
Total Kjeldahl Nitrogen	3.34	0.2	mg/L	3.42			2.2	16	
Turbidity	ND	0.1	NTU	12.0			NC	10	
Metals									
Calcium	110	0.1	mg/L	97.8			11.9	20	
Iron	1.5	0.1	mg/L	1.3			12.4	20	
Magnesium	219	0.2	mg/L	196			11.3	20	
Manganese	0.035	0.005	mg/L	0.030			13.8	20	
Potassium	102	0.1	mg/L	91.4			10.5	20	
Sodium	2140	0.2	mg/L	2010			6.3	20	
Microbiological Parameters									
E. coli	ND	1	CFU/100mL	ND			NC	30	
Fecal Coliforms	ND	1	CFU/100mL	ND			NC	30	
Total Coliforms	ND	1	CFU/100mL	ND			NC	30	
Heterotrophic Plate Count	ND	10	CFU/mL	ND			NC	30	

Certificate of Analysis
Client: LRL Associates Ltd.
Client PO:

Report Date: 25-Apr-2023
Order Date: 17-Apr-2023
Project Description: 220487

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	167	1	mg/L	158	90.3	70-124			
Fluoride	1.00	0.1	mg/L	ND	100	70-130			
Nitrate as N	1.09	0.1	mg/L	ND	109	77-126			
Nitrite as N	0.940	0.05	mg/L	ND	94.0	82-115			
Sulphate	41.5	1	mg/L	32.6	88.4	70-130			
General Inorganics									
Ammonia as N	1.21	0.01	mg/L	0.151	106	81-124			
Dissolved Organic Carbon	17.2	0.5	mg/L	7.8	93.5	60-133			
Phenolics	0.027	0.001	mg/L	ND	107	67-133			
Total Dissolved Solids	100	10	mg/L	ND	100	75-125			
Sulphide	0.48	0.02	mg/L	ND	96.0	79-115			
Tannin & Lignin	1.2	0.1	mg/L	0.2	92.9	71-113			
Total Kjeldahl Nitrogen	4.31	0.1	mg/L	3.42	88.9	81-126			
Metals									
Calcium	8370	0.1	mg/L	ND	83.7	80-120			
Magnesium	8180	0.2	mg/L	ND	81.8	80-120			
Manganese	42.2	0.005	mg/L	ND	84.3	80-120			
Potassium	10400	0.1	mg/L	1820	85.6	80-120			
Sodium	8460	0.2	mg/L	ND	84.6	80-120			

Qualifier Notes:

Sample Qualifiers :

1 : Confluent background colonies on filter: may interfere with target reactions and the analysts' ability to count E. coli & Total Coliform. The target colonies may be under-represented.

2 : Elevated reporting limit due to dilution required because of high target analyte concentration.

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

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

Paracel ID: 2316079

PARACEL LABORATORIES LTD.

Paracel Order Number	Chain Of Custody Ontario Drinking Water Samples № 18167

Client Name: LRL	Project Ref: 220487	Waterworks Name:		Samples Taken By:		
Contact Name: Jessica Arthurs	Quote #:	Waterworks Number:		Name: Jessica Arthurs		
Address: 5430 Canotek Rd. Ottawa, On K1J 9G2	PO #:	Address: 357 Entrepreneur Ottawa, Ontario		Signature:		
After Hours Contact: Jessica Arthurs	E-mail: Jarthurs@lrl.ca			Page 1 of 1		
Telephone: 613 842 3434	Fax:	Public Health Unit:		Turn Around Time Required: ☐ 1 day ☐ 2 day ☐ 3 day ☒ 4 day		

Samples Submitted Under: (Indicate ONLY one)
☐ ON REG 170/03 ☐ ON REG 319/08 ☐ Private Well
☐ ON REG 243/07 ☒ Other ODWS

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

Have LSN forms been submitted to MOE/MOHLTC?: ☐ Yes ☒ No ☐ N/A
Are these samples for human consumption?: ☒ Yes ☐ No
All information must be completed before samples will be processed.

Required Analyses

	LOCATION NAME	SAMPLE ID	Sample Type: R/T/D/P	Source Type: G/S	Reportable: Y/N	Resample	DATE	TIME	# of Containers	Free/Combined Chlorine Residual mg/L	Standing / Flushed: S/F (REG 243)	Total Coliform/E. Coli	HPC	Lead	THM	Subdivision Package			
1	Pressure Tank	357 Entrepreneur-Pre	R	G	N	-	April 17/23	11:15	8	-	F					X			
2	Washroom Tap	357 Entrepreneur-Post	T	G	N	-	April 17/23	11:35	8	-	F					X			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			

Comments:

Method of Delivery: Walk-in

Relinquished By (Sign):	Received By Driver/Depot:	Received at Lab:	Verified By:
Relinquished By (Print): Jessica Arthurs	Date/Time:	Date/Time: Apr 17/23 1pm	Date/Time: Apr 17/23 1:19pm
Date/Time: April 17, 2023 12:58 pm	Temperature: °C	Temperature: 11.6 °C	pH Verified: ☐ By:

1-800-749-1947
www.paracellabs.com

Certificate of Analysis

LRL Associates Ltd.
5430 Canotek Road
Ottawa, ON K1J 9G2
Attn: Eric Lavergne

Report Date: 5-Sep-2023
Order Date: 31-Aug-2023

Client PO:
Project: 220487
Custody: 18335

Order #: 2335315

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

Paracel ID	Client ID
2335315-01	363 Entrepreneur Crescent Supply Well - 4 Hour
2335315-02	363 Entrepreneur Crescent Supply Well - 8 Hour

Approved By:

Dale Robertson, BSc
Laboratory Director

PARACEL LABORATORIES LTD.

Order #: 2335315

Certificate of Analysis

Report Date: 05-Sep-2023

Client: **LRL Associates Ltd.**

Order Date: 31-Aug-2023

Client PO:

Project Description: 220487

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Alkalinity, total to pH 4.5	EPA 310.1 - Titration to pH 4.5	1-Sep-23	1-Sep-23
Ammonia, as N	EPA 351.2 - Auto Colour	1-Sep-23	1-Sep-23
Anions	EPA 300.1 - IC	31-Aug-23	31-Aug-23
Colour	SM2120 - Spectrophotometric	31-Aug-23	31-Aug-23
Conductivity	EPA 9050A- probe @25 °C	1-Sep-23	1-Sep-23
Dissolved Organic Carbon	MOE 3247B - Combustion IR	31-Aug-23	31-Aug-23
E. coli	MOE E3407	31-Aug-23	31-Aug-23
Fecal Coliform	SM 9222D	31-Aug-23	31-Aug-23
Heterotrophic Plate Count	SM 9215C	31-Aug-23	31-Aug-23
Metals, ICP-MS	EPA 200.8 - ICP-MS	31-Aug-23	1-Sep-23
pH	EPA 150.1 - pH probe @25 °C	1-Sep-23	1-Sep-23
Phenolics	EPA 420.2 - Auto Colour, 4AAP	31-Aug-23	31-Aug-23
Hardness	Hardness as CaCO3	31-Aug-23	1-Sep-23
Sulphide	SM 4500SE - Colourimetric	1-Sep-23	1-Sep-23
Tannin/Lignin	SM 5550B - Colourimetric	31-Aug-23	1-Sep-23
Total Coliform	MOE E3407	31-Aug-23	31-Aug-23
Total Dissolved Solids	SM 2540C - gravimetric, filtration	31-Aug-23	1-Sep-23
Total Kjeldahl Nitrogen	EPA 351.2 - Auto Colour, digestion	1-Sep-23	1-Sep-23
Turbidity	SM 2130B - Turbidity meter	31-Aug-23	31-Aug-23
VOCs by P&T GC-MS	EPA 624 - P&T GC-MS	1-Sep-23	1-Sep-23

Certificate of Analysis

Report Date: 05-Sep-2023

Client: **LRL Associates Ltd.**

Order Date: 31-Aug-2023

Client PO:

Project Description: 220487

Client ID:		363 Entrepreneur Crescent Supply Well - 4 Hour	363 Entrepreneur Crescent Supply Well - 8 Hour	-	-		
Sample Date:		30-Aug-23 12:05	30-Aug-23 16:15	-	-	-	-
Sample ID:		2335315-01	2335315-02	-	-		
Matrix:		Drinking Water	Drinking Water	-	-		
	MDL/Units						
Microbiological Parameters							
E. coli	1 CFU/100mL	ND [1]	1 [1]	-	-	-	-
Total Coliforms	1 CFU/100mL	2 [1]	1 [1]	-	-	-	-
Fecal Coliforms	1 CFU/100mL	ND	ND	-	-	-	-
Heterotrophic Plate Count	10 CFU/mL	90	70 [4]	-	-	-	-
General Inorganics							
Alkalinity, total	5 mg/L	703	705	-	-	-	-
Ammonia as N	0.01 mg/L	4.72	4.71	-	-	-	-
Dissolved Organic Carbon	0.5 mg/L	9.4	8.5	-	-	-	-
Colour	2 TCU	8	8	-	-	-	-
Conductivity	5 uS/cm	14300	14200	-	-	-	-
Hardness	mg/L	1020	1030	-	-	-	-
pH	0.1 pH Units	8.2	8.3	-	-	-	-
Phenolics	0.001 mg/L	<0.001	<0.001	-	-	-	-
Total Dissolved Solids	10 mg/L	7950	7880	-	-	-	-
Sulphide	0.02 mg/L	0.23	0.23	-	-	-	-
Tannin & Lignin	0.1 mg/L	0.7	0.7	-	-	-	-
Total Kjeldahl Nitrogen	0.1 mg/L	4.7	4.7	-	-	-	-
Turbidity	0.1 NTU	3.8	3.5	-	-	-	-
Anions							
Chloride	1 mg/L	4560	4460	-	-	-	-
Fluoride	0.1 mg/L	0.2	0.2	-	-	-	-
Nitrate as N	0.1 mg/L	<0.1	<0.1	-	-	-	-
Nitrite as N	0.05 mg/L	<0.25 [2]	<0.25 [2]	-	-	-	-
Sulphate	1 mg/L	3	4	-	-	-	-

PARACEL LABORATORIES LTD.

Order #: 2335315

Certificate of Analysis

Report Date: 05-Sep-2023

Client: **LRL Associates Ltd.**

Order Date: 31-Aug-2023

Client PO:

Project Description: 220487

	Client ID:	363 Entrepreneur Crescent Supply Well - 4 Hour	363 Entrepreneur Crescent Supply Well - 8 Hour	-	-		
	Sample Date:	30-Aug-23 12:05	30-Aug-23 16:15	-	-	-	-
	Sample ID:	2335315-01	2335315-02	-	-		
	Matrix:	Drinking Water	Drinking Water	-	-		
	MDL/Units						
Metals							
Aluminum	0.001 mg/L	0.025	0.018	-	-	-	-
Antimony	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Arsenic	0.001 mg/L	<0.001	<0.001	-	-	-	-
Barium	0.001 mg/L	4.17	4.22	-	-	-	-
Beryllium	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Boron	0.01 mg/L	0.79	0.76	-	-	-	-
Cadmium	0.0001 mg/L	<0.0001	<0.0001	-	-	-	-
Calcium	0.1 mg/L	48.3	49.0	-	-	-	-
Chromium	0.001 mg/L	<0.001	<0.001	-	-	-	-
Cobalt	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Copper	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Iron	0.1 mg/L	0.3	0.3	-	-	-	-
Lead	0.0001 mg/L	<0.0001	<0.0001	-	-	-	-
Magnesium	0.2 mg/L	218	220	-	-	-	-
Manganese	0.005 mg/L	0.009	0.007	-	-	-	-
Molybdenum	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Nickel	0.001 mg/L	<0.001	<0.001	-	-	-	-
Potassium	0.1 mg/L	61.3	63.3	-	-	-	-
Selenium	0.001 mg/L	<0.001	<0.001	-	-	-	-
Silver	0.0001 mg/L	<0.0001	<0.0001	-	-	-	-
Sodium	0.2 mg/L	2670	2620	-	-	-	-
Strontium	0.01 mg/L	5.71	5.71	-	-	-	-
Thallium	0.001 mg/L	<0.001	<0.001	-	-	-	-

Certificate of Analysis

Report Date: 05-Sep-2023

Client: **LRL Associates Ltd.**

Order Date: 31-Aug-2023

Client PO:

Project Description: 220487

	Client ID:	363 Entrepreneur Crescent Supply Well - 4 Hour	363 Entrepreneur Crescent Supply Well - 8 Hour	-	-		
	Sample Date:	30-Aug-23 12:05	30-Aug-23 16:15	-	-	-	-
	Sample ID:	2335315-01	2335315-02	-	-		
	Matrix:	Drinking Water	Drinking Water	-	-		
	MDL/Units						
Metals							
Tin	0.01 mg/L	<0.01	<0.01	-	-	-	-
Titanium	0.005 mg/L	<0.005	<0.005	-	-	-	-
Tungsten	0.01 mg/L	<0.01	<0.01	-	-	-	-
Uranium	0.0001 mg/L	<0.0001	<0.0001	-	-	-	-
Vanadium	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Zinc	0.005 mg/L	<0.005	<0.005	-	-	-	-
Volatiles							
Acetone	0.005 mg/L	<0.0050	<0.0050	-	-	-	-
Benzene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Bromodichloromethane	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Bromoform	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Bromomethane	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Carbon Tetrachloride	0.0002 mg/L	<0.0002	<0.0002	-	-	-	-
Chlorobenzene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Chloroethane	0.001 mg/L	<0.0010	<0.0010	-	-	-	-
Chloroform	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Dibromochloromethane	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Dichlorodifluoromethane	0.001 mg/L	<0.0010	<0.0010	-	-	-	-
1,2-Dibromoethane	0.0002 mg/L	<0.0002	<0.0002	-	-	-	-
1,2-Dichlorobenzene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
1,3-Dichlorobenzene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
1,4-Dichlorobenzene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
1,1-Dichloroethane	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-

PARACEL LABORATORIES LTD.

Order #: 2335315

Certificate of Analysis

Report Date: 05-Sep-2023

Client: **LRL Associates Ltd.**

Order Date: 31-Aug-2023

Client PO:

Project Description: 220487

Client ID:		363 Entrepreneur Crescent Supply Well - 4 Hour	363 Entrepreneur Crescent Supply Well - 8 Hour	-	-		
Sample Date:		30-Aug-23 12:05	30-Aug-23 16:15	-	-	-	-
Sample ID:		2335315-01	2335315-02	-	-		
Matrix:		Drinking Water	Drinking Water	-	-		
	MDL/Units						
Volatiles							
1,2-Dichloroethane	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
1,1-Dichloroethylene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
cis-1,2-Dichloroethylene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
trans-1,2-Dichloroethylene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
1,2-Dichloroethylene, total	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
1,2-Dichloropropane	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
cis-1,3-Dichloropropylene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
trans-1,3-Dichloropropylene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
1,3-Dichloropropene, total	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Ethylbenzene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Hexane	0.001 mg/L	<0.0010	<0.0010	-	-	-	-
Methyl Ethyl Ketone (2-Butanone)	0.005 mg/L	<0.0050	<0.0050	-	-	-	-
Methyl Isobutyl Ketone	0.005 mg/L	<0.0050	<0.0050	-	-	-	-
Methyl tert-butyl ether	0.002 mg/L	<0.0020	<0.0020	-	-	-	-
Methylene Chloride	0.005 mg/L	<0.0050	<0.0050	-	-	-	-
Styrene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
1,1,1,2-Tetrachloroethane	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
1,1,2,2-Tetrachloroethane	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Tetrachloroethylene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Toluene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
1,1,1-Trichloroethane	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
1,1,2-Trichloroethane	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Trichloroethylene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-

PARACEL LABORATORIES LTD.

Order #: 2335315

Certificate of Analysis

Report Date: 05-Sep-2023

Client: **LRL Associates Ltd.**

Order Date: 31-Aug-2023

Client PO:

Project Description: 220487

Client ID:		363 Entrepreneur Crescent Supply Well - 4 Hour	363 Entrepreneur Crescent Supply Well - 8 Hour	-	-		
Sample Date:		30-Aug-23 12:05	30-Aug-23 16:15	-	-	-	-
Sample ID:		2335315-01	2335315-02	-	-		
Matrix:		Drinking Water	Drinking Water	-	-		
	MDL/Units						
Volatiles							
Trichlorofluoromethane	0.001 mg/L	<0.0010	<0.0010	-	-	-	-
Vinyl chloride	0.0002 mg/L	<0.0002	<0.0002	-	-	-	-
m,p-Xylenes	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
o-Xylene	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Xylenes, total	0.0005 mg/L	<0.0005	<0.0005	-	-	-	-
Toluene-d8	Surrogate	102%	103%	-	-	-	-
4-Bromofluorobenzene	Surrogate	100%	105%	-	-	-	-
Dibromofluoromethane	Surrogate	103%	92.7%	-	-	-	-

PARACEL LABORATORIES LTD.

Order #: 2335315

Certificate of Analysis

Report Date: 05-Sep-2023

Client: **LRL Associates Ltd.**

Order Date: 31-Aug-2023

Client PO:

Project Description: 220487

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions								
Chloride	ND	1	mg/L					
Fluoride	ND	0.1	mg/L					
Nitrate as N	ND	0.1	mg/L					
Nitrite as N	ND	0.05	mg/L					
Sulphate	ND	1	mg/L					
General Inorganics								
Alkalinity, total	ND	5	mg/L					
Ammonia as N	ND	0.01	mg/L					
Dissolved Organic Carbon	ND	0.5	mg/L					
Colour	ND	2	TCU					
Conductivity	ND	5	uS/cm					
Phenolics	ND	0.001	mg/L					
Total Dissolved Solids	ND	10	mg/L					
Sulphide	ND	0.02	mg/L					
Tannin & Lignin	ND	0.1	mg/L					
Total Kjeldahl Nitrogen	ND	0.1	mg/L					
Turbidity	ND	0.1	NTU					
Metals								
Aluminum	ND	0.001	mg/L					
Antimony	ND	0.0005	mg/L					
Arsenic	ND	0.001	mg/L					
Barium	ND	0.001	mg/L					
Beryllium	ND	0.0005	mg/L					
Boron	ND	0.01	mg/L					
Cadmium	ND	0.0001	mg/L					
Calcium	ND	0.1	mg/L					
Chromium	ND	0.001	mg/L					
Cobalt	ND	0.0005	mg/L					
Copper	ND	0.0005	mg/L					
Iron	ND	0.1	mg/L					
Lead	ND	0.0001	mg/L					
Magnesium	ND	0.2	mg/L					

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	%REC	%REC Limit	RPD	RPD Limit	Notes
Manganese	ND	0.005	mg/L					
Molybdenum	ND	0.0005	mg/L					
Nickel	ND	0.001	mg/L					
Potassium	ND	0.1	mg/L					
Selenium	ND	0.001	mg/L					
Silver	ND	0.0001	mg/L					
Sodium	ND	0.2	mg/L					
Strontium	ND	0.01	mg/L					
Thallium	ND	0.001	mg/L					
Tin	ND	0.01	mg/L					
Titanium	ND	0.005	mg/L					
Tungsten	ND	0.01	mg/L					
Uranium	ND	0.0001	mg/L					
Vanadium	ND	0.0005	mg/L					
Zinc	ND	0.005	mg/L					
Microbiological Parameters								
E. coli	ND	1	CFU/100mL					
Total Coliforms	ND	1	CFU/100mL					
Fecal Coliforms	ND	1	CFU/100mL					
Heterotrophic Plate Count	ND	10	CFU/mL					
Volatiles								
Acetone	ND	0.0050	mg/L					
Benzene	ND	0.0005	mg/L					
Bromodichloromethane	ND	0.0005	mg/L					
Bromoform	ND	0.0005	mg/L					
Bromomethane	ND	0.0005	mg/L					
Carbon Tetrachloride	ND	0.0002	mg/L					
Chlorobenzene	ND	0.0005	mg/L					
Chloroethane	ND	0.0010	mg/L					
Chloroform	ND	0.0005	mg/L					
Dibromochloromethane	ND	0.0005	mg/L					
Dichlorodifluoromethane	ND	0.0010	mg/L					
1,2-Dibromoethane	ND	0.0002	mg/L					

PARACEL LABORATORIES LTD.

Order #: 2335315

Certificate of Analysis

Report Date: 05-Sep-2023

Client: **LRL Associates Ltd.**

Order Date: 31-Aug-2023

Client PO:

Project Description: 220487

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	%REC	%REC Limit	RPD	RPD Limit	Notes
1,2-Dichlorobenzene	ND	0.0005	mg/L					
1,3-Dichlorobenzene	ND	0.0005	mg/L					
1,4-Dichlorobenzene	ND	0.0005	mg/L					
1,1-Dichloroethane	ND	0.0005	mg/L					
1,2-Dichloroethane	ND	0.0005	mg/L					
1,1-Dichloroethylene	ND	0.0005	mg/L					
cis-1,2-Dichloroethylene	ND	0.0005	mg/L					
trans-1,2-Dichloroethylene	ND	0.0005	mg/L					
1,2-Dichloroethylene, total	ND	0.0005	mg/L					
1,2-Dichloropropane	ND	0.0005	mg/L					
cis-1,3-Dichloropropylene	ND	0.0005	mg/L					
trans-1,3-Dichloropropylene	ND	0.0005	mg/L					
1,3-Dichloropropene, total	ND	0.0005	mg/L					
Ethylbenzene	ND	0.0005	mg/L					
Hexane	ND	0.0010	mg/L					
Methyl Ethyl Ketone (2-Butanone)	ND	0.0050	mg/L					
Methyl Isobutyl Ketone	ND	0.0050	mg/L					
Methyl tert-butyl ether	ND	0.0020	mg/L					
Methylene Chloride	ND	0.0050	mg/L					
Styrene	ND	0.0005	mg/L					
1,1,1,2-Tetrachloroethane	ND	0.0005	mg/L					
1,1,2,2-Tetrachloroethane	ND	0.0005	mg/L					
Tetrachloroethylene	ND	0.0005	mg/L					
Toluene	ND	0.0005	mg/L					
1,1,1-Trichloroethane	ND	0.0005	mg/L					
1,1,2-Trichloroethane	ND	0.0005	mg/L					
Trichloroethylene	ND	0.0005	mg/L					
Trichlorofluoromethane	ND	0.0010	mg/L					
Vinyl chloride	ND	0.0002	mg/L					
m,p-Xylenes	ND	0.0005	mg/L					
o-Xylene	ND	0.0005	mg/L					
Xylenes, total	ND	0.0005	mg/L					

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	%REC	%REC Limit	RPD	RPD Limit	Notes
Surrogate: 4-Bromofluorobenzene	*0.0808*		*%*	*101*	*50-140*			
Surrogate: Dibromofluoromethane	*0.0781*		*%*	*97.6*	*50-140*			
Surrogate: Toluene-d8	*0.0793*		*%*	*99.1*	*50-140*			

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	4460	20	mg/L	4460			0.0	20	
Fluoride	0.20	0.1	mg/L	0.19			3.0	20	
Nitrate as N	ND	0.1	mg/L	ND			NC	20	
Nitrite as N	ND	0.25	mg/L	ND			NC	20	GEN07
Sulphate	4.24	1	mg/L	4.47			5.4	20	
General Inorganics									
Alkalinity, total	698	5	mg/L	703			0.7	14	
Ammonia as N	4.66	0.04	mg/L	4.71			0.9	18	
Dissolved Organic Carbon	8.4	0.5	mg/L	9.4			11.2	37	
Colour	4	2	TCU	4			0.0	12	
Conductivity	14000	5	uS/cm	14300			1.7	5	
pH	8.2	0.1	pH Units	8.2			0.1	3.3	
Phenolics	ND	0.001	mg/L	ND			NC	10	
Total Dissolved Solids	92.0	10	mg/L	84.0			9.1	10	
Sulphide	ND	0.02	mg/L	ND			NC	10	
Tannin & Lignin	0.7	0.1	mg/L	0.7			1.4	11	
Total Kjeldahl Nitrogen	4.82	0.2	mg/L	4.70			2.6	16	
Turbidity	ND	0.1	NTU	ND			NC	10	
Metals									
Aluminum	0.022	0.001	mg/L	0.025			15.3	20	
Antimony	ND	0.0005	mg/L	ND			NC	20	
Arsenic	ND	0.001	mg/L	ND			NC	20	
Barium	4.52	0.010	mg/L	4.17			7.9	20	
Beryllium	ND	0.0005	mg/L	ND			NC	20	
Boron	0.82	0.01	mg/L	0.79			2.8	20	
Cadmium	ND	0.0001	mg/L	ND			NC	20	
Calcium	45.8	0.1	mg/L	48.3			5.4	20	
Chromium	ND	0.001	mg/L	ND			NC	20	
Cobalt	ND	0.0005	mg/L	ND			NC	20	
Copper	ND	0.0005	mg/L	ND			NC	20	

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Iron	0.3	0.1	mg/L	0.3			12.2	20	
Lead	0.0001	0.0001	mg/L	ND			NC	20	
Magnesium	203	0.2	mg/L	218			7.1	20	
Manganese	0.008	0.005	mg/L	0.009			11.6	20	
Molybdenum	ND	0.0005	mg/L	ND			NC	20	
Nickel	ND	0.001	mg/L	ND			NC	20	
Potassium	59.1	0.1	mg/L	61.3			3.7	20	
Selenium	ND	0.001	mg/L	ND			NC	20	
Silver	0.0002	0.0001	mg/L	ND			NC	20	
Sodium	2650	2.0	mg/L	2670			1.0	20	
Thallium	ND	0.001	mg/L	ND			NC	20	
Tin	ND	0.01	mg/L	ND			NC	20	
Titanium	ND	0.005	mg/L	ND			NC	50	
Tungsten	ND	0.01	mg/L	ND			NC	20	
Uranium	ND	0.0001	mg/L	ND			NC	20	
Vanadium	ND	0.0005	mg/L	ND			NC	20	
Zinc	ND	0.005	mg/L	ND			NC	20	
Microbiological Parameters									
E. coli	ND	1	CFU/100mL	1			NC	30	BAC01
Total Coliforms	ND	1	CFU/100mL	1			NC	30	BAC01
Fecal Coliforms	ND	1	CFU/100mL	ND			NC	30	
Heterotrophic Plate Count	60	10	CFU/mL	70			15.0	30	
Volatiles									
Acetone	ND	0.0050	mg/L	ND			NC	30	
Benzene	ND	0.0005	mg/L	ND			NC	30	
Bromodichloromethane	ND	0.0005	mg/L	ND			NC	30	
Bromoform	ND	0.0005	mg/L	ND			NC	30	
Bromomethane	ND	0.0005	mg/L	ND			NC	30	
Carbon Tetrachloride	ND	0.0002	mg/L	ND			NC	30	
Chlorobenzene	ND	0.0005	mg/L	ND			NC	30	
Chloroethane	ND	0.0010	mg/L	ND			NC	30	

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Chloroform	ND	0.0005	mg/L	ND			NC	30	
Dibromochloromethane	ND	0.0005	mg/L	ND			NC	30	
Dichlorodifluoromethane	ND	0.0010	mg/L	ND			NC	30	
1,2-Dibromoethane	ND	0.0002	mg/L	ND			NC	30	
1,2-Dichlorobenzene	ND	0.0005	mg/L	ND			NC	30	
1,3-Dichlorobenzene	ND	0.0005	mg/L	ND			NC	30	
1,4-Dichlorobenzene	ND	0.0005	mg/L	ND			NC	30	
1,1-Dichloroethane	ND	0.0005	mg/L	ND			NC	30	
1,2-Dichloroethane	ND	0.0005	mg/L	ND			NC	30	
1,1-Dichloroethylene	ND	0.0005	mg/L	ND			NC	30	
cis-1,2-Dichloroethylene	ND	0.0005	mg/L	ND			NC	30	
trans-1,2-Dichloroethylene	ND	0.0005	mg/L	ND			NC	30	
1,2-Dichloropropane	ND	0.0005	mg/L	ND			NC	30	
cis-1,3-Dichloropropylene	ND	0.0005	mg/L	ND			NC	30	
trans-1,3-Dichloropropylene	ND	0.0005	mg/L	ND			NC	30	
Ethylbenzene	ND	0.0005	mg/L	ND			NC	30	
Hexane	ND	0.0010	mg/L	ND			NC	30	
Methyl Ethyl Ketone (2-Butanone)	ND	0.0050	mg/L	ND			NC	30	
Methyl Isobutyl Ketone	ND	0.0050	mg/L	ND			NC	30	
Methyl tert-butyl ether	ND	0.0020	mg/L	ND			NC	30	
Methylene Chloride	ND	0.0050	mg/L	ND			NC	30	
Styrene	ND	0.0005	mg/L	ND			NC	30	
1,1,1,2-Tetrachloroethane	ND	0.0005	mg/L	ND			NC	30	
1,1,2,2-Tetrachloroethane	ND	0.0005	mg/L	ND			NC	30	
Tetrachloroethylene	ND	0.0005	mg/L	ND			NC	30	
Toluene	ND	0.0005	mg/L	ND			NC	30	
1,1,1-Trichloroethane	ND	0.0005	mg/L	ND			NC	30	
1,1,2-Trichloroethane	ND	0.0005	mg/L	ND			NC	30	
Trichloroethylene	ND	0.0005	mg/L	ND			NC	30	
Trichlorofluoromethane	ND	0.0010	mg/L	ND			NC	30	
Vinyl chloride	ND	0.0002	mg/L	ND			NC	30	

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
m,p-Xylenes	ND	0.0005	mg/L	ND			NC	30	
o-Xylene	ND	0.0005	mg/L	ND			NC	30	
Surrogate: 4-Bromofluorobenzene	*0.0886*		*%*		*111*	*50-140*			
Surrogate: Dibromofluoromethane	*0.0765*		*%*		*95.7*	*50-140*			
Surrogate: Toluene-d8	*0.0798*		*%*		*99.8*	*50-140*			

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	9.86	1	mg/L	ND	98.6	78-114			
Fluoride	1.17	0.1	mg/L	0.19	97.8	70-130			
Nitrate as N	1.00	0.1	mg/L	ND	99.6	77-126			
Nitrite as N	1.08	0.05	mg/L	ND	108	82-110			
Sulphate	14.8	1	mg/L	4.47	103	70-130			
General Inorganics									
Ammonia as N	1.02	0.01	mg/L	ND	102	81-124			
Dissolved Organic Carbon	12.8	0.5	mg/L	3.1	97.1	60-133			
Phenolics	0.026	0.001	mg/L	ND	103	67-133			
Total Dissolved Solids	96.0	10	mg/L	ND	96.0	75-125			
Sulphide	0.50	0.02	mg/L	ND	100	79-115			
Tannin & Lignin	1.8	0.1	mg/L	0.7	110	71-113			
Total Kjeldahl Nitrogen	0.99	0.1	mg/L	ND	98.7	81-126			
Metals									
Aluminum	82.2	0.001	mg/L	25.1	114	80-120			
Arsenic	49.1	0.001	mg/L	0.246	97.8	80-120			
Barium	48.6	0.001	mg/L	ND	97.3	80-120			
Beryllium	37.3	0.0005	mg/L	0.0182	74.5	80-120			QM-07
Boron	50.0	0.01	mg/L	ND	100	80-120			
Cadmium	50.6	0.0001	mg/L	ND	101	80-120			
Calcium	10600	0.1	mg/L	ND	106	80-120			
Chromium	50.5	0.001	mg/L	0.330	100	80-120			
Cobalt	49.6	0.0005	mg/L	0.287	98.7	80-120			
Copper	44.3	0.0005	mg/L	0.0834	88.5	80-120			
Iron	2510	0.1	mg/L	344	86.5	80-120			
Lead	40.8	0.0001	mg/L	0.0346	81.6	80-120			
Magnesium	10200	0.2	mg/L	ND	102	80-120			
Manganese	55.0	0.005	mg/L	9.04	92.0	80-120			
Molybdenum	53.7	0.0005	mg/L	0.137	107	80-120			
Nickel	46.5	0.001	mg/L	0.196	92.6	80-120			

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Potassium	69700	0.1	mg/L	61300	83.6	80-120			
Selenium	48.9	0.001	mg/L	ND	97.8	80-120			
Silver	51.0	0.0001	mg/L	ND	102	80-120			
Sodium	10100	0.2	mg/L	ND	101	80-120			
Thallium	45.7	0.001	mg/L	0.014	91.4	80-120			
Tin	39.5	0.01	mg/L	0.05	78.8	80-120			QM-07
Titanium	57.8	0.005	mg/L	ND	116	70-130			
Tungsten	55.5	0.01	mg/L	0.17	111	80-120			
Uranium	51.3	0.0001	mg/L	0.0266	103	80-120			
Vanadium	51.7	0.0005	mg/L	0.221	103	80-120			
Zinc	35.2	0.005	mg/L	2.19	66.0	80-120			QM-07
Volatiles									
Acetone	0.0934	0.0050	mg/L	ND	93.4	50-140			
Benzene	0.0447	0.0005	mg/L	ND	112	60-130			
Bromodichloromethane	0.0478	0.0005	mg/L	ND	120	60-130			
Bromoform	0.0338	0.0005	mg/L	ND	84.5	60-130			
Bromomethane	0.0422	0.0005	mg/L	ND	105	50-140			
Carbon Tetrachloride	0.0417	0.0002	mg/L	ND	104	60-130			
Chlorobenzene	0.0377	0.0005	mg/L	ND	94.3	60-130			
Chloroethane	0.0504	0.0010	mg/L	ND	126	50-140			
Chloroform	0.0410	0.0005	mg/L	ND	102	60-130			
Dibromochloromethane	0.0421	0.0005	mg/L	ND	105	60-130			
Dichlorodifluoromethane	0.0446	0.0010	mg/L	ND	112	50-140			
1,2-Dibromoethane	0.0442	0.0002	mg/L	ND	110	60-130			
1,2-Dichlorobenzene	0.0395	0.0005	mg/L	ND	98.7	60-130			
1,3-Dichlorobenzene	0.0419	0.0005	mg/L	ND	105	60-130			
1,4-Dichlorobenzene	0.0396	0.0005	mg/L	ND	99.0	60-130			
1,1-Dichloroethane	0.0473	0.0005	mg/L	ND	118	60-130			
1,2-Dichloroethane	0.0407	0.0005	mg/L	ND	102	60-130			
1,1-Dichloroethylene	0.0451	0.0005	mg/L	ND	113	60-130			
cis-1,2-Dichloroethylene	0.0502	0.0005	mg/L	ND	125	60-130			

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
trans-1,2-Dichloroethylene	0.0486	0.0005	mg/L	ND	122	60-130			
1,2-Dichloropropane	0.0460	0.0005	mg/L	ND	115	60-130			
cis-1,3-Dichloropropylene	0.0453	0.0005	mg/L	ND	113	60-130			
trans-1,3-Dichloropropylene	0.0446	0.0005	mg/L	ND	111	60-130			
Ethylbenzene	0.0371	0.0005	mg/L	ND	92.8	60-130			
Hexane	0.0490	0.0010	mg/L	ND	122	60-130			
Methyl Ethyl Ketone (2-Butanone)	0.0958	0.0050	mg/L	ND	95.8	50-140			
Methyl Isobutyl Ketone	0.0931	0.0050	mg/L	ND	93.1	50-140			
Methyl tert-butyl ether	0.127	0.0020	mg/L	ND	127	50-140			
Methylene Chloride	0.0406	0.0050	mg/L	ND	101	60-130			
Styrene	0.0440	0.0005	mg/L	ND	110	60-130			
1,1,1,2-Tetrachloroethane	0.0432	0.0005	mg/L	ND	108	60-130			
1,1,2,2-Tetrachloroethane	0.0454	0.0005	mg/L	ND	114	60-130			
Tetrachloroethylene	0.0404	0.0005	mg/L	ND	101	60-130			
Toluene	0.0374	0.0005	mg/L	ND	93.6	60-130			
1,1,1-Trichloroethane	0.0418	0.0005	mg/L	ND	105	60-130			
1,1,2-Trichloroethane	0.0430	0.0005	mg/L	ND	107	60-130			
Trichloroethylene	0.0496	0.0005	mg/L	ND	124	60-130			
Trichlorofluoromethane	0.0445	0.0010	mg/L	ND	111	60-130			
Vinyl chloride	0.0476	0.0002	mg/L	ND	119	50-140			
m,p-Xylenes	0.0744	0.0005	mg/L	ND	93.0	60-130			
o-Xylene	0.0359	0.0005	mg/L	ND	89.8	60-130			
Surrogate: 4-Bromofluorobenzene	*0.0701*		*%*		*87.6*	*50-140*			
Surrogate: Dibromofluoromethane	*0.0841*		*%*		*105*	*50-140*			
Surrogate: Toluene-d8	*0.0729*		*%*		*91.2*	*50-140*			

Qualifier Notes:

Login Qualifiers :

Container(s) - Labeled improperly/insufficient information - 1x VOC vial received unlabelled.

Applies to Samples: 363 Entrepreneur Crescent Supply Well - 8 Hour

Sample Qualifiers :

1: Greater than 200 CFU of background colonies present. This may interfere with target growth and ability of the analyst to count E. coli & Total Coliform. The target colonies may be under-represented.

2: Elevated reporting limit due to dilution required because of high target analyte concentration.

4: This isolate was present as a spreading colony, potentially caused as a consequence of condensation within the strip/plate. Typically, this type of colony is a result of a few colonies or less. The proportions may differ and other isolates may be masked.

QC Qualifiers:

BAC01 Greater than 200 CFU of background colonies present. This may interfere with target growth and ability of the analyst to count E. coli & Total Coliform. The target colonies may be under-represented.

GEN07 Elevated reporting limit due to dilution required because of high target analyte concentration.

QM-07 The spike recovery was outside acceptance limits for the MS and/or MSD. The batch was accepted based on other acceptable QC.

Sample Data Revisions:

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable

ND: Not Detected

MDL: Method Detection Limit

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

%REC: Percent recovery.

RPD: Relative percent difference.

NC: Not Calculated

PARACEL LABORATORIES LTD.

Paracel ID: 2335315

Paracel Order Number	Chain Of Custody
2335315	Ontario Drinking Water Samples № 18335

Client Name:	LRL Associates Ltd.	Project Ref:	220487	Waterworks Name:	
Contact Name:	Eric Lavergne	Quote #:		Waterworks Number:	
Address:	5430 Canotek Rd	PO #:		Address:	
After Hours Contact:		E-mail:	elavergne@lrl.ca		
Telephone:	613 842 3434	Fax:		Public Health Unit:	

Samples Taken By:
Name: Eric Lavergne
Signature: [signature]
Page ___ of ___
Turn Around Time Required: ☐ 1 day ☐ 2 day ☐ 3 day ☒ 4 day

Samples Submitted Under: (Indicate ONLY one)
☐ ON REG 170/03 ☐ ON REG 319/08 ☐ Private Well
☐ ON REG 243/07 ☒ Other ODWS

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

Have LSN forms been submitted to MOE/MOHLTC?: ☐ Yes ☒ No ☐ N/A
Are these samples for human consumption?: ☐ Yes ☒ No
All information must be completed before samples will be processed.

	LOCATION NAME	SAMPLE ID	Sample Type: R/T/D/P	Source Type: G/S	Reportable: Y/N	Resample	DATE	TIME	# of Containers	Free/Combined Chlorine Residual mg/L	Standing / Flushed: S/F (REG 243)	Total Coliform/E. Coli	HPC	Lead	THM	Subdivision Package	VOC	Trace Metals
1	363 Entrepreneur crescent	363 Entrepreneur crescent Supply Well - 4 Hour	R	G			Aug 30/2023	12:15 pm	12							X	X	X
2																		
3	363 Entrepreneur crescent	363 Entrepreneur crescent Supply Well - 8 Hour	R	G				4:15 PM	12							X	X	X
4																		
5																		
6																		
7																		
8																		
9																		
10																		

Comments:

Method of Delivery: Walk In

Relinquished By (Sign): [signature]	Received By Driver/Depot:	Received at Lab: CB 904	Verified By: SD
Relinquished By (Print): Eric Lavergne	Date/Time:	Date/Time: Aug 31/23	Date/Time: Aug 31, 2023 9:31am
Date/Time:	Temperature: °C	Temperature: 16.1 °C	pH Verified: ☐ By: SD

SCHEDULE C

July 26, 2024

Shelley Kilby
Coordinator, Water Well Management Program Environmental Monitoring and Reporting Branch
Ministry of the Environment, Conservation and Parks 125 Resources Rd
Toronto, ON M9P 3V6

ATTENTION: Ms. Shelley Kilby, Coordinator, Water Well Management Program

---

Re: **363 ENTREPRENEUR CRESCENT, OTTAWA, ONTARIO, REQUEST FOR DIRECTOR APPROVAL**

Ms. Kilby,

Further to a discussion with our Project Manager, Jessica Arthurs, we have been advised that the operation of the well (A379014) located on our site at 363 Entrepreneur Crescent, Ottawa, Ontario will require Director Approval for it to be used in our operation. Additionally, for Director Approval to be considered, the following requirements are to be followed, they are:

1. Ensure that the well is properly vented to the outside atmosphere in a manner that will safely disperse all gases, as per section 15.1 of Regulation 903;

2. The services of a water treatment specialist shall be retained and we shall install, operate and maintain a water treatment system in the distribution system, in accordance with recommendations of the water treatment specialist, to address the total dissolved solids and chloride present in the well water prior to the water being used in the building;

3. The water treatment system shall be properly maintained and operational at all times in accordance with the recommendations of the water treatment specialist;

4. All faucets within the building shall be labelled to indicate that the water is not intended for human consumption;

5. The well water shall not be used as a drinking water source under any circumstances by any person and botted water shall be supplied for consumption by employees;

6. Due to elevated chloride, steps shall be taken to mitigate the impact of corrosion on plumbing including: use of approved PEX pipe and fittings, installation of stainless steel fixtures, and not installing water treatment systems that may increase corrosivity of the water; and

7. The well identified by well record number A379014 shall be maintained as per Reg. 903 until such time as the water supply is no longer required. At that point, the water supply well shall be decommissioned in accordance with Reg. 903.

Once the water treatment system becomes operational, we shall immediately notify, in writing, the Director appointed for the purposes of subsection 21 (10) of the Wells Regulation of the date when the water treatment system is operational.
To notify the Director, we will send an email correspondence to the wellshelpdesk@ontario.ca.

We find these requirements acceptable and would politely request that the Ministry of Environment, Conservation and Parks consider our application for Director Approval for this site.

Please advise at your earliest convenience.

Title: Owner

Signature:

Date: July 30th, 2024

ATTACHMENT J

Moisture Surplus Values (Ottawa)

Ottawa Airport, ON WATER BUDGET MEANS FOR THE PERIOD 1950-2010 DC20492

LAT.... 45.32 WATER HOLDING CAPACITY... 50 MM HEAT INDEX... 36.41
LONG... 75.67 LOWER ZONE............... 30 MM A............ 1.075

DATE	TEMP (C)		PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	-10.6		64	13	15	0	0	0	27	83	50	299
28- 2	-8.8		57	12	18	1	1	0	29	110	50	356
31- 3	-2.7		66	32	80	5	5	0	107	64	50	422
30- 4	5.9		72	67	69	32	32	0	104	0	50	494
31- 5	13.0		74	74	0	80	79	-1	13	0	32	568
30- 6	18.3		82	82	0	116	97	-19	4	0	14	651
31- 7	20.8		89	89	0	135	94	-41	3	0	5	740
31- 8	19.5		87	87	0	117	83	-34	1	0	9	827
30- 9	14.6		84	84	0	75	66	-9	7	0	20	912
31-10	8.1		77	76	0	36	35	-1	24	0	37	77
30-11	1.3		80	63	8	10	10	0	50	9	49	157
31-12	-7.0		78	26	15	1	1	0	38	47	50	236
AVE	5.9	TTL	911	705	205	608	503	-105	407			

Ottawa Airport, ON STANDARD DEVIATIONS FOR THE PERIOD 1950-2010 DC20492

DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	3.0	26	16	18	1	1	0	31	43	0	55
28- 2	2.6	29	15	27	1	1	0	37	59	0	59
31- 3	2.3	28	22	47	4	4	0	53	83	0	65
30- 4	1.7	31	31	84	8	8	0	84	0	2	74
31- 5	1.9	32	32	0	12	11	5	21	0	19	85
30- 6	1.2	38	38	0	9	26	26	17	0	19	93
31- 7	1.2	42	42	0	8	30	31	12	0	14	93
31- 8	1.3	39	39	0	8	30	32	5	0	16	107
30- 9	1.5	38	38	0	8	14	13	20	0	21	110
31-10	1.4	37	37	2	7	7	3	27	0	19	37
30-11	1.7	27	28	9	4	4	0	30	13	6	45
31-12	3.0	30	22	14	1	1	0	29	34	0	56

Ottawa Airport, ON WATER BUDGET MEANS FOR THE PERIOD 1950-2010 DC20492

LAT.... 45.32 WATER HOLDING CAPACITY... 75 MM HEAT INDEX... 36.41
LONG... 75.67 LOWER ZONE............... 45 MM A............ 1.075

DATE	TEMP (C)		PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	-10.6		64	13	15	0	0	0	27	83	75	299
28- 2	-8.8		57	12	18	1	1	0	29	110	75	356
31- 3	-2.7		66	32	80	5	5	0	107	64	75	422
30- 4	5.9		72	67	69	32	32	0	104	0	75	494
31- 5	13.0		74	74	0	80	80	0	13	0	56	568
30- 6	18.3		82	82	0	116	107	-10	4	0	28	651
31- 7	20.8		89	89	0	135	104	-32	2	0	10	740
31- 8	19.5		87	87	0	117	85	-32	1	0	12	827
30- 9	14.6		84	84	0	75	66	-9	4	0	26	912
31-10	8.1		77	76	0	36	35	-1	15	0	52	77
30-11	1.3		80	63	8	10	10	0	42	9	71	157
31-12	-7.0		78	26	15	1	1	0	36	47	75	236
AVE	5.9	TTL	911	705	205	608	526	-84	384			

Ottawa Airport, ON STANDARD DEVIATIONS FOR THE PERIOD 1950-2010 DC20492

DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	3.0	26	16	18	1	1	0	30	43	0	55
28- 2	2.6	29	15	27	1	1	0	37	59	0	59
31- 3	2.3	28	22	47	4	4	0	53	83	0	65
30- 4	1.7	31	31	84	8	8	0	84	0	2	74
31- 5	1.9	32	32	0	12	12	0	21	0	22	85
30- 6	1.2	38	38	0	9	19	19	17	0	28	93
31- 7	1.2	42	42	0	8	28	30	11	0	22	93
31- 8	1.3	39	39	0	8	29	31	5	0	23	107
30- 9	1.5	38	38	0	8	14	14	17	0	29	110
31-10	1.4	37	37	2	7	7	2	23	0	28	37
30-11	1.7	27	28	9	4	4	0	33	13	11	45
31-12	3.0	30	22	14	1	1	0	30	34	3	56

Ottawa Airport, ON WATER BUDGET MEANS FOR THE PERIOD 1950-2010 DC20492

LAT.... 45.32 WATER HOLDING CAPACITY...100 MM HEAT INDEX... 36.41
LONG... 75.67 LOWER ZONE............... 60 MM A............ 1.075

DATE	TEMP (C)		PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	-10.6		64	13	15	0	0	0	25	83	99	299
28- 2	-8.8		57	12	18	1	1	0	28	110	99	356
31- 3	-2.7		66	32	80	5	5	0	106	64	100	422
30- 4	5.9		72	67	69	32	32	0	104	0	100	494
31- 5	13.0		74	74	0	80	80	0	13	0	81	568
30- 6	18.3		82	82	0	116	112	-4	4	0	47	651
31- 7	20.8		89	89	0	135	115	-21	2	0	19	740
31- 8	19.5		87	87	0	117	88	-29	1	0	18	827
30- 9	14.6		84	84	0	75	66	-8	3	0	32	912
31-10	8.1		77	76	0	36	35	-1	10	0	63	77
30-11	1.3		80	63	8	10	10	0	34	9	91	157
31-12	-7.0		78	26	15	1	1	0	33	47	97	236
AVE	5.9	TTL	911	705	205	608	545	-63	363			

Ottawa Airport, ON STANDARD DEVIATIONS FOR THE PERIOD 1950-2010 DC20492

DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	3.0	26	16	18	1	1	0	30	43	5	55
28- 2	2.6	29	15	27	1	1	0	37	59	3	59
31- 3	2.3	28	22	47	4	4	0	53	83	0	65
30- 4	1.7	31	31	84	8	8	0	84	0	2	74
31- 5	1.9	32	32	0	12	12	0	21	0	22	85
30- 6	1.2	38	38	0	9	12	11	17	0	34	93
31- 7	1.2	42	42	0	8	25	26	11	0	30	93
31- 8	1.3	39	39	0	8	29	30	5	0	30	107
30- 9	1.5	38	38	0	8	14	13	15	0	35	110
31-10	1.4	37	37	2	7	6	2	21	0	36	37
30-11	1.7	27	28	9	4	4	0	34	13	19	45
31-12	3.0	30	22	14	1	1	0	30	34	8	56

Ottawa Airport, ON WATER BUDGET MEANS FOR THE PERIOD 1950-2010 DC20492

LAT.... 45.32 WATER HOLDING CAPACITY...125 MM HEAT INDEX... 36.41
LONG... 75.67 LOWER ZONE............... 75 MM A............ 1.075

DATE	TEMP (C)		PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	-10.6		64	13	15	0	0	0	24	83	122	299
28- 2	-8.8		57	12	18	1	1	0	28	110	123	356
31- 3	-2.7		66	32	80	5	5	0	105	64	125	422
30- 4	5.9		72	67	69	32	32	0	104	0	125	494
31- 5	13.0		74	74	0	80	80	0	13	0	106	568
30- 6	18.3		82	82	0	116	115	-1	4	0	69	651
31- 7	20.8		89	89	0	135	122	-13	2	0	33	740
31- 8	19.5		87	87	0	117	92	-25	1	0	28	827
30- 9	14.6		84	84	0	75	67	-7	3	0	41	912
31-10	8.1		77	76	0	36	35	-1	9	0	74	77
30-11	1.3		80	63	8	10	10	0	27	9	108	157
31-12	-7.0		78	26	15	1	1	0	29	47	119	236
AVE	5.9	TTL	911	705	205	608	560	-47	349			

Ottawa Airport, ON STANDARD DEVIATIONS FOR THE PERIOD 1950-2010 DC20492

DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	3.0	26	16	18	1	1	0	31	43	10	55
28- 2	2.6	29	15	27	1	1	0	37	59	8	59
31- 3	2.3	28	22	47	4	4	0	54	83	0	65
30- 4	1.7	31	31	84	8	8	0	84	0	2	74
31- 5	1.9	32	32	0	12	12	0	21	0	22	85
30- 6	1.2	38	38	0	9	9	4	17	0	39	93
31- 7	1.2	42	42	0	8	21	23	11	0	37	93
31- 8	1.3	39	39	0	8	26	28	5	0	38	107
30- 9	1.5	38	38	0	8	13	11	14	0	42	110
31-10	1.4	37	37	2	7	6	2	20	0	42	37
30-11	1.7	27	28	9	4	4	0	32	13	25	45
31-12	3.0	30	22	14	1	1	0	30	34	14	56

Ottawa Airport, ON WATER BUDGET MEANS FOR THE PERIOD 1950-2010 DC20492

LAT.... 45.32 WATER HOLDING CAPACITY...150 MM HEAT INDEX... 36.41
LONG... 75.67 LOWER ZONE............... 90 MM A............ 1.075

DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	-10.6	64	13	15	0	0	0	23	83	144	299
28- 2	-8.8	57	12	18	1	1	0	26	110	146	356
31- 3	-2.7	66	32	80	5	5	0	103	64	150	422
30- 4	5.9	72	67	69	32	32	0	104	0	150	494
31- 5	13.0	74	74	0	80	80	0	13	0	131	568
30- 6	18.3	82	82	0	116	116	0	4	0	93	651
31- 7	20.8	89	89	0	135	127	-8	2	0	52	740
31- 8	19.5	87	87	0	117	97	-19	1	0	41	827
30- 9	14.6	84	84	0	75	68	-6	3	0	54	912
31-10	8.1	77	76	0	36	36	-1	8	0	88	77
30-11	1.3	80	63	8	10	10	0	23	9	126	157
31-12	-7.0	78	26	15	1	1	0	26	47	140	236
AVE	5.9 TTL	911	705	205	608	573	-34	336			

Ottawa Airport, ON STANDARD DEVIATIONS FOR THE PERIOD 1950-2010 DC20492

DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	3.0	26	16	18	1	1	0	31	43	15	55
28- 2	2.6	29	15	27	1	1	0	37	59	12	59
31- 3	2.3	28	22	47	4	4	0	54	83	0	65
30- 4	1.7	31	31	84	8	8	0	84	0	2	74
31- 5	1.9	32	32	0	12	12	0	21	0	22	85
30- 6	1.2	38	38	0	9	8	1	17	0	41	93
31- 7	1.2	42	42	0	8	18	18	11	0	42	93
31- 8	1.3	39	39	0	8	22	23	5	0	44	107
30- 9	1.5	38	38	0	8	12	10	14	0	49	110
31-10	1.4	37	37	2	7	6	2	19	0	47	37
30-11	1.7	27	28	9	4	4	0	30	13	31	45
31-12	3.0	30	22	14	1	1	0	29	34	20	56

Ottawa Airport, ON WATER BUDGET MEANS FOR THE PERIOD 1950-2010 DC20492

LAT.... 45.32 WATER HOLDING CAPACITY...200 MM HEAT INDEX... 36.41
LONG... 75.67 LOWER ZONE...............120 MM A............ 1.075

DATE	TEMP (C)		PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	-10.6		64	13	15	0	0	0	21	83	187	299
28- 2	-8.8		57	12	18	1	1	0	24	110	191	356
31- 3	-2.7		66	32	80	5	5	0	99	64	199	422
30- 4	5.9		72	67	69	32	32	0	103	0	200	494
31- 5	13.0		74	74	0	80	80	0	13	0	181	568
30- 6	18.3		82	82	0	116	116	0	4	0	143	651
31- 7	20.8		89	89	0	135	132	-3	2	0	97	740
31- 8	19.5		87	87	0	117	106	-11	1	0	78	827
30- 9	14.6		84	84	0	75	70	-4	3	0	89	912
31-10	8.1		77	76	0	36	36	0	7	0	123	77
30-11	1.3		80	63	8	10	10	0	19	9	164	157
31-12	-7.0		78	26	15	1	1	0	22	47	182	236
AVE	5.9	TTL	911	705	205	608	589	-18	318			

Ottawa Airport, ON STANDARD DEVIATIONS FOR THE PERIOD 1950-2010 DC20492

DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	3.0	26	16	18	1	1	0	30	43	24	55
28- 2	2.6	29	15	27	1	1	0	36	59	20	59
31- 3	2.3	28	22	47	4	4	0	55	83	4	65
30- 4	1.7	31	31	84	8	8	0	83	0	2	74
31- 5	1.9	32	32	0	12	12	0	21	0	22	85
30- 6	1.2	38	38	0	9	9	0	17	0	41	93
31- 7	1.2	42	42	0	8	11	10	11	0	48	93
31- 8	1.3	39	39	0	8	16	16	5	0	54	107
30- 9	1.5	38	38	0	8	10	8	14	0	59	110
31-10	1.4	37	37	2	7	6	1	19	0	55	37
30-11	1.7	27	28	9	4	4	0	29	13	41	45
31-12	3.0	30	22	14	1	1	0	28	34	29	56

Ottawa Airport, ON WATER BUDGET MEANS FOR THE PERIOD 1950-2010 DC20492

LAT.... 45.32 WATER HOLDING CAPACITY...225 MM HEAT INDEX... 36.41
LONG... 75.67 LOWER ZONE...............135 MM A............ 1.075

DATE	TEMP (C)		PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	-10.6		64	13	15	0	0	0	21	83	209	299
28- 2	-8.8		57	12	18	1	1	0	24	110	214	356
31- 3	-2.7		66	32	80	5	5	0	97	64	224	422
30- 4	5.9		72	67	69	32	32	0	103	0	225	494
31- 5	13.0		74	74	0	80	80	0	13	0	206	568
30- 6	18.3		82	82	0	116	116	0	4	0	168	651
31- 7	20.8		89	89	0	135	133	-2	2	0	121	740
31- 8	19.5		87	87	0	117	109	-8	1	0	99	827
30- 9	14.6		84	84	0	75	71	-4	3	0	109	912
31-10	8.1		77	76	0	36	36	0	7	0	143	77
30-11	1.3		80	63	8	10	10	0	18	9	185	157
31-12	-7.0		78	26	15	1	1	0	21	47	204	236
AVE	5.9	TTL	911	705	205	608	594	-14	314			

Ottawa Airport, ON STANDARD DEVIATIONS FOR THE PERIOD 1950-2010 DC20492

DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	3.0	26	16	18	1	1	0	30	43	28	55
28- 2	2.6	29	15	27	1	1	0	36	59	24	59
31- 3	2.3	28	22	47	4	4	0	56	83	7	65
30- 4	1.7	31	31	84	8	8	0	82	0	2	74
31- 5	1.9	32	32	0	12	12	0	21	0	22	85
30- 6	1.2	38	38	0	9	9	0	17	0	41	93
31- 7	1.2	42	42	0	8	10	7	11	0	49	93
31- 8	1.3	39	39	0	8	14	13	5	0	58	107
30- 9	1.5	38	38	0	8	10	7	14	0	63	110
31-10	1.4	37	37	2	7	6	1	19	0	58	37
30-11	1.7	27	28	9	4	4	0	29	13	44	45
31-12	3.0	30	22	14	1	1	0	28	34	33	56

Ottawa Airport, ON WATER BUDGET MEANS FOR THE PERIOD 1950-2010 DC20492

LAT.... 45.32 WATER HOLDING CAPACITY...250 MM HEAT INDEX... 36.41
LONG... 75.67 LOWER ZONE...............150 MM A............ 1.075

DATE	TEMP (C)		PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	-10.6		64	13	15	0	0	0	20	83	232	299
28- 2	-8.8		57	12	18	1	1	0	23	110	238	356
31- 3	-2.7		66	32	80	5	5	0	96	64	248	422
30- 4	5.9		72	67	69	32	32	0	102	0	250	494
31- 5	13.0		74	74	0	80	80	0	13	0	231	568
30- 6	18.3		82	82	0	116	116	0	4	0	193	651
31- 7	20.8		89	89	0	135	134	-1	2	0	145	740
31- 8	19.5		87	87	0	117	111	-6	1	0	121	827
30- 9	14.6		84	84	0	75	72	-3	3	0	130	912
31-10	8.1		77	76	0	36	36	0	7	0	164	77
30-11	1.3		80	63	8	10	10	0	18	9	207	157
31-12	-7.0		78	26	15	1	1	0	20	47	226	236
AVE	5.9	TTL	911	705	205	608	598	-10	309			

Ottawa Airport, ON STANDARD DEVIATIONS FOR THE PERIOD 1950-2010 DC20492

DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	3.0	26	16	18	1	1	0	29	43	32	55
28- 2	2.6	29	15	27	1	1	0	36	59	27	59
31- 3	2.3	28	22	47	4	4	0	56	83	9	65
30- 4	1.7	31	31	84	8	8	0	82	0	2	74
31- 5	1.9	32	32	0	12	12	0	21	0	22	85
30- 6	1.2	38	38	0	9	9	0	17	0	41	93
31- 7	1.2	42	42	0	8	9	5	11	0	50	93
31- 8	1.3	39	39	0	8	12	11	5	0	61	107
30- 9	1.5	38	38	0	8	9	6	14	0	66	110
31-10	1.4	37	37	2	7	7	1	19	0	61	37
30-11	1.7	27	28	9	4	4	0	29	13	47	45
31-12	3.0	30	22	14	1	1	0	28	34	36	56

Ottawa Airport, ON WATER BUDGET MEANS FOR THE PERIOD 1950-2010 DC20492

LAT.... 45.32 WATER HOLDING CAPACITY...265 MM HEAT INDEX... 36.41
LONG... 75.67 LOWER ZONE...............159 MM A............ 1.075

DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	-10.6	64	13	15	0	0	0	20	83	246	299
28- 2	-8.8	57	12	18	1	1	0	23	110	252	356
31- 3	-2.7	66	32	80	5	5	0	96	64	263	422
30- 4	5.9	72	67	69	32	32	0	102	0	265	494
31- 5	13.0	74	74	0	80	80	0	13	0	246	568
30- 6	18.3	82	82	0	116	116	0	4	0	208	651
31- 7	20.8	89	89	0	135	134	-1	2	0	160	740
31- 8	19.5	87	87	0	117	112	-5	1	0	135	827
30- 9	14.6	84	84	0	75	72	-3	3	0	144	912
31-10	8.1	77	76	0	36	36	0	7	0	177	77
30-11	1.3	80	63	8	10	10	0	18	9	221	157
31-12	-7.0	78	26	15	1	1	0	20	47	240	236
AVE	5.9 TTL	911	705	205	608	599	-9	309			

Ottawa Airport, ON STANDARD DEVIATIONS FOR THE PERIOD 1950-2010 DC20492

DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	3.0	26	16	18	1	1	0	29	43	34	55
28- 2	2.6	29	15	27	1	1	0	36	59	29	59
31- 3	2.3	28	22	47	4	4	0	56	83	10	65
30- 4	1.7	31	31	84	8	8	0	82	0	2	74
31- 5	1.9	32	32	0	12	12	0	21	0	22	85
30- 6	1.2	38	38	0	9	9	0	17	0	41	93
31- 7	1.2	42	42	0	8	8	4	11	0	51	93
31- 8	1.3	39	39	0	8	11	10	5	0	62	107
30- 9	1.5	38	38	0	8	9	5	14	0	68	110
31-10	1.4	37	37	2	7	7	1	19	0	62	37
30-11	1.7	27	28	9	4	4	0	29	13	49	45
31-12	3.0	30	22	14	1	1	0	28	34	38	56

Ottawa Airport, ON WATER BUDGET MEANS FOR THE PERIOD 1950-2010 DC20492

LAT.... 45.32 WATER HOLDING CAPACITY...275 MM HEAT INDEX... 36.41
LONG... 75.67 LOWER ZONE...............165 MM A............ 1.075

DATE	TEMP (C)		PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	-10.6		64	13	15	0	0	0	19	83	255	299
28- 2	-8.8		57	12	18	1	1	0	23	110	261	356
31- 3	-2.7		66	32	80	5	5	0	96	64	272	422
30- 4	5.9		72	67	69	32	32	0	101	0	275	494
31- 5	13.0		74	74	0	80	80	0	13	0	256	568
30- 6	18.3		82	82	0	116	116	0	4	0	218	651
31- 7	20.8		89	89	0	135	135	-1	2	0	170	740
31- 8	19.5		87	87	0	117	113	-4	1	0	144	827
30- 9	14.6		84	84	0	75	72	-2	3	0	153	912
31-10	8.1		77	76	0	36	36	0	7	0	186	77
30-11	1.3		80	63	8	10	10	0	18	9	230	157
31-12	-7.0		78	26	15	1	1	0	20	47	249	236
AVE	5.9	TTL	911	705	205	608	601	-7	307			

Ottawa Airport, ON STANDARD DEVIATIONS FOR THE PERIOD 1950-2010 DC20492

DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	3.0	26	16	18	1	1	0	29	43	35	55
28- 2	2.6	29	15	27	1	1	0	36	59	30	59
31- 3	2.3	28	22	47	4	4	0	56	83	11	65
30- 4	1.7	31	31	84	8	8	0	81	0	2	74
31- 5	1.9	32	32	0	12	12	0	21	0	22	85
30- 6	1.2	38	38	0	9	9	0	17	0	41	93
31- 7	1.2	42	42	0	8	8	3	11	0	51	93
31- 8	1.3	39	39	0	8	11	9	5	0	63	107
30- 9	1.5	38	38	0	8	9	5	14	0	69	110
31-10	1.4	37	37	2	7	7	1	19	0	63	37
30-11	1.7	27	28	9	4	4	0	29	13	50	45
31-12	3.0	30	22	14	1	1	0	28	34	39	56

Ottawa Airport, ON WATER BUDGET MEANS FOR THE PERIOD 1950-2010 DC20492

LAT.... 45.32 WATER HOLDING CAPACITY...280 MM HEAT INDEX... 36.41
LONG... 75.67 LOWER ZONE...............168 MM A............ 1.075

DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	-10.6	64	13	15	0	0	0	19	83	260	299
28- 2	-8.8	57	12	18	1	1	0	23	110	266	356
31- 3	-2.7	66	32	80	5	5	0	95	64	277	422
30- 4	5.9	72	67	69	32	32	0	101	0	280	494
31- 5	13.0	74	74	0	80	80	0	13	0	261	568
30- 6	18.3	82	82	0	116	116	0	4	0	223	651
31- 7	20.8	89	89	0	135	135	-1	2	0	175	740
31- 8	19.5	87	87	0	117	113	-4	1	0	148	827
30- 9	14.6	84	84	0	75	72	-2	3	0	157	912
31-10	8.1	77	76	0	36	36	0	7	0	191	77
30-11	1.3	80	63	8	10	10	0	18	9	234	157
31-12	-7.0	78	26	15	1	1	0	20	47	254	236
AVE	5.9 TTL	911	705	205	608	601	-7	306			

Ottawa Airport, ON STANDARD DEVIATIONS FOR THE PERIOD 1950-2010 DC20492

DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	3.0	26	16	18	1	1	0	29	43	35	55
28- 2	2.6	29	15	27	1	1	0	36	59	31	59
31- 3	2.3	28	22	47	4	4	0	56	83	12	65
30- 4	1.7	31	31	84	8	8	0	81	0	2	74
31- 5	1.9	32	32	0	12	12	0	21	0	22	85
30- 6	1.2	38	38	0	9	9	0	17	0	41	93
31- 7	1.2	42	42	0	8	8	3	11	0	52	93
31- 8	1.3	39	39	0	8	10	9	5	0	64	107
30- 9	1.5	38	38	0	8	9	5	14	0	69	110
31-10	1.4	37	37	2	7	7	1	19	0	64	37
30-11	1.7	27	28	9	4	4	0	29	13	50	45
31-12	3.0	30	22	14	1	1	0	28	34	39	56

Ottawa Airport, ON WATER BUDGET MEANS FOR THE PERIOD 1950-2010 DC20492

LAT.... 45.32 WATER HOLDING CAPACITY...300 MM HEAT INDEX... 36.41
LONG... 75.67 LOWER ZONE...............180 MM A............ 1.075

DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	-10.6	64	13	15	0	0	0	19	83	279	299
28- 2	-8.8	57	12	18	1	1	0	23	110	285	356
31- 3	-2.7	66	32	80	5	5	0	95	64	297	422
30- 4	5.9	72	67	69	32	32	0	101	0	300	494
31- 5	13.0	74	74	0	80	80	0	13	0	281	568
30- 6	18.3	82	82	0	116	116	0	4	0	243	651
31- 7	20.8	89	89	0	135	135	0	2	0	194	740
31- 8	19.5	87	87	0	117	114	-3	1	0	167	827
30- 9	14.6	84	84	0	75	73	-2	3	0	176	912
31-10	8.1	77	76	0	36	36	0	7	0	209	77
30-11	1.3	80	63	8	10	10	0	18	9	252	157
31-12	-7.0	78	26	15	1	1	0	20	47	272	236
AVE	5.9 TTL	911	705	205	608	603	-5	306			

Ottawa Airport, ON STANDARD DEVIATIONS FOR THE PERIOD 1950-2010 DC20492

DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	3.0	26	16	18	1	1	0	29	43	37	55
28- 2	2.6	29	15	27	1	1	0	36	59	33	59
31- 3	2.3	28	22	47	4	4	0	57	83	13	65
30- 4	1.7	31	31	84	8	8	0	81	0	2	74
31- 5	1.9	32	32	0	12	12	0	21	0	22	85
30- 6	1.2	38	38	0	9	9	0	17	0	41	93
31- 7	1.2	42	42	0	8	8	2	11	0	52	93
31- 8	1.3	39	39	0	8	10	8	5	0	65	107
30- 9	1.5	38	38	0	8	9	5	14	0	71	110
31-10	1.4	37	37	2	7	7	1	19	0	65	37
30-11	1.7	27	28	9	4	4	0	29	13	52	45
31-12	3.0	30	22	14	1	1	0	28	34	41	56

Ottawa Airport, ON WATER BUDGET MEANS FOR THE PERIOD 1950-2010 DC20492

LAT.... 45.32 WATER HOLDING CAPACITY...400 MM HEAT INDEX... 36.41
LONG... 75.67 LOWER ZONE...............240 MM A............ 1.075

DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	-10.6	64	13	15	0	0	0	19	83	375	299
28- 2	-8.8	57	12	18	1	1	0	22	110	382	356
31- 3	-2.7	66	32	80	5	5	0	94	64	395	422
30- 4	5.9	72	67	69	32	32	0	99	0	400	494
31- 5	13.0	74	74	0	80	80	0	13	0	381	568
30- 6	18.3	82	82	0	116	116	0	4	0	343	651
31- 7	20.8	89	89	0	135	135	0	2	0	294	740
31- 8	19.5	87	87	0	117	116	-1	1	0	265	827
30- 9	14.6	84	84	0	75	74	-1	3	0	272	912
31-10	8.1	77	76	0	36	36	0	7	0	305	77
30-11	1.3	80	63	8	10	10	0	18	9	349	157
31-12	-7.0	78	26	15	1	1	0	19	47	369	236
AVE	5.9 TTL	911	705	205	608	606	-2	301			

Ottawa Airport, ON STANDARD DEVIATIONS FOR THE PERIOD 1950-2010 DC20492

DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	3.0	26	16	18	1	1	0	29	43	44	55
28- 2	2.6	29	15	27	1	1	0	36	59	39	59
31- 3	2.3	28	22	47	4	4	0	57	83	20	65
30- 4	1.7	31	31	84	8	8	0	80	0	2	74
31- 5	1.9	32	32	0	12	12	0	21	0	22	85
30- 6	1.2	38	38	0	9	9	0	17	0	41	93
31- 7	1.2	42	42	0	8	8	0	11	0	53	93
31- 8	1.3	39	39	0	8	8	4	5	0	69	107
30- 9	1.5	38	38	0	8	8	2	14	0	76	110
31-10	1.4	37	37	2	7	7	0	19	0	69	37
30-11	1.7	27	28	9	4	4	0	29	13	57	45
31-12	3.0	30	22	14	1	1	0	28	34	46	56

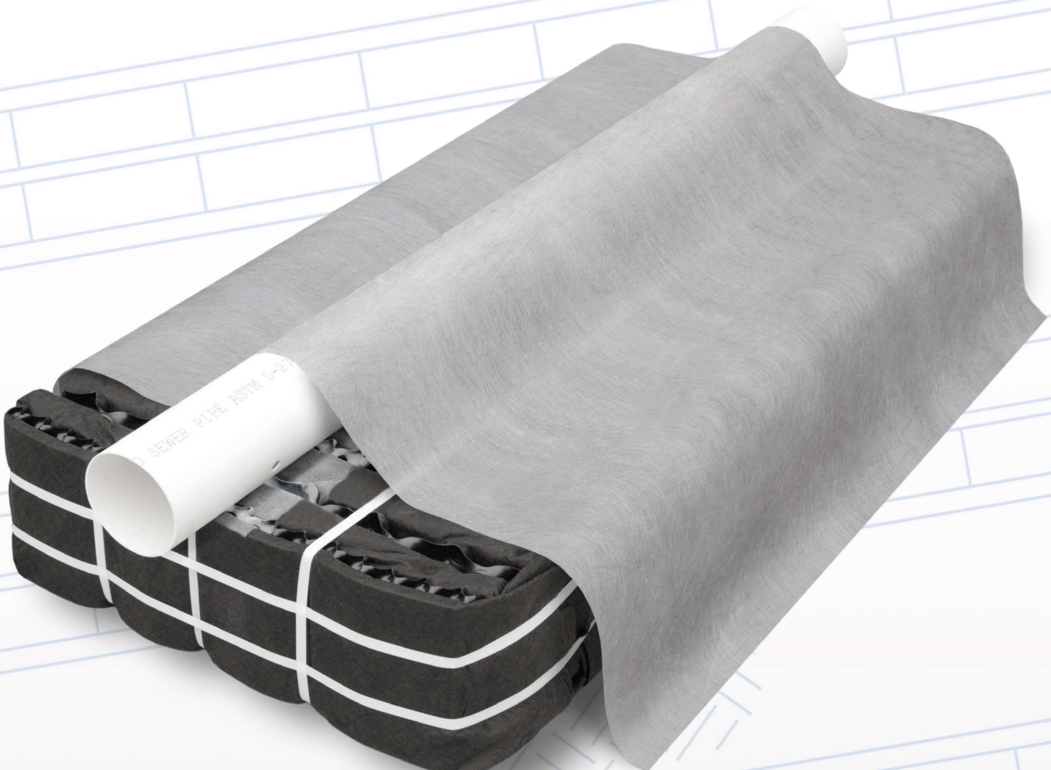
ATTACHMENT K

Sewage Disposal System Specifications

GSF®

Geotextile Sand Filter

Eljen GSF System Overview



eljen CORPORATION

Innovative Onsite Products & Solutions Since 1970

www.eljen.com

Eljen GSF System Description

Each GSF Module is made up of geotextile fabric and a plastic core material that work together to provide vertical surface area and oxygen transfer. The GSF System applies secondary treated effluent to the soil, increasing the soil's long-term acceptance rate. A Specified Sand layer provides additional filtration, and prevents saturated conditions.

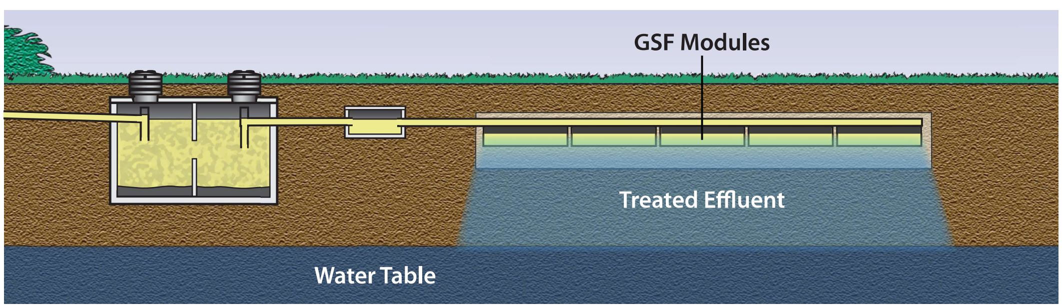
PRIMARY TREATMENT ZONE

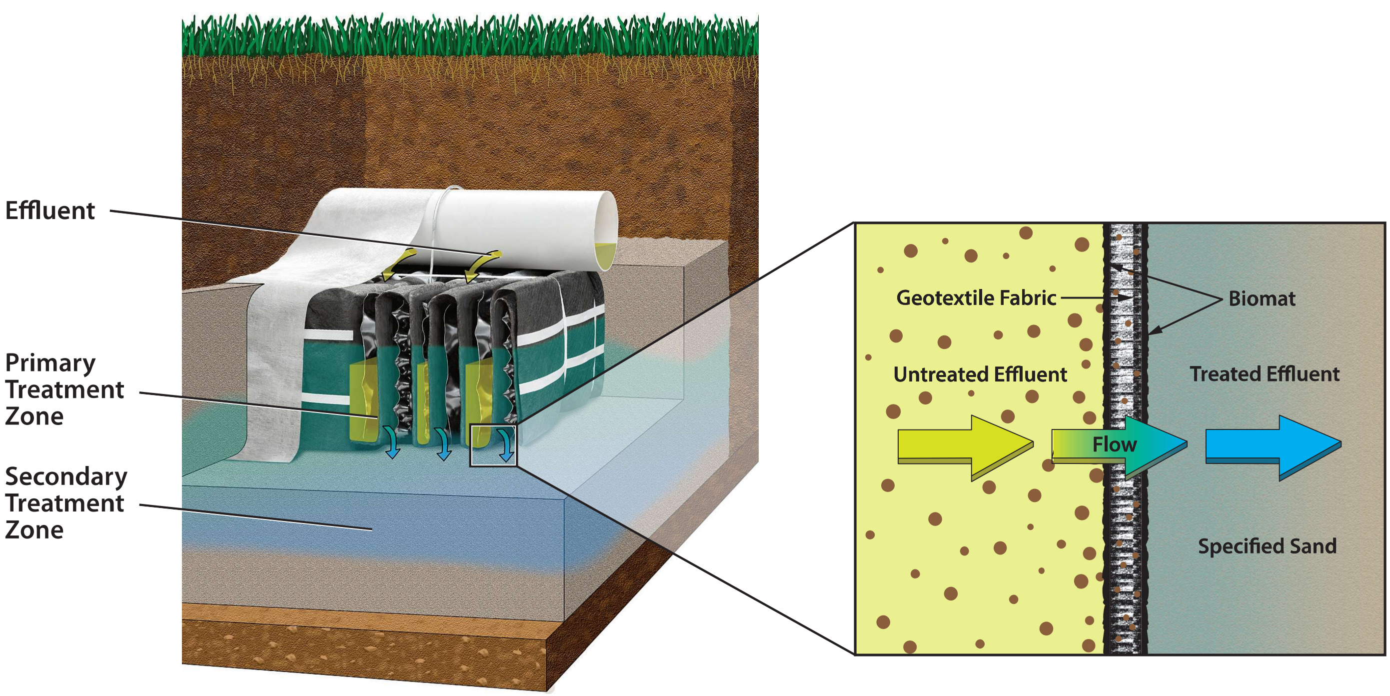
- Perforated pipe is centered above the GSF Module to distribute septic effluent over and into corrugations created by the plastic core of the GSF Module.
- The Module's unique design provides increased surface area for biological treatment of nutrients and contaminants.
- Open air channels within the Module support aerobic bacterial growth on the Module's geotextile fabric interface, and promote oxygen in the system.
- An anti-siltation geotextile fabric covers the top and sides of the GSF Module to protect the system from the migration of fines.
- The GSF Module provides biomat management, and takes the burden of treatment and biomat development off of the native soil.

SECONDARY TREATMENT ZONE

- Effluent drips into the Specified Sand layer and supports unsaturated flow into the native soil.
- The Specified Sand layer also protects the soil from compaction and helps maintain cracks and crevices in the soil.
- Native soil provides final filtration and allows for groundwater recharge.

GSF SYSTEM OPERATION





Testing Overview and Performance

NSF Standard 40

This standard determines whether treatment systems product secondary treatment effluent quality, with Class I systems achieving a 30-day average effluent quality of 25 mg/L CBOD5 and 30 mg/L TSS or less, and pH 6.0-9.0. Testing and certification are done at an independent third party testing facility.

NSF Certified to NSF/ANSI Standard 40

SETUP: Gravity GSF system with 6" of ASTM C33 sand in a bed configuration. 450 gal/day, (2.0 gal/ ft^2 loading rate).

RESULTS: The Eljen GSF is Tested and Certified by NSF to NSF Standard 40 Class 1 since 2014.

More information can be found at www.NSF.org.

NSF Standard 245

This standard includes Total Nitrogen reduction requirements with Class I systems achieving a 30-day average effluent quality of more than 50% Total Nitrogen removal, 25 mg/L CBOD5 and 30 mg/L TSS or less, and PH 6.0-9.0. Testing and certification are done at an independent third party testing facility.

NSF Certified to NSF/ANSI Standard 245

SETUP: Gravity GSF system in a bed configuration with 18" of ASTM C33 sand, 12" of sand/woodchip mixture, and 2" of limestone. 450 gal/day (2.0 gal/ft^2 loading rate).

RESULTS: Tested and Certified by NSF to NSF Standard 245 Class 1 since 2018.

More information can be found at www.NSF.org.

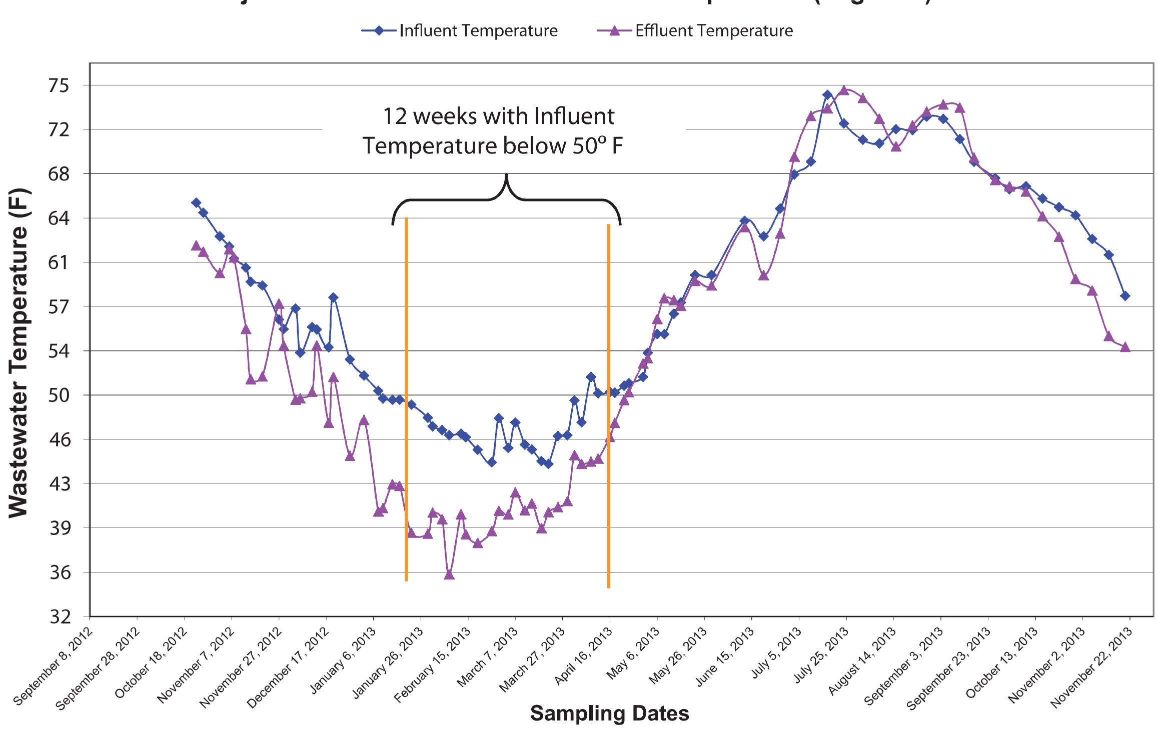
The third-party testing results listed below were taken over a 12 month consecutive period. This extended sampling period provided verification to the stability and consistency of the Eljen GSF's performance and capability to handle colder weather conditions. A summary of the test results from the independent third-party evaluation are listed below:

Eljen GSF A42 Modules Treatment Performance during third party 12 months testing (includes 12 consecutive weeks with influent temperature below 50° F)

	CBOD (mg/L)	TSS (mg/L)	Fecal Coliform (MPN/100ml)
Average	2.0	2.7	66*
Average (cold water period)	1.2	1.7	13*
Median	1.0	2.5	71*
Min Value	1.0	2.5	2*
Max Value	7.2	7.0	10 965*

*Geometric average

Eljen GSF - A42 Influent and Effluent Temperature (degree F)



COMPANY HISTORY

Established in 1970, Eljen Corporation created the world's first prefabricated drainage system for foundation drainage and erosion control applications. In the mid-1980s, we introduced our Geotextile Sand Filter products for the passive advanced treatment of onsite wastewater in both residential and commercial applications. Today, Eljen is a global leader in providing innovative products and solutions for protecting our environment and public health.

COMPANY PHILOSOPHY

Eljen Corporation is committed to advancing the onsite industry through continuous development of innovative new products, delivering high-quality products and services to our customers at the best price, and building lasting partnerships with our employees, suppliers, and customers.

eljen CORPORATION

Innovative Onsite Products & Solutions Since 1970

Tel: 800-444-1359 • Fax: 860-610-0427

www.eljen.com

ATTACHMENT L

Barium Fact Sheet

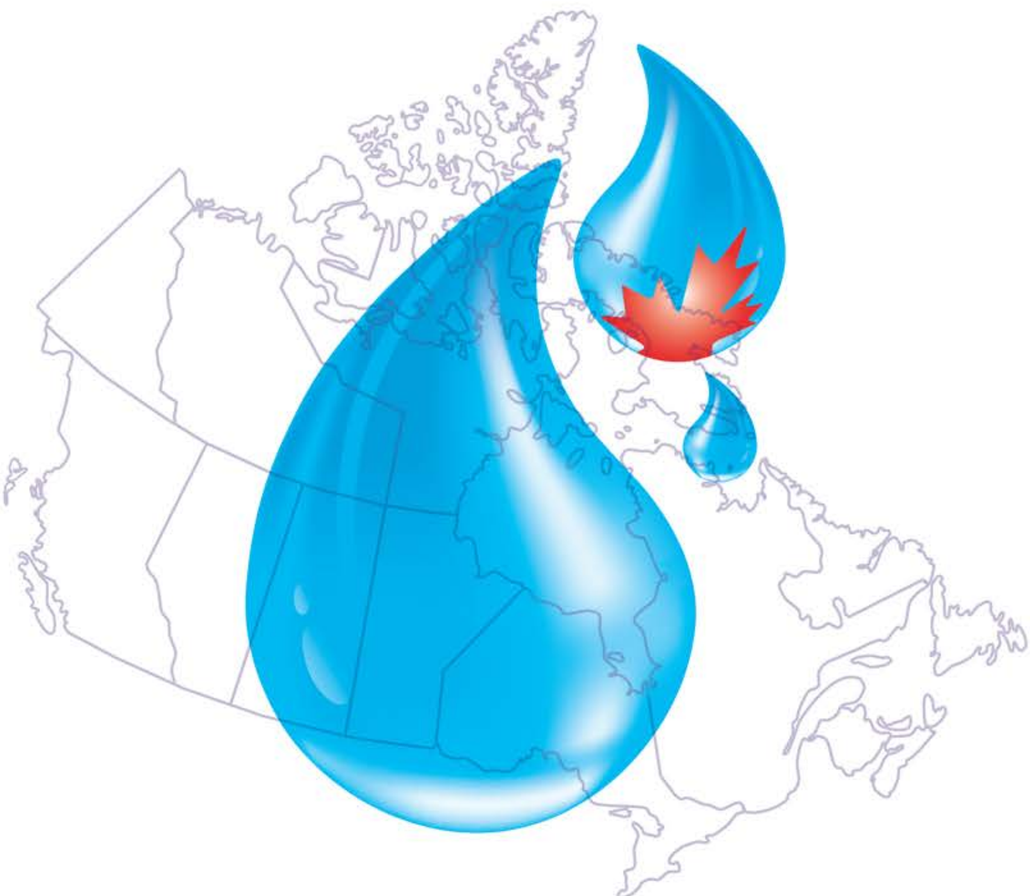
Health Canada Santé Canada

Your health and safety… our priority. Votre santé et votre sécurité… notre priorité.

Gui elines or Cana ian Drin ing ater ualit

Guideline Technical Document

arium



Canada

Health Canada is the federal department responsible for helping the people of Canada maintain and improve their health. *Health Canada is committed to improving the lives of all of Canada's people and to making this country's population among the healthiest in the world as measured by longevity, lifestyle and effective use of the public health care system.*

Guidelines for Canadian Drinking Water Quality: Guideline Technical Document –Barium

is available on the internet at the following address:

www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality.html

Également disponible en français sous le titre :

Recommandations pour la qualité de l’eau potable au Canada : Document technique –Le baryum

To obtain additional information, please contact:

Health Canada
Address Locator 0900C2
Ottawa, ON K1A 0K9
Tel.: 613-957-2991
Toll free: 1-866-225-0709
Fax: 613-941-5366
TTY: 1-800-465-7735
E-mail: hc.publications-publications.sc@canada.ca

Published: January 2020

Cat.: H144-13/16-2019E-PDF
ISBN: 978-0-660-32163-9
Pub.: 190280

Guidelines for Canadian Drinking Water Quality

Guideline Technical Document

Barium

Health Canada
Ottawa, Ontario

January, 2020

This document may be cited as follows:

Health Canada (2020). Guidelines for Canadian Drinking Water Quality: Guideline Technical Document — Barium. Water and Air Quality Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario (Catalogue No - H144-13/16-2019E-PDF).

The document was prepared in collaboration with the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment.

Any questions or comments on this document may be directed to:

Water and Air Quality Bureau
Healthy Environments and Consumer Safety Branch
Health Canada
269 Laurier Avenue West, Address Locator 4903D
Ottawa, Ontario
Canada K1A 0K9

Tel.: 1-833-223-1014 (toll free)
Fax: 613-952-2574
E-mail: hc.water-eau.sc@canada.ca

Other Guideline Technical Documents for the Guidelines for Canadian Drinking Water Quality can be found on the following web page:
www.canada.ca/en/healthcanada/services/environmental-workplace-health/water-quality/drinking-water.html

Table of Contents

Barium

January 2020

Part I. Overview and Application

1.0 Guideline

A maximum acceptable concentration (MAC) for total barium in drinking water is 2.0 mg/L (2,000 µg/L).

2.0 Executive summary

Barium occurs in various compounds in the environment either naturally or from human activities. While the main use of barium is as a drilling fluid additive in oil and gas exploration, it is also used as a contrast agent in X-ray diagnostic tests and in a wide array of products, including plastics, rubbers, paint, glass, carpets, ceramics, sealants, furniture, fertilizers and pesticides.

Naturally occurring barium can be found in most types of rocks and can enter surface and groundwater by leaching and eroding from sedimentary rocks. A total of over 20 radioactive barium isotopes, with various degrees of stability and radioactivity, have been identified in the environment. However, the focus of this document is limited to barium's chemical properties.

This guideline technical document reviews and assesses all identified health risks associated with barium in drinking water. It assesses new studies and approaches and takes into consideration the availability of appropriate treatment technology. Based on this review, the guideline for barium in drinking water is a maximum acceptable concentration of 2 mg/L.

2.2 Health effects

The International Agency for Research on Cancer has not classified barium as to its carcinogenicity. The U.S. Environmental Protection Agency concluded that barium is not likely to be carcinogenic to humans from exposure through ingestion; other international agencies agree that there is no evidence showing that exposure to barium through ingestion could cause cancer.

Studies have found links between the ingestion of barium and unwanted effects on blood pressure in animals and humans. However, adverse effects on the kidneys have shown the strongest association with chronic oral exposure to barium. In humans, effects have been observed on the kidneys following exposure to high levels of barium in poisoning events; in animals, kidney effects are considered the most sensitive health effect associated with long-term ingestion of barium, especially in mice, the most sensitive species. Consequently, the MAC of 2.0 mg/L has been established to be protective of the general population, based on studies of kidney effects in mice.

2.3 Exposure

Canadians are primarily exposed to barium through food and drinking water, with food being the main source of exposure. Concentrations of barium in food items in Canada vary widely, depending on the food item and the soil conditions. Barium levels can also vary greatly in Canadian drinking water, depending on geological formations and anthropogenic activities surrounding the source water. Intake of barium from drinking water is not expected to occur through either skin contact or inhalation.

2.4 Analysis and treatment

Several analytical methods are available for the analysis of total barium in drinking water at levels well below the MAC. Total barium in a water sample includes both its dissolved and particulate forms. Analysis of total barium is needed for comparison to the MAC.

Although conventional coagulation treatment is not effective for barium removal, there are several effective methods for its removal from municipal drinking water supplies. These include lime softening and ion exchange softening. Both technologies reduce water hardness and other divalent metals such as barium, achieving multiple objectives. Membrane separation processes such as reverse osmosis and nanofiltration are also capable of removing barium in drinking water. Other control strategies include switching to a new source, blending, and interconnecting with another water system.

At the residential level, there are certified residential treatment devices for removing barium from drinking water using reverse osmosis and ion exchange technologies. Distillation systems are also effective but none are certified. It is important to note that reverse osmosis and distillation systems should be installed only at the point of use, as the treated water may be corrosive to internal plumbing components.

2.5 International considerations

Drinking water quality guidelines, standards and/or guidance from other national and international organizations may vary due to the science available at the time of assessment, as well as differing policies and approaches, including the choice of key study, and the use of different consumption rates, body weights and allocation factors.

Other organizations have set guidelines or regulations pertaining to the concentration of barium in drinking water. The World Health Organization established a guideline for drinking-water quality of 1.3 mg/L for barium. The United States Environmental Protection Agency's standard and the guideline established by the Australia National Health and Medical Research Council are both set at 2.0 mg/L. The European Union has not established a limit for barium in drinking water.

3.0 Application of the guideline

Note: Specific guidance related to the implementation of drinking water guidelines should be obtained from the appropriate drinking water authority in the affected jurisdiction.

All water utilities should implement a risk management approach such as the source-to-tap or water safety plan approach to ensure water safety. These approaches require a system assessment to: characterize the source water; describe the treatment barriers that prevent or reduce contamination; identify the conditions that can result in contamination; and implement control measures. Operational monitoring is then established and operational/management protocols are instituted (e.g., standard operating procedures, corrective actions and incident responses). Compliance monitoring is determined and other protocols to validate the water safety plan are implemented (e.g., record keeping, consumer satisfaction). Operator training is also required to ensure the effectiveness of the water safety plan at all times.

3.1 Monitoring

3.1.1 Source characterization

Source water should be characterized to determine if barium is present. If the barium concentration is approaching the MAC and/or the concentration is known to be or expected to be changing with time (e.g., anthropogenic activities are introduced), monitoring of the source water should be conducted annually. Authorities may consider reduced monitoring when there is sufficient data demonstrating that barium is present at concentrations below the MAC in the source water and/or appropriate treatment is in place. Utilities practising control options that involve a new, blended, or interconnected source of water for addressing the barium concentration should assess the water quality of new sources and blended water to ensure that it does not interfere with the existing treatment processes, impact the distribution system, and/or cause other water quality issues.

3.1.2 Operational monitoring

Where treatment is required to remove barium, operational monitoring should be implemented to confirm whether the treatment process is functioning as required. The frequency of operational monitoring will depend on the treatment process.

Utilities using lime softening for barium removal should conduct operational monitoring of pH. Utilities using ion exchange water softening (i.e., a strong-acid cation exchange resin in sodium form) for hardness and barium removal in their source water should monitor for hardness breakthrough in each ion exchange vessel to identify the timing for resin regeneration and achieve effective barium removal. An operational consideration when using strong-acid cation resins in hydrogen form includes chromatographic peaking. Since barium and calcium are the cations most preferred by these ion exchange resins, chromatographic peaking may be observed for ions such as sodium and magnesium in the treated water. The hydrogen form of strong-acid cation and weak-acid cation exchange resins must be followed by a carbon dioxide stripping process and a pH or alkalinity adjustment step to reduce the corrosivity of the treated water. Utilities using strong-acid cation exchange resins in sodium form should be aware that this process may introduce undesirable quantities of sodium into the treated water.

Reverse osmosis, ion exchange and electrodialysis/electrodialysis reversal are often operated with a bypass blending of a portion of the influent (incoming) flow with the treated water to obtain the desired water quality. It is important to monitor blended treated water to determine final barium concentrations when this control option is used.

3.1.3 Compliance monitoring

When treatment is in place for barium reduction (including control options), it is recommended that compliance monitoring be conducted annually, at minimum, to confirm that the MAC is not exceeded. Samples should be collected after treatment prior to distribution (typically at the entry point to the distribution system). Paired samples of source and treated water should be taken to confirm the efficacy of the treatment or control option.

3.1.4 Distribution system

Like other inorganics, barium may accumulate in distribution systems and be intermittently released. Consequently, monitoring should also be conducted throughout the distribution system when barium is or was historically present in the source water. Since the stability of metals accumulated in distribution system piping scales is unpredictable, it is difficult to establish a monitoring program for barium in distribution systems. The number and location of barium monitoring sites in the distribution system should take into consideration the site-specific accumulation and release risk factors. Factors that influence barium accumulation (i.e., manganese deposits, iron corrosion products and phosphate precipitates) and remobilization (i.e., changes to water chemistry and physical/hydraulic disturbances in the distribution system) could be used as indicators of when and where to monitor for barium releases.

When water quality changes or physical disruptions occur in the system, the release of barium and other contaminants may be indicated by the presence of discoloured water or increased turbidity resulting from the release of deposits or scales present on the pipe wall. When this occurs, monitoring for barium and other contaminants should be conducted.

However, the absence of discoloured water should not be interpreted as the absence of metal release. Monitoring for barium should be done in conjunction with other metals that can co-occur in the distribution system (e.g., iron, manganese, arsenic, lead).

3.1.5 Private wells

Homeowners with private wells are encouraged to have their water tested for barium to ensure that the concentration in their water supply is below the MAC. Homeowners with private wells using residential treatment devices should conduct routine testing on both the water entering the treatment device and the treated water to verify that the treatment device is effective.

Homeowners using ion exchange softeners should be aware that the treatment unit may introduce undesirable quantities of sodium into the treated water.

Part II. Science and Technical Considerations

4.0 Identity, use and sources in the environment

Barium (Ba; CAS Registry No. 7440-39-3) is a soft, silvery white element. It is a divalent cation and belongs to the Group IIA (alkaline-earth metal) of the periodic table of elements. It has a specific gravity of 3.6 at 25°C, a melting point of 727°C and a boiling point of 1897°C (CRC, 2017). Barium is widely distributed across the earth's crust (0.04%) with an average concentration of 10–425 mg/kg, and ranks 16th in abundance amongst non-gaseous elements (Taylor, 1964; Schroeder et al., 1972). Coal can contain barium in concentrations of up to 3,000 mg/kg (WHO, 2001; ATSDR, 2007). Naturally occurring barium is a combination of seven stable isotopes. However, more than 20 isotopes have been identified, most of them being highly radioactive and with half-lives ranging from several milliseconds to several minutes (WHO, 1990; Boffito, 1991; U.S. EPA, 2005). Only non-radiological forms of barium will be assessed in this document.

Barium does not occur in its elemental form in nature; it occurs as a divalent cation associated with other elements and is mostly found in igneous, sedimentary and metamorphic rocks (Boffito, 1991). Common barium compounds include barium sulphate (barite), barium carbonate (witherite), barium chloride, barium hydroxide, barium oxide, and barium sulphide. Barium reacts with water to form barium hydroxide. Water-soluble barium compounds include salts of acetate, hydroxide, silicate, chlorate, nitrate, thiocyanate, cyanide, oxide and halides (excluding fluoride); salts of arsenate, carbonate, citrate, fluoride, oxalate, and tartrate are only slightly soluble in water but are soluble in acids. Barium chromate and phosphate are insoluble in water but are soluble in acids, whereas barium sulphate is insoluble in water and is only slightly soluble in acids. All barium salts, excluding sulphate, show increasing solubility with decreasing pH (WHO, 1990). Table 1 provides the physicochemical properties of common barium compounds.

Table 1: Physicochemical properties of barium compounds (adapted from CCME, 2013)

Substance	Chemical formula	Physical description	Molecular weight (g/mol)	Vapour pressure (mm Hg)[a]	Solubility (g/100 g water)
Barium	Ba	Silvery yellow metal (cubic)	137	6.65×10^{-4} at 630°C	Reacts with water
Barium carbonate	$BaCO_3$	White orthorhombic crystals	197.34	Essentially zero	0.0014 at 20°C
Barium chloride	$BaCl_2$	White orthorhombic crystals; hygroscopic	208.3	Essentially zero	37.0 at 25°C
Barium sulphate	$BaSO_4$	White orthorhombic crystals	233.39	No data	0.00031 at 20°C
Barium hydroxide	$Ba(OH)_2$	White powder	171.34	0 at 15°C	4.91 at 25°C
Barium oxide	BaO	White, yellowish powder; cubic and hexagonal	153.33	Essentially zero	1.5 at 20°C

Substance	Chemical formula	Physical description	Molecular weight (g/mol)	Vapour pressure (mm Hg)[a]	Solubility (g/100 g water)
Barium sulphide	BaS	Colourless cubic crystals or gray powder	169.39	No data	8.94 at 25°C

[a] Data from ATSDR (2007)

The main use of barium (as barite) is as a drilling fluid additive to increase fluid density (hydrostatic pressure) in applications such as oil and gas exploration; this represents 85% of the global use. Barite is also used as a contrast agent to improve the visibility of certain organs in X-ray diagnostic tests; in the chemical sector it is used in plastic and rubber products, paints, glass, carpets, ceramics, sealants, furniture, cement vessels, superconducting films, and nuclear reactors (Dumont, 2007; CCME, 2013). Barium nitrate is used in the manufacturing of pyrotechnics. Barium chloride is used in the production of sodium hydroxide, aluminum alloys, pigments and textiles, and in the treatment of boiler water (Dibello et al., 2003). Barium is also used in some pesticide applications, such as barium metaborate (used as a microbiocide/ microbiostat in paints, paper/paper products, industrial adhesives and coatings), and barium carbonate is used as a rodenticide (U.S. EPA, 1993; ATSDR, 2007).

Barite and witherite are two commercial barium compounds widespread throughout Canada, with more than 150 deposits identified and four main orebodies (Giant Mascot and Mineral King in BC; Buchans in NL; and Walton in NS) (CCME, 2013). Small deposits of witherite have been found in Thunder Bay (Dumont, 2007). In 2007, Canadian production of barite and witherite was estimated to be 7,196 tonnes, while 68,971 tonnes were used in Canada (Dumont, 2007).

4.1 Environmental fate

Barium is naturally present in metamorphic, igneous and sedimentary rocks at a wide range of concentrations; however, anthropogenic activities (such as the dispersal of barium-rich fertilizers and insecticides, drilling mud, and shale gas development) can also increase its concentration. Sulphates and carbonates precipitate barium in the soil, and metal oxides and hydroxides also favour its adsorption onto soil particles. The mobility of barium in soil is generally low, given that it adsorbs easily to clay minerals and organic matter; it tends to form insoluble salts and not soluble humic complexes. Under acidic, anaerobic and high chloride/low sulphate conditions, as well as conditions of reduced reduction–oxidation potential, barium mobility is increased, favouring its migration to groundwater (Kravchenko et al., 2014).

The release of barium into the air can result from electric power generation, heating plant operation, gasoline combustion, metal smelting and kiln operation in cement plants, as well as from mining and refuse incineration (CCME, 2013). Point sources of barium include effluents and cuttings from oil drilling sites, since barite is often used as a main constituent in drilling mud suspensions (Breuer et al., 2004). Barium in the air is associated with particulate matter and mainly occurs in insoluble forms (e.g., sulphate) (Kravchenko et al., 2014).

Naturally occurring barium can be found in igneous, metamorphic and sedimentary rocks. Leaching and eroding of barium from sedimentary rocks can be a substantial source of barium in surface and groundwater; the barium concentrations are determined by dissolved ion concentrations (mainly sulphate and carbonate) and by adsorption of barium ions onto suspended particulate matter, clay, metal oxides, and hydroxides (Taylor, 1964; WHO, 2001; Colbert and McManus, 2005; CCME, 2013). The formation of barium sulphate leads to its precipitation (CCME, 2013). As pH decreases, the sulphur species present in water will be reduced to lower oxidation states, increasing the water solubility of barium compounds, with barium sulphate ($BaSO_4$) and carbonate ($BaCO_3$) being more dependent on pH than barium chloride ($BaCl_2$) (ATSDR, 2007; Kravchenko et al., 2014). The presence of chloride and other anions such as nitrate (NO_3) and carbonate (CO^{2-}) generally increases the solubility of barium sulphate, and when present in water with a pH less than 9.3, 98% of barium will be found as the free divalent cation (Ba^{2+}), while less than 2% will be present as other chemical species, including $BaB(OH)^{4+}$, $BaCl^+$, $BaCO_3$, $BaNO^{3+}$ and $BaOH^+$ (Venugopal and Luckey, 1978; ATSDR, 2007; Tudorache et al., 2010; CCME, 2013). In water with a pH greater than 9.3, the dominant species of barium is $BaCO_3$, limiting its solubility (ATSDR, 2007). Substantial quantities of barium can be released due to IX reactions or oxide dissolution surrounding deep submarine springs (Charette and Sholkovitz, 2006; Moore, 2010). Barium and barium sulphide (BaS) may be solubilized from barite during anaerobic respiration by sulphate-reducing bacteria (Baldi et al., 1996).

5.0 Exposure

Food and drinking water represent the main sources of exposure to barium for the general population; however, the available data indicate that contributions from these sources can be highly variable. In drinking water, barium content can also vary greatly, depending on the geological formations and the anthropogenic activities surrounding the source water. Exposure from air, consumer products or soil is expected to be negligible. The available exposure data reported below suggest that food represents the main source of exposure to barium and drinking water represents a significant, but lesser, source.

5.1 Water

In Prince Edward Island, 14 236 samples from private drilled wells and municipal wells using the same aquifer were analyzed for barium over a 7-year period (June 2010 to February 2017) (PEI Department of Communities, Land and Environment, 2017). Of 14,236 samples, 1,006 were equal to or less than the detection limit (DL) of either 10 µg/L or 2 µg/L, depending on when the samples were taken; the mean concentration of barium was 290 µg/L, the median was 17 µg/L and the maximum level detected was 5,452 µg/L.

In Newfoundland and Labrador, barium levels in 483 public drinking water systems were reported from 2012 through 2016 using a DL of 1 µg/L (Newfoundland and Labrador Department of Environment and Conservation, 2017). For raw surface water, 169 out of 762 samples were below the DL, as were 25 out of 101 samples from raw groundwater. Raw surface water had a mean level of 20 µg/L, a median of 10 µg/L and a maximum of 130 µg/L; raw groundwater had a mean and median level of 90 µg/L and a maximum of 560 µg/L. In treated surface water,
2,590 out of 3,259 samples were below the DL; the mean was 20 µg/L, the median was 10 µg/L and the maximum level observed was 140 µg/L. In treated groundwater, 567 out of 1,683 samples were below the DL; the mean was 90 µg/L, the median was 60 µg/L and the maximum level detected was 700 µg/L.

In New Brunswick, barium in drinking water was measured in 231 Crown (groundwater wells only) and 476 municipal water supply systems (ground and surface water) between 2007 and 2017 using a DL of 10 µg/L (New Brunswick Department of Health, 2017). In the Crown systems, 364 out of 1,544 samples were below the DL. In treated groundwater, the mean level found was 111 µg/L, the median was 54 µg/L and the maximum was 1,300 µg/L. In raw groundwater, the mean level was 52 µg/L, the median was 53 µg/L and the maximum was 301 µg/L. In municipal systems, 590 out of 4,203 samples were below the DL. In the municipal water distribution systems, the mean level observed was 70 µg/L, the median was 25 µg/L and the maximum was 3,330 µg/L. In municipal raw water, the mean level found was 120 µg/L, the median was 65 µg/L and the maximum was 986 µg/L. In municipal surface water sources, the mean was 28 µg/L, the median was 15 µg/L and the maximum was 746 µg/L; for groundwater sources, the mean was 126 µg/L, the median was 76 µg/L and the maximum was 986 µg/L.

In Quebec, 11,889 samples of treated drinking water were taken from 3,178 distribution systems between 2013 and 2016 (Ministère de l'Environnement et de la Lutte contre les changements climatiques, 2017). There were 3,843 samples below the DL of 0.2–50 µg/L (32%); the mean level observed was 69 µg/L, the median was 20 µg/L and the maximum was 11,000 µg/L. As part of a long-term groundwater survey, more than 1,719 barium analyses were conducted between 1971 and 2014 in various regions of Quebec; these barium data are from various research projects with varying analytical methodologies. From a total of 1,490 observation wells, individual wells and drinking water facilities, the mean barium level observed was 153 µg/L and the maximum concentration was 10,000 µg/L.

The Ambient Groundwater Geochemistry project characterizes the chemical state of groundwater for southern Ontario (an area of 96,000 km^2), with about 2,300 samples taken between 2007 and 2014 (Hamilton, 2015). There were 40 out of 2,255 samples below the DL of 0.1 µg/L (1.8%); the mean level was 128 µg/L, the median was 64.5 µg/L and the maximum was 4,940 µg/L.

In Manitoba, from 2009 to 2017, 1,478 raw and 1,722 treated water samples were analyzed for total barium using a DL of 0.3 µg/L (Manitoba, 2017). For raw water, the mean level found was 70 µg/L, the median was 30 µg/L and the maximum was 2,473 µg/L; for treated water (which includes distribution system data), the mean was 50 µg/L, the median was 20 µg/L and the maximum was 2,170 µg/L. Manitoba surface waters are monitored through a series of monitoring programs, such as the Long-term Water Quality Monitoring Program, the Lake Winnipeg Monitoring Program and the Coordinated Aquatic Monitoring Program. Between 2006 and 2017, the mean and median total barium concentrations in surface waters were 52 µg/L and 43 µg/L, respectively, with a maximum value of 1,720 µg/L; only one sample out of 6,777 samples was below the DL of 0.2 µg/L. In northern Manitoba lakes and rivers, an average concentration of less than 10 µg/L (range of 4.6 to 8.7 µg/L; n = 5) has been reported (CCME, 2013).

In Saskatchewan, total drinking water barium levels were reported for 2007–2017 using a DL of 0.1–0.5 µg/L (Saskatchewan Water Security Agency, 2017). Groundwater (raw) (n = 1243) had a mean level of 51 µg/L, a median of 14 µg/L and a maximum of 1,210 µg/L. Surface water (raw) (n = 451) had a mean concentration of 51 µg/L, a median of 46 µg/L and a maximum of 920 µg/L. Treated water (n = 223) had a mean of 78.3 µg/L, a median of 64 µg/L and a maximum of 1,440 µg/L.

An average concentration of 91 µg/L was reported for five river basins in Alberta (range of 7 to 389 µg/L; n = 748) (CCME, 2013).

In Yukon, levels of barium in drinking water were reported for samples taken from 2009 to 2017 (Yukon Environmental Health Services, 2017). Overall, the mean level observed was 59 µg/L, the median was 27 µg/L and the maximum was 819 µg/L; 29 out of 315 samples were below the DL of 0.1–25 µg/L. The mean and median levels, respectively, were 95 µg/L and 80 µg/L for raw water; for groundwater, these levels were 50 µg/L and 25 µg/L. The mean concentration observed was 57 µg/L in treated water (n = 30) and 26 µg/L in surface water (n = 5).

As part of the National Survey of Disinfection By-Products and Selected Emerging Contaminants, Health Canada collected drinking water at three points throughout the distribution systems from 65 sites across Canada during the 2009 and 2010 summer and winter months (DL = 5 µg/L) (Health Canada, 2016). In raw surface water samples (n = 89), barium had a mean concentration of 27 µg/L, a median of 19 µg/L and a maximum of 120 µg/L. In treated surface water (n = 70), barium had a mean concentration of 24 µg/L, a median of 16 µg/L and a maximum of 120 µg/L. In raw well water samples (n = 35), the mean concentration of barium was 103 µg/L, the median was 52 µg/L and the maximum was 500 µg/L. In treated well water (n = 27), barium had a mean concentration of 105 µg/L, a median of 80 µg/L and a maximum of 510 µg/L.

Between 2000 and 2016, Environment Canada collected freshwater quality data from over 200 federal and federal–provincial sampling sites at various locations and sampling frequencies throughout Canada's aquatic ecosystems (ECCC, 2017). For total barium, all 18,985 samples were above the DL of 0.02–1 µg/L; the mean level observed was 40.1 µg/L, the median was 25.3 µg/L and the maximum was 1,900 µg/L.

The Canadian Total Diet Study (CTDS) is a Health Canada initiative that measures the concentrations of different chemicals in foods and uses these data to estimate dietary exposures for different age–sex groups of the Canadian population (Health Canada, 2012b). In this study barium concentrations were measured in the tap water of nine cities between 2000 and 2012. In St. John’s the mean level observed was <3.6–57 µg/L, in Halifax it was 5.9–73 µg/L, in Quebec City 21–61 µg/L, in Montreal 15–247 µg/L, in Toronto <1–14 µg/L, in Ottawa 13–42 µg/L, in Winnipeg 1.2–14 µg/L, in Calgary 31–46 µg/L, and in Vancouver <11–62 µg/L.

From the Canadian Provincial/Territorial monitoring data reported above, as well as data from the National Survey of Disinfection By-Products and Selected Emerging Contaminants, an average of approximately 88 µg/L can be derived using the mean levels for treated drinking water; using an adult body weight of 74 kg and a drinking water consumption rate of 1.53 L/day (Health Canada, 2019), an estimated intake of 2 µg/kg bw per day (rounded) for barium from drinking water can be calculated for adults in the general Canadian population.

5.2 Food

Diet is estimated to be the primary route of barium exposure for the general Canadian population. The average dietary exposures to barium in Canada have been assessed through the CTDS (Health Canada, 2012a). Based on the CTDS data collected between 1993 and 2010 from nine Canadian cities (St. John’s, Halifax, Montreal, Ottawa, Toronto, Winnipeg, Calgary,Vancouver, and Whitehorse), the average dietary exposures to barium expressed on a body weight basis were estimated to be 12.4–27.7 µg/kg bw per day for infants aged 0–6 months, 16.6–26.6 µg/kg bw per day for children 7 months to 4 years old, 14.5–19.9 µg/kg bw per day for 5- to 11-year-olds, 9–12.4 µg/kg bw per day for 12- to 19-year-olds, and 5.1–10.1 µg/kg bw per day for persons aged 20 and above.

Based on the 1993–2012 CTDS data, average barium concentrations in common food items varied between the different years and cities in Canada. Sources of dietary exposure include food commodities such as grain-based products, fruits, vegetables, nuts, and herbs and spices (Health Canada, 2012b). Average barium concentrations from the CTDS were 19–5,403 µg/kg in grain-based products, 15–3,169 µg/kg in fruits, 3–4,023 µg/kg in vegetables, 1,755–5,033 µg/kg in nuts, and 20,750–38,172 µg/kg in herbs and spices. Average barium concentrations in infant milk and soy formulas ranged from16 µg/L to 216 µg/L. The Canadian Council of Ministers of the Environment (CCME) estimated the average barium concentrations in human breast milk to be 3.61 µg/L, based on an average of barium concentrations from six international studies (Canadian, Austrian, Italian, and Emirati) (CCME, 2013). Environment and Climate Change Canada (ECCC) (2016) reported average and 95th percentile intakes of 0.21 µg/kg bw per day and 0.24 µg/kg bw per day, respectively, for infants, based on concentrations in breast milk from 2001 Canadian mothers measured between 2008 and 2011 as part of the core Maternal–Infant Research on Environmental Chemicals (MIREC) study.

5.3 Air

In air, barium is associated with dust and suspended particulates. Barium occurs mainly as the sulphate or carbonate form and possibly as other insoluble forms (WHO, 1990; ATSDR, 2007). Data from the National Air Pollution Surveillance (NAPS) Program suggest that much of the barium in ambient air is bound to the coarse fraction of particulate matter (PM) (2.5–10 µm) (CCME, 2013). NAPS collects data on more than 300 ambient air pollutants across Canada (Environment Canada, 2013). For fine particulates ($PM_{2.5}$), the mean concentration was 7 ng/m^3, the median was 4 ng/m^3, and the maximum was 58 ng/m^3 (n = 157). For coarse particulates (PM_{10}), the mean was 9 ng/m^3, the median 6 ng/m^3, and the maximum was 50 ng/m^3 (n = 1,735). A mean of 2.7 ng/m^3 was reported for the background concentration in indoor air in Canada based on two small monitoring studies (two Canadian homes in Alberta and one American retirement facility; standard deviation (SD) = 4.2, n = 40 samples) (CCME, 2013). In a Science Approach Document (SciAD) by ECCC (2016), median barium levels in 1,025 household dust samples were reported as 277 µg/g (95th percentile, 528 µg/g); median barium levels for outdoor and indoor air associated with $PM_{2.5}$ were reported as 0.94 ng/m^3 (range, 0.04–18.89 ng/m^3; n = 910) and 1.06 ng/m^3 (95th percentile, 4.71 ng/m^3), respectively (Environment Canada, 2011; Rasmussen et al., 2016).

5.4 Consumer products

Barite is licensed in different oral natural health products in Canada and as a radiological contrast media for opacification of the gastrointestinal tract; however, the compound is insoluble and absorption is considered minimal (Health Canada, 2017). Skin products, cosmetics and tattoo inks can also contain barium (CCME, 2013; New Zealand Ministry of Health, 2013). However, daily intakes from these products were not estimated, as there are no available data on the proportion of the general population using these items, and absorption through the skin is considered negligible, based on the physicochemical properties of the element.

5.5 Soil

Soil concentrations of barium vary widely, depending on geological formations and anthropogenic inputs ranging from 15 to 3,000 mg/kg (up to 37,000 mg/kg near barite deposits). The Geological Survey of Canada reported a mean concentration in Canadian soil of 140 mg/kg (SD = 120; n = 7,397) (CCME, 2013). Moreover, a mean concentration of barium in indoor dust was estimated at 305.3 mg/kg (SD = 311.3; n = 165) based on the Ottawa residential study of Rasmussen et al. (2001).

5.6 Biomonitoring data

The most common biological matrix used as an indicator of barium exposure in biomonitoring studies is urine. In the U.S., the National Health and Nutrition Examination Survey (NHANES) III (1988–1994) as well as seven consecutive cycles of the Centers for Disease Control (CDC)-NHANES (up to 2012) provide data on urinary barium concentrations (normalized to creatinine concentrations) based on a representative sample of the U.S. population of all ages (n = 2,502 during the 2011–2012 cycle) (Paschal et al., 1998; CDC, 2015). Generally, urinary barium concentrations have remained relatively stable over the years, with children (aged 6–11) having significantly higher urinary barium levels (median, 2.18 µg/g creatinine (95% confidence interval (CI) = 1.70–2.61) than adolescents (aged 12–19; median, 1.42 µg/g creatinine (95% CI = 1.24–1.78) and adults (aged ≥20; median, 1.31 µg/g creatinine (95% CI = 1.20–1.43). In the 2011–2012 cycle, females had a significantly higher median urinary barium concentration than males, at 1.51 versus 1.17 mg/g creatinine, respectively; however, this difference was not found to be statistically significant at the 95th percentile level. Similarly, a German study by Heitland and Koster (2006) reported mean urinary barium levels of 1.2 µg/g creatinine for 72 children (aged 2–17) and 1.3 µg/g creatinine for 87 adults (aged 18–65) and a French study by Goullé et al. (2005) reported a median of 0.89 mg/L (corrected for creatinine enzymatic determination) in the urine of 100 healthy adults.

5.7 Multi-route exposure through drinking water

Barium can be absorbed via the inhalation route; however, exposure to barium vapours while showering or bathing is not expected to occur, since barium is not volatile (vapour pressure is close to null). Dermal absorption of barium during showering and bathing is considered negligible, since the skin permeability constant is 1×10^{-3} cm/h (U.S. EPA, 2004), indicating that the dermal route of exposure would contribute less than 10% of the drinking water consumption level (Krishnan and Carrier, 2008). Hence, the inhalation and dermal routes during showering and bathing are unlikely to contribute significantly to the total exposure.

6.0 Analytical methods

6.1 Standardized methods

Standardized methods available for the analysis of total barium in drinking water and their respective method detection limits (MDL) are summarized in Table 2. MDLs are dependent on the sample matrix, instrumentation, and selected operating conditions and will vary between individual laboratories. Analysis of barium should be carried out as directed by the responsible drinking water authority. Water utilities should discuss sampling requirements with the accredited laboratory conducting the analysis to ensure that quality control procedures are met and that method reporting limits (MRLs) are low enough to ensure accurate monitoring at concentrations below the MAC.

Table 2: Approved analytical methods for the analysis of barium in drinking water

Method (Reference)	Methodology	MDL (µg/L)	Interferences/Comments
EPA 200.5 Rev. 4.2 (U.S. EPA, 2003)	Axially viewed inductively coupled atomic emission spectrometry (AVICP-AES)	0.05	Subject to spectral, physical, chemical and memory interferences. Matrix interferences: Ca, Mg and Na >125 mg/L and Si >250 mg/L
EPA 200.7 Rev. 4.4 and SM 3120B (U.S. EPA, 1994a; APHA et al., 2017)	Inductively coupled plasma-atomic emission spectrometry (ICP-AES)	1.0	Subject to spectral, physical, chemical and memory interferences. Matrix interferences: TDS>0.2% (w/v) for EPA 200.7 and TDS>1500 mg/L for SM 3120B
EPA 200.8 Rev. 5.4 (U.S. EPA, 1994b)	Inductively coupled plasma-mass spectrometry (ICP-MS)	0.04[a] –0.8[b]	Subject to isobaric elemental and polyatomic ion interferences, and physical. Matrix interferences: TDS>0.2% (w/v)
SM 3111D (APHA et al., 2017)	Flame atomic absorption spectrometry	30.0	Subject to several interferences; primarily chemical interference (lack of adsorption by atoms). To prevent barium ionization Na^+, K^+ and Li^+ cations are added in excess.
SM 3113B (APHA et al., 2017)	Electrothermal atomic absorption spectrometry	2.0	Subject to molecular absorption, chemical and matrix interferences.

[a]MDL in selective ion monitoring mode; [b]MDL in scanning mode

The current U.S. EPA practical quantitation limit (PQL) for barium is 0.15 mg/L (U.S. EPA, 2009). A number of accredited laboratories in Canada were contacted to determine what reporting limits (RLs) are achievable for barium analysis. The RLs generally ranged from 0.0001 mg/L (0.1 µg/L) to 0.1 mg/L (1.0 µg/L) using ICP-MS; however, one laboratory reported a RL of 0.2 mg/L (200 µg/L) using ICP-OES (CEAEQ, 2018; AGAT Laboratories, 2019; ALS Environmental, 2019; Maxxam Analytics, 2019).

6.2 Sample preservation and preparation

Generally, operational considerations for analysis of barium in drinking water (i.e., sample preservation, storage) can be found in the references listed in Table 2 above. Accurate quantification of dissolved, particulate (suspended) and total barium in samples is dependent on proper sample preservation and preparation steps. The SM 3030B method provides guidance on filtration and preservation procedures for determining dissolved or particulate metals (APHA et al., 2012). To determine dissolved barium concentrations, samples should be filtered (0.45 µm pore diameter) at the time of collection using preconditioned plastic filtering devices under either vacuum or pressure. The filtrate should be acidified to pH <2 with concentrated nitric acid. To determine particulate barium, the filter should be retained and the particulate material on it digested in the laboratory using appropriate methods (APHA et al., 2012).

Currently, EPA methods 200.7 and 200.8 and SM 3111D, SM 3113B, SM 3120B do not require hot acid digestion for total recoverable metals unless the turbidity of the sample is greater than 1 nephelometric turbidity unit (NTU). Digestion for EPA methods is performed by transferring an aliquot of the sample into a solution of nitric acid and hydrochloric acid followed by gentle heating to a temperature of approximately 85°C (i.e., hot digestion) (U.S. EPA, 1994a, 1994b). Microwave-assisted digestion (SM 3030 K) is recommended for analyzing total recoverable metals using SM methods that are based on ICP-MS. Although some of the methods in Table 2 do not require hot acid digestion unless turbidity is greater than 1 NTU, research conducted on other metals, such as lead and chromium, has indicated that this does not accurately quantify the total metal concentration in a sample. As such, the current protocol may underestimate total barium in drinking water when particulate barium is present. For example, analytical requirements under UCMR 3 include solubilizing the acid-preserved sample by gentle heating using nitric acid, regardless of the sample turbidity or the method used (U.S. EPA, 2012a).

7.0 Treatment technology and distribution system considerations

7.1 Barium in water

In aqueous environments, barium typically exists in divalent form as Ba^{2+}. Under certain conditions, barium may form mineral precipitates involving sulphate, carbonate or chromate (Friedman et al., 2010). In the presence of a sulphate (SO_4^{2-}) concentration of ≥2 mg/L and a pH level below 9.3, insoluble barite ($BaSO_4$) may precipitate and become the dominant barium species. Most water sources contain sufficient SO_4^{2-} concentration to precipitate $BaSO_4$, thus maintaining barium concentrations at low levels. In the presence of carbonate ions (CO_3^{2-}) and at a pH greater than 9.3, witherite ($BaCO_3$) exhibits fast precipitation kinetics and becomes the dominant species, limiting barium solubility (Rai et al., 1984; Snyder et al., 1986; McComish and Ong, 1988; ATSDR, 2007; Menzie et al., 2008). Barium ions form weak complexes with Cl^- OH^- and NO_3^- and the solubilities of these complexes are less dependent on pH than that of barite or witherite (Menzie et al., 2008; Tang and Johannesson, 2010; Kravchenko et al., 2014). Barium is not readily oxidized or reduced (Menzie et al., 2008; Groschen et al., 2009). Kravchenko et al. (2014) indicated that changes in the oxidation state do not directly affect barium solubility in natural water. However, the redox potential may impact the species of sulphur. For example, if the $SO_4^{2-}$is reduced to a lower oxidation state (e.g., H_2S), the depleted SO_4^{2-} concentration will result in an increase of barium solubility.

Due to the cationic nature of soluble barium species, barium may be associated with various solid matrices, such as metal oxides, clay and organic matter. A study found that barium may displace other sorbed alkaline earth metals from manganese dioxide (MnO_2), silicon dioxide (SiO_2) and titanium dioxide (TiO_2). However, these alkaline metals may displace barium from aluminium oxide (Al_2O_3) (Rai et al., 1984). Similarly to most cationic trace metals, the sorption properties of barium are enhanced at higher pH (Friedman et al., 2010).

7.2 Municipal scale treatment

Limited data exist on the removal of naturally occurring barium in drinking water. The U.S. EPA (1998) lists lime softening, ion exchange (IX), reverse osmosis (RO) and electrodialysis/electrodialysis reversal (ED/EDR) as the most effective treatment processes for removing barium from drinking water.

Conventional coagulation/filtration techniques showed low barium removal from drinking water (up to 30%). Two-stage coagulation processes may achieve greater effectiveness (approximately 80% removal) than conventional coagulation; however, they are not common practice in Canada (Sorg and Logsdon, 1980; Lovins et al., 1999).

Chemical behaviour of barium is very similar to that of calcium and magnesium, principal components of water hardness. Therefore, processes used for hardness reduction in drinking water, such as chemical precipitation and ion exchanges softening, have been reported effective for barium removal and can make the treatment of barium more cost effective (Snoeyink et al., 1984). Chemical precipitation is often used at existing conventional treatment facilities, achieving multiple objectives (hardness removal and divalent metals such as barium) (Parks and Edwards, 2006). Early pilot- and full-scale lime softening studies reported up to 95% barium removal in drinking water at a pH range of 10.0–10.5. Dissolved barium is precipitated as barium carbonate, a mechanism that occurs for calcium removal during treatment of hard water (Sorg and Logsdon, 1980).

One of the most effective technologies for reducing barium concentration in drinking water is based on IX softening. Ion exchange softening is an effective method for hardness removal for small systems and in the point-of-entry treatment devices. Limited full-scale dataand a number of comprehensive bench-scale studies indicated that strong-acid cation (SAC) and weak-acid cation (WAC) exchange resins remove 95–97% of barium to achieve a treated water concentration of below 1.0 mg/L (Kojola et al., 1978; Snoeyink et al., 1984, 1987a, 1987b;Myers et al., 1985; Snyder et al., 1986).

High-pressure membrane separation processes such as RO and nanofiltration (NF) are proven technologies for hardness removal from drinking water and are therefore expected to be efficient for barium removal. However, RO can be costly to install and operate due to the high pressure required and the extensive pre-treatment to preserve the membrane's life. ED/EDR is less commonly reported; however, it is also effective for barium removal from drinking water. Electrodialysis is typically applied for desalination of seawater and brackish water with a low turbidity (Sorg and Logsdon, 1980; Krause and Stover, 1982).

The selection and effectiveness of each treatment strategy are driven by several factors, including source water chemistry, the concentration of barium, pre-existing treatment processes, operational conditions of a specific treatment method, the utility's treatment goals, and residual handling concerns and costs. Careful selection of the appropriate technology for a specific application is important, as the performance of each treatment technology is impacted by the specific chemical quality of the water being treated.

Where applicable, the appropriate authorities should be consulted to ensure that the disposal of liquid and solid waste residuals from the treatment of drinking water meet applicable regulations.

7.2.1 Control options

Typical control options for reducing excess barium levels in drinking water include switching to a new source, blending, and interconnecting with and/or purchasing water from another water system (Willey, 1987; U.S. EPA, 2012b). Attention must be given to the water quality of a new source prior to making any changes to an existing supply. Characterization of the water quality must be carried out to ensure that changes in water quality resulting from control options are assessed and that potential impacts on the existing treatment processes and distribution system are determined. For example, if the new water source is more aggressive, it may cause leaching of lead or copper in the distribution system. Any change in water quality should not result in other compliance issues. The disinfectant type (chlorine or chloramine) should be the same when blending two different water sources, to avoid water quality and disinfection issues.

Switching to another source may involve drilling a new well in an aquifer containing low barium levels, sealing off water-producing zones containing high barium levels, or finding an uncontaminated surface water source. Switching to another source may also be limited by the availability of new sources, existing water rights, and/or costs for transporting the new source water to the treatment plant.

Blending involves diluting the barium concentrations of a contaminated source with another source containing low or no barium. To minimize the piping required to carry the sources to a common mixing point, it would be ideal for the sources to be close to each other. Blending usually occurs in a storage tank or a common header, with resulting barium concentrations below the MAC. Corrosion issues should be considered when blending different water qualities.

When interconnecting with another water system, the recipient system must consider a number of factors, including whether there is a nearby water supply that meets the MAC for barium, whether this other system is willing to interconnect or consolidate and whether the interconnecting system can handle the increased demand resulting from additional customers. Costs are an additional consideration in the decision-making process for interconnection.

7.2.2 Conventional coagulation

Conventional coagulation with alum and iron salts provides low levels of barium removal (Krause and Stover, 1982). In a jar-test study, conventional coagulation has been shown to achieve an approximately 30% removal of total barium, reducing concentrations to approximately 5.0 mg/L from 7.0 to 8.5 mg/L in groundwater with either alum or ferric sulphate doses as high as 120.0 mg/L and a pH range of from 7.5 to 8.0 (Sorg and Logsdon, 1980). The test indicated that the formation of $BaSO_4$ was a very slow process and conventional coagulation was not an effective mechanism for barium removal. Due to the high solubility of barium hydroxide [$Ba(OH)_2$] and barium chloride ($BaCl_2$) the formation of these complexes was also reported to be an ineffective factor in the removal of barium by a conventional coagulation treatment (Sorg and Logsdon, 1980).

A two-stage coagulation process may achieve a more efficient removal of barium; however, it is not generally recommendable, since the second step is costly and requires additional space to store treated water between the two coagulation steps. In a bench-scale two-stage coagulation study, up to 80% of barium was removed, reducing approximately 8.0 mg/L barium in the feed water to less than 1.6 mg/L. The process used 100.0 mg/L of either alum or ferric sulphate and allowed for 1 h of sedimentation, followed by a second stage using 20.0 mg/L doses of coagulant and another 1 h of sedimentation (Sorg and Logsdon, 1980).

7.2.3 Chemical precipitation

A chemical precipitation process is commonly used in water treatment utilities to remove hardness and heavy metals such as iron and manganese, as well as barium, radium, cadmium, arsenic, lead, strontium and uranium. Chemical precipitation can also be used as a pretreatment or intermediate treatment in membrane systems to reduce the potential for scaling/fouling of membranes by mineral salts.

Lime softening is the most common application of chemical precipitation. During lime softening, dissolved barium is precipitated as $BaCO_3$, the same mechanism that occurs in calcium removal from hard water. Jar-test, pilot-scale and limited full-scale data indicated that barium was effectively removed from water and that the efficiency was pH dependent. Jar tests revealed that a barium concentration of 7.0–8.0 mg/L in groundwater was effectively reduced by lime softening. The removal was pH dependent and increased from 65% at pH 8.7 to a peak of 98% at pH 10.5 and then declined to 55% at pHs greater than 11.6. Barium and hardness removal curves follow the same trend except in a pH range of 10.6–11.4, when the hardness removal curve developed a sharp increase due to the magnesium removal. At a pH greater than 11.0, barium can become more soluble as barium hydroxide and therefore becomes more challenging to remove. Pilot- and full-scale treatment data have confirmed these trends with respect to the dependence of barium removal on pH. In pilot-scale tests, raw water barium concentrations of 12.6 mg/L, 10.1 mg/L and 10.4 mg/L were reduced to 2.0 mg/L, 0.7 mg/L and 1.6 mg/L in the filtered water at pH levels of 9.2, 10.5 and 11.6, respectively. The hardness reductions achieved were, respectively, from 214 mg/L to 109 mg/L, from 216 mg/L to 86 mg/L and from 209 mg/L to 42 mg/L. Grab samples from two full-scale lime softening plants operating at pH levels of 10.5 and 10.3 showed 88.0% and 95.3% barium removal, respectively. The source waters had average influent barium concentrations of 7.5 mg/L and 17.4 mg/L and average hardness of 272 mg/L and 246 mg/L as $CaCO_3$, respectively (Sorg and Logsdon, 1980).

Although it is not a conventional softening method, Parks and Edwards (2006) found that precipitative softening using sodium carbonate (Na_2CO_3) only was highly effective for barium removal. The primary objective of their study, which sampled 370 raw waters (⅔ groundwater, ⅓ surface water), was to survey the range of inorganic contaminant removals achieved by precipitative softening using Na_2CO_3. They reported that raising the pH of water samples to 10.3 using a fixed dose of Na_2CO_3 achieved an approximately 100% removal of barium from 145 raw water samples containing barium levels of 10–884 μg/L. Their findings suggest that further research should be done on softening water using Na_2CO_3 when requiring the removal of barium alone, rather than total hardness.

Since $BaSO_4$ is relatively insoluble in water under alkaline conditions, it may precipitate when a sulphate-containing compound, such as gypsum [calcium sulphate ($CaSO_4$)], is used as a precipitating chemical and sodium hydroxide is used for a pH adjustment (Krause and Stover, 1982). Krause and Stover (1982) reported on the effectiveness of a pilot-scale system using chemical precipitation followed by direct filtration. The system demonstrated that with an addition of 100 mg/L of $CaSO_4$ and 352 mg/L NaOH, a barium concentration of approximately 6.0 mg/L was reduced to 0.5 mg/L in the treated water at a pH of 11.0 (91.0% removal). The removal occurred at a filter hydraulic loading rate of 1.5 gpm/ft^2 (2.4 mm/s) with a filter head-loss of 27 in. (69 cm) after an 8-h run (end of the run). The precipitation process removed $BaSO_4$ along with calcium hardness in drinking water. Other chemicals (such as alum, calcium hydroxide and ferric sulphate) used for precipitation of barium were less effective. Since the sodium concentration in the finished water increases, due to pH adjustment with sodium hydroxide, the authors indicated that modification of the chemicals used for pH adjustment would be required. Although the authors tested the precipitation of $BaSO_4$ at a pH of 11, such a high pH is likely not necessary, based on several kinetic studies of $BaSO_4$ (Aoun et al., 1996; van Leeuwen et al., 1996; Kugler et al., 2015). In addition, the high chemical doses used would affect the cost and sludge production. Bench, pilot- and full-scale studies are needed on the precipitation of $BaSO_4$ from drinking water supplies.

7.2.4 Ion exchange

The most common application of IX in drinking water treatment is water softening. Extensive research has been conducted on the applicability of SAC and WAC exchange resins for the removal of scale-forming calcium (Ca^{2+}) and magnesium (Mg^{2+}) cations and, to lesser extent, of other alkaline earth metals (including Ba^{2+} and radium (Ra^{2+})) in drinking water (Sorg and Logsdon, 1980; Krause and Stover, 1982; Snoeyink et al., 1984, 1987a, 1987b; Myers et al., 1985; Snyder et al., 1986; Clifford, 1999; Elder and Budd, 2011). These types of IX resins come in different forms. SAC exchange resins in sodium (Na^+), hydrogen (H^+) and Ca^{2+} forms as well as WAC in H^+ form can be used for removing barium in drinking water.

Clifford et al. (2011) compared separation factors of a number of cations on SAC resins and produced an ion selectivity sequence for ten divalent cations. The sequence describes the selectivity order in which cations are preferred by SAC resins and suggests that during water softening Ba^{2+} cations are preferentially removed compared with Ca^{2+} and Mg^{2+} forms. The WAC resins exhibit the same selectivity sequence as SAC resins except that the H^+ ion is the most preferred cation (Clifford et al., 2011).

The application of ion exchange treatment generates liquid waste brine that requires handling and disposal; this should be taken into consideration by authorities when evaluating IX as a treatment option.

7.2.4.1 SAC resins in sodium and hydrogen forms

The SAC resins in Na^+ or H^+ forms exchange the Na^+ or H^+ cations for Ca^{2+}, Mg^{2+} and other cations such as Ba^{2+} in the water, either as carbonate hardness or noncarbonate hardness, in a pH range of 2–11. The pH and alkalinity of the water treated with SAC (Na^+) remained approximately unchanged throughout the production run. However, the SAC (H^+) resin is rarely used in water softening because it produces acidic and corrosive water (Clifford, 1999) requiring acid-resistant materials, CO_2 stripping and pH adjustment of the treated water (Snoeyink et al., 1984, 1987a, 1987b; Myers et al., 1985; Snyder et al., 1986).

Barium showed similar breakthrough curves for both SAC (Na^+) and SAC (H^+) resins; hardness showed similar trends as well (Snyder et al., 1986; Snoeyink et al., 1987a). One of the major operational considerations when using IX treatment, especially with SAC (H^+) resins, includes chromatographic peaking, whereby the less preferred ions (i.e., Na^+ and Mg^{2+}) are displaced by more preferred ions (Ba^{2+} and Ca^{2+}), causing the effluent of Na^+ and Mg^+ concentrations to be greater than the influent concentration (Snoeyink et al., 1987a; Clifford, 1999*)*. For conventional SAC (Na^+) softening, chromatographic peaking is not a major operational consideration if the treatment run is terminated at hardness breakthrough.

With resins such as SAC (Na^+) that have a strong affinity for barium, it may be difficult to remove barium from the exhausted resin. Barium accumulates on resin with repetitive exhaustion–regeneration cycles, and higher doses of regenerant are required to regain the resin's capacity. The regeneration curve of the SAC (H^+) resin regenerated using hydrochloric acid (HCl) follows the same trend as the regeneration curve of SAC (Na^+) conducted with sodium chloride (NaCl) regenerant. Although barium can be precipitated in the spent NaCl brine before disposal, the authors stated that this brine cannot be reused due to the depletion of Na^+ ions (Snoeyink et al., 1984, 1987a, 1987b; Myers et al., 1985). However, recent research has demonstrated that a spent brine can be reused (after barium removal) by adding NaCl to maintain the Na^+ concentration of the brine (Clifford et al., 2011).

An early study reported that two full-scale IX softening plants were capable of achieving a barium concentration of 1.0 mg/L in treated water (Sorg and Logsdon, 1980). Plant 1 had two IX beds operating in a parallel mode, which treated a groundwater barium concentration of 10.0 mg/L (hardness 218 mg/L as $CaCO_3$). Plant 2 had three parallel resin beds, which treated groundwater with a barium concentration of 19.0 mg/L (hardness 230 mg/L as $CaCO_3$). Samples were collected from raw and treated water through one treatment cycle for one IX bed from each treatment plant. The plant 1 treatment run was terminated before either hardness or barium achieved breakthrough. The plant 2 run was terminated beyond both hardness and barium breakthrough. The tested IX beds reduced the barium concentrations to 1.0 mg/L for 153 bed volumes (BVs) (7.14×10^5 L) and 100 BVs (7.87×10^5 L) for plants 1 and 2, respectively. Plant 1 achieved 94–99% barium removal and 95–99% hardness removal. However, plant 2 reduced hardness and barium concentration to 142 mg/L and 5.8 mg/L, respectively, when the process was terminated. Both treatment plants practised blending of a portion of the raw water with the treated water to increase the hardness and to stabilize the distributed water. Since the blended waters had barium concentrations of 1.5–4.5 mg/L for both treatment plants, the authors concluded that blending was not a feasible practice at these two locations because the high influent barium concentrations at both locations would increase barium levels above the treatment goal of 1.0 mg/L even if only a small portion of the raw water was blended with the treated water (Sorg and Logsdon, 1980).

In comprehensive laboratory studies, a SAC (Na^+) resin with an exchange capacity of 1.8 mEq/mL (4.8 mEq/g resin) was tested in repetitive exhaustion–regeneration cycles for barium, radium and hardness reduction in drinking water (Snoeyink et al., 1984; 1987a). The virgin resin was capable of reducing an influent barium concentration of 20.0 mg/L to 1.0 mg/L for approximately 1,200 BVs. The results indicated that the magnesium concentration in the treated water reached a peak concentration of approximately two times the influent concentration at approximately 600 BVs and subsequently reached the influent concentration after approximately 1,200 BVs. The calcium effluent concentration was also greater than the influent concentration at the end of the same process conducted with the virgin resin. Each exhaustion run had been terminated at a hardness breakthrough of 40.0 mg as $CaCO_3$/L, and a regenerant dose of 1.8 mEq NaCl/mL resin [6.5 lb NaCl/ft^3 resin (3 kg NaCl/m^3 resin)] was used in the regeneration cycle. During several repetitive exhaustion–regeneration cycles, the regenerated resin was capable of treating approximately 225 BVs of water before both barium and hardness achieved breakthrough (together) at 1.0 mg/L and 40.0 mg as $CaCO_3$/L, respectively. A regenerant dose of 2.7 mEq NaCl/mL resin [9.75 lb NaCl/ft^3 resin (4 kg NaCl/m^3 resin)] was capable of increasing the number of the BVs processed per exhaustion cycle to 260–270 BVs. However, an increase of the regenerant dose from 1.8 mEq NaCl/mL resin to 2.7 mEq NaCl/mL decreased the regeneration efficiency from 60% to 46%. The early breakthrough of barium indicated that it was accumulating on the resin. The virgin resin concentration was increased from 0.15 mEq Ba^{2+}/mL to a constant value of 0.38 mEq Ba^{2+}/mL after several regeneration cycles with a regenerant dose of 1.8 mEq NaCl/mL resin. At steady-state (i.e., when the barium uptake by the resin was equal to the barium removed by regeneration), the regenerant dose of 1.8 mEq NaCl/mL removed only 20% of the accumulated barium from the resin. Despite the barium accumulation, the number of BVs to hardness breakthrough remained constant. The study found that the barium concentration was effectively reduced to below 1.0 mg/L as long as the SAC (Na^+) resin was not exhausted for hardness ions (Snoeyink et al., 1984; 1987a). These results have been confirmed by full-scale SAC (Na^+) columns used to remove hardness and barium in groundwater (Snoeyink et al., 1987a). One of the SAC (Na^+) columns was run beyond the hardness breakthrough and achieved water hardness and barium concentrations of 153 mg as $CaCO_3$/L and 6.4 mg/L, respectively. However, another column, treating source water from another well at the same site and operating the exhaustion run to hardness breakthrough, was capable of reducing hardness and barium concentrations to 7.0 mg as $CaCO_3$/L and 0.3 mg/L, respectively.

Snoeyink et al. (1987a) concluded that for raw water quality similar to the water used in the laboratory study cited above, two parallel SAC (Na^+) columns operating in a staggered regeneration mode with a regenerant dose of 1.8 mEq NaCl/mL resin could effectively reduce the barium concentration below 1.0 mg/L in a blended treated water, if the exhaustion cycles were terminated at the hardness breakthrough. An important advantage of operating several columns in parallel with staggered regeneration is that treated water quality is less variable compared with single-column operation. This can be a major consideration when the contaminant leakage and/or chromatographic peaking are high during a portion of the exhaustion run (Clifford et al., 2011).

It should be noted that using SAC (Na^+) resins may result in undesirable quantities of sodium in the treated water. Therefore, SAC (Ca^{2+} and H^+) and WAC (H^+) resins are alternatives that can be used for the production of sodium-free treated water. However, proper corrosion control in the finished water should be practised.

7.2.4.2 SAC resin in calcium form

Several studies reported that the SAC (Ca^{2+}) resin was capable of effectively reducing barium and radium concentrations in drinking water (Myers et al., 1985; Snoeyink et al., 1987b; Clifford, 1999; Atassi et al., 2007). However, until approximately 100–200 BVs of SAC (Ca^{2+}) exhaustion, calcium ions are exchanged for all the cations in the feed water, resulting in finished water that is very high in hardness; after that point the total hardness decreases to the influent level. An exhausted SAC (Ca^{2+}) resin requires calcium chloride ($CaCl_2$) brine to be regenerated, and the spent brine may be reused after precipitating and removing barium. Proper doses of $CaSO_4$ are needed to precipitate barium as $BaSO_4$ in the spent brine and to prevent fouling of the resin during the following regeneration cycle. If the brine also contains Ra^{2+}, it will coprecipitate on the $BaSO_4$ and will also be removed (Myers et al., 1985).

A pilot-scale SAC (Ca^{2+}) system was tested in several repetitive exhaustion–regeneration cycles. The regenerated resin was capable of reducing an influent barium concentration of 12.0 mg/L to 1.0 mg/L for run lengths of approximately 1,300 BVs during the third loaded (exhaustion) run. The regeneration has been conducted with a regenerant dose of 6.0 eq $CaCl_2$/L resin (compared with only 1.8 eq NaCl/L resin [Snoeyink et. al., 1987]) and the spent $CaCl_2$brine was reclaimed and reused. The exhausted SAC (Ca^{2+}) resin required less frequency of regeneration than the SAC (Na^+) resin (Atassi et al., 2007).

In laboratory tests, a virgin SAC (Ca^{2+}) resin was capable of reducing barium concentration of up to 23.0 mg/L to below 1.0 mg/L in the treated water for a run length of approximately 1,200 BVs, at a loading rate of 5.4 gpm/ft^2 (13.2 m/h) and an empty bed contact time of 2.5 min (Myers et al., 1985). The hardness, alkalinity and pH of the water were nearly unchanged throughout the treatment runs. The exhausted SAC (Ca^{2+}) resin was effectively regenerated (92–100% removal of barium from the column) with a regenerant dose of 6 eq 0.85 $CaCl_2$/L. Both regenerant concentration and regenerant dose affected the barium concentration in the treated water in the following exhaustion runs. When the regenerant doses were increased from 4.0 to 6.0 and to 8.0 eq $CaCl_2$/L resins, a barium concentration of 1.0 mg/L was achieved for run lengths of 500, 900 and 1,100 BVs, respectively. The study reported that a mole ratio of 1.1:1 ($CaSO_4$:barium) reduced barium concentration in the spent brine and the brine was successfully reused (Myers et al., 1985). Snoeyink et al. (1987b) indicated that the use of the SAC (Ca^{2+}) resin in parallel with SAC (Na^+) may produce treated water with the desired level of hardness in addition to barium removal. However, to prevent an increased sodium concentration in the treated water, SAC (Ca^{2+}) can be used in parallel with SAC (H^+) and WAC (H^+), followed by carbon dioxide stripping.

7.2.4.3 WAC resin in hydrogen form

The WAC (H^+) resins have weak-acid functional groups and only exchange ions in the neutral to alkaline pH range. The IX process results in partial softening and produces treated water with a low alkalinity and low total dissolved solids (TDS) levels. WAC (H^+) resins also require acid-resistant material, CO_2 stripping and pH adjustment of the product water (Snoeyink et al., 1984, 1987a, 1987b; Myers et al., 1985; Snyder et al., 1986). Although WAC (H+) resins can be regenerated by weak acids that are only slightly stronger than the resin functional group, strong acids such as HCl are usually applied. However, sulphuric acid (H_2SO_4) should not be used, as $BaSO_4$ is precipitated on the resin and destroys its capacity. Since barium is easily removed from the exhausted WAC (H^+) resin with approximately 5–10% excess regenerant, it does not accumulate on the resin. The regeneration of WAC (H^+) resin produced less spent regenerant per unit volume of treated water than the regeneration of the SAC column (Snyder et al., 1986; Clifford, 1999; Elder and Budd, 2011). WAC (H^+) systems can be complex to operate and maintain, and they may have increased costs related to the chemicals and materials used (Snoeyink et al., 1984, 1987a, 1987b; Clifford, 1999; Clifford et al., 2011).

In laboratory tests, WAC (H^+) resin was found to effectively remove barium (22.0 mg/L), radium and hardness without increasing the sodium concentration in the treated water . A virgin WAC (H^+) resin (capacity of 11.5 mEq/g resin) showed an approximately identical selectivity for barium and calcium ions, as both contaminants break through at approximately 800 BVs, while magnesium ions break through earlier, at 650 BVs. The virgin WAC (H^+) resin showed a lower capacity for barium but greater capacities for hardness and alkalinity than the virgin SAC (H^+) resin under similar operating conditions. Through several repetitive exhaustion–regeneration cycles, the WAC (H^+) resin was capable of producing treated water with a barium concentration below 1.0 mg/L (22.0 mg/L influent) for run lengths of 600–650 BVs. A regenerant dose of 8.5 mEq HCl/g resin (i.e., only 75% of the stoichiometric amount) was capable of achieving 93–95% regeneration efficiency and greater than 99% removal of divalent ions from the resin. However, regenerating the resin with a dose of 7.6 mEq HCl/g resin (i.e., 66% of the stoichiometric amount) produced higher barium concentrations ranging from 0.5 to 1.3 mg/L in the treated water as a result of incomplete removal of barium from the resin during the regeneration cycles (Snyder et al., 1986).

A common practice in water softening is bypass blending, which involves diverting a portion of the influent flow around the treatment vessel and blending the diverted water with the treated water. Blending of finished water with raw water may stabilize finished water and decrease the cost of treatment by reducing the volume of water treated, which results in less frequent regeneration and therefore a savings in chemical and brine disposal costs (Clifford, 1999). However, the barium concentration in the bypass water needs to be considered to ensure that the finished water concentration is not above the MAC.

7.2.5 Membrane technology

Effective membrane technologies for barium removal in drinking water include RO, NF, as well as ED/EDR (U.S. EPA, 1998; Odell, 2010). The primary difference between RO and NF is the size of dissolved contaminants that can be removed. RO membranes effectively reduce TDS and monovalent ions while NF membranes are mainly used for the removal of hardness (Ca^{2+}, Mg^{2+}) and organics (e.g., precursors of disinfection byproducts). ED/EDR is most typically used for TDS reduction and inorganic ion removal (U.S. EPA, 2012b).

RO treatment systems typically require prefiltration for particle removal and often include other pretreatment steps, such as the addition of anti-scaling agents, dechlorination and/or softening. Pretreatment is required to preserve membrane life because the presence of chlorine residuals, particulates, and scale-forming ions (i.e., Ca^{2+}, Ba^{2+}, iron, and silica) in the feed water can adversely affect the performance of RO processes. The scale deposit on the membrane surface is an important consideration when designing and operating RO systems (Boerlage et al., 2002). Site-specific testing is recommended to determine the design criteria, potential fouling and pre-treatment needs when utilities consider RO treatment.Post-treatment for RO permeate (i.e., finished water) typically includes pH adjustment, addition of corrosion inhibitors and disinfection. RO concentrate disposal must also be considered in the design and operation of RO plants. Systems that integrate two or more membrane processes or combine a membrane process with other treatment processes (i.e., integrated membrane system [IMS]) are implemented to improve overall process water recovery and reduce waste stream concentrations (Ning et al., 2006; Gabelich et al., 2007).

The performance of an IMS was tested for barium removal from May 1998 to January 1999 at a 56.6 MGD water treatment plant located in East St. Louis, Illinois (Lovins et al., 1999). The IMS was supplied with surface water pretreated by conventional coagulation/sedimentation/ filtration processes (CSF). The raw water had a low barium concentration (average of 0.11 mg/L) and the CSF pretreatment achieved an average barium concentration of 0.07 mg/L. The IMS unit consisted of three spiral-wound, crossflow NF membranes with a maximum pressure of 400 psi (27 bars); a composite thin-film membrane with a cut-off rating of 100–200 Da and 85 m^2 of filtration area (CSF-NF1); a composite thin-film membrane with a cut-off rating of 150–300 Da and 97 m^2 of filtration area (CSF-NF2); and a cellulose acetate membrane with a cut-off rating of 300 Da and 123 m^2 of filtration area (CSF-NF3). Inorganic permeate water quality varied by membrane type and produced water with average barium concentrations of 0.002, 0.026 and 0.021 mg/L, respectively, corresponding to average barium removals of 97.1%, 62.9% and 70.0%, respectively. Since CSF-NF1 also decreased hardness and alkalinity to below DLs (not provided) it required corrosion control measures to stabilize treated water. By contrast, the CSF-NF2 and the CSF-NF3 membranes allowed more alkalinity and hardness to pass into the permeate, which produced more stable and less corrosive product water. The CSF-NF3 membrane was more resistant to fouling than both the CSF-NF1 and CSF-NF2 membranes, while CSF-NF1 and CSF-NF2 were more sensitive to the operating conditions (e.g., flux and recovery) and feed water chemistry (e.g., pH) (Lovins et al., 1999).

7.2.5.1 Improving recovery of reverse osmosis

Inorganic scale formation (e.g. silica, barium sulphate and calcium carbonate) remains a serious impediment to achieving high RO recovery. Scaling resulting from the precipitation of salts within the membrane module leads to permeate flux decline and shortening of the membrane life. As water passes through the RO membrane, rejected Ba^{2+} ions accumulate near the membrane surface, and its concentration may increase to the point where precipitation of barium salts occurs (Boerlage et al., 2000; Gabelich et al., 2007). Barium sulphate can be problematic for any drinking water treatment methods that concentrate barium (Boerlage et al., 2000; Ning et al., 2006; Gabelich et al., 2007; WQA, 2014). For example, membrane scaling by barium sulphate can reduce membrane recovery and also cause flux decline and potentially severe membrane damage (Boerlage et al., 2000; Ning et al., 2006).

Lime softening followed by filtration and pH adjustment is an effective pre-treatment to improve the performance of RO for enhanced removal of mineral salt scaling from water sources. Intermediate concentrate chemical stabilization (ICCS) strategies apply conventional or pellet softening to a primary (first pass) RO concentrate to remove scale-forming compounds such as barium, followed by secondary RO treatment to improve the overall system recovery (He et al., 2011). An implementation of conventional lime-softening-based ICCS technology (a primary RO concentrate followed by a secondary RO system) was capable of improving the overall system recovery from 85% to 92.5–95.5% (He et al., 2011). Using a lime dose of 1,220 mg/L, the ICCS reduced an average barium concentration of 0.34 mg/L in the RO concentrate to an average of 0.05 mg/L (86% reduction) at pH 10.5. At this pH level silica, strontium and calcium concentrations were also reduced to 76%, 84% and 77%, respectively. The authors found that a pelletized-based ICCS technique removed less barium**,** silica, strontium and calcium from the primary RO concentrate when compared with conventional lime-softening-based ICCS (He et al., 2011).

Ning et al. (2006) reported the results of a bench-scale and pilot-scale study at a large inland desalination plant in El Paso, Texas. Precipitative softening by magnesium hydroxide [$Mg(OH)_2$] powder and conventional lime softening using calcium hydroxide [$Ca(OH)_2$] powder were assessed for the removal of silica and barium from RO concentrate that was subsequently treated by secondary RO to demonstrate improved RO recovery. Treatment with $Mg(OH)_2$ powder reduced a barium concentration from 0.9 mg/L to 0.34 mg/L in the concentrate (64% reduction) within 1 h of processing time at a pH range of 7.8–9.1 but did not provide sufficient silica reduction (only 16%). Conventional lime softening conducted with $Ca(OH)_2$ reduced a barium concentration from 0.9 mg/L to 0.43 mg/L (50%) and silica from 143 mg/L to 48 mg/L (66%) at pH 10.3–10.6 after 1 h. Excess lime softening at pH 12.0 improved the settleability of the sludge due to the coagulative effect of $Mg(OH)_2$ precipitates. However, an influent barium concentration of 0.9 mg/L was reduced by only 30% and 67% after 1 and 3 h, respectively. The silica concentration of 155 mg/L was reduced by 96% and 98% after 1 and 3 h, respectively. It was concluded that concentrate from primary (i.e., first-pass) RO membranes would be most effectively treated by conventional lime softening at a pH of 11.5 for 1 to 3 h. In the pilot-scale study, the authors found that the performance of the primary RO had an 85–90% recovery level, which was limited by the presence of silica and precipitated barium sulphate. Treatment of the primary RO concentrate by lime softening followed by a secondary RO sufficiently reduced membrane fouling through reduction of silica and barium concentrations and also resulted in an increased overall recovery of the system to approximately 97%.

Similarly, both Rahardianto et al. (2007) and Gabelich et al. (2007) demonstrated that two-stage desalination RO, supplemented with precipitative softening treatment of primary RO concentrate, was an effective approach to remove mineral salt scaling including barium sulphate, as well as improving process recovery to 95–98%. Gabelich et al. (2007) suggested that barium removal during precipitative softening was enhanced by inclusion into or onto calcium carbonate crystalline lattice during precipitation.

7.2.6 Emerging technologies

7.2.6.1 Adsorptive media

Araissi et al. (2016) tested an adsorptive zeolite 4A medium for barium removal in batch experiments using feed water with barium concentrations of from 0.3 mmol (41.1 mg/L) to 25 mmol (3,432 mg/L) at pH levels of 8.2–11.0. The samples were stirred for 14 h in contact with 0.15 g of the media. The maximum observed adsorption capacity was 2.25 mmol Ba^{2+}/g. The authors indicated that the mechanism of barium removal was considered an IX process. The batch experiments were also carried out using a binary system of barium and strontium, and the authors found that strontium was preferentially removed by zeolite over barium. They also indicated that zeolite may provide an effective IX material for removing barium in water. Sato et al. (2011) reported on the use of zeolite 4A media filters for the removal of radioactive contaminants including barium from drinking waters associated with the severe incident at the Fukushima Daiichi Nuclear Power Station. The authors found that synthetic zeolite 4A efficiently removed cesium, strontium and barium but gave no details regarding the capacity of the filters or the operating conditions.

7.2.7 Distribution system considerations

The accumulation of trace inorganic contaminants (TICs) in the drinking water distribution system is a complex function of numerous factors, including contaminant concentration in treated water, pH and redox conditions in the distribution system and pipe material. Iron oxyhydroxides and hydrous manganese oxides are significant sinks for TIC accumulation because of their adsorptive affinity for them. Water quality changes or physical disruptions in the distribution system can remobilize contaminants into the bulk water. Indicators of this include the presence of discoloured water or increased turbidity.

Barium has been repeatedly detected in samples from both distribution system piping scales and solids mobilized during hydrant flushing (Schock et al., 2008; Freidman et al., 2010; Peng et al., 2012; Lytle et al., 2014). Barium deposition in the distribution system occurs primarily due to the surface adsorption and/or co-precipitation reactions involving soluble barium species (Ba^{2+}), which are enhanced at elevated pH (Friedman et al., 2010). Barium accumulation is strongly influenced by the co-occurrence of manganese deposits, phosphate precipitates and/or phosphate surface groups and to lesser extent by the concentration of barium in the water (McComish and Ong, 1988; Sugiyama et al., 1992; Charette and Sholkovitz, 2006; Schock et al., 2008; Friedman et al., 2010; Peng et al., 2012).

Barium may also enter the distribution system water through leaching from cement-based materials and linings under aggressive water chemistry and/or hydraulic conditions. Leaching of barium from cement-mortar linings can result in the precipitation of $BaCO_3$ and $BaSO_4$ in the distribution system (Friedman et al., 2010). Guo et al. (1998) conducted laboratory tests to determine the extent of leaching from ductile iron pipes lined *in situ* with Portland cement (type I) mortar. The pipes were lined, cured and subsequently disinfected in accordance with ANSI/AWWA standards. The tests were performed using tap water from a New Jersey water distribution system. Under static conditions barium concentration was increased gradually by up to 18% of its respective U.S. EPA drinking water standard of 2.0 mg/L during the first 14 days of water stagnation. The cement used to line the test pipes contained a lower amount of metals than most commercially available cements.

Lead-pipe scale samples collected from 91 pipe specimens of lead and lead-lined service lines from 26 different water distribution systems in the U.S. had an average barium concentration of 199.0 mg/kg scale [range of 1.0 mg/kg (0.0001 % wt) to 2,850 mg/kg scale (0.3 % wt)]. Barium was detected in concentrations greater than the reporting level of 5.0 mg/kg (0.0005 % wt) in 87 of the 91 samples (95%) (Schock et al., 2008).

Barium was the most concentrated TIC detected in scale samples and sediments collected from the distribution systems of 20 U.S. drinking water utilities supplied by groundwater, surface water and blended water sources (Friedman et al., 2010; Peng et al., 2012). The distributed water had barium concentrations ranging from 0.002 to 0.6 mg/L, pH levels of 7.1 to 8.5 and alkalinity of 48 to 289 mg/L as $CaCO_3$. Friedman et al. (2010) reported that the median barium concentration of all scale deposits and sediment samples was 94 µg/g. Specifically, median barium concentrations in scale deposits and hydrant-flush solids were 88 µg/g (0.009% wt) and 104 µg/g (0.01% wt), respectively. Five of the deposit samples with barium concentrations ranging from 460 µg/g (0.05%wt) to 2,400 µg/g (0.24% wt) also had high manganese (372–46,700 µg/g) and phosphorous concentrations (2,000–12,300 µg/g). Zasoski and Burau (1988) indicated that manganese dioxide has been extremely effective for adsorption of cationic species similar to barium. Similarly, Peng et al. (2012) observed a notable correlation between barium and manganese concentration in scale deposits. This correlation supported the data from previous studies (Murray, 1975; Sugiyama et al., 1992) showing that manganese oxides formed in corrosion products interact with barium more strongly than iron oxides.

Barium concentrations in 22 hydrant flush solids and two pipe specimen samples from 12 different water utility distribution systems ranged from 60.8 µg/g (0.006% wt) to 9,276 µg/g (0.9% wt), with an average value of 0.24% wt (Lytle et al., 2014). All waters had a pH range of 7.0–8.0, alkalinity of 251–476 mg/L as $CaCO_3$ and were sourced from groundwater.

Friedman et al. (2010) reported an estimated barium mass of 76.0 lb (34.5 kg) accumulated on a 100-mile pipe length (160 km) [based on a 12-in. diameter pipe (30.5 cm)].The authors noted that theoretically 16–26% of the scale deposit would need to be released to exceed the U.S. EPA drinking water standard for barium of 2.0 mg/L.

7.2.8 Treatment chemicals in contact with drinking water

Barium impurities may be present in various chemicals (such as alum, calcium hydroxide, calcium hypochlorite and polyaluminium chloride) that are used in drinking water treatment (NHMRC, 2011). NSF/ANSI Standards 60 sets a maximum concentration for barium that can be present in treatment chemicals. This maximum concentration is known as the single product allowable concentration (SPAC). Current SPAC for barium under NSF/ANSI Standard 60 is 0.2 mg/L (NSF/ANSI, 2018).

7.3 Residential scale

In cases where barium removal is desired at the household level, for example when a household obtains its drinking water from a private well, a residential drinking water treatment device may be an option for decreasing barium concentrations.

Health Canada does not recommend specific brands of drinking water treatment devices, but it strongly recommends that consumers use devices that have been certified by an accredited certification body as meeting the appropriate NSF International (NSF)/American National

Standards Institute (ANSI) drinking water treatment unit standards. These standards have been designed to safeguard drinking water by helping to ensure the material safety and performance of products that come into contact with drinking water. Certification organizations provide assurance that a product conforms to applicable standards and must be accredited by the Standards Council of Canada (SCC). In Canada, the following organizations have been accredited by the SCC to certify drinking water devices and materials as meeting NSF/ANSI standards (SCC, 2019):

- CSA Group (www.csagroup.org);
- NSF International (www.nsf.org);
- Water Quality Association (www.wqa.org);
- UL LLC (www.ul.com);
- Bureau de normalisation du Québec (www.bnq.qc.ca);
- International Association of Plumbing & Mechanical Officials (www.iapmo.org); and
- Truesdail Laboratories Inc. (www.truesdail.com).

An up-to-date list of accredited certification organizations can be obtained from the SCC (2019).

Water treatment technologies able to be certified to NSF standards for barium reduction include cation exchange, RO and distillation. Applicable NSF/ANSI Standards are NSF/ANSI Standard 44: Cation Exchange Water Softeners (NSF/ANSI, 2016a); NSF/ANSI Standard 58: Reverse Osmosis Drinking Water Treatment Systems (NSF/ANSI, 2016b) and NSF/ANSI Standard 62: Drinking Water Distillation Systems (NSF/ANSI, 2016c).

For drinking water treatment devices to be certified to NSF/ANSI standards 44, 58 and 62 for the reduction of barium concentration, the devices must be capable of reducing an average influent (challenge) concentration of 10.0 mg/L to a maximum final concentration of 2.0 mg/L or less. In addition, treatment devices certified to standards 44 and 62 can be certified either specifically for barium reduction (as noted above) or for the removal of hardness and TDS, respectively, which are used as a surrogate for barium in these standards. If water softeners (cation exchange systems using 100% sulphonated polystyrene divinyl benzene resin), certified to NSF/ANSI Standard 44 and reduced hardness concentration to below 1.0 gpg (17.1 mg/L) from an influent hardness of 20 gpg (342 mg/L) will be able effectively to reduce barium in drinking water. For a treatment device to be certified to NSF/ANSI Standard 62 using TDS as a surrogate must achieve a minimum TDS reduction of 99% from an influent concentration of 1,000 mg/L.

RO systems are intended for point-of-use (POU) installation, as larger quantities of influent water are needed to obtain the required volume of treated water, which is generally not practical for residential-scale point-of-entry systems. RO systems should only be installed at POU, as the water they have treated may be corrosive to internal plumbing components. A consumer may need to pretreat the influent water to reduce fouling and extend the service life of the membrane. Distillation systems are also intended for POU installation only. The distillation process is effective, however, there are no currently certified systems available.

Selection of the most effective treatment system for a household will depend on a variety of factors, including the concentration of barium, and such other parameters as hardness, alkalinity and the pH of the source water. Before a treatment device is installed, the water should be tested to determine the general water chemistry and verify the presence and concentration of barium. Periodic testing by an accredited laboratory should be conducted on both the water entering the treatment device and the finished water to verify that the treatment device is effective. Treatment devices lose their removal capacity through usage and time and need to be maintained and/or replaced. Consumers should verify the expected longevity of the components in their treatment device according to the manufacturer's recommendations and service it when required.

Various household water softeners have been randomly sampled to examine their barium removal efficiency. The influent barium concentrations ranged from 0.5 mg/L to 6.4 mg/L and influent hardness varied from 205 mg/L to 248 mg/L as $CaCO_3$. All tested water softeners reduced barium concentration to below 1.0 mg/L and hardness to between 2 mg/L to 35 mg/L as $CaCO_3$ (Snoeyink et al., 1987a).

Homeowners with private wells using IX softeners in sodium form should be aware that the treatment unit may introduce undesirable quantities of sodium in the treated water.

8.0 Kinetics and metabolism

8.1 Absorption

Barium absorption from the diet in humans was reported to vary widely, generally ranging from 1% to 60% (LeRoy et al., 1966; Schroeder et al., 1972; Leggett, 1992; Kravchenko et al., 2014). Factors influencing absorption include age, chemical species/solubility, fasting status, vitamin D status, and the presence of other ions in the diet (Leggett, 1992). Despite the variability and uncertainty of the results, Leggett (1992) proposed an absorption of 20% for water-soluble forms of barium by the gastrointestinal tract, which at the time of the review aligned with the value applied by the International Commission on Radiological Protection (ICRP, 1980). Peak blood level was reported to occur 2 h after ingestion of barium chloride, with a serum half-life of 3 h (Downs et al., 1995).

A wide range of oral absorption values have also been reported in laboratory animals (1–95%), with more water-soluble forms having higher absorption (Venugopal and Luckey, 1978; Kravchenko et al., 2014). In rats, 85% of $BaCl_2$ was absorbed at 14–18 days of age, 63% at 22 days of age, and 6% at age 6 weeks and older (Taylor et al., 1962). Having adult rats fast for 18 h pre-exposure increased absorption by a factor of three. Rats receiving 10 mg /L of barium as barium sulphate by intubation exhibited peak barium blood levels 15 min after dosing, with 50% remaining in the blood 4 h post exposure (McCauley and Washington, 1983). The maximum blood concentration was higher with barium sulphate than with barium chloride or barium carbonate. In dogs, oral absorption of barium chloride was reported to range between 1–7% and 50% (Cuddihy and Griffith, 1972).

In rats administered barium chloride via gavage, younger rats (14–22 days old) absorbed barium more efficiently than older animals (6–70 weeks old) (i.e., 63–84% in young animals versus 7–8% in older rats) (Taylor et al., 1962). In this same study, fasting was also found to increase absorption from 7–8% to 20%. Absorption after the first 7 h following administration was not investigated. The ICRP (1993) and the World Health Organization (WHO, 1990) also reported that children may absorb barium to a greater extent than adults; the ICRP (1993) has estimated oral absorption of soluble barium to be 60% in infants, 30% in children 1–15 years old and 20% in adults.

The solubility of barium compounds under environmental conditions does not necessarily influence their absorption in the body. McCauley and Washington (1983) compared absorption efficiencies of different barium compounds and found that single gavage doses of ^{131}Ba-labelled barium sulphate and barium chloride (amounting to 10 mg of barium) were absorbed at similar rates, as indicated by blood and tissue levels in rats. The authors suggested that the similar absorption efficiencies may be attributed to the solubilization of the low dose of barium sulphate by hydrochloric acid in the stomach. Barium carbonate in a vehicle containing sodium bicarbonate was poorly absorbed, most likely owing to the buffering capacity of sodium bicarbonate, which may have impaired the hydrochloric-acid-mediated conversion to barium chloride. These results suggest that soluble barium compounds or compounds generating barium ions in the acidic environment of the stomach have similar absorption efficiencies.

8.2 Distribution

Barium mainly deposits in bone and connective tissues, with bones containing approximately 66–90% of the total body burden (Schroeder et al., 1972; Venugopal and Luckey 1978; Tardiff et al., 1980). Barium can also accumulate in teeth, as shown in a study by Miller et al. (1985) in which the ratio of barium to calcium observed in the teeth of children from a community with high levels of barium in drinking water (10 mg/L) was five times higher than among children from another community with barium levels of 0.2 mg/L, despite their similar ethnic and socioeconomic status. Barium also distributes widely into different tissues, with lungs, fat, muscle, skin, connective and soft tissues being found to contain 0.1–0.5 mg of barium in adult humans in the United States (Schroeder et al., 1972).

No differences in distribution were found between sexes of rats exposed to 10–250 mg/L of barium as barium chloride for 4–13 weeks (Tardiff et al., 1980). Barium is also known to cross the placental barrier (Venugopal and Luckey, 1978; McCauley and Washington, 1983). The highest concentrations of barium in rats intubated with 10 mg/L of barium chloride for 24 h were found in the heart, muscles, eye, liver, and kidney (McCauley and Washington, 1983).

8.3 Metabolism

Barium is not metabolized in the human body. As an ion it is monovalent and not subject to changes in oxidation state.

8.4 Excretion

In humans barium is excreted in feces and urine, with feces representing the primary route of excretion; Schroeder et al. (1972) reported that for a total intake of 1.33 mg/day (1.24, 0.086, and 0.001 mg/day from food, water, and air, respectively) approximately 90% of the barium is excreted in the feces and 2% in the urine. Similar results were observed by Tipton et al. (1969); two men excreted 95%–98% and 2%–5% of a daily barium intake via feces and urine, respectively.

8.5 Physiologically based pharmacokinetic (PBPK) models

No PBPK modelling for barium was identified in the currently available literature.

9.0 Health effects

Barium is not considered to be an essential element (Venugopal and Luckey, 1978; Ferrante et al., 2014; Chellan and Sadler, 2015).

Different barium compounds have differing solubilities in water and body fluids, which influences their toxicity. The Ba^{2+} ion and the water-soluble compounds of barium (mainly chloride, nitrate, and hydroxide) are toxic to humans and animals. Barium carbonate, although relatively insoluble in water, is soluble in the gastrointestinal tract, allowing uptake into serum and tissues thereby capable of causing effects. Water-insoluble barium compounds, such as barium sulphate, serve as inefficient sources of Ba^{2+} ion and are therefore generally nontoxic to humans. The nontoxic nature of barium sulphate has made it useful in medical applications; for example, it serves as a contrast medium for X-ray examination of the gastrointestinal tract. However, barium sulphate or other insoluble barium compounds can become toxic if the gastrointestinal tract is compromised (e.g., in the case of colon cancer), thereby allowing barium to enter the bloodstream (ATSDR, 2007).

9.1 Effects in humans

The database on human health effects from barium exposure is limited. Health effects reported from acute exposure to high levels of barium carbonate or chloride are largely related to hypokalemia, which can lead to complications such as ventricular tachycardia, hypertension and/or hypotension, muscle weakness and paralysis. Portal of entry gastrointestinal effects such as vomiting, abdominal cramps, and watery diarrhea have also been reported shortly after ingestion of high doses. Associations between barium in drinking water and mortality from cardiovascular disease are largely negative; however, one retrospective study reported a positive association, although a lack of controlling for confounding factors and poor exposure characterization render the results unreliable. The impacts of barium exposure on developmental and reproductive toxicity, as well as hearing loss, have been investigated; however, results are inconclusive, largely due to poor exposure characterization. The carcinogenicity of barium has not been evaluated in humans.

9.1.1 Acute toxicity

Acute poisoning with barium salts can occur (levels unreported) in cases of accidental human oral ingestion and suicide attempts. In these situations, barium has caused hypokalemia (low serum potassium levels), leading to neuromuscular (e.g., muscle weakness and paralysis, abnormal reflexes, tingling, dizziness) and cardiovascular effects (e.g., arrhythmias, electrocardiogram abnormalities) (McNally, 1925; Diengott et al., 1964; Lewi et al., 1964; Ogen et al., 1967; Talwar and Sharma, 1979; Deng et al., 1991; Downs et al., 1995; Koch et al., 2003; Rhyee and Heard, 2009; Payen et al., 2011; Bhoelan et al., 2014). In one case study, the absorbed barium came from a carbonate salt present in flour that was solubilized as a result of the acidic stomach pH.

Gastrointestinal effects (gastric pain, vomiting, diarrhea, tightness in the throat, dryness of the mouth, hemorrhage) are reported as acute effects following barium ingestion. The acute responses can progress to increased blood pressure, progressive muscular paralysis, cardiovascular and respiratory failure, and even death (Downs et al., 1995; Jourdan et al., 2001; Bhoelan et al., 2014). Hemoglobin in the urine and renal failure have also been observed (Morton, 1945; Gould et al., 1973; Wetherill et al., 1981; Phelan et al., 1984; Jha et al., 1993; Silva et al., 2003; Koch et al., 2003; Lukasik-Glebocka et al., 2014). Doses of 1–15 g of barium sulphide have caused death. However, in another case medical treatment following exposure to up to 133 g of barium carbonate prevented a lethal response (Downs et al., 1995).

9.1.2 Subchronic and chronic toxicity and carcinogenicity

9.1.2.1 Cardiovascular toxicity

A retrospective study found higher mortality rates ($p < 0.05$) from all cardiovascular diseases and for heart diseases (data retrieved from death certificates for the years 1971–1975) in Illinois communities with barium concentrations of 2–10 mg/L in drinking water compared with communities having <0.2 mg/L in their drinking water (25,433 adults of four high-barium communities and 46,905 adults of seven low-barium communities) (Brenniman et al., 1979; Brenniman and Levy, 1985). The communities were matched for demographic characteristics and socioeconomic status; however, there was no adjustment for the use of water softeners, medication, smoking, diet and exercise. Moreover, the rate of population change was about 70% in the communities with the highest concentrations during the decade preceding the study dates, and no information was provided on the length of time individuals lived in a community.

Additionally, exposure was poorly characterized; no information was provided on tap water consumption rates. In another study that evaluated cardiovascular morbidity, no differences in blood pressure, stroke, heart or kidney disease were observed ($p < 0.05$) between an Illinois community with a mean of 7.3 mg/L in drinking water (n = 1,175 adults in West Dundee) and another one with a mean of 0.1 mg/L (n = 1,203 adults in McHenry) for the years 1976–1977 (Brenniman et al., 1981; as summarized in Brenniman and Levy, 1985).

No association between barium intake from drinking water and cardiovascular markers (i.e., cholesterol, glucose, and triglyceride levels, blood pressure, heart rate, electrocardiographic endpoints) were found in 11 American male volunteers (27–61 years old) (Wones et al., 1990). Barium was administered via the drinking water at successive barium concentrations of 0 ppm for the first 2 weeks, 5 ppm for the next 4 weeks and 10 ppm (as barium chloride) for the final 4 weeks. Factors associated with cardiovascular risk (such as exercise and food intake) were controlled. However, the small number of subjects, the duration of exposure, and the lack of absorption data limit an interpretation of the results of this study.

9.1.2.2 Developmental and reproductive toxicity

There is little information from human studies on reproductive and developmental effects from soluble barium compounds. In a small prospective epidemiological study, there were no differences (in gestational age, birth weight, and major or minor malformations; $p = 1.0$) in babies (n = 32) born to mothers who inadvertently swallowed barium sulphate used in radiography procedures during the first trimester of pregnancy when compared with 94 control mothers (Han et al., 2011). Moreover, there was no evidence of teratogenicity in babies (n = 5) born to mothers who were inadvertently exposed to barium via enema (Han et al., 2010). Nevertheless, the low solubility and absorption rates of barium sulphate used in medical procedures confound the interpretation of these results with respect to soluble barium compounds.

A small, single-site case–control study reported that barium was among the metals that were reported to be elevated in the hair ($p = 0.003$) and urine ($p = 0.002$) of 25 children (mean age of 5 years) with autism spectrum disorder in Saudi Arabia compared with 25 non-autistic children matched for age and sex. However, this study had several shortcomings: mothers of autistic children were exposed to second-hand smoke, controls were chosen through case referrals, and no attempt was made to identify which other trace elements and heavy metals could be responsible for the associations (Blaurock-Busch et al., 2011).

9.1.2.3 Other effects

In a pilot cross-sectional study, Ohgami et al. (2016) reported an association between hearing loss (auditory thresholds) and concentrations of barium in hair (odds ratio (OR) = 4.75) (95% confidence interval (CI): 1.44, 17.68) at 8 kHz and OR = 15.48 (95% CI: 4.04,79.45) at 12 kHz and toenails (OR = 3.20 (95% CI: 1.35, 7.85)) at 8 kHz and OR = 3.63 (95% CI: 1.58, 8.55 at 12 kHz) in Bangladesh (n = 145 individuals of both sexes aged 12 to 55); however, with no associations with urine levels being observed and sources of exposure not reportedly characterized, the results of this study limit any inferences that can be made with respect to barium exposure and hearing loss.

Utilizing the data from NHANES 1999–2002 to explore the association between waist circumference and body mass index with the body burdens of various toxic metals, Padilla et al. (2010) reported that urinary barium showed a direct positive association with body mass index and waist circumference ($p < 0.05$), suggesting that environmental exposure to barium (and other metals) may influence variations in weight gain or loss in humans.

9.2 Effects on experimental animals

The database on health effects in animals following barium exposure is also somewhat limited. Investigations into cardiovascular function generally did not find any significant alterations in blood pressure or electrocardiogram readings following low-dose oral exposure. Some studies did find significant increases in blood pressure; however, the use of a low mineral diet with less than adequate levels of calcium may have influenced the study results.

The most sensitive adverse effect of barium appears to be renal toxicity. Nephropathy has been observed in rats and mice following short- and long-term oral exposure to barium, with steep dose–response curves being observed in both species; data in mice suggest that the severity and sensitivity to renal lesions is related to the duration of exposure.

Reproductive and developmental studies are limited, with results generally being negative for impacts on reproductive tissues or reproductive performance in rats and mice. Decreases in sperm number and quality as well as shortened estrous cycles and morphological alterations in the ovaries have been observed in rats; however, study weaknesses render these results inconclusive. Decreased pup birth weight and a nonsignificant decrease in litter size have been reported in the offspring of rats exposed to barium chloride in drinking water prior to mating. Finally, several studies found that oral exposure to barium did not significantly increase tumour incidence.

9.2.1 Acute toxicity

Fluid in the trachea, inflammation of the small and large intestine, decreased liver/brain weight ratio, increased kidney/brain weight ratio, darkened liver, ocular discharge and decreased body weight were reported in rats administered by gavage 60–960 mg Ba/kg as barium chloride in water (Borzelleca et al., 1988). In this study the LD_{50} (median lethal dose) values were reported as 419 and 408 mg $BaCl_2$/kg bw in male and female Sprague-Dawley rats, respectively. Another study reported an LD_{50} of 132 mg Ba/kg bw and 220 mg Ba/kg bw for adults and weanling Charles River rats (strain not specified), respectively, gavaged with barium chloride in water (Tardiff et al., 1980). Also, ECG abnormalities, tachycardia, ventricular fibrillation, muscle paralysis, salivation, diarrhea, hypertension, respiratory paralysis, hypokalemia, and death were observed following intravenous infusion of barium chloride in mongrel dogs (Roza and Berman, 1971).

9.2.2 Short-term exposure

9.2.2.1 Kidney effects

The U.S. National Toxicology Program (NTP, 1994) conducted toxicity studies in F344/N rats and B6C3F1 mice by administering barium chloride dihydrate (99% pure) in drinking water for 15 days and 13 weeks. In the 15-day studies, rats (70 days old; 5/sex/dose) were administered barium at concentrations of 0, 125, 250, 500, l,000, or 2,000 ppm (10, 15, 35, 60, or 110 mg/kg bw per day for both males and females), and mice (77 days old; 5/sex/dose) received 0, 40, 80, 173, 346, or 692 ppm (10, 30, 65, 110, or 200 mg/kg bw per day for males; 10, 35, 65, 115, or 180 mg/kg bw per day for females). In rats, no chemical-related deaths, differences in final mean body weights or clinical findings of toxicity were observed; in addition, no significant differences in absolute or relative organ weights, hematology, clinical chemistry, or neurobehavioral parameters were reported. Water consumption by male and female rats in the highest dose group was slightly less (≤16%) than controls during the second week. In mice, no chemical-related deaths, differences in mean body weights and water consumption, or clinical/histopathological evidence of toxicity were observed; in the highest dose group, relative liver weight of males and absolute and relative liver weights of females were significantly higher than those of the controls.

In the 13-week studies, F344/N rats and B6C3F1 mice (43 days old; 10/sex/dose) were administered barium (as barium chloride in drinking water *ad libitum*) at concentrations of 0, 125, 500, 1,000, 2,000 and 4,000 mg/L (0, 10, 30, 65, 110 or 200 mg Ba/kg bw per day for male rats; and 0, 10, 35, 65, 115 or 180 mg Ba/kg bw per day for female rats; 0, 15, 55, 100, 205 or 450 mg Ba/kg bw per day for male mice; and 0, 15, 60, 110, 200 or 495 mg Ba/kg bw per day for female mice, as determined by the study authors) (NTP, 1994). In rats, water consumption by males and females in the high dose group was 30% lower than controls; chemical-related kidney lesions (three males and three females) and death (three males and one female) were also observed in this dose group. No changes in blood pressure were observed throughout the 13-week period in any of the dose groups. Absolute and relative kidney weights in females of the 115 or 180 mg/kg bw per day dose groups as well as in males of the 200 mg/kg bw per day dose group were significantly higher than controls and were related to chemical-induced renal lesions; a no-observed-adverse- effect level (NOAEL) of 65 mg/kg bw per day for increased kidney weights in female rats can be identified from this study. In mice, final mean body weights for males and females of the highest dose group were significantly lower than controls, with males consuming 18% less water than controls. More severe kidney lesions were observed in mice than in rats, with multifocal to diffuse nephropathy (i.e., tubule dilatation, regeneration and atrophy), crystals and eosinophilic casts in atrophic tubules and increased mortality being reported in both sexes in the highest dose group; a NOAEL of 200 mg/kg bw per day for kidney lesions in female mice can be identified from this study.

Fisher-344/N rats and B6C3F1 mice received barium chloride dihydrate (10 animals/sex/species/dose) via drinking water at concentrations of 0, 1,000, 2,000 or 4,000 mg Ba/L (equivalent to doses of 0, 65, 110 and 200 mg Ba/kg bw per day for males; and 0, 65, 115 and 180 mg Ba/kg bw per day for females, as estimated by the study authors) for 13 weeks (Dietz et al., 1992). Mortality was 10–30% for rats and 60–70% for mice in the highest dose groups. Mortality in mice was attributed to treatment-related renal toxicity, whereas in rats, renal lesions were less severe and were not attributed mortality in the high dose group. Toxic nephrosis and crystals in the lumen of renal tubules (postulated by authors as insoluble barium salts) were observed in more than 80% of the mice of both sexes in the highest dose group. Renal lesions were characterized by dilatation (containing eosinophilic granular casts and crystals), regeneration, and atrophy (lined with epithelial cells with stained basophilic cytoplasm) of the tubular cells in mice. There was an irregular depression of the renal capsule near the collapsed tubules. Also, an increase in fibrous tissue was observed between the tubules in the cortex and outer medulla. In rats, only a few foci of dilated tubules were observed in the outer medulla in both sexes at the highest dose. A NOAEL of 2,000 mg Ba/L (110 mg Ba/kg bw per day) was identified by the authors of this study.

In a study investigating the protective effects of pomegranate peel against barium-mediated kidney damage, a single group of six adult Wistar rats exposed to barium chloride (67 ppm, equivalent to 10 mg/kg bw per day, as reported by the study authors) for 21 days reduced creatinine clearance (indicator of glomerular dysfunction) compared with controls (Elwej et al., 2016a). The barium group also had various hemorrhage foci and leucocyte infiltration that were evident in the Bowman's space portion of the Bowman's capsule that surrounds the glomeruli.

Female Sprague-Dawley rats gavaged for 10 days with 100, 145, 209 and 300 Ba/kg bw per day in water had a decreased kidney/brain weight ratio in all dose groups except the highest; however, the authors concluded that these results were likely not barium-related, due to the absence of effects in the highest dose group (Borzelleca et al., 1988).

No adverse effects were observed in young adult rats (Charles River rats; 30 animals/sex/dose) exposed to 0, 10, 50 or 250 mg Ba/L as barium chloride in drinking water (equivalent to 2–3, 6–13, or 28–64 mg Ba/kg bw per day for males; and 2–3, 7–15, or 36–68 mg Ba/kg bw per day for females, as reported by the study authors) for 13 weeks (Tardiff et al., 1980).

9.2.2.2 Cardiovascular effects

An increase in barbiturate-induced myocardial contractile depression was observed in young female Long-Evans hooded rats exposed for 16 months to 100 ppm barium chloride via drinking water (Kopp et al., 1985). An increase in systolic blood pressure was measured in barium-treated rats compared with controls (n = 12). Reduced myocardial contractile velocity and conduction system in the atrioventricular nodal region and disturbances in energy metabolism were also observed after 16 months of exposure.

9.2.2.3 Other effects

A decrease in motor activity (mice and rats), weaker grip strength (mice), and a decrease in thermal sensitivity (mice) were also observed at the 4,000 ppm dose in the NTP (1994) study, as described above; forelimb grip strength of female mice receiving 4,000 ppm was also lower following 90 days of exposure.

Female ICR mice (n = 5) exposed to barium chloride in drinking water for 2 weeks or 2 months (equivalent to doses of 0.14 and 1.4 mg Ba/kg bw per day, as indicated by the authors) had severe hearing loss in both dose groups after 2 weeks, and severe degeneration of the inner ear after 2 months (Ohgami et al., 2012) when compared with controls. Several study weaknesses limit the interpretation of these findings. These weaknesses include the use of a strain of mouse that has been shown to suffer from progressive hearing loss (thus this study requires replication in other species); the measurement of inner ear barium levels was done at a time (11 weeks) long after hearing analysis was performed (5 weeks); no differences in bone-barium levels were observed between the treatment groups; and levels of barium in other tissues (including kidney, liver and heart) were undetectable, which is inconsistent with what would be expected following barium exposure.

9.2.3 Long-term exposure and carcinogenicity

9.2.3.1 Kidney effects

As part of the NTP study described above (NTP, 1994), rats and mice (60/sex/dose) were also exposed to barium chloride in drinking water at concentrations of 0, 500, 1,250 and 2,500 mg/L (as barium) (0, 15, 30, 60 mg Ba/kg bw per day for male rats; 0, 15, 45, 75 mg Ba/kg bw per day for female rats; 0, 30, 75 or 160 mg Ba/kg bw per day for male mice; and 0, 40, 90 or 200 mg Ba/kg bw per day for female mice, as estimated by the study authors) for 103–105 weeks. In rats, no chemically related effects were observed at any dose. In mice, mild to severe nephropathy in males and females (i.e., tubule regeneration of cortical and medullary epithelium, dilatation, hyaline cast formation, multifocal interstitial fibrosis, and glumerulosclerosis in some animals; brown crystals within tubule lumens and interstitium and renal cysts in males) and increased mortality due to kidney lesions was reported in the high dose group. In the 15-month interim evaluation, urea nitrogen levels were elevated in mice of all dosage groups (although the finding was not statistically significant, according to the authors) indicating that some animals were beginning to experience changes in kidney function consistent with the observed pathology, even at the lower doses. A NOAEL of 75 mg/kg bw per day can be identified for nephropathy in male mice.

Long-Evans rats exposed to 5 mg Ba/L (52/sex; as barium acetate) via drinking water had increased proteinuria in males only after lifetime exposure, whereas females showed no significant difference from controls; no kidney lesions in treated rats were noted by the authors (Schroeder and Mitchener, 1975a). A reduction in survival was observed in male Swiss mice of the Charles River CD strain (but not in females) exposed to 5 mg Ba/L (as barium acetate) via drinking water; however, no kidney lesions in treated mice were noted by the authors (Schroeder and Mitchener, 1975b).

Rats administered barium chloride via drinking water at concentrations of 1–1,000 mg Ba/L (the authors only indicated that 10 ppm was equivalent to 1.5 mg Ba/kg bw per day) for 16– 68 weeks exhibited structural changes to the glomeruli at the highest dose of 1,000 ppm (or approximately 150 mg/kg bw per day) (McCauley et al., 1985); thus a lowest-observed-adverse-effect level (LOAEL) of 150 mg/kg bw per day can be identified from this study.

9.2.3.2 Cardiovascular effects

Perry et al. (1985, 1989) exposed female Long-Evans weanling rats (13 per dose group) to barium chloride in drinking water at concentrations of 0, 1, 10 or 100 ppm for 1–16 months. An increase in mean systolic blood pressure was observed in the 10 ppm group at 8–16 months. The increase in the 100 ppm dose group was observed from the first month to the end of the study.

Other studies have not observed these associations following exposures as high as 150 mg/kg bw per day (1,000 ppm) (McCauley et al., 1985) and 180 mg/kg bw per day (4,000 ppm) (NTP 1994). Animals in the Perry et al. (1985, 1989) studies were fed a rye-based diet with calcium levels below the recommended daily requirement (NRC, 1995), which may have rendered them more sensitive to the cardiovascular effects of barium; since some evidence in humans indicates that reduced dietary calcium is a risk factor for hypertension (McCarron et al., 1984), the relevance of the results from these studies is uncertain.

9.2.3.3 Other effects

Lymphoid depletion was observed in the spleen, thymus and lymph nodes of mice and rats exposed to 2,500 ppm barium chloride dihydrate for 103–105 weeks (NTP, 1994). A NOAEL of 180 mg/kg bw per day for rats and 205 mg/kg bw per day for mice can be identified from this study.

9.2.3.4 Carcinogenicity

No increase in tumour incidence was observed in Fisher-344/N rats or B6C3F1 mice exposed to concentrations of up to 2,500 mg/L of barium (60–75 mg/kg bw per day in rats; 160–200 mg/kg bw per day in mice) via drinking water for 2 years (NTP, 1994). Statistically significant decreases were observed in the trends of mononuclear cell leukemia and neoplasms as well as non-neoplastic lesions of the adrenal gland in male rats and of the mammary gland in female rats. Also, statistically significant decreases in hepatocellular adenoma were observed in male mice. Moreover, no increase in tumours was found in Long-Evans rats or Swiss mice (52 animals/species/sex) exposed to 5 ppm barium acetate in drinking water for 540 days (Schroeder and Mitchener, 1975a, 1975b), or after male SD rats were exposed to 1–100 ppm barium chloride for 68 weeks (McCauley et al., 1985).

9.2.4 Genotoxicity

In vitro studies have generally not found evidence of barium genotoxicity; one *in vivo* study found an increase in one type of somatic mutation at a high dose.

9.2.4.1 In vitro findings

Barium chloride (10 to 10,000 µg/plate) caused no significant increase in gene mutation frequency in *Salmonella typhimurium* (TA97, TA98, TA100, TA1535, and TA1537) with and without Aroclor 1254-induced rat or hamster liver S9 fractions (Rossman et al., 1991; NTP, 1994). Moreover, no increase in gene mutation or DNA damage was found (via assay with H17 and M45 strains of *Bacillus subtilis*, DNA polymerase test from avian myoblastosis virus, and microscreen assay with *Escherichia coli* WP2) with barium nitrate and barium chloride (Nishioka, 1975; Sirover and Loeb, 1976a, 1976b; Kanematsu et al., 1980; Rossman et al., 1991). Also, barium chloride did not induce sister chromatid exchanges, chromosomal aberrations or cell cycle delay in Chinese hamster ovary cells (NTP, 1994). However, barium chloride (at 250 µg/ml and above) induced an increase in gene mutations in L5178Y mouse lymphoma cells in the presence of metabolic activation (no increases in mutant colonies were observed without S9 activation) (NTP, 1994).

9.2.4.2 In vivo findings

Yesilada (2001) reported increases in small single wing spots (the wing spot test is indicative of somatic mutations) in *Drosophila melanogaster* exposed to high concentrations of barium nitrate (10 mM), but not at lower concentrations (1 mM). The effect of barium on large single spots and twin spots was inconclusive at both 1 and 10 mM.

9.2.5 Reproductive and developmental toxicity

In the NTP (1994) study, as described above, significantly increased testicular ($p \leq 0.01$) and uterine ($p \leq 0.05$) weights were observed in rats of the 2,500 ppm dose group (60 mg Ba/kg bw per day for males and 75 mg Ba/kg bw per day for females) following 15 months of exposure via drinking water; no significant changes in the weights of reproductive organs were observed in mice. A NOAEL of 60 mg/kg bw per day for rats and 160 mg/kg bw per day for mice can be identified from this study. However, the significance of these findings is unknown, since reproductive and developmental toxicity was not assessed.

Dietz et al. (1992) conducted a single-generation mating trial in which groups of male and female F-344/N rats and B6C3F1 mice (20/sex/species/group) were exposed to barium chloride dihydrate in the drinking water at 0, 1,000, 2,000, or 4,000 ppm for the rats and 0, 500, 1,000, or 2,000 ppm for the mice for 60 days (males) or 30 days (females). Estimated doses (from a subchronic study by the same authors described in Section 9.2.2) for rats were 0, 65, 110, and 200 mg/kg per day for males and 0, 65, 115, and 180 mg/kg per day for females; for mice the estimated doses were 0, 55, 100, and 205 mg/kg per day for males and 0, 60, 110, and 200 mg/kg per day for females. After the exposure period, males and females from the same exposure groups were housed together until there was evidence of mating or until the end of the mating period (8 days). Numerous reproductive parameters were assessed. For both rats and mice no changes in epididymal sperm counts, sperm motility, sperm morphology, testicular or epididymal weights or vaginal cytology were observed. In rats, pregnancy rates were below historically normal values for the laboratory; however, they were not treatment related. No significant alterations in gestation length, pup survival, or occurrence of external abnormalities were observed. A statistically significant ($p < 0.01$) decrease in live pup weight at birth was observed in the 4,000 ppm group; however, after 5 days of age no significant alterations in pup body weight were observed. In mice, no alterations in maternal weight gain, average length of gestation, pup survival or pup weights were observed. A statistically significant ($p < 0.05$) decrease in average litter size occurred on days 0 and 5 in the 1,000 ppm treatment group but not in the 2,000 ppm treatment group. No external abnormalities were observed in the offspring. A NOAEL of 115 mg/kg bw per day for rats and 200 mg/kg bw per day for mice can be identified from this study.

Decreased ovary weight and ovaries/brain weight ratio were observed in 29- to 37-day-old Sprague-Dawley rats (10 animals/sex/dose) exposed to 198 mg Ba/kg from barium chloride administered by gavage in water once daily for 10 days, but not at 138 mg Ba/kg (Borzelleca et al., 1988); thus a NOAEL of 138 mg Ba/kg can be identified from this study.

9.3 Mode of action

As reported in Section 9.2, chronic and subchronic drinking water studies in rats and mice indicate that the kidney is a sensitive target of barium toxicity; however, the mode of action for barium-mediated kidney toxicity has not been fully elucidated. Available data indicate that kidney toxicity may be associated with oxidative processes. Wistar rats receiving 67 mg/L barium chloride for 21 days had an increase in kidney and liver markers of oxidative stress (tissue lipoperoxide, lipid hydroperoxides, advanced oxidation protein product, malondialdehyde, and H_2O_2 levels), a decrease in catalase, superoxide dismutase and glutathione peroxidase enzyme activities, vitamin C, and glutathione and non-protein thiol. An increase in metallothionein content was also observed (Elwej et al., 2016a, 2016b). Thus, oxidative stress could be responsible for damaged cellular macromolecules, such as proteins, cell membranes and/or disruption of the mitochondrial respiration chain (Storz et al., 2005). The oxidative stress hypothesis is supported by high levels of H_2O_2, malondialdehyde and advanced oxidation protein product. More specifically, H_2O_2 can be converted to the hydroxyl radical, which can cause rapid lipid peroxidation and the depletion of glutathione levels, increasing the susceptibility of organs to oxidative stress. Moreover, the oral administration of pomegranate peel powder (5% of diet) improved all barium-induced renal and liver damage, possibly by acting as an electron donor (antioxidant).

The acute cardiovascular and neuromuscular toxicity of barium reported in case studies has been attributed to its hypokalemia effect (Roza and Berman, 1971; Koch et al., 2003). As a potassium channel antagonist, barium increases intracellular potassium and decreases its extracellular levels by blocking the efflux of cellular potassium and increasing the sodium-potassium-ATPase pump activity (Payen et al., 2011). It is possible that the increased intracellular potassium concentrations may result in a decreased resting membrane potential; however, there is also evidence of a barium-induced neuromuscular blockade and membrane depolarization (Phelan et al., 1984; Thomas et al., 1998). In addition, since barium has chemical properties similar to calcium, they can interact through biochemical pathways involving calcium binding proteins and compete for binding sites (IPCS, 1990). Hypertensive effects of barium in rats reported by Perry et al. (1989) may have been due to inadequate calcium levels in the diet.

10.0 Classification and assessment

The International Agency for Research on Cancer (IARC) has not classified barium as to its carcinogenicity. The U.S. EPA (2005) concluded that barium is considered not likely to be carcinogenic to humans via oral intake. Other agencies have concluded that there is no evidence that barium is carcinogenic via the oral route (IPCS, 2001; WHO, 2016). Several animal studies found no increase in tumours following long-term exposure to barium in drinking water at levels as high as 2,500 mg/L (60–75 mg/kg bw per day in rats; 160–200 mg/kg bw per day in mice) (Schroeder and Mitchener, 1975a, 1975b; McCauley et al., 1985; NTP, 1994).

Nephropathy in mice is considered to be the most sensitive health effect associated with chronic oral exposure to soluble salts of barium. In humans, renal failure has been observed following exposure to high levels of barium in poisoning events (see Section 9.1). The chronic mouse study by the NTP (1994) was chosen as the key study for deriving a health-based value (HBV) for barium in drinking water for the following reasons: it used an adequate number of animals (60/sex/dose); administration of barium was via drinking water; histopathological analysis indicated that the observed renal lesions were morphologically different from the spontaneous degenerative renal lesions commonly observed in aging mice; and mice appear to be the most sensitive of the animal species tested, exhibiting the lowest NOAEL for kidney effects (75 mg/kg bw per day). Additionally, a dose–response relationship was observed; a statistically significant number of mice in the high dose group exhibited mild to severe cases of nephropathy (along with a significant increase in mortality due to treatment-related renal lesions), and within the second highest dose group, one female and two males (out of 60) exhibited mild to moderate chemical-related nephropathy.

Hypertension has also been reported in animals and humans following exposure to barium; however, the evidence is conflicting. In humans, the dose–response data are insufficient to support an association between chronic barium exposure and hypertension. Results from epidemiological studies are limited either by their small sample sizes, short durations of exposure, poor exposure characterization, inadequate controlling of important risk factors for hypertension, or a combination thereof. In animals the results are equivocal; the positive findings are potentially influenced by an experimental diet low in calcium, which has been identified as a possible risk factor for hypertension in humans. As a result the data on hypertensive effects were considered inadequate for deriving an HBV.

Benchmark dose (BMD; U.S. EPA BMD software version 2.6.1) modelling was performed using the nephropathy incidence in mice as reported in the 2-year NTP (1994) study at a 10% and 5% increased incidence over background rates (the benchmark response; BMR). Male and female mouse data were modelled separately as well as combined, with both average dose and individual gender doses giving similar modelling results. Of the models that provided a reasonable fit (via evaluation of goodness of fit p-value > 0.1; BMD/BMDL (benchmark dose lower confidence limit) ratio < 5; and visual inspection of the curve), the model providing the best fit (i.e., lowest Akaike information criterion) as well as the most conservative BMD/BMDL values was the multistage 3 model for male mice. A BMR of 5% was selected due to the following statistical and biological considerations: the study design provides sufficient statistical power (e.g., 50–100 animals/dose/sex); the BMR falls near the low end of the observable dose range; the BMD and BMDL values are similar; and the health endpoint is severe. As the lower 95% confidence limit on the benchmark dose for a 5% response ($BMDL_5$) of 58 mg/kg bw per day for male mice is lower than the corresponding values for both females and males and females combined, this has been selected as the point of departure for the calculation of the HBV for barium in drinking water.

Limited information is available on the age-related differences in susceptibility to barium. Although adults were symptomatic, children did not appear to be affected in two food poisoning incidents involving barium carbonate (Lewi and Bar-Khayim, 1964; Deng et al., 1991); however, the lack of examination of children and the uncertainty regarding their barium intake limits the interpretation of these results. Age-related differences in the absorption of ingested barium are reported for both animals and humans. Studies by Taylor et al. (1962) and Cuddihy and Griffith (1972) indicate that oral absorption of barium in younger animals may be an order of magnitude greater than in older animals; additionally, the ICRP (1993) estimates the oral absorption of soluble barium to be 60% in infants, 30% in children 1–15 years old and 20% in adults. With increased uptake of barium and higher bone remodelling rates in infants and children than in adults, there is a greater potential for barium accumulation in bone; however, the significance of this not known and requires further investigation.

Using the $BMDL_5$ identified above, a tolerable daily intake (TDI) can be calculated as follows:

$$\text{TDI} = \frac{58 \text{ mg/kg bw per day}}{300}$$

$$= 0.19\text{mg/kg bw per day}$$

where:

- 58 mg/kg bw per day is the lower 95% confidence limit on the benchmark dose ($BMDL_5$) for increased incidence of nephropathy in male mice as described above; and

- 300 is the uncertainty factor (10 for interspecies and 10 for intraspecies variation, as well as 3 for database deficiencies, including the lack of a two-generation reproduction toxicity study).

Using this TDI, the HBV for barium in drinking water for non-cancer effects is derived as follows:

$$\text{HBV} = \frac{0.19 \text{ mg/kg bw per day} \times 74 \text{ kg} \times 0.20}{1.53 \text{ L per day}}$$

$$= 2.0 \text{ mg/L (rounded)}$$

where:

- 0.19 mg/kg bw per day is the TDI, as derived above;
- 74 kg is the average body weight for an adult (Health Canada, 2019);
- 0.2 is the allocation factor for drinking water, since food represents the main source of exposure and drinking water represents a significant but lesser source of exposure (see Section 5.0); and
- 1.53 L/day is the drinking water intake rate for an adult (Health Canada, 2019).

11.0 International considerations

The U.S. EPA (1995) established a maximum contaminant level of 2 mg/L based on the possibility of increased blood pressure in humans. In a more recent evaluation, the U.S. EPA IRIS derived an RfD of 200 µg/kg bw per day for nephrotoxicity based on the benchmark dose lower 95% confidence limit ($BMDL_5$) of 63 mg/kg bw per day derived from a 2-year mouse study (U.S. EPA, 2005). Although the same key study was used in both assessments, Health Canada and the U.S. EPA's points of departure differ because Health Canada used 2-year nephropathy data only, as reported by the NTP (1994), whereas the EPA included both the interim 15-month and 2-year evaluations.

The WHO (2016) established a drinking water guideline value of 1.3 mg/L for barium based on the same uncertainty factor (300) and $BMDL_5$ of 63 mg/kg bw per day as determined by the U.S. EPA (2005). An allocation factor of 20%, an adult body weight of 60 kg and a drinking- water consumption rate of 2 L per day were used in calculating the final guideline value.

The Australian government has established a drinking water guideline of 2.0 mg/L based on a NOAEL of 0.2 mg/kg bw per day from Brenniman and Levy (1985) for no observed adverse effects on blood pressure and kidney disease (NHMRC, 2011).

12.0 Rationale

Barium is present in many drinking water sources, both naturally and as a result of human activities. The barium levels in Canadian drinking water will vary greatly, depending on geological formations as well as anthropogenic activities, including oil and gas exploration and the use of fertilizers and pesticides. Barium exists as a mixture of over 20 naturally occurring radioisotopes with various levels of radioactivity. The focus of this document is limited to barium's chemical properties. Based on these chemical properties, exposure to barium from drinking water would only be a concern from ingestion—it is not expected to be a concern through either inhalation or dermal absorption.

IARC has not classified barium as to its carcinogenicity. The U.S. EPA concluded that barium is not likely to be carcinogenic to humans via ingestion, and other international agencies have stated that there is no evidence showing that barium could cause cancer via ingestion. The kidneys are considered to be the major target for barium toxicity. In humans, renal failure has been observed following exposure to high levels of barium in poisoning events; in animals, kidney effects are considered the most sensitive health effect associated with chronic oral exposure, especially in mice, the most sensitive species. For these reasons, an HBV of 2.0 mg/L was derived to be protective of the general population, based on kidney effects from a study in mice.

A MAC of 2.0 mg/L is established for barium in drinking water. The MAC is protective of potential health effects, can be reliably measured by available analytical methods and is achievable by municipal and residential scale treatment technologies. As part of its ongoing guideline review process, Health Canada will continue to monitor new research in this area and recommend any change to the guideline that is deemed necessary.

13.0 References

AGAT Laboratories (2019). Personal communications with S. Sambrano (Burnaby, B.C.).

ALS Environmental (2019). Personal communication with Hua Wo (Winnipeg, MB).

Aoun, M., Plasari, E., David, R. and Villermaux, J. (1996). Are barium sulfate kinetics sufficiently well known for testing precipitation reactor models? Chem. Eng. Sci., 51(10): 2449–2458.

APHA, AWWA and WEF (2017). Standard methods for the examination of water and wastewater, 23nd edition. American Public Health Association, American Water Works Association and Water Environment Federation, Washington, DC.

Araissi, M., Ayed, I., Elaloui, E. and Moussaoui, Y. (2016). Removal of barium and strontium from aqueous solution using zeolite 4A. Water Sci. Technol., 73(7): 1628–1636.

Atassi, A., Feizoulof, C., Lecuyer, E., Nebel, J. and Medler, S. (2007). Barium removal using selective ion exchange with calcium chloride regeneration for reducing chloride discharge. Proceedings of the American Water Works Association Water Quality Technology Conference, Toronto, Ontario.

ATSDR (2007). Toxicological profile for barium. Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services, Public Health Service, Atlanta, Georgia.

Baldi, F., Pepi, M., Burrini, D., Kniewald, G., Scali, D. and Lanciotti, E. (1996). Dissolution of barium from barite in sewage sludges and cultures of *desulfovibrio desulfuricans*. Appl. Environ. Microbiol., 62(7): 2398–2404.

Bhoelan, B. S., Stevering, C. H., van der Boog, A. T. J. and van der Heyden, M. A. G. (2014). Barium toxicity and the role of the potassium inward rectifier current. Clin. Toxicol., 52(6): 584–593.

Blaurock-Busch, E., Amin, O.R. and Rabah, T. (2011). Heavy metals and trace elements in hair and urine of a sample of arab children with autistic spectrum disorder. Mædica, 6(4): 247–257.

Boerlage, S., Kennedy, M.D., Bremere, I., Witkamp, G.J., Van Der Hoek, J.P. and Schippers, J.C. (2000). Stable barium sulphate supersaturation in reverse osmosis. J. Membr. Sci., 179(1–2): 53–68.

Boerlage, S.F.E., Kennedy, M.D., Bremere, I., Witkamp, G.J., Van der Hoek, J.P. and Schippers, J.C. (2002). The scaling potential of barium sulphate in reverse osmosis systems. J. Membr. Sci., 197(1–2): 251-268.

Boffito, C. (1991). Barium. Kirk-Othmer encyclopedia of chemical technology. 4th Edition. John Wiley and Sons., Hoboken, New Jersey, 3: 902–908.

Borzelleca, J.F., Condie, L.W. and Egle, J.L. (1988). Short-term toxicity (one-and ten-day gavage) of barium chloride in male and female rats. Int. J. Toxicol., 7(5): 675–685.

Brenniman, G.R., Namekata, T., Kojola, W.H., Carnow, B.W. and Levy, P.S. (1979). Cardiovascular disease death rates in communities with elevated levels of barium in drinking water. Environ. Res., 20(2): 318–324.

Brenniman, G.R., Kojola, W.H., Levy, P.S., Carnow, B.W. and Namekata, T. (1981). High barium levels in public drinking water and its association with elevated blood pressure. Arch. Environ. Health, 36(1): 28–32.

Brenniman, G.R. and Levy, P.S. (1985). Epidemiological study of barium in Illinois drinking water supplies. In: Advances in modern environmental toxicology. Vol. IX. Princeton Publishing Co., Princeton, NJ. (ed.). pp. 231–249.

Breuer, M., Ditrich, K., Habicher, T., Hauer, B., Kesseler, M., Sturmer, R. and Zelinski, T. (2004). Industrial methods for the production of optically active intermediates. Angew. Chem. Int. Ed. Engl., 43(7): 788–824.

British Columbia Ministry of Health (2017). Personal communication from D. Fishwick.

CCME (2013). Canadian soil quality guidelines for barium: Protection of human health. Scientific criteria document PN 1493 ISBN 978-1-896997- 97-1 PDF. Canadian Council of Ministers of the Environment. Available at: www.ccme.ca/files/Resources/supporting_scientific_documents/pn_1493_basqg_scd_prob_1.0.pdf

CDC (2015). Fourth national report on human exposure to environmental chemicals. Updated tables, February. U.S. Department of Health and Human Services. Centers for Disease Control and Prevention, Atlanta, Georgia. Available at: www.cdc.gov/biomonitoring/pdf/FourthReport_UpdatedTables_Feb2015.pdf

CEAEQ (2018). Centre d'expertise en analyse environnementale du Quebec. Programme d'accreditation des laboratories d'analyse. Critères de variation relatifs, DR-12-VCR. Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques,

Charette, M.A. and Sholkovitz, E.R. (2006). Trace element cycling in a subterranean estuary: Part 2. Geochemistry of the pore water. Geochim. Cosmochim. Acta, 70(4): 811–826.

Chellan, P. and Sadler, P.J. (2015). The elements of life and medicines. Philos. Trans. A Math. Phys. Eng. Sci., 373(2037).

Clifford, D.A. (1999). Ion exchange and inorganic adsorption. Chapter 9 in: Water quality and treatment: a handbook of community water supplies, 5th edition. Letterman, R.D. (ed). American Water Works Association. Denver, Colorado.

Clifford, D., Sorg, T. and Ghurye, G. (2011). Ion exchange and adsorption of inorganic contaminants. Chapter 12 in: Water quality and treatment: A handbook of drinking water. 6th edition. Edzwald, J.K. (ed.). American Water Works Association, Denver, Colorado.

Colbert, D. and McManus, J. (2005). Importance of seasonal variability and coastal processes on estuarine manganese and barium cycling in a Pacific Northwest estuary. Cont. Shelf Res., 25(11): 1395–1414.

CRC (2017). CRC handbook of chemistry and physics. Rumble, J.R.. (ed.). 98th edition. Available at: http://hbcponline.com/faces/contents/ContentsSearch.xhtml

Cuddihy, R.G. and Griffith, W.C. (1972). A biological model describing tissue distribution and whole-body retention of barium and lanthanum in beagle dogs after inhalation and gavage. Health Phys., 23(5): 621–633.

Deng, J.F., Jan, I.S. and Cheng, H.S. (1991). The essential role of a poison center in handling an outbreak of barium carbonate poisoning. Vet. Hum. Toxicol., 33(2): 173–175.

Dibello, P. M., Manganaro, J. L., Aguinaldo, E. R., Mahmood, T. and Lindahl, C. B. (2003). Barium compounds. Kirk-Othmer encyclopedia of chemical technology. Available at: https://onlinelibrary.wiley.com/doi/pdf/10.1002/0471238961.0201180904090205.a01.pub2

Diengott, D., Rozsa, O., Levy, N. and Muammar, S. (1964). Hypokalaemia in barium poisoning. Lancet, 284(7355): 343–344.

Dietz, D.D., Elwell, M.R., Davis, W.E. and Meirhenry, E.F. (1992). Subchronic toxicity of barium chloride dihydrate administered to rats and mice in the drinking water. Fundam. Appl. Toxicol., 19: 527–537.

Downs, J.C.U., Milling, D. and Nichols, C.A. (1995). Suicidal ingestion of barium-sulfide-containing shaving powder. Am. J. Forensic Med. Pathol., 16(1): 56–61.

Dumont, M. (2007). Barite and witherite. Canadian minerals yearbook. Natural Resources Canada, Minerals and Metals Sector. [as cited in CCME, 2013]

ECCC (2016). Science approach document biomonitoring-based approach 2 for barium-containing substances molybdenum-containing substances silver-containing substances thallium-containing substances inorganic tin-containing substances. Environment and Climate Change Canada. Available at: www.ec.gc.ca/ese-ees/default.asp?lang=En&n=D335D89F-1#toc03

ECCC (2017). National long-term water quality monitoring data. Environment and Climate Change Canada. Available at: http://data.ec.gc.ca/data/substances/monitor/national-long-term-water-quality-monitoring-data/?lang=en

Elder, D. and Budd, G.C. (2011). Overview of water treatment processes. Chapter 5 in: Water quality and treatment: a handbook on drinking water. 6th edition. Edzwald, J.K. (ed.). American Water Works Association, Denver, Colorado.

Elwej, A., Ghorbel, I., Marrekchi, R., Boudawara, O., Jamoussi, K., Boudawara, T., Zeghal, N. and Sefi, M. (2016a). Improvement of kidney redox states contributes to the beneficial effects of dietary pomegranate peel against barium chloride-induced nephrotoxicity in adult rats. Arch. Physiol. Biochem., 122(3): 130–140.

Elwej, A., Grojja, Y., Ghorbel, I., Boudawara, O., Jarraya, R., Boudawara, T. and Zeghal, N. (2016b). Barium chloride induces redox status unbalance, upregulates cytokine genes expression and confers hepatotoxicity in rats—alleviation by pomegranate peel. Environ. Sci. Pollut. Res., 23(8): 7559–7571.

Environment Canada (2011). National Air Pollution Surveillance Program. PM Speciation - metals data (9 files). Available at: http://maps-cartes.ec.gc.ca/rnspa-naps/data.aspx?lang=en

Environment Canada (2013). National air pollution surveillance (NAPS) monitoring results. Environment Canada. Available at: http://maps-cartes.ec.gc.ca/rnspa-naps/data.aspx?lang=en

Ferrante, M., Conti, G.O., Rasic-Milutinovic, Z. and Jovanovic, D. (2014). Health effects of metals and related substances in drinking water. Ferrante, M., Conti, G.O., Rasic-Milutinovic, Z. and Jovanovic, D. (eds.). EWA Publishing, London, United Kingdom.

Friedman, M.J., Hill, A.S., Reiber, S.H., Valentine, R.L., Larsen, G., Young, A., Korshin, G.V. and Peng, C-Y. (2010). Assessment of inorganics accumulation in drinking water system scales and sediments. Water Research Foundation and United States Environmental Protection Agency, Denver, Colorado.

Gabelich, C.J., Williams, M.D., Rahardianto, A., Franklin, J.C. and Cohen, Y. (2007). High-recovery reverse osmosis desalination using intermediate chemical demineralization. J. Membr. Sci., 301(1–2): 131–141.

Gould, D.B. (1973). Barium sulfide poisoning. Some factors contributing to survival. Arch. Intern. Med., 132(6): 891–894.

Goullé, J.P., Mathieu, L., Castermant, J., Neveu, N., Bonneau, L., Laine, G., Bouige, D. and Lacroix, C. (2005). Metal and metalloid multi-elementary ICP-MS validation in whole blood, plasma, urine and hair. Reference values. Forensic Sci. Int. 153 (1): 39–44.

Groschen, G.E., Arnold, T.L., Morrow, W.S. and Warner, K.L. (2009). Occurrence and distribution of iron, manganese, and selected trace elements in ground water in the glacial aquifer system of the Northern United States. U.S. Geological Survey. Available at: https://pubs.usgs.gov/sir/2009/5006/pdf/SIR2009-5006.pdf

Hamilton, S.M. (2015). Ambient groundwater geochemistry data for southern Ontario, 2007–2014; Ontario Geological Survey, Miscellaneous Release—Data 283–Revised. Available at: http://www.geologyontario.mndm.gov.on.ca/mndmaccess/mndm_dir.asp?type=pub&id=MRD283-REV

Han, B.H., Han, J.Y., Ahn, H.K. and Nava-Ocampo, A.A. (2010). Conventional barium enema in early pregnancy. J. Obstet. Gynaecol., 30(6): 559–562.

Han, B.H., Lee, K.S., Han, J.Y., Choi, J.S., Ahn, H.K., Ryu, H.M., Yang, J.H., Han, H.W. and Nava-Ocampo, A.A. (2011). Pregnancy outcome after 1st-trimester inadvertent exposure to barium sulphate as a contrast media for upper gastrointestinal tract radiography. J. Obstet. Gynaecol., 31(7): 586–588.

He, C., Gross, M., Westerhoff, P.K., Fox, P. and Li, K. (2011). Comparing conventional and pelletized lime softening concentrate chemical stabilization. Water Research Foundation and City of Phoenix Water Services Department, Denver, Colorado.

Health Canada (2012a). Dietary intakes of contaminants and other chemicals for different age-sex groups of Canadians for Total Diet Study (1993–2007). Bureau of Chemical Safety, Health Products and Food Branch, Health Canada, Ottawa, Ontario. Available at: https://www.canada.ca/en/health-canada/services/food-nutrition/food-nutrition-surveillance/canadian-total-diet-study.html

Health Canada (2012b). Concentrations (ng/g) of trace elements in total diet study composites (1993–2012). Bureau of Chemical Safety, Health Products and Food Branch, Health Canada, Ottawa, Ontario. Available at: www.canada.ca/en/health-canada/services/food-nutrition/food-nutrition-surveillance/canadian-total-diet-study.html

Health Canada (2016). Personal communication from A. M. Tugulea.

Health Canada (2017). Licensed Natural Health Products Database. Available at: http://webprod.hc-sc.gc.ca/nhpid-bdipsn/search-rechercheReq.do

Health Canada (in preparation). Canadian exposure factors used in human health risk assessments. Health Canada, Ottawa, Ontario.

Heitland, P. and Koster, H.D. (2006). Biomonitoring of 30 trace elements in urine of children and adults by ICP-MS. Clin. Chim. Acta, 365 (1-2): 310–318.

ICRP (1980). Limits for intakes of radionuclides by workers. International Commission on Radiation Protection, Oxford, Permagon Press, ICRP Publication 30, Part 2.

ICRP (1993). Age-dependent doses to members of the public from intake of radionuclides - Part 2, Ingestion dose coefficients. International Commission on Radiation Protection, Publication 67, Ann. ICRP, 23 (3–4).

IPCS (1990). Barium. World Health Organization, International Programme on Chemical Safety, Geneva, Switzerland. (Environmental Health Criteria 107). Available at: www.inchem.org/documents/ehc/ehc/ehc107.htm

Jha, S.K., Kumar, R. and Verma, B.S. (1993). A case of barium carbonate poisoning. J. Assoc. Physicians India, 41(11): 750–751.

Jourdan, S., Bertoni, M., Sergio, P., Michele, P. and Rossi, M. (2001). Suicidal poisoning with barium chloride. Forensic Sci. Int., 119(2): 263–265.

Kanematsu, N., Hara, M. and Kada, T. (1980). Rec assay and mutagenicity studies on metal compounds. Mutat. Res./Gen. Toxicol., 77(2): 109–116.

Koch, M., Appoloni, O., Haufroid, V., Vincent, J. and Lheureux, P. (2003). Acute barium intoxication and hemodiafiltration. J. Toxicol. Clin. Toxicol., 41(4): 363–367.

Kojola, W.H., Brenniman, G.R. and Carnow, B.W. (1979). A review of environmental characteristics and health effects of barium in public water supplies. Rev. Environ. Health, 3(1): 79–95.

Kopp, S.J., Perry, H.M., Feliksik, J.M., Erlanger, M. and Perry, E.F. (1985). Cardiovascular dysfunction and hypersensitivity to sodium pentobarbital induced by chronic barium chloride ingestion. Toxicol. Appl. Pharmacol., 77(2): 303–314.

Krause, T.L. and Stover, E.L. (1982). Evaluating water treatment techniques for barium removal. J. Am. Water Works Assoc., 74(9): 478–485.

Kravchenko, J., Darrah, T.H., Miller, R.K., Lyerly, H.K. and Vengosh, A. (2014). A review of the health impacts of barium from natural and anthropogenic exposure. Environ. Geochem. Health, 36(4): 797–814.

Krishnan, K. and Carrier, R. (2008). Approaches for evaluating the relevance of multiroute exposures in establishing guideline values for drinking water contaminants. J. Environ. Sci. Health C, 26: 300–316.

Kugler, R.T., Doyle, S. and Kind, M. (2015). Fundamental insights into barium sulfate precipitation by time-resolved *in situ* synchrotron radiation wide-angle X-ray scattering (WAXS). Chem. Eng. Sci, 133: 140–147.

Leggett, R.W. (1992). Fractional absorption of ingested barium in adult humans. Health Phys., 62(6): 556–561.

LeRoy, G.V., Rust, J.H. and Hasterlik, R.J. (1966). The consequences of ingestion by man of real and simulated fallout. Health Phys., 12(4): 449–473.

Lewi, Z., Warsaw, D.M. and Bar-Khayim, Y. (1964). Food-poisoning from barium carbonate. Lancet, 284(7355): 342–343.

Lovins, W., Taylor, J., Kozic, R.M., Abbasedegan, M., LeChevallier, M. and Ajy, K. (1999). Multi-contaminant removal by integrated membrane systems. Proceedings of the American Water Works Association Water Quality and Technology Conference, Denver, Colorado.

Lukasik-Głębocka, M., Sommerfeld, K., Hanć, A., Grzegorowski, A., Barałkiewicz, D., Gaca, M. and Zielińska-Psuja, B. (2014). Barium determination in gastric contents, blood and urine by inductively coupled plasma mass spectrometry in the case of oral barium chloride poisoning. J. Anal. Toxicol., 38(6): 380–382.

Lytle, D.A., Sorg, T., Wang, L. and Chen, A. (2014). The accumulation of radioactive contaminants in drinking water distribution systems. Water Res., 50: 396–407.

Manitoba Conservation and Water Stewardship (2017). Personal communication with J. Muenster and K. Philip.

Maxxam Analytics (2019). Personal communication M. Comeau (Bedford. NS).

McCarron, D.A., Morris, C.D., Henry, H.J. and Stanton, J.L. (1984). Blood pressure and nutrient intake in the United States. Science, 224: 1392–1398.

McCauley, P.T. and Washington, I.S. (1983). Barium bioavailability as the chloride, sulfate, or carbonate salt in the rat. Drug Chem. Toxicol., 6(2): 209–217.

McCauley, P.T., Douglas, B.H., Laurie, R.D. and Bull, R.J. (1985). Investigations into the effect of drinking water barium on rats. In: Advances in modern environmental toxicology. Vol. IX. Princeton Publishing Co., Princeton, NJ. (ed.). pp. 197-210.

McComish, M.F. and Ong, J.H. (1988). Trace metals. Chapter 7 in: Environmental inorganic chemistry. Bodek, I., Lyman, W.J., Reehl, W.F. and Rosenblatt, D.H. (eds.). Pergamon Press, Amsterdam.

McNally, W.D. (1925). Two deaths from the administration of barium salts. J. Am. Med. Assoc., 84(24): 1805–1807.

Menzie, C.A., Southworth, B., Stephenson, G. and Feisthauer, N. (2008). The importance of understanding the chemical form of a metal in the environment: The case of barium sulfate (barite). Hum. Ecol. Risk Assess. 14(5): 974–991.

Miller, R., Featherstone, J., Curzon, M., Mills, T., and Shields, C. (1985). Barium in teeth as indicator of body burden. Adv. Mod. Env., 9: 211.

Ministère de l'Environnement et de la Lutte contre les changements climatiques (2017). Personal communication from C. Robert and A. Bolduc.

Moore, W.S. (2010). A reevaluation of submarine groundwater discharge along the southeastern coast of North America. Global Biogeochem. Cycles, 24(4): n/a-n/a.

Morton, W. (1945). Poisoning by barium carbonate. Lancet, 246(6380): 738–739.

Murray, J.W. (1975). The interaction of metal ions at the manganese dioxide-solution interface. Geochim. Cosmochim. Acta, 39(4): 505–519.

Myers, A.G., Snoeyink, V.L. and Snyder, D.W. (1985). Removing barium and radium through calcium cation exchange. J. Am. Water Works Assoc., 77(5): 60–66.

New Brunswick Department of Health (2017). Personal communication with K. Gould.

New Zealand Ministry of Health (2013). Survey of selected samples of tattoo inks for the presence of heavy metals. Ministry of Health, Wellington. Available at: https://www.health.govt.nz/publication/survey-selected-samples-tattoo-inks-presence-heavy-metals-2013

Newfoundland and Labrador Department of Environment and Conservation (2017). Personal communication from H. Khan.

NHMRC (2011). Australian drinking water guidelines. National Health and Medical Research Council. Available at: https://nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Ning, R.Y., Tarquin, A., Trzcinski, M. and Patwardhan, G. (2006). Recovery optimization of RO concentrate from desert wells. Desalination, 201(1–3): 315–322.

Nishioka, H. (1975). Mutagenic activities of metal compounds in bacteria. Mutat. Res. Envir. Muta., 31(3): 185–189.

NRC (1995). Nutrient requirements of laboratory animals. National Research Council. National Academy Press, Washington, DC, p. 13.

NSF/ANSI (2015). Standard 60: Drinking water treatment chemicals—health effects. NSF International/American National Standards Institute, Ann Arbor, Michigan.

NSF/ANSI (2016a). Standard 44: Residential cation exchange water softeners. NSF International/American National Standards Institute, Ann Arbor, Michigan.

NSF/ANSI (2016b). Standard 58: Reverse osmosis drinking water treatment systems. NSF International/American National Standards Institute, Ann Arbor, Michigan.

NSF/ANSI (2016c). Standard 62: Drinking water distillation systems. NSF International/American National Standards Institute, Ann Arbor, Michigan.

NSF/ANSI (2016d). Standard 61: Drinking water system components—health effects. NSF International/American National Standards Institute, Ann Arbor, Michigan.

NTP (1994). Toxicology and carcinogenesis studies of barium chloride dihydrate (CAS No. 10326-27-9) in: F344/N rats and B6C3F1 mice (Drinking Water Studies). National Toxicology Program, Tech. Rep. Ser., 432: 1–285.

Odell, L. (2010). Treatment technologies for groundwater. American Water Works Association. Denver, Colorado.

Ogen, S., Rosenbluth, S. and Eisenberg, A. (1967). Food poisoning due to barium carbonate in sausage. Isr. J. Med. Sci., 3(4): 565–568.

Ohgami, N., Hori, S., Ohgami, K., Tamura, H., Tsuzuki, T., Ohnuma, S. and Kato, M. (2012). Exposure to low-dose barium by drinking water causes hearing loss in mice. Neurotoxicol., 33(5): 1276–1283.

Ohgami, N., Mitsumatsu, Y., Ahsan, N., Akhand, A.A., Li, X., Iida, M., Yajima, I., Naito, M., Wakai, K., Ohnuma, S. and Kato, M. (2016). Epidemiological analysis of the association between hearing and barium in humans. J. Expos. Sci. Environ. Epidemiol., 26(5): 488–493.

Padilla, M.A., Elobeid, M., Ruden, D.M. and Allison, D.B. (2010). An examination of the association of selected toxic metals with total and central obesity indices: NHANES 99-02. Int. J. Environ. Res. Public Health, 7: 3332–3347.

Parks, J.L. and Edwards, M. (2006). Precipitative removal of As, Ba, B, Cr, Sr and V using sodium carbonate, ASCE J. Environ. Eng., 132(5): 489–496.

Paschal, D.C., Ting, B.G., Morrow, J.C., Pirkle, J.L., Jackson, R.J., Sampson, E.J., Miller, D.T. and Caldwell, K.L. (1998). Trace metals in urine of United States residents: reference range concentrations. Environ. Res., 76 (1): 53–59.

Payen, C., Dellinger, A., Pulce, C., Cirimele, V., Carbonnel, V., Kintz, P. and Descotes, J. (2011). Intoxication by large amounts of barium nitrate overcome by early massive K supplementation and oral administration of magnesium sulphate. Hum. Exp. Toxicol., 30(1): 34–37.

PEI Department of Communities, Land and Environment (2017). Personal communication from G. Somers.

Peng, C., Hill, A.S., Friedman, M.J., Valentine, R.L., Larson, G.S., Romero, A.M.Y., Reiber, S.H. and Korshin, G.V. (2012). Occurrence of trace inorganic contaminants in drinking water distribution systems. J. Am. Water Works Assoc., 104(3): 53–54.

Perry, H.M., Perry, E.F., Erlanger, M.W. and Kopp, S.J. (1985). Barium-induced hypertension. Chapter 20 in: Inorganics in drinking water and cardiovascular disease. Calabrese, E. (ed). Princeton, New Jersey, Princeton Publishing Co., pp. 221–229.

Perry Jr, H.M., Perry, H.M., Kopp, S.J., Kopp, S.J., Perry, E.F., Perry, E.F., Erlanger, M.W. and Erlanger, M.W. (1989). Hypertension and associated cardiovascular abnormalities induced by chronic barium feeding. J. Toxicol. Environ. Health, 28(3): 373–388.

Phelan, D.M., Hagley, S.R. and Guerin, M.D. (1984). Is hypokalaemia the cause of paralysis in barium poisoning? Br. Med. J., 289(6449): 882.

Rahardianto, A., Gao, J., Gabelich, C.J., Williams, M.D. and Cohen, Y. (2007). High recovery membrane desalting of low-salinity brackish water: Integration of accelerated precipitation softening with membrane RO. J. Membr. Sci., 289(1–2): 123–137.

Rai, D., Zahara, J., Schwab, A., Schmidt, R., Girvin, D. and Rogers, J. (1984). Chemical attenuation rates, coefficients and constant in leachate migration. Vol I: A critical review. Pacific Northwest Laboratories, Richland, Washington.

Rasmussen, P.E., Subramanian, K.S. and Jessiman, B.J. (2001). A multi-element profile of housedust in relation to exterior dust and soils in the city of Ottawa, Canada. Sci. Total Environ., 267(1–3): 125–140.

Rasmussen et al. (2016). Preliminary exposure data for five metals from 2014-2017 CMP(3) research. February 15, 2016. Exposure and Biomonitoring Division, Health Canada, Ottawa, Ontario. Personal communication, unpublished data [as cited in ECCC, 2016].

Rhyee, S.H. and Heard, K. (2009). Acute barium toxicity from ingestion of "snake" fireworks. J. Med. Toxicol., 5(4): 209–213.

Rossman, T.G., Molina, M., Meyer, L., Boone, P., Klein, C.B., Wang, Z., Li, F., Lin, W.C. and Kinney, P.L. (1991). Performance of 133 compounds in the lambda prophage induction endpoint of the Microscreen assay and a comparison with *S. typhimurium* mutagenicity and rodent carcinogenicity assays. Mutat. Res./Gen. Toxicol., 260(4): 349–367.

Roza, O. and Berman, L.B. (1971). The pathophysiology of barium: hypokalemic and cardiovascular effects. J. Pharmacol. Exp. Ther., 177(2): 433–439.

Saskatchewan Water Security Agency (2017). Personal communication from S. Ferris.

Sato, I., Kudo, H. and Tsuda, S. (2011). Removal efficiency of water purifier and adsorbent for iodine, cesium, strontium, barium and zirconium in drinking water. J. Toxicol. Sci., 36(6): 829–834.

SCC (2019). Directory of accredited product, process and service certification bodies. Standards Council of Canada, Ottawa, Ontario. Available at: http://www.scc.ca/en/accreditation/product-process-and-service-certification/directory-of-accredited-clients

Schock, M. Hyland, R. and Welch, M. (2008). Occurrence of contaminant accumulation in lead pipe scales from domestic drinking-water distribution systems. Environ. Sci. Technol, 42(12): 4285–4291.

Schroeder, H.A., Tipton, I.H. and Nason, P. (1972). Trace metals in man: strontium and barium. J. Chronic Dis., 25: 491–517.

Schroeder, H.A. and Mitchener, M. (1975a). Life-term studies in rats: effects of aluminum, barium, beryllium, and tungsten. J. Nutr., 105(4): 421–427.

Schroeder, H.A. and Mitchener, M. (1975b). Life-term effects of mercury, methyl mercury, and nine other trace metals on mice. J. Nutr, 105(4): 452–458.

Silva, T.A., Freitas, K.A. and Damasceno, J.J.R. (2003). Experimental evaluation of conical-cylindrical thickeners operating with aqueous barium sulfate suspensions. Mater. Sci. Forum, 416–418(1): 731–736.

Sirover, M.A. and Loeb, L.A. (1976a). Infidelity of DNA synthesis *in vitro*: screening for potential metal mutagens or carcinogens. Science, 194(4272): 1434–1436.

Sirover, M.A. and Loeb, L.A. (1976b). Metal-induced infidelity during DNA synthesis. Proc. Natl. Acad. Sci. U. S. A., 73(7): 2331–2335.

Snoeyink, V., Jongeward, C., Myers, A. and Richter, S. (1984). Barium and radium in water treatment plant wastes. U. S. Environment Protection Agency. Municipal Environmental Research Laboratory, Cincinatti, Ohio. EPA 600-S2-85-006.

Snoeyink, V.L., Cairns-Chambers, C. and Pfeffer, J.L. (1987a). Strong-acid ion exchange for removing barium, radium, and hardness. J. Am. Water Works Assoc., 79(8): 66–72.

Snoeyink, V., Chambers, C., Schmidt, C., Manner, r., Myers, A., Pfeffer, J., Richter, J., Richter, S. and Snyder, D. (1987b). Removal of barium and radium from groundwater. Water Engineering Research Laboratory, U. S. Environment Protection Agency, Cincinatti, Ohio. EPA 600-M-86-021.

Snyder, D.W., Snoeyink, V.L. and Pfeffer, J.L. (1986). Weak-acid ion exchange for removing barium, radium, and hardness. J. Am. Water Works Assoc., 78(9): 98–104.

Sorg, T.J. and Logsdon, G.S. (1980). Treatment technology to meet the interim primary drinking water regulations for inorganics: Part 5. J. Am. Water Works Assoc., 72(7): 411–422.

Storz, P., Döppler, H. and Toker, A. (2005). Protein kinase d mediates mitochondrion-to-nucleus signaling and detoxification from mitochondrial reactive oxygen species. Mol. Cell. Biol. 25(19): 8520–8530.

Sugiyama, M., Hori, T., Kihara, S. and Matsui, M. (1992). A geochemical study on the specific distribution of barium in Lake Biwa, Japan. Geochim. Cosmochim. Acta, 56(2): 597–605.

Talwar, K.K. and Sharma, B.K. (1979). Myocardial damage due to barium chloride poisoning. Indian Heart J., 31(4): 244–245.

Tang, J. and Johannesson, K.H. (2010). Ligand extraction of rare earth elements from aquifer sediments: implications for rare earth element complexation with organic matter in natural waters. Geochim. Cosmochim. Acta, 74(23): 6690–6705.

Tardiff, R.G., Robinson, M. and Ulmer, N.S. (1980). Subchronic oral toxicity of BaCl2 in rats. J. Environ. Pathol. Toxicol., 4(5–6): 267.

Taylor, D.M., Bligh, P.H. and Duggan, M.H. (1962). The absorption of calcium, strontium, barium and radium from the gastrointestinal tract of the rat. Biochem. J., 83: 25–29.

Taylor, S.R. (1964). Abundance of chemical elements in the continental crust: A new table. Geochim. Cosmochim. Acta, 28: 1273–1285.

Thomas, M., Bowie, D. and Walker, R. (1998). Acute barium intoxication following ingestion of ceramic glaze. Postgrad. Med. J., 74(875): 545–546.

Tipton, I. H., Stewart, P. L. and Dickson, J. (1969). Patterns of elemental excretion in long term balance studies. Health. Phys. 16: 455–462.

Tudorache, A., Marin, C., Badea, I.A. and Vladescu, L. (2010). Barium concentrations and speciation in mineral natural waters of central Romania. Environ. Monit. Assess., 165(1–4): 113–123.

U.S. EPA (1993). Barium metaborate R.E.D. facts. U.S. Environmental Protection Agency. Available at: www3.epa.gov/pesticides/chem_search/reg_actions/reregistration/fs_PC-011101_1-Dec-93.pdf

U.S. EPA. (1994a). Method 200.7 Revision 4.4. Determination of metals and trace elements in water and wastes by inductively coupled plasma-atomic emission spectrometry. Environment Monitoring Systems Laboratories, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio.

U.S. EPA. (1994b). Method 200.8 Revision 5.4. Determination of trace elements in waters and wastes by inductively coupled plasma-mass spectrometry. Environment Monitoring Systems Laboratories, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio.

U.S. EPA. (1995). National primary drinking water regulations. Barium. Office of Water, U.S. Environmental Protection Agency. EPA-811-F-95-002b-T. Available at: https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations#Inorganic

U.S. EPA. (1998). Small system compliance technology list for the non-microbial contaminants regulated before 1996. Office of Water, U.S. Environmental Protection Agency, Washington, DC. EPA 815-R-98-002.

U.S. EPA. (2003). Method 200.5 Revision 4.2. Determination of trace elements in drinking water by axially viewed inductively coupled plasma - atomic emission spectrometry. National Exposure Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio. EPA 600-R-06-115.

U.S. EPA. (2004). Risk assessment guidance for superfund. Volume I: Human health evaluation manual (Part E, Supplemental guidance for dermal risk assessment). Office of Superfund Remediation and Technology Innovation, U.S. Environmental Protection Agency, Washington, DC. EPA/540/R/99/005 OSWER 9285.7-02EP PB99-963312.

U.S. EPA. (2005). Toxicological review of barium and compounds (CAS No. 7440-39-3) In support of summary information on the Integrated Risk Information System (IRIS). U.S. Environmental Protection Agency, Washington, DC. EPA/635/R-05/001.

U.S. EPA. (2009). Analytical feasibility support document for the second six-year review of existing national primary drinking water regulations. Office of Water, U.S. Environmental Protection Agency, Washington, DC. EPA 815-B- 09-003.

U.S. EPA. (2012a). Federal Registry Part II. Revisions of the unregulated contaminant monitoring regulation (UCMR
3) for public water systems; final rule. Vol 77, No 85. May 2, 2012. U.S. Environmental Protection Agency, Washington, DC.

U.S. EPA. (2012b). Drinking water treatability database. Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC. Available at: http://iaspub.epa.gov/tdb/pages/general/home.do

U.S. EPA. (2012c). 2012 Edition of the drinking water standards and health advisories. Office of Water, U.S. Environmental Protection Agency, Washington, DC. Available at: https://nepis.epa.gov/Exe/ZyPDF.cgi/P100N01H.PDF?Dockey=P100N01H.PDF

Van Leeuwen, M.L.J., Bruinsma, O.S.L. and van Rosmalen, G.M. (1996). Three zone approach for precipitation of barium sulphate. J. Crystal Growth, 166: 1004–1008.

Venugopal, B. and Luckey, T.D. (1978). Metal toxicity in mammals, Volume 2: Chemical toxicity of metals and metalloids. Plenum Press, New York.

Wetherill, S.F., Guarino, M.J. and Cox, R.W. (1981). Acute renal failure associated with barium chloride poisoning. Ann. Intern. Med., 95(2): 187–188.

WHO (1990). Environmental health criteria 107. Barium. World Health Organization, International Program on Chemical Safety. Available at: www.inchem.org/documents/ehc/ehc/ehc107.htm

WHO (2001). Barium and barium compounds. Concise international chemical assessment document, World Health Organization, Geneva, Switzerland.

WHO (2016). Barium in drinking-water. Background document for development of WHO guidelines for drinking-water quality. World Health Organization, Geneva, Switzerland. Available at: https://www.who.int/water_sanitation_health/water-quality/guidelines/chemicals/barium-background-jan17.pdf

Willey, B.R. (1987). Finding treatment options for inorganics. Water Eng. Manage., 134(10): 28–31.

Wones, R.G., Stadler, B.L. and Frohman, L.A. (1990). Lack of effect of drinking water barium on cardiovascular risk factors. Environ. Health Perspect., 85: 355–359.

WQA. (2013). Barium fact sheet: Technical application bulletin. Water Quality Assocation, National Headquarters & Laboratory, Lisle, Illinois. Available at: https://www.wqa.org/Portals/0/Technical/Technical%20Fact%20Sheets/2014_Barium.pdf

Yesilada, E. (2001). Genotoxicity testing of some metals in the *drosophila* wing somatic mutation and recombination test. Bull. Environ. Contam. Toxicol., 66(4): 464–469.

Yukon Environmental Health Services (2017). Personal communication with P. Brooks.

Zasoski, R.J. and Burau, R.G. (1988). Sorption and sorptive interaction of cadmium and zinc on hydrous manganese oxide. Soil Sci. Soc. Am. J., 52:81–87.

Appendix A: List of acronyms

ATSDR	Agency for Toxic Substances and Disease Registry
BMD	benchmark dose
BMDL	benchmark dose lower confidence limit
BW	body weight
CCME	Canadian Council of Ministers of the Environment
CDC	Centers for Disease Control
CI	confidence interval
CSA CTDS	Canadian Standards Association Canadian Total Diet Study
DL	detection limit
DNA	deoxyribonucleic acid
ECG ED/EDR	electrocardiogram electrodialysis/electrodialysis reversal
EPA	Environmental Protection Agency (U.S.)
HBV	health-based value
IARC	International Agency for Research on Cancer
ICRP	International Commission on Radiological Protection
IPCS	International Programme on Chemical Safety
IX	ion exchange
LD_{50}	median lethal dose
LOAEL	lowest-observed-adverse-effect level
MDL	method detection limit
NF	nanofiltration
NHANES	National Health and Nutrition Examination Survey
NOAEL	no-observed-adverse-effect level
NRC	National Research Council
NSF	NSF International
NTP	National Toxicology Program (U.S.)
OR	odds ratio
RO	reverse osmosis
SAC	strong-acid cation
SCC	Standards Council of Canada
TDI	tolerable daily intake
TDS	total dissolved solids
WAC	weak-acid cation
WHO	World Health Organization

ATTACHMENT M

Water Treatment Specialist Correspondence

Nelson Water Inc
248 Westbrook Road
Carp, ON K0A 1L0
(613) 831-8491

Estimate 83212553
Job 83217529
Estimate Date 12/12/2024
Customer PO

Billing Address
LRL Engineering
Boundary Road
Ottawa, ON K0A Canada

Job Address
LRL Engineering
Boundary Road
Ottawa, ON K0A Canada

Estimate Details

Commercial Water Treatment Proposal: This system will provide similar water quality as to the previously sent water report of the neighbour.
It would reduce sodium, hardness, TDS, Chloride, Iron and other harmful traits.
Electrical is to be installed and provided by the owner.

Service #	Description	Quantity	Your Price	Your Total
NWS103	Installation package for Antiscale injection. Includes: • Labour to Install and configure ECON FP Stenner feed pump, mixing tank and 35 Gal chemical solution tank. • Durable and chemical resistant stainless steel injection port. • Stenner Flowmeter • anti scale concentrate (up to a year supply of anti scale) one jug • Anti-scale mixing ratio calculated based on your unique equipment and water chemistry.	1.00	$840.00	$840.00
7354492 Ecowater 7354492	ETF SERIES 12" **Chemical-Free Air Aspirated Sulfur/Iron Filter EIV** Electronic Timer Controls with HydroLink Plus Wi-Fi and Smartphone App Monitoring. EcoWater Systems factory warranty: Lifetime-5-7-1-1	1.00	$3,699.00	$3,699.00
NWMT948	Clack Mixing Tank Assembly 9" x 48" with in/out head and standpipe	1.00	$322.94	$322.94
E20PHF71S7 E20PHF71S7	ECON FP STENNER • Part only Price (stock item)	1.00	$799.99	$799.99
G21832PN7 Unk 35 Gal Chem	35 Gal Chem Solution Tank 18in X 33in	1.00	$246.53	$246.53
RSLHP7200 Waterite RSLHP7200	VECTAMAXX™ RSL High Pressure RO System 7200 GPD • VECTAMAXX™ RSL Higher pressure (225 psi) for feed water with up to 5000 TDS Stainless solenoids and fittings, stainless piping all systems include autoflush with RO controller and panel mount TDS meter.	1.00	$13,893.00	$13,893.00
43616 Norwesco 500 Gal	TANK - POLY 500 USGAL SPECIALTY 31 X 70 X 74" Weight: 193 lbs.	1.00	$3,633.00	$3,633.00
98562817 Grundfos SCALA2 3-45	SCALA2 PUMP, 22 GPM 3-45, **240V** 60HZ SELF PRIMING with pressure control • Successor to the Grundfos MQ • labour included to install pump with all material.	1.00	$2,359.50	$2,359.50
NWNF948 Nelson Water NWNF948	NWNF948 - Nelson Water Neutralizing Filter is a Re-mineralization System Loaded with Neutralite Media to raise PH	1.00	$695.00	$695.00
VH200-F10	VH200-F10 - UV Water Disinfection System	1.00	$1,049.99	$1,049.99

Viqua VH200-F10

Sub-Total	$27,538.95
Tax	$3,580.06
Total	$31,119.01
Est. Financing	$416.19

HST/GST 133676296

Risk-Free Guarantee: If the equipment does not perform as indicated by the manufacturer's specifications, you are entitled to a refund of the unit purchase price less installation and removal charges. The guarantee is valid one year from the installation date. The guarantee is conditional upon adherence to maintenance procedures as recommended by the manufacturer. Additional equipment may be required if input water quality differs from the time of installation. This estimate is only valid for 30 days from the estimate date.

Waterite

REVERSE OSMOSIS

COMMERCIAL REVERSE OSMOSIS SYSTEMS

Designed with our ***XFLOW*** membrane technology, Waterite's commercial RO systems combine ultra-low system maintenance, pressures with high balanced membrane element cross flows; achieve high efficiency and big energy savings. All systems feature quality Waterite ***BLACKMAXX***® RO membrane elements. Our Systems are certified to CAN/USA C22.2 No.68 Standards for motor operated appliances.

Commercial Reverse Osmosis Systems

VECTAPURE ***RSX II™*** (Nominal 350-700 GPD)

Vectapure RSX™ systems include as standard features: stainless membrane housings, heavy duty rotary vane pumps, stainless steel needle valves, 10” Big Blue 5 micron polyspun prefilter and a powder coated aluminum frame for corrosion resistance.

VECTAPURE ***RSX Lite™*** (Nominal 800 GPD)

Vectapure RSX Lite™ models are equipped with two fully encapsulated 400 GPD TFC membranes, 10” Big Blue 5 micron polyspun filter, dual flow meters, dual TDS meters and a powder coated aluminum frame for corrosion resistance dual pressure gauges.

MODEL	RSX350	RSX700	RSX800LB
MEMBRANE SIZE	2.5 X 21	2.5 X 21	3 X 13
# OF MEMBRANES	1	2	2
MEMBRANE MANUFACTURER RATED PRODUCTION	350	700	800
OPERATING PRESSURE (PSI)	150	150	Min. 50
MAX RECOVERY RATE	60% @ 1500 TDS		50% @ 500 TDS
OPERATING VOLTAGE	115 v	115 v	NOT REQUIRED
SOURCE WATER	Tap	Tap	Tap
INLET (INCH)	3/8 QC	3/8 QC	3/8 QC
PERMEATE (INCH)	3/8 QC	3/8 QC	3/8 QC
UNIT DIM. (DxWxH)	19.5"x19"x34.25"	19.5"x19"x34.25"	19.5"x19"x34.25"
WEIGHT	46	56	30

Commercial Reverse Osmosis Systems

VECTAMAXX **RSR™** (Nominal 1,200-2,400 GPD)

VECTAMAXX RSR™ systems include a powder coated aluminum frame for superior corrosion resistance, whisper quiet multi-stage stainless drive pump, stainless steel piping, dual flow meters, 10” Big Blue 5 micron polyspun prefilter, factory programmed micro controller with auto flush, dual TDS meters and dual pressure gauges.

MODEL	RSR1200	RSR2400
MEMBRANE SIZE	4 X 21	4 x 40
# OF MEMBRANES	1	1
MEMBRANE MANUFACTURER RATED PRODUCTION	1200	2400
OPERATING PRESSURE (PSI)	135	135
MAX RECOVERY RATE	60% @ 1000 TDS	
OPERATING VOLTAGE	115 v	115 v
SOURCE WATER	Tap / Brackish	Tap / Brackish
INLET (INCH)	1/2 QC	1/2 QC
PERMEATE (INCH)	3/8 QC	3/8 QC
UNIT DIM. (DxWxH)	19.5"x19"x34.5"	19.5"x19"x52"
WEIGHT	84	92

Commercial Reverse Osmosis Systems

VECTAMAXX RSL™ (Nominal 2,400-9,600 GPD)

VECTAMAXX RSL™ systems include as standard features: stainless membrane housings, stainless drive pumps, 20” Big Blue 5 micron polyspun prefilter, stainless steel piping, factory programmed micro controller with auto flush, pressure gauges, dual TDS meters and a powder coated aluminum frame for superior corrosion resistance. For brackish water, the RSL™ is available in high pressure models (RSLHP™).

MODEL	RSL2400 RSL2400HP	RSL4800 RSL4800HP	RSL7200 RLS7200HP	RSL9600 RLS9600HP
MEMBRANE SIZE	4 X 40	4 X 40	4 X 40	4 X 40
# OF MEMBRANES	1	2	3	4
MEMBRANE MANUFACTURER RATED PRODUCTION	2400	4800	7200	9600
OPERATING PRESSURE (PSI)	130 230	130 230	140 230	130 230
MAX RECOVERY RATE	60% @ <1000 TDS, 40% @ >1000 TDS 60% @ <2000 TDS, 40% @ >4000 TDS			
OPERATING VOLTAGE	230 v	230 v	230 v	230 v
SOURCE WATER	Tap or brackish	Tap or brackish	Tap or brackish	Tap or brackish
INLET (INCH)	1 FNPT	1 FNPT	1 FNPT	1 FNPT
PERMEATE (INCH)	1/2 QC	1/2 QC	1/2 QC	1/2 QC
UNIT DIM. (DxWxH)	24"x31"x50"	24"x31"x50"	24"x31"x50"	24"x31"x50"
WEIGHT	96/124	114/142	132/160	154/178

Commercial Reverse Osmosis Systems

RB8 BLACKMAXX® (Nominal 20,000-120,000 GPD)

RB8 BLACKMAXX® systems include as standard features: stainless drive pumps, stainless steel pump prefilter housing and high pressure piping, digital flow and TDS monitors, factory programmed micro controller with auto flush, CIP-ready (CIP not included). Everything to assure simplicity, dependability and rugged performance.

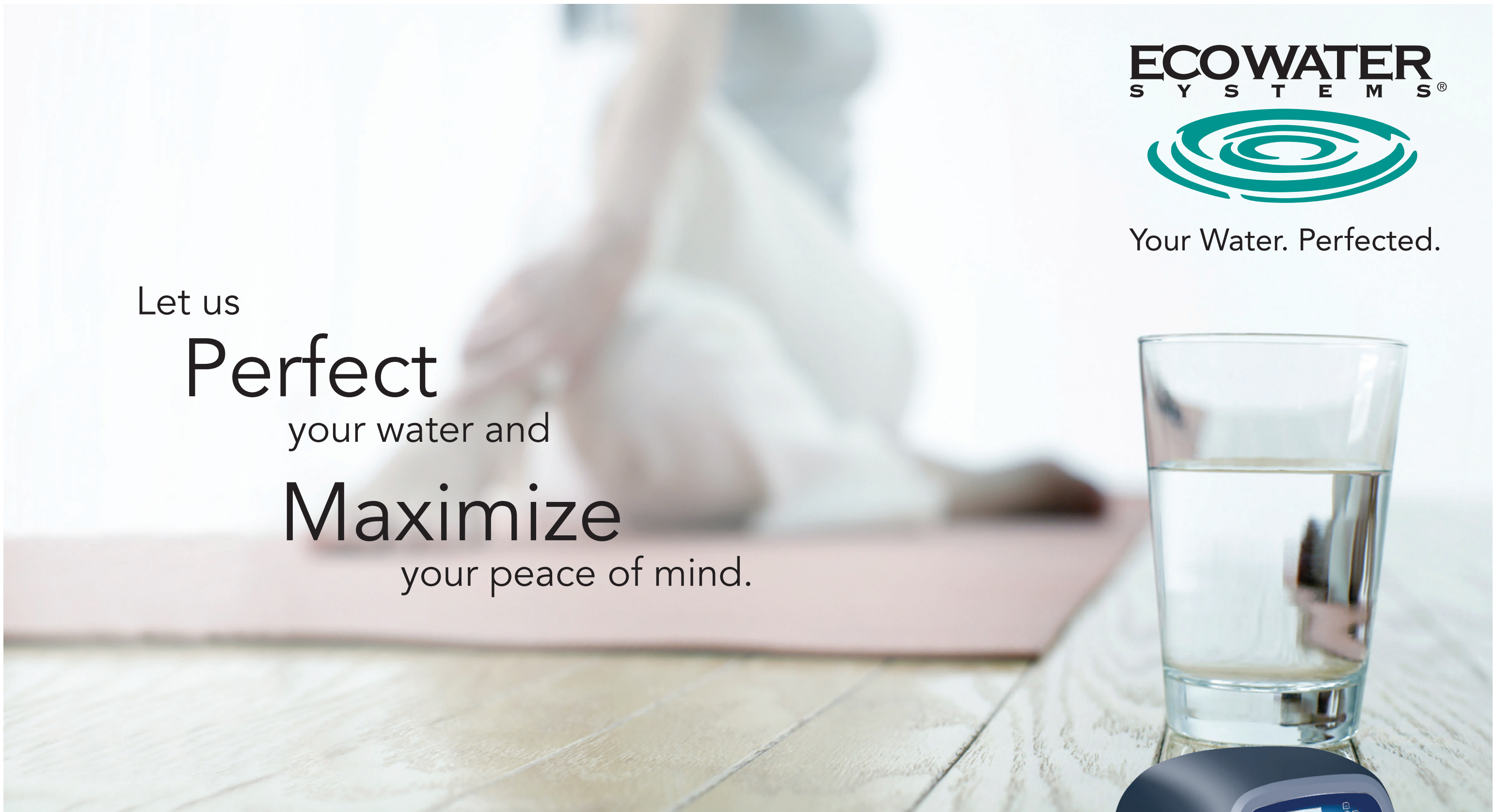
MODEL	RB820K RB8HP20K	RB830K RB8HP30K	RB840K RB8HP40K	RB860K RB8HP60K	RB880K RB8HP80K	RB8120K RB8HP120K
MEMBRANE SIZE	8 x 40	8 x 40	8 x 40	8 x 40	8 x 40	8 x 40
# OF MEMBRANES	2	3	4	6	8	12
MEMBRANE MANUFACTURER RATED PRODUCTION	20,000	30,000	40,000	60,000	80,000	120,000
OPERATING PRESSURE (PSI)	135/225	135/225	135/225	135/225	135/225	135/225
MAX RECOVERY RATE	Based on feed water quality					
OPERATING VOLTAGE	230VAC 3PH	230VAC 3PH	230VAC 3PH	230VAC 3PH	230VAC 3PH	230VAC 3PH
SOURCE WATER	Tap or brackish	Tap or brackish	Tap or brackish	Tap or brackish	Tap or brackish	Tap or brackish
INLET (INCH)	1.5 FPT	1.5 FPT	1.5 FPT	2 FPT	2 FPT	2 FPT
PERMEATE (INCH)	1 FPT	1 FPT	1 FPT	1.25 FPT	1.25 FPT	1.5 FPT
UNIT DIM. (DxWxH)	30"x64.75"x67.5"	30"x64.75"x67.5"	30"x64.75"x67.5"	32"x105"x67.5"	32"x105"x67.5"	32"x150"x67.5"
WEIGHT	Determined at time of order					

Franklin Water Treatment Canada

FRANKLIN WATER TREATMENT CANADA, INC.
5-200 Discovery Place
Winnipeg, MB, R2R 0P7
waterite.com

Available from:

Updated 08/04/23 Rev A



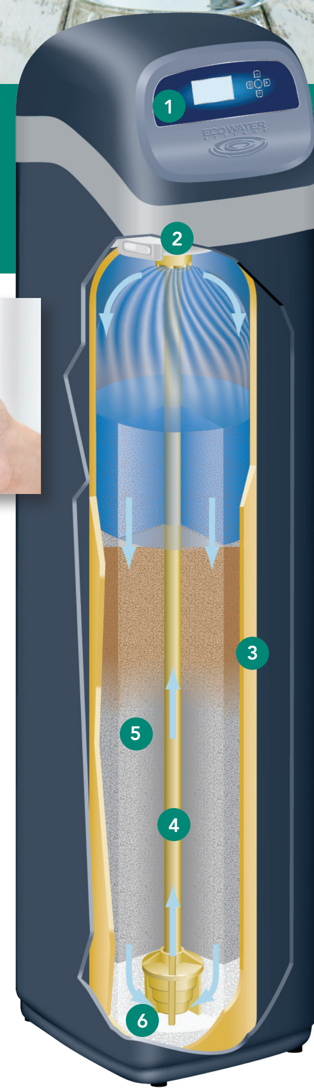
ECOWATER SYSTEMS®

Your Water. Perfected.

Let us
Perfect
your water and
Maximize
your peace of mind.

ETF2300AIV & EIV

ECOWATER SERIES – AIR ASPIRATED FILTERS



Eliminate Problem Water for Good

Air Aspirated Chemical Free Filter

Chemical free system is clean and economical, using air instead of bleach, chlorine or potassium permanganate. Fresh air provides oxidation.

1 Electronic Timer Controls with HydroLinkPlus® Wi-Fi and Smartphone App Monitoring

Wi-Fi enabled technology sends continuous and excessive water use, system error and service reminder alerts.

Water Meter

Allowing for chemical feed dosing, flow switch operation and water use information.

2 Naturally Aspirated Air Induction

Air is drawn into mineral tank for oxidation, no pumps or chemicals.

3 Multi-Wrap Fiberglass Reinforced Media Tank

Durable fiberglass-wrapped tank liner – doesn't deteriorate, rust, or corrode.

4 Full One-Inch Riser

One-inch diameter for increased flow rates, which ensures that household demand is adequately met.

Multi-Cycle Valve with Easy-Clamp Ring and Patented Coated Disc

5 Models ETF2300AIV 10" & 12" Ship with Zeolite Media for Iron Removal

Models ETF2300EIV 10" & 12" Ship Without Media, Allowing for Loading Media of Choice

6 Washed Quartz Underbedding

Washed quartz underbedding aids in dispersion of water throughout the media tank.

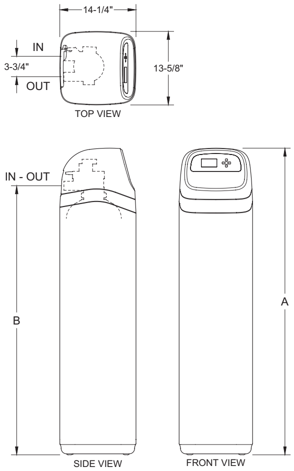
U.S. Patent #5,919,373

Designed, Engineered & Assembled in the U.S.A.

ETF2300AIV & EIV

ECOWATER SERIES
AIR ASPIRATED FILTERS

DIMENSIONS



	ETF2300 AIV10	ETF2300 AIV12	ETF2300 EIV10	ETF2300 EIV12
Nominal Resin Tank Size	10" Diam. x 47"	12" Diam. x 54"	10" Diam. x 47"	12" Diam. x 54"
A	57"	62.5"	57"	62.5"
B	50"	55.75"	50"	55.75"

SPECIFICATIONS

	ETF2300AIV10	ETF2300AIV12	ETF2300EIV10[3]	ETF2300EIV12[4]
Maximum Clear or Red Iron* Removal (ppm)[1]	10	10	–	–
Maximum Water Pressure (psi)	80	80	80	80
Supply Water Temperature Limits (°F/C°)[1]	4 -120/4 - 49	4 -120/4 - 49	120/49	120/49
Maximum Flow Rate (gpm)	7 – 10	9 – 15	–	–
Minimum Backwash Flow Rate (gpm)[2]	7[2]	10[2]	–	–

Electrical Requirement, 120V, 50/60Hz, (24V DC, 500 mA, power supply included)

*Except, bacterial and organically bound iron.

[1]Actual performance may vary depending on local water conditions. [2]Well pump must be able to provide the minimum flow for 30+ minutes.
[3]System is shipped with gravel only, no media. Can be loaded with media of customer's choice. System is shipped with 10" x 47" mineral tank and 7 gpm backwash flow control. Follow media manufacturer's recommendation for application and backwash flow rates.
[4]System is shipped with gravel only, no media. Can be loaded with media of customer's choice. System is shipped with 12" x 54" mineral tank and 10 gpm backwash flow control. Follow media manufacturer's recommendation for application and backwash flow rates.

ECOWATER SYSTEMS®

Your Water. Perfected.

MEMBER Water Quality Association

EcoWater Systems LLC
P.O. Box 64420
St. Paul, MN 55164-0420

EcoWater Canada Ltd.
5240 Bradco Blvd.
Mississauga, Ontario
Canada L4W 1G7

EcoWater Systems Europe N.V.
Geelseweg 56 2250 Olen
Belgium

Kunshan EcoWater Systems Co. Ltd.
483 San Xiang Rd.
Kunshan, Jiangsu Province, PRC 215335

Nelson Water

Contact Us

Hello, this is your estimate

Location: Boundary Road, Ottawa, ON, K0A

JOB ID
83217529

Commercial Water Treatment Proposal

Your Price
$31,119.01

Or as low as $416.19/mo

Financeit.

Get pre-qualified >

Accept Estimate

Summary

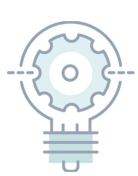
This system will provide similar water quality as to the previously sent water report of the neighbour.
It would reduce sodium, hardness, TDS, Chloride, Iron and other harmful traits.
Electrical is to be installed and provided by the owner.

7354492

Your Price
$3,699.00

ETF SERIES 12" **Chemical-Free Air Aspirated Sulfur/Iron Filter EIV** Electronic Timer Controls with HydroLink Plus Wi-Fi and Smartphone App…

View More



NWS103

Your Price
$840.00

Installation package for Antiscale injection. Includes:…

View More

NWMT948

Your Price
$322.94

Clack Mixing Tank Assembly 9" x 48" with in/out head and standpipe

E20PHF71S7

Your Price
$799.99

ECON FP STENNER…

View More

G21832PN7

Your Price
$246.53

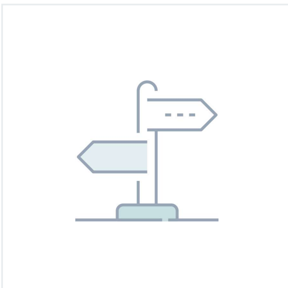
35 Gal Chem Solution Tank 18in X 33in

RSLHP7200

Your Price
$13,893.00

VECTAMAXX™ RSL High Pressure RO System 7200…

View More



43616

Your Price
$3,633.00

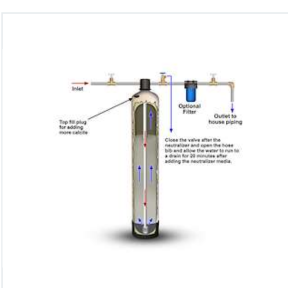
TANK - POLY 500 USGAL SPECIALTY 31 X 70 X 74"
Weight: 193 lbs.

98562817

Your Price
$2,359.50

SCALA2 PUMP, 22 GPM 3-45, **240V** 60HZ SELF PRIMING with pressure…

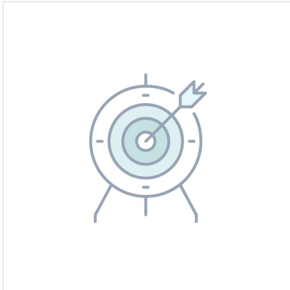
View More



NWNF948

Your Price
$695.00

NWNF948 - Nelson Water Neutralizing Filter is a Re-mineralization System Loaded with Neutralite Media to raise PH



VH200-F10

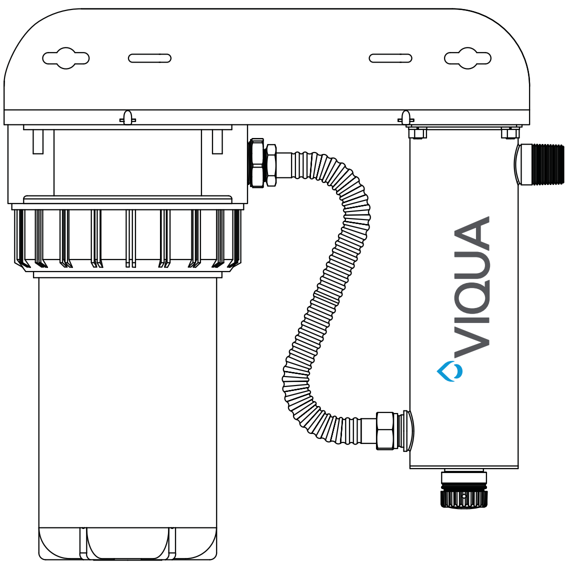
Your Price
$1,049.99

VH200-F10 - UV Water Disinfection System

Subtotal	$27,538.95
Tax	$3,580.06
Total	**$31,119.01**

Contact Us

Owner's Manual



Powered by Sterilight

Models:
VH200-F10, VH410-F20

425 Clair Rd. W, Guelph, Ontario, Canada N1L 1R1
t. (+1) 519.763.1032 • tf. (+1) 800.265.7246 (US and Canada only)
t. (+31) 73 747 0144 (Europe only) • f. (+1) 519.763.5069
e-mail: info@viqua.com
www.viqua.com

MEMBER Water Quality Association

520190-R_RevJ

Congratulations on the purchase of your ultraviolet (UV) water disinfection system! This system uses the most advanced UV technology on the market and is designed to provide you with years of trouble free operation with minimal maintenance required to protect your drinking water from microbiological contaminants.

To ensure ongoing disinfection of your water, UV lamps need to be replaced annually with VIQUA factory-supplied replacements. VIQUA lamps are the result of extensive development resulting in a highly efficient disinfection platform with extremely stable UV output over the entire 9000 hour lifetime. Its success has led to a proliferation of non-genuine copies in the market.

The UV lamp is the heart of the disinfection system, and there should be no compromise when it's time for a replacement.

Why should you insist on genuine factory supplied VIQUA replacement lamps?

- Use of widely available, non-genuine, replacement lamps has been shown to damage the control module of VIQUA UV disinfection equipment.
- An increasing number of calls to VIQUA Technical Support are connected with non-genuine lamps being used (unknowingly) as replacements.
- Damage arising from the use of non-genuine lamps poses a safety risk and is not covered by equipment warranty.
- Unless the UV equipment is equipped with a UV sensor (monitor), it is not possible to verify the UV (invisible) output of replacement lamps.
- Similar appearance to the original lamp and the presence of (visible) blue light does not mean equivalent disinfection performance.
- VIQUA replacement lamps undergo rigorous performance testing and strict quality control processes to ensure that the safety and performance certifications of the original equipment are not compromised.

So, you can see that it's simply not worth the risk! Insist on genuine VIQUA replacement lamps.

Section 1 Safety Information

These are the original instructions. Please read this entire manual before operating this equipment. Pay attention to all danger, warning, and caution statements in this manual. Failure to do so could result in serious personal injury or damage to the equipment.

Make sure that the protection provided by this equipment is not impaired. DO NOT use or install this equipment in any manner other than that specified in the installation manual.

1.1 Potential Hazards:

Read all labels and tags attached to the system. Personal injury or damage to the system could occur if not observed.

	Waste electrical and electronic equipment (WEEE). This symbol indicates that you should not discard wasted electrical or electronic equipment (WEEE) in the trash. For proper disposal, contact your local recycling/reuse or hazardous waste center.		This symbol indicates not to store any combustible or flammable material close to the system.
Hg	This symbol indicates there is Mercury present.		This symbol indicates that the contents of the transport package are fragile and the package should be handled with care.
	This is the safety alert symbol. Obey all safety messages that follow this symbol to avoid potential injury. When on the equipment, refer to the Operational and Maintenance manual for additional safety information.	UV-C	This symbol indicates safety glasses with side protection is required for protection against UV exposure.
	This symbol indicates a risk of electrical shock and/or electrocution exists.		This symbol indicates gloves must be worn.
	This symbol indicates the marked equipment may contain a component that can eject forcibly. Obey all procedures to safely depressurize.		This symbol indicates safety boots must be worn.
	This symbol indicates the system is under pressure.		This symbol indicates the operator must read all available documentation to perform required procedures.
	This symbol indicates there is a potential UV hazard. Proper protection must be worn.	Cu	This symbol indicates the plumber must use copper piping.
	This symbol indicates the marked item could be hot and should not be touched without care.		This symbol indicates that the system should only be connected to a properly grounded, grounding-type controller receptacle that is protected by a Ground Fault Circuit Interrupter (GFCI).
	This symbol indicates there is a potential for VERY hot water when flow is started.		

1.2 Safety Precautions:

DANGER

Failure to follow these instructions will result in serious injury or death.

- **Electric Shock:** To avoid possible electric shock, special care should be taken since water is present near the electrical equipment. Unless a situation is encountered that is explicitly addressed by the provided maintenance and troubleshooting sections, DO NOT attempt repairs yourself, refer to an authorized service facility.
- **GROUNDING:** This product must be grounded. If it should malfunction or breakdown, grounding provides a path of least resistance for electric current to reduce the risk of electrical shock. This system is equipped with a cord having an equipment-grounding conductor and a grounding plug. The plug must be plugged into an appropriate outlet that is properly installed and grounded in accordance with all local codes and ordinances. Improper connection of the equipment-grounding conductor can result in a risk of electrocution. Check with a qualified electrician or service personnel if you are in doubt as to whether the outlet is properly grounded. DO NOT modify the plug provided with this system – if it does not fit in the outlet, have a proper outlet installed by a qualified electrician. DO NOT use any type of adapter with this system.
- **GROUND FAULT CIRCUIT INTERRUPTER PROTECTION**: To comply with the National Electrical Code (NFPA 70) and to provide additional protection from the risk of electric shock, this system should only be connected to a properly grounded, grounding-type controller receptacle that is protected by a Ground Fault Circuit Interrupter (GFCI) or to a residual current device (RCD) having a rated residual operating current not exceeding 30 mA. Inspect operation of GFCI as per manufacturer's suggested maintenance schedule.
- DO NOT operate the disinfection system if it has a damaged cord or plug, if it is malfunctioning or if it has been dropped or damaged in any manner.
- DO NOT use this disinfection system for other than intended use (potable water applications). The use of attachments not recommended or sold by the manufacturer / distributor may cause an unsafe condition.
- DO NOT install this disinfection system where it will be exposed to the weather or to temperatures below freezing.
- DO NOT store this disinfection system where it will be exposed to the weather.
- DO NOT store this disinfection system where it will be exposed to temperatures below freezing unless all water has been drained from it and the water supply has been disconnected.

⚠ WARNING

- During extended periods of no water flow, the water in your chamber can become very hot (Approx. 60 °C) and potentially lead to scalding. It is recommended to run your water until this hot water has been purged from your chamber. Do not allow water to contact your skin during this time. To eliminate this condition, a temperature management valve can be installed at the outlet of your UV system.
- Do not pass water through the UV system for a minimum of 5 minutes after applying power (including after power interruptions) to avoid passing under-treated water that may, in rare instances, pose health hazards.
- This system contains a UV Lamp. Do not operate the UV Lamp when it is removed from the chamber. Unintended use or damage of the system may result in the exposure of dangerous UV radiation. UV radiation may, even in little doses, cause harm to the eyes and skin.
- Changes or modifications made to this system without the consent of the manufacturer could render the system unsafe for operation and may void the manufacturer's warranty.

WARNING: This product can expose you to chemicals including phthalates, which is known to the state of California to cause cancer, and mercury, which is known to the State of California to cause birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov.

⚠ CAUTION

Failure to follow these instructions could result in minor or moderate injury.

- Carefully examine the disinfection system after installation. It should not be plugged in if there is water on parts not intended to be wet such as, the controller or lamp connector.
- Due to thermal expansion concerns and potential material degradation due to UV exposure, it is recommended to use metal fittings and at least 10" of copper pipe on the outlet of your UV chamber.
- **Hg EXPOSURE**: The UV lamp contains mercury. If the lamp breaks, then avoid inhalation or ingestion of the debris and avoid exposure to eyes and skin. Never use a vacuum cleaner to clean up a broken lamp as this may scatter the spilled mercury. Obey local regulations and guidelines for the removal and disposal of mercury waste.

Hg

NOTICE

- The UV lamp inside the disinfection system is rated at an effective life of approximately 9000 hours. To ensure continuous protection, replace the UV lamp annually.
- The UV system is not to be used or played with by children. Persons with reduced physical, sensory or mental capabilities, or lack of experience and knowledge, are also not to handle the UV system unless they have been given supervision or instruction.
- This system is intended to be permanently connected to the water lines.
- This system is not intended to be used in or above water or outdoors or used in swimming pools when persons are in the pool.
- **EXTENSION CORDS**: If an extension cord is necessary, use only 3-wire extension cords that have 3-prong grounding-type plugs and 3-pole cord connectors that accept the plug from this system. Use only extension cords that are intended for outdoor use. Use only extension cords having an electrical rating not less than the rating of the system. A cord rated for less amperes or watts than this system rating may overheat. Exercise caution when arranging the cord so that it will not be tripped over or pulled. DO NOT use damaged extension cords. Examine extension cord before using and replace if damaged. DO NOT abuse extension cord. Keep extension cord away from heat and sharp edges. Always disconnect the extension cord from the receptacle before disconnecting this system from the extension cord. Never yank cord to pull plug from outlet. Always grasp the plug and pull to disconnect.
- If the supply cord is damaged, it must be replaced by a special cord or assembly available from the manufacturer or its service agent.
- **SYSTEM PROTECTION:** To protect your Controller, a UL1449 certified (or equivalent) transient voltage surge suppressor is strongly recommended.
- The UV lamp in this system conforms to the applicable provisions of the Code of Federal Regulations (CFR) requirements including, Title 21, Chapter 1, Subchapter J, Radiological Health.
- Read and understand the Owner’s Manual before operating and performing any maintenance on this equipment.

1.3 Water Chemistry

Water quality is extremely important for the optimum performance of your UV system. The following levels are recommended for installation:

Water Quality and Minerals	Level
Iron	< 0.3 ppm (0.3 mg/L)
Hardness*	< 7 gpg (120 mg/L)
Turbidity	< 1 NTU
Manganese	< 0.05 ppm (0.05 mg/L)
Tannins	< 0.1 ppm (0.1 mg/L)
UV Transmittance	> 75% (call factory for recommendations on applications where UVT < 75%)

* Where total hardness is less than 7 gpg, the UV unit should operate efficiently provided the quartz sleeve is cleaned periodically. If total hardness exceeds 7 gpg, the water should be softened. If your water chemistry contains levels in excess of those mentioned above, proper pre-treatment is recommended to correct these water problems prior to the installation of your UV disinfection system. These water quality parameters can be tested by your local dealer, or by most private analytical laboratories. *Proper pre-treatment is essential for the UV disinfection system to operate as intended.*

Section 2 General Information

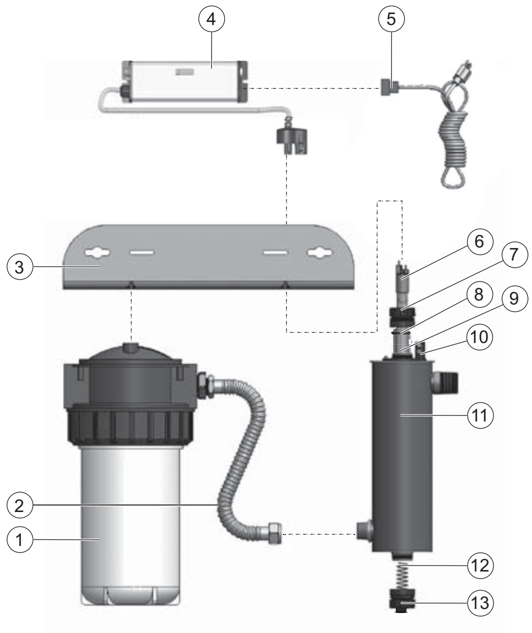


Figure 1 System Components

Item	Description	Part Number	UV Systems
1	Filter Housing	AWP40B-V	VH200-F10
		AWP42B-V	VH410-F20
	Sediment cartridge filter 10” High 5 micron	CMB-510-HF	VH200-F10
	Sediment cartridge filter 20" High 5 Micron	CMB-520-HF	VH410-F20
2	SS Flexible Hose	410997-R	VH200-F10
		411041-R	VH410-F20
3	Bracket	420589-R	Used on all systems.
4	Controller - 100-240V/50-60HZ	BA-ICE-CL	Used on all systems.
5	IEC Replacement Power Cords For VIQUA ICE Controller™ (Sold Separately)	602636	NORTH AMERICAN (NEMA 5-15P), 3-PRONG GROUNDED
		602637	CONTINENTAL EUROPEAN (CEE 7/7) 2-PIN WITH GROUND, “SCHUKO”
		260012	UK VERSION (BS 1363) 3-PRONG GROUNDED (5 AMP FUSE)
		260013	AUSTRALIAN VERSION (AS 3112) 3-PRONG GROUNDED
		260019	NO CONNECTOR, 3-WIRE, BARE LEADS
6	UV lamp	S200RL-HO	VH200-F10
		S410RL-HO	VH410-F20
7	Gland Nut	RN-001	Used on all systems.
8	O-ring	410867	Used on all systems.
9	Quartz Sleeve	QS-001	VH200-F10
		QSO-410	VH410-F20
10	Lamp Connector Base	270276-R	Used on all systems.
11	304 Stainless Steel Chamber	-	-
12	Spring	SP008	Used on all systems.
13	Gland nut with plug	RN-001/1	Used on all systems

Section 3 Installation

3.1 V Disin ection S stem

CA TI N	
⚠	Electronic controller must be connected to a Ground Fault Protected Circuit (GFCI) receptacle. Ensure the green ground wire ring terminal is securely fastened to chamber ground stud.

The disinfection system is designed to be installed at point-of-entry. Drip loops in all cordage connected to the controller is highly recommended. Refer to Figure 3.

The complete water system, including any pressure or hot water tanks, must be sterilized before start up by flushing with chlorine (household bleach) to destroy any residual contamination. Refer to Section 3.2.

For safety purposes, the disinfection system must be connected to a Ground Fault Protected Circuit (GFCI).

The disinfection system is intended for indoor use only, do not install disinfection system where it may be exposed to the weather.

Install the disinfection system on cold water line only.

If treating the entire house, install the disinfection system before any branch lines.

Proce ure:

1. Figure 2 shows the installation of a typical drinking water system and the related components that may be used for the installation. The use of a bypass assembly is recommended in case the system requires “off-line” maintenance. If this is the case, it must be noted that the system will require supplementary disinfection of the distribution system if any water is used during this bypass condition. In addition, during bypass, the water will NOT be disinfected and a “DO NOT CONSUME THE WATER” tag should be physically installed on the bypass assembly until such time as the system is sanitized and returned to service. Please refer to Section 3.2 for the complete disinfection procedure. If the water is to be consumed while the system is off-line, the water must be boiled for two minutes prior to consumption.

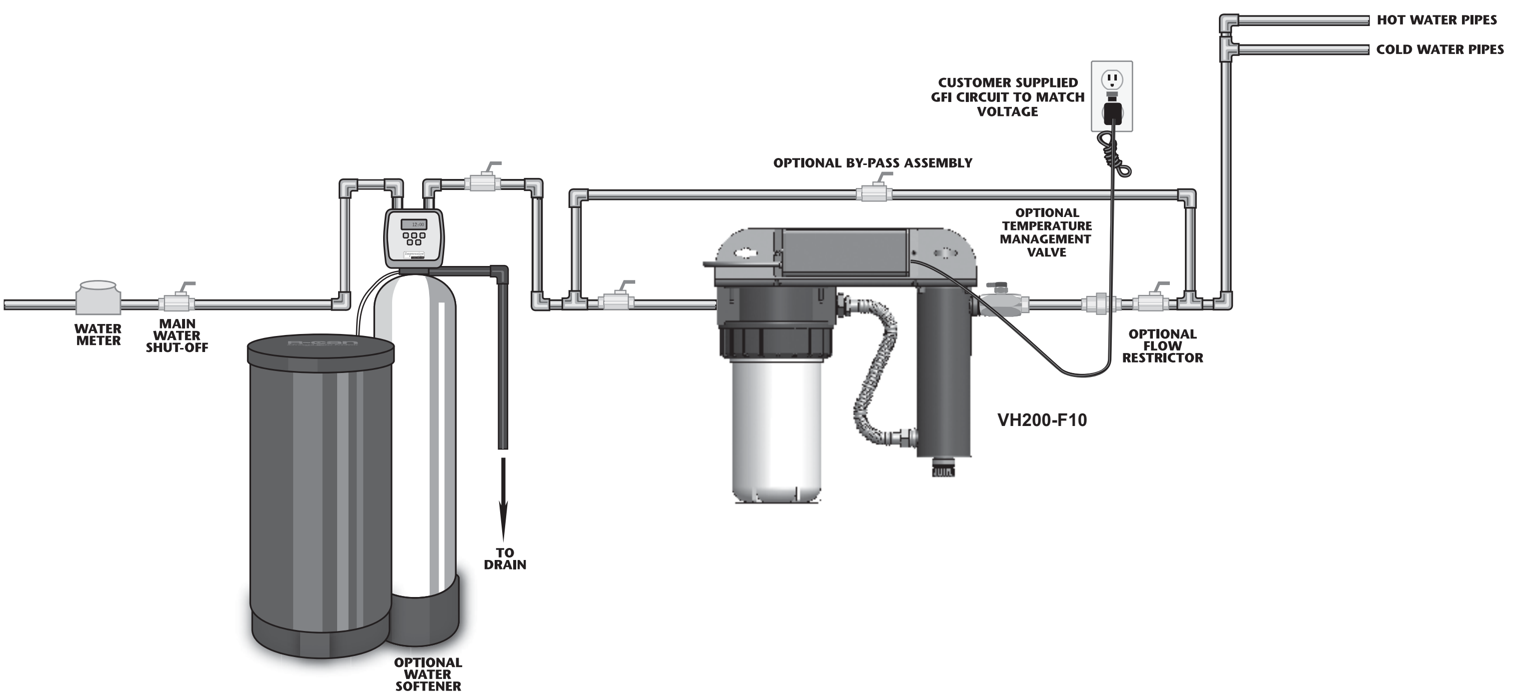


Figure 2 Disinfection System

2. Select a suitable location for the disinfection system and its related components. As it is recommended to install a ground fault protected circuit (GFCI), make sure that this is taken into consideration prior to any installation. When selecting a mounting location, enough space must be left to allow for the removal of the UV lamp sleeve, as well as enough space to change out the filter cartridges. See Figure 3 for typical clearance dimensions.

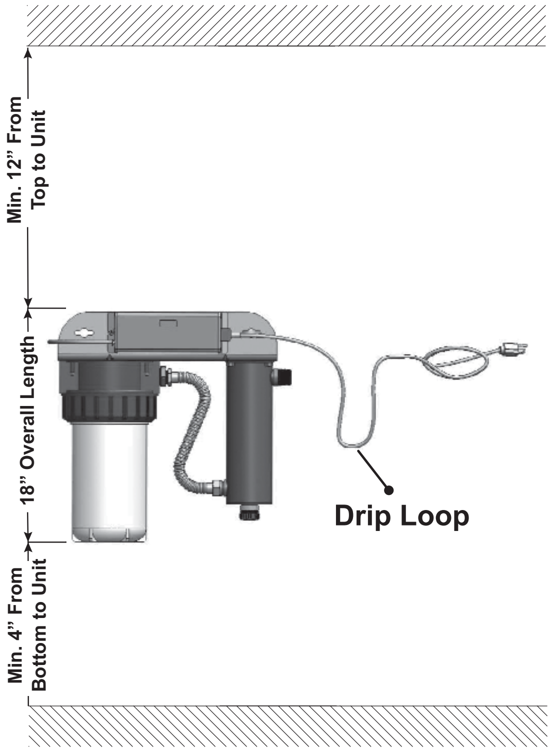


Figure 3 Disinfection Installation

Note: *The above illustration is relevant for VH200 only.*

3. Mount the system to the wall with appropriate lag bolts (not supplied) through the two mounting holes located on the metal bracket. The use of a flow restrictor device is recommended when installing your system in order to maintain the manufacturers maximum rated flow. The flow restrictor should be installed on the outlet port and is designed to be installed in one direction only. Ensure that the flow of the water matches the flow direction as indicated on the flow restrictor. Refer to Figure 4.

Note: *DO NOT solder connections while attached to the system as this could damage the O-ring seals.*

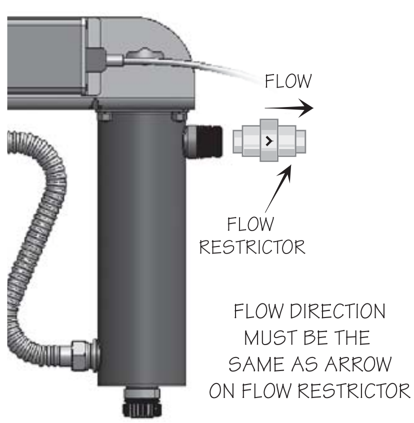


Figure 4 Flow Restrictor

4. Make sure you allow for a “drip-loop” on the power cord to prevent any water from potentially entering the controller. Refer to Figure 3.
5. Install the UV lamp. Refer to Section 4.1.
6. Install the cartridges. Refer to Section 4.3.
7. When all plumbing connections are made, slowly turn on the water supply and check for leaks. The most likely cause for leaks is from o-ring seals. In case of a leak at the chamber, shut water off, remove the retaining nut, wipe the o-ring and threads clean and re-install. In case of a leak at the filters, remove the sump, wipe the o-ring and threads clean, ensure the o-ring is properly seated, then reinstall.
8. Once it is determined that there are no leaks, plug the system into the ground fault interrupter, and check controller to ensure the system is operating properly.The controller is designed to detect both power to the system and UV lamp illumination.

   Note: *DO NOT look directly at the glowing UV lamp.*
9. Allow the water to run for a few minutes to clear any air or dust that may be in the chamber.

   Note: *When there is no flow, the water in the cell will become warm, as the UV lamp is always on. To remedy this, run a cold water tap anywhere in the house for a minute to flush out the warm water.*

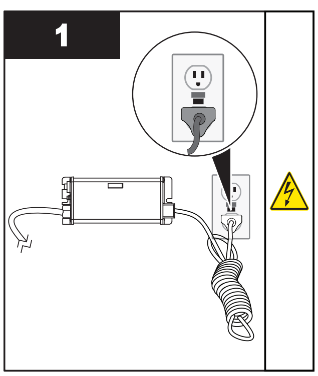
3.2 Disinfection Procedure

Prerequisites:

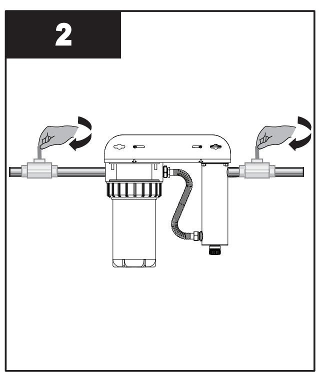
- Reapply a generous amount of lubricant to the O-ring when reinstalling sumps.

Procedure:

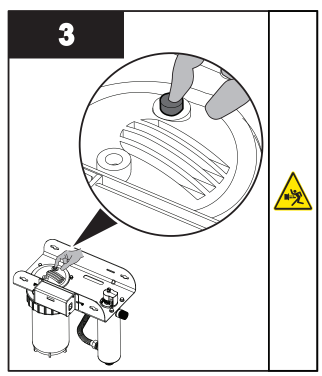
UV disinfection is a physical process and does not add any potentially harmful chemicals to the water. As UV does not provide a disinfection residual, it is imperative that the entire distribution system located after the UV be chemically disinfected to ensure that the water is free from any bacteriological contaminants. The disinfection process must be performed immediately after the UV unit is installed and repeated thereafter whenever the UV is shut down for service, without power, or inoperative for any reason. The procedure for sanitizing the plumbing system is readily accomplished as follows:



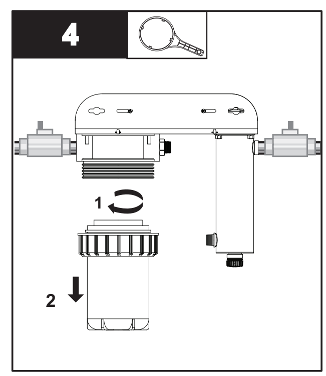
- Ensure the controller is plugged in for entire disinfection process.



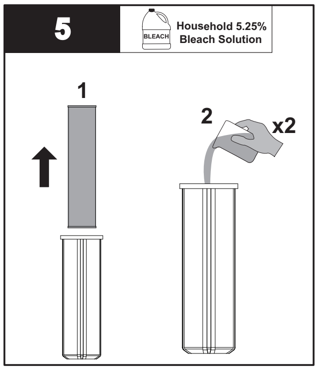
- Shut off the water supply.
- Close each faucet.



- Press the pressure button to release the pressure from the cartridges.

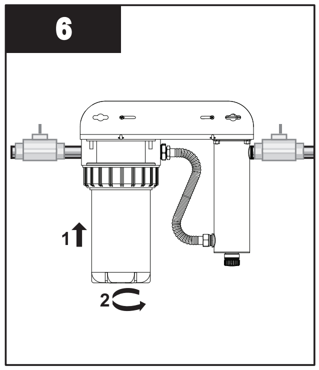


- Remove sump housing using sump wrench.

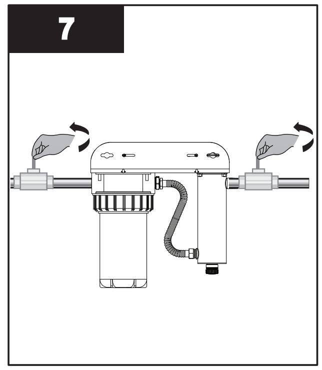


- Remove cartridge and pour 2 cups of household bleach solution into the sump housing.

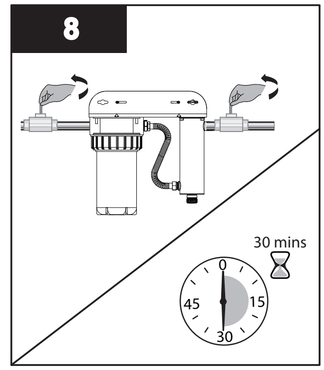
__Note:__ DO NOT use Hydrogen Peroxide.



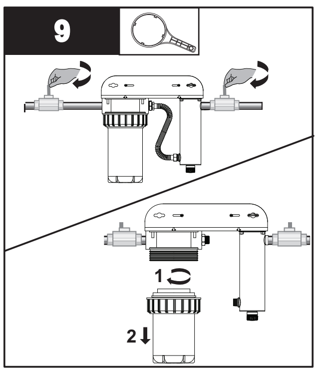
- Connect only the sump housing to the unit.



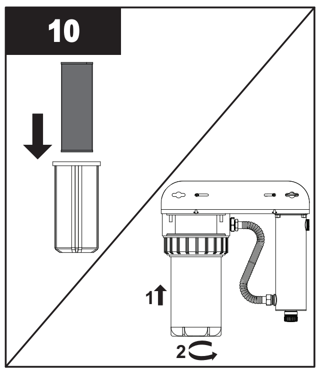
- Turn on water supply.
- Allow water to fill the chamber.



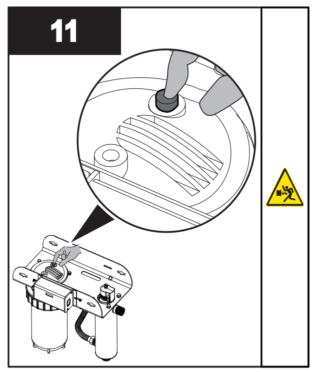
- Turn on the cold water supply followed by hot water (if available) until you smell the bleach.
- Close all faucets and allow bleach to settle in the water lines for 30 minutes.



- With all faucets closed, remove sump housing using sump wrench.



- Reinstall the cartridge into sump housing and connect to the unit.
- Flush all water outlets until bleach can no longer be smelled (at least 5 minutes).



- Press the pressure button to purge air and to complete the disinfection procedure.

Notes: *1) The addition of chlorine (bleach) to a hot water tank that has in the past been fed with untreated raw water with high levels of other contaminants (iron, manganese, hydrogen sulphide, organics, etc.) will result in oxidation of these contaminants and may require repeated flushing of the hot water tank. This contingency must be dealt with independently under the start-up procedure for any other conditioners that may form a part of the pre-treatment for the UV unit.*

2) The above disinfection procedure will result in a massive chlorine residual far in excess of the 0.5 to 1.0 mg/L typically present in municipally chlorinated water and of a magnitude consistent with the minimum 50 mg/L chlorine solution recommended for the disinfection of distribution systems known to be contaminated. Do not consume water until complete system has been flushed.

Section 4 Maintenance

ARNING

Always disconnect power before performing any work on the disinfection system.

Always shut-off water flow and release water pressure before servicing.

Regularly inspect your disinfection system to ensure that the power indicators are on and no alarms are present.

Replace the UV lamp annually (or biennially if seasonal home use) to ensure maximum disinfection.

Always drain the chamber when closing a seasonal home or leaving the unit in an area subject to freezing temperatures.

4.1 Replacing V Lamp

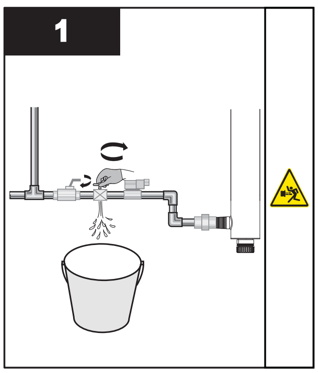
NOTICE

Reset lamp life timer after lamp replacement. Refer to Section 5.1.3. Refer to www.lamprecycle.org for UV lamp disposal.

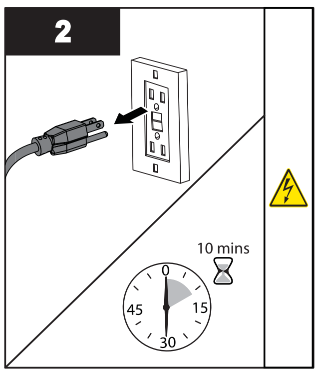
Do not use water during replacement of UV lamp.

Lamp replacement is a quick and simple procedure requiring no special tools. The UV lamp must be replaced after 9000 hours of continuous operation (approximately one year) in order to ensure adequate disinfection.

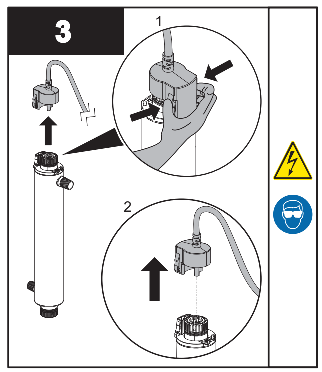
Proce ure:



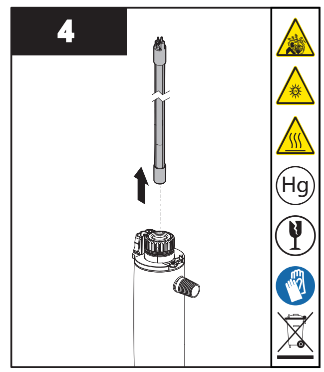
Shut off the water line to chamber and release system pressure before servicing.



Disconnect main power source and allow the unit to cool for 10 minutes.

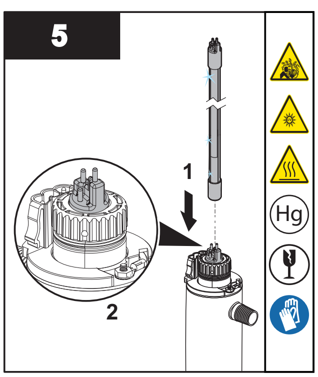


Remove the lamp connector by squeezing the plastic locking tabs on the side of the connector.

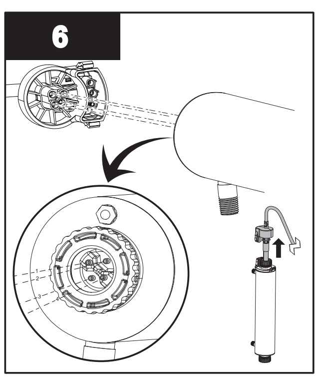


Remove the lamp in upward direction from the chamber and lamp connector base.

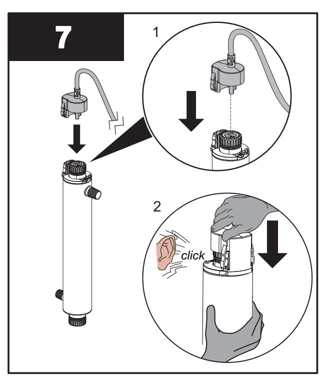
Always hold the lamp at the ceramic ends.



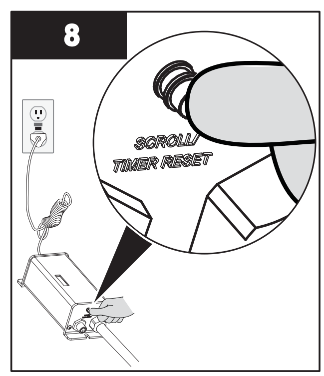
Insert the new lamp fully into the chamber leaving about two inches of the lamp protruding from the chamber.



Attach the connector to the lamp. Note that the connector will only allow correct installation in one position.



Push the lamp connector against lamp connector base together until an audible click is heard.



Hold down the timer reset button and reapply power to the controller until you see r-SEt, then release timer reset button.

A 5 second delay will occur until you hear an audible tone and LED display will read once again 365.

Re-pressurize the system to check for leaks.

VIQUA

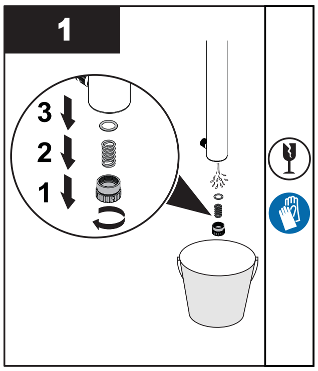
4.2 Cleaning and Replacing Quartz Sleeve

Note: *Minerals in the water slowly form a coating on the lamp sleeve. This coating must be removed because it reduces the amount of UV light reaching the water, thereby reducing disinfection performance. If the sleeve can not be cleaned, it must be replaced.*

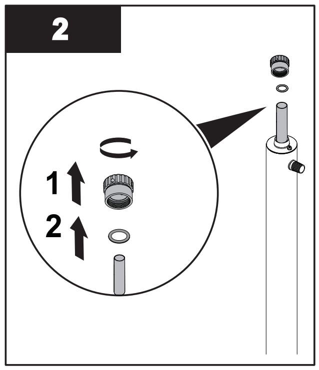
Prerequisites:

- Shut off water supply and drain all lines.
- Remove the UV lamp. Refer to Section 4.1.

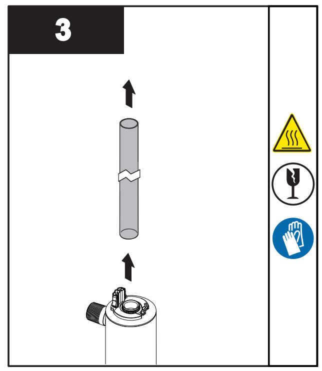
Procedure:



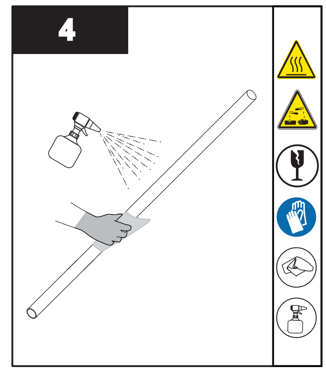
- Remove the bottom retaining nut, floating spring, and O-ring.



- Remove the top retaining nut and O-ring.

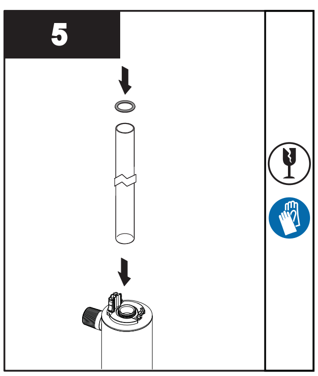


- Remove the quartz sleeve.

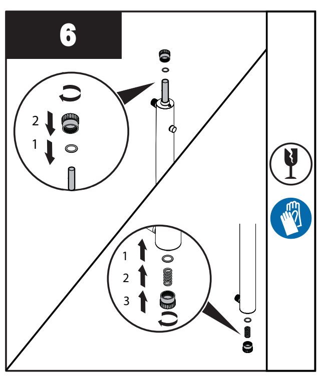


- Clean the quartz sleeve with a cloth soaked in CLR, vinegar or some other mild acid and then rinse with water.

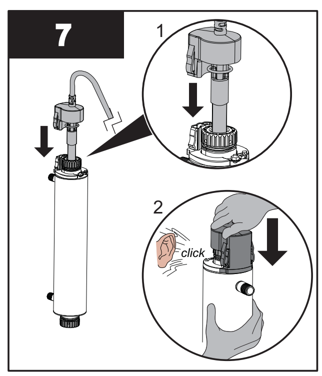
Note: *If sleeve cannot be cleaned completely or it is scratched or cracked, then replace the sleeve.*



- Reinstall the quartz sleeve in the chamber allowing the sleeve to protrude an equal distance at both ends of the chamber.
- Slide supplied O-rings onto each end of the quartz sleeve.



- Reinstall the top and bottom retaining nuts, floating spring, and O-rings respectively.
- When service is complete, assemble the prerequisites in the reverse order of disassembly.



- Push the lamp connector against lamp connector base together until an audible click is heard.
- Re-pressurize the system to check for leaks.
- Plug in controller and verify the POWER-ON LED display is illuminated and controller power-up sequence operates

Note: *After replacing the UV lamp or quartz sleeve perform the disinfection procedure, refer to Section 3.2.*

4.3 Replacing Cartri ges

It is recommended to change the filter cartridge every six months (or earlier). Please note that a drop in pressure may indicate that the filter cartridge requires replacement.

Note: *Prior to performing any work on the drinking water system, ALWAYS DISCONNECT THE CONTROLLER FIRST. As a small amount of water may leak from the cartridges during this procedure, please place a small bucket under the system to catch any water.*

Proce ure:

1. Shut-off the water flow to the unit, depress pressure relief button on top of the filter head to relieve pressure in the filter. Refer to Figure 5.

Figure 5 Pressure Relief Button

2. Place a bucket or pail under the stainless steel chamber. Remove retaining nut to drain system.
3. Remove the filter housing from the unit by turning the blue collar counter-clockwise until it falls free from the head. Pull down the white filter housing (be careful as it will be full of water and will be heavy). Refer to Figure 6.

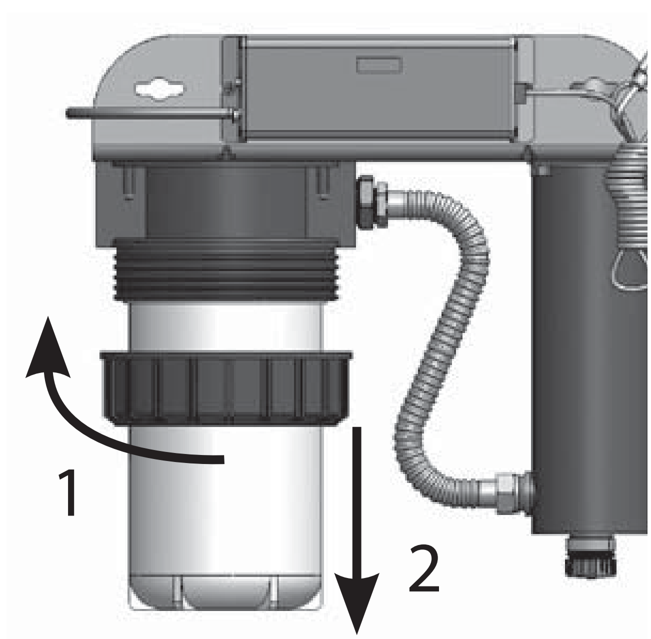


Figure 6 Removing Filter Housing

4. Discard the used cartridge and clean the sump housing as required. Make sure to thoroughly rinse the sump with water to remove any cleaning agents.Before installing a new cartridge, please ensure that the o-ring seals are properly seated on the shoulders at the top of the sump (Refer to Figure 7), if there is any visible damage on the o-rings please replace them (P/N: OR40-50). Reapply a generous amount of lubricant to the O-ring when reinstalling sumps.

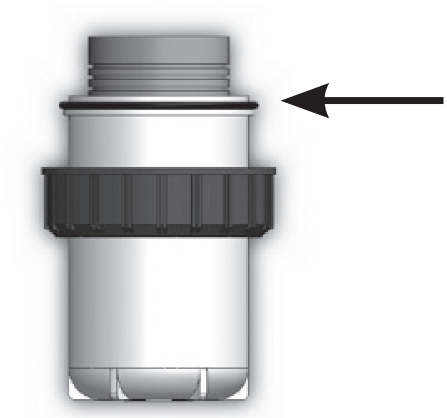


Figure 7 O-ring on Sump

5. Ensure o-rings are liberally coated with a silicone based lubricant.
6. Install the new cartridge in the reverse procedure as stated above turning the collar clockwise until the sump is tight.

   Note: *Do not over tighten.*
7. Plug UV unit into the Ground Fault Circuit Interrupter (GFCI) outlet and power-up the system.
8. Slowly turn on the water supply and allow any air that may now be present to bleed off by depressing pressure relief button on top of the sump until air is purged from filter. Now you are ready to return the system to use.

Section 5 peration

ARNING

The advanced warning system has been installed to provide the optimum protection against microbiological contamination in water. **D N T** disregard the warning signals. The best way to ensure optimum UV performance is to have the water microbiologically tested by a recognized testing agency on a regular basis.

5.1 asic S stems Incorporating A-ICE-CL Controllers

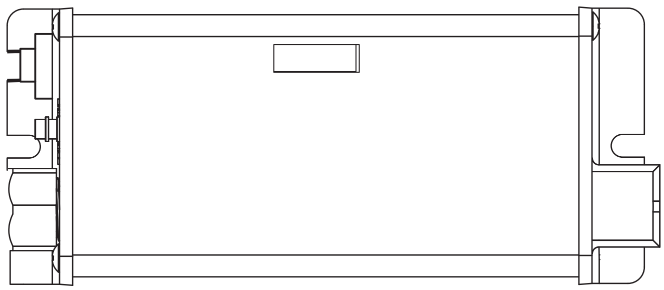


Figure 8 BA-ICE-CL Controllers

5.1.1 Lamp Li e Remaining a s

365 The controller tracks the number of days of operation of the UV lamp and the controller. The default screen will display the total lamp life remaining (in days). The controller will count down the number of days remaining until the UV lamp requires changing (365 days to 1 day). At “0” days, the controller will display A3 and sound an intermittent audible chirp (1 second on, 5 seconds off), indicating the need to change the UV lamp.

5.1.2 n erstan ing our A3 Co e

A3 ***DEFERRAL*** - Once the “A3” or end of lamp life message is shown on the LED display, the audible alarm can be deferred up to 4 separate times. The delay is designed to allow you time to address the alarm while you obtain a new UV lamp. This can be done by simply depressing the timer reset button for 5 seconds, which is located on the left side of the controller. Each time the timer reset button is pressed the controller alarm is deferred seven days. Once the final 7 day deferral has been reached the alarm can only be silenced by changing the UV lamp and manually resetting the controller timer, refer to Section 4.1.

5.1.3 Resetting Lamp Li e

Refer to Section 4.1.

Note: *Even though the alarm on the system can be deferred for a period of time, it is important to address each and every alarm condition as they are indicating that there is a potential problem with the system and should be remedied.*

5.1.4 Total Da s o peration

1680 The controller also displays the total running time of the controller. To obtain this reading, press the push-button once. The total running time of the controller will be numerically displayed in days. This information will remain displayed for ten seconds and will then revert back to the lamp life remaining default screen. It should be noted that this value cannot be reset.

5.1.5 Lamp Failure lan Screen

When the system recognizes LAMP FAILURE (no current running through the UV lamp), the display will be blank (no default LAMP LIFE REMAINING screen) and the system will sound an intermittent audible tone (1 second on,1 second off). The system will remain in this state, until this condition is remedied.

Not performance tested or certified by NSF.

Section 6 Trou leshooting

S mptom	Possi le Causes	Solutions
Pressure Drop	Sediment pre-filter clogged	Replace filter cartridge and refer to Section 2. ***Note:*** *Check source water supply as fluctuations may occur in source pressure.*
High Bacteria Counts	Quartz sleeve is stained or dirty	Clean sleeve with scale cleaner and eliminate source of staining problem (ie. soften hard water, refer to Section 4.2.
	Change in feed water quality	Have source water tested to ensure that water quality is still within allowable limits for this system.
	Contamination in water lines after UV system (eg. due to a power failure, plumbing dead ends, etc.)	Refer to Section 3.2, Disinfection Procedure to disinfect your system.
	Possible break-through of sediment through pre-filter	Test source water for turbidity - may need stepped filtration in order to catch all sediment entering water system (20 micron filter followed by a 5 micron filter followed by UV system).
Heated Product Water	Common concern caused by infrequent use of water	Run water until it returns to ambient temperature.
		Install temperature management valve.
Water Appears Milky	Caused by air in the water lines	Run water until air is purged.
Chamber Leaking Water	Problem with O-ring seal (on retaining nut)	Ensure O-ring is in place, check for cuts or abrasions, clean O-ring, moisten with water/ lubricant and re-install, replace if necessary (Refer to Section 2 for part number).
	Condensation on chamber caused by excessive humidity & cold water	Check location of disinfection system and control humidity.
	Inadequate inlet/outlet port connections	Check thread connections, reseal with Teflon® tape and re-tighten.
System Shutting Down Intermittently	Interrupted controller	Ensure system has been installed on its own circuit, as other equipment may be drawing power away from UV (ie. pump or fridge). UV system should not be installed on a circuit which is incorporated into a light switch.
Lamp Failure Alarm on - New UV Lamp	Loose connection between lamp and connector	Disconnect the UV lamp from connector and reconnect, ensuring that a tight fit is accomplished
	Moisture build up in connector may keep UV lamp and connector from making a solid connection	Eliminate chance of any moisture getting to the connector and/or lamp pins

DISPLAY FA LT M DES	
LED display reads “A3”	Lamp life expired - countdown is at “0” days Press reset button for a deferred alarm, replace UV lamp (refer to Section 4.1).
LED display is blank	Controller is in lamp failure mode Power system down, allowing it to reset itself; apply power in order to confirm that the controller is able to power lamp Check to see if there is sufficient power to the UV system

Section 7 Manu acturer s Dose Flo Chart

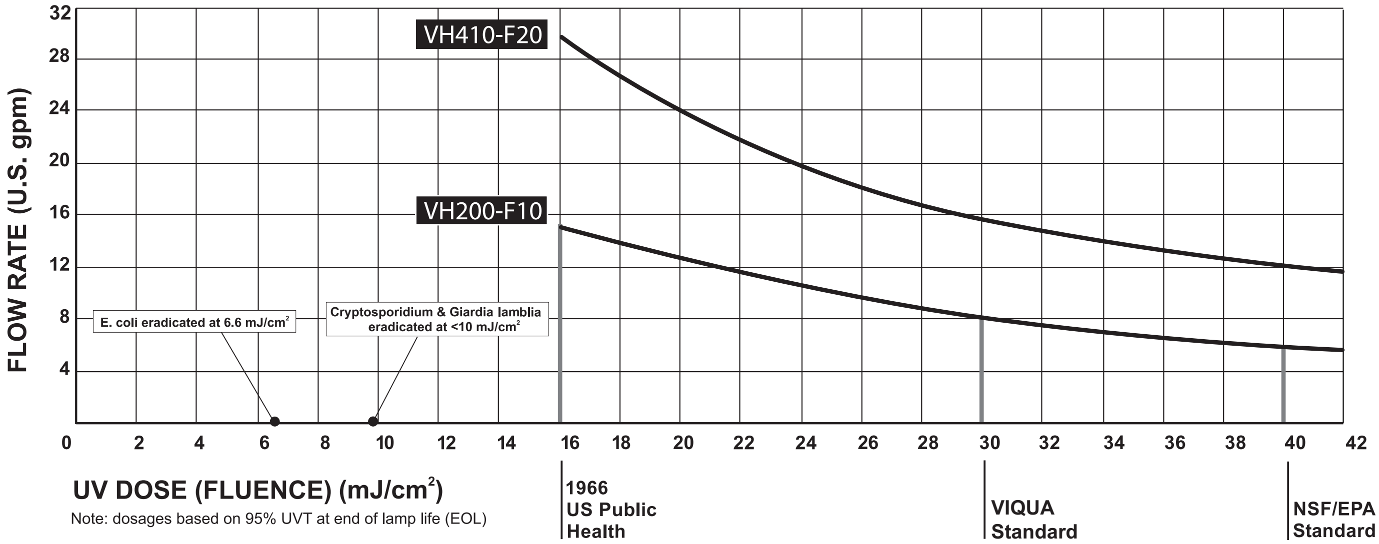


Figure 9 Dose Flow Chart

Not performance tested or certified by NSF.

Section Speci ications

.1 Stan ar an Vali ate

Mo el		V 200-F10	V 410-F20
Flow Rate	US Public Health 16 mJ/cm^2	16 GPM (60 lpm) (3.6 m^3/hr)	34 GPM (130 lpm) (7.8 m^3/hr)
	VIQUA Standard 30 mJ/cm^2	9 GPM (34 lpm) (2.0 m^3/hr)	18 GPM (70 lpm) (4.2 m^3/hr)
	NSF/EPA 40 mJ/cm^2	7 GPM (26 lpm) (1.6 m^3/hr)	14 GPM (54 lpm) (3.3 m^3/hr)
Overall Dimensions (width x depth x height)		17”x 10.5” x 17.8”	17" x 10" x 29"
Inlet/Outlet Port Size		1“FNPT/Combo 3/4“FNPT & 1“MNPT	3/4” FNPT
Shipping Weight		10.5 kg (23 lbs)	13.2 kg (29 lbs)
Electrical	Voltage	100-240 V/ 50/60 Hz	100-240 V/ 50/60 Hz
	Max. Current	1.5 Amp	1.5 Amp
	Power Consumption	35 W	60W
	Lamp Watts	27 W	45W
Maximum Operating Pressure		100 psi (689 kPa)	100 psi (689 kPa)
Minimum Operating Pressure		15 psi (103 kPa)	15 psi (103 kPa)
Ambient Water Temperature		2-40 °C (36-104 °F)	2-40 °C (36-104 °F)
UV Lamp Type		Sterilume™- HO (high output)	Sterilume™- HO (high output)
Visual “Power-On”		Yes	Yes
Audible Lamp Failure		Yes	Yes
Lamp Replacement Reminder		Yes	Yes
Visual Lamp Life Remaining		Yes	Yes
Total Running Time		Yes	Yes
254 nm UV Monitor		No	No
Solenoid Output (solenoid not incl.)		No	No
Chamber Material		304 SS	304 SS
Filter Housing		10” high flow	20” high flow

Section Manu acturer s arrant

ur Commitment

VIQUA is committed to ensuring your experience with our products and organization exceeds your expectations. We have manufactured your UV disinfection system to the highest quality standards and value you as our customer. Should you need any support, or have questions about your system, please contact our Technical Support team at 1.800.265.7246 or technicalsupport@viqua.com and we will be happy to assist you. We sincerely hope you enjoy the benefits of clean, safe drinking water after the installation of your VIQUA disinfection system.

o to Ma e a arrant Claim

Note: *To maximise the disinfection performance and reliability of your VIQUA product, the system must be properly sized, installed and maintained. Guidance on the necessary water quality parameters and maintenance requirements can be found in your Owner's Manual.*

In the event that repair or replacement of parts covered by this warranty are required, the process will be handled by your dealer. If you are unsure whether an equipment problem or failure is covered by warranty, contact our Technical Support team at 1.800.265.7246 or e-mail technicalsupport@viqua.com. Our fully trained technicians will help you troubleshoot the problem and identify a solution. Please have available the model number (system type), the date of purchase, the name of the dealer from whom you purchased your VIQUA product ("the source dealer"), as well as a description of the problem you are experiencing. To establish proof of purchase when making a warranty claim, you will either need your original invoice, or have previously completed and returned your product registration card via mail or online.

Speci ic arrant Co erage

Warranty coverage is specific to the VIQUA range of products. Warranty coverage is subject to the conditions and limitations outlined under "General Conditions and Limitations".

Ten-Year Limite arrant or VI A V Cham er

VIQUA warrants the UV chamber on the VIQUA product to be free from defects in material and workmanship for a period of ten (10) years from the date of purchase. During this time, VIQUA will repair or replace, at its option, any defective VIQUA UV chamber. Please return the defective part to your dealer who will process your claim.

Three-Year Limite arrant or Electrical an ar are Components

VIQUA warrants the electrical (controller) and hardware components to be free from defects in material and workmanship for a period of three (3) years from the date of purchase. During this time, VIQUA will repair or replace, at its option, any defective parts covered by the warranty. Please return the defective part to your dealer who will process your claim.

ne-Year Limite arrant or V lamps, Slee es, an V Sensors

VIQUA warrants UV lamps, sleeves, and UV sensors to be free from defects in material and workmanship for a period of one (1) year from the date of purchase. During this time, VIQUA will repair or replace, at its option, any defective parts covered by the warranty.Your dealer will process your claim and advise whether the defective item needs to be returned for failure analysis.

Note: *Use only genuine VIQUA replacement lamps and sleeves in your system. Failure to do so may seriously compromise disinfection performance and affect warranty coverage.*

General Con itions an Limitations

None of the above warranties cover damage caused by improper use or maintenance, accidents, acts of God or minor scratches or imperfections that do not materially impair the operation of the product. The warranties also do not cover products that are not installed as outlined in the applicable Owner's Manual.

Parts repaired or replaced under these warranties will be covered under warranty up to the end of the warranty period applicable to the original part.

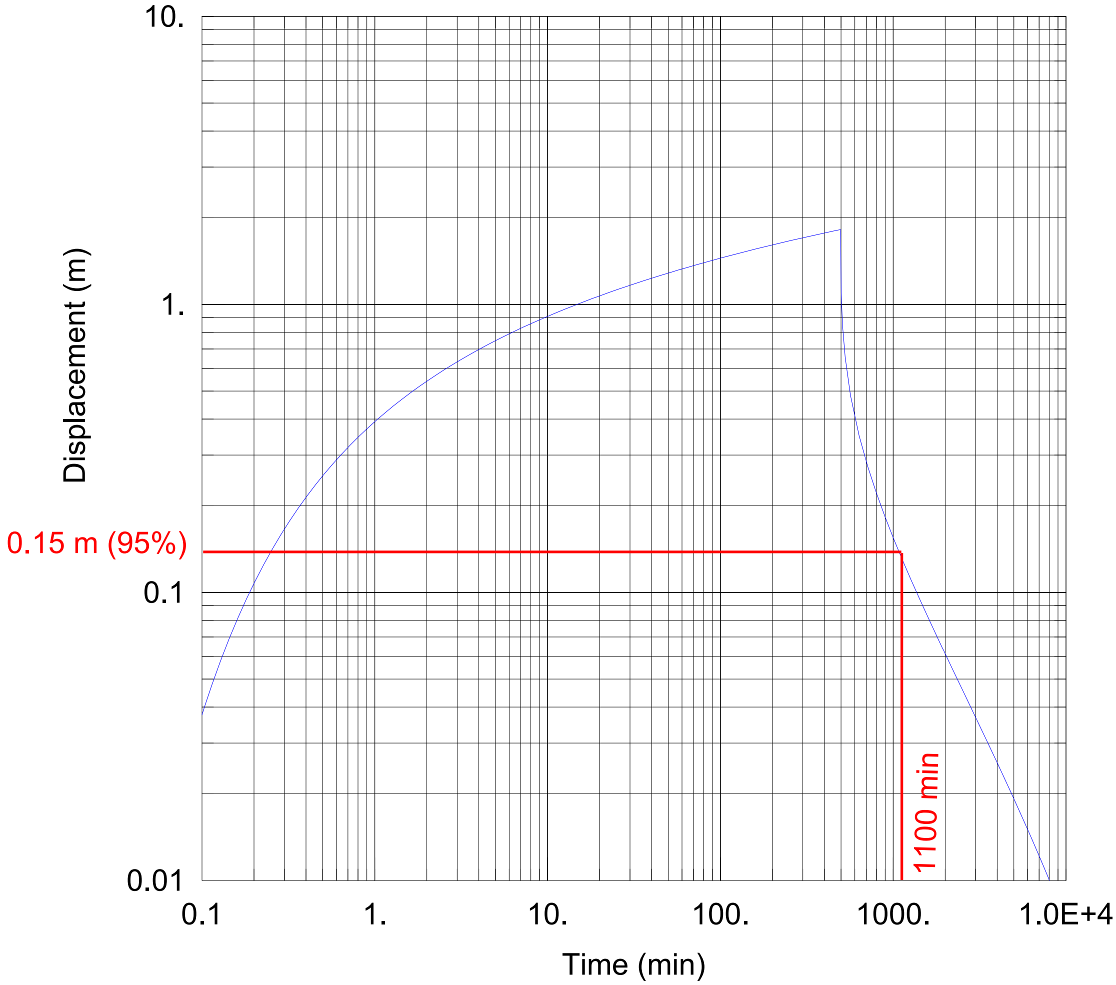
The above warranties do not include the cost of shipping and handling of returned items.The limited warranties described above are the only warranties applicable to the VIQUA range of products. These limited warranties outline the exclusive remedy for all claims based on a failure of or defect in any of these products, whether the claim is based on contract, tort (including negligence), strict liability or otherwise. These warranties are in lieu of all other warranties whether written, oral, implied or statutory. Without limitation, no warranty of merchantability or of fitness for a particular purpose shall apply to any of these products.

VIQUA does not assume any liability for personal injury or property damage caused by the use or misuse of any of the above products. VIQUA shall not in any event be liable for special, incidental, indirect or consequential damages. VIQUA's liability shall, in all instances, be limited to repair or replacement of the defective product or part and this liability will terminate upon expiration of the applicable warranty period.

425 Clair Rd. W, Guelph, Ontario, Canada N1L 1R1
t. (+1) 519.763.1032 • tf. (+1) 800.265.7246 (US and Canada only)
t. (+31) 73 747 0144 (Europe only) • f. (+1) 519.763.5069
e-mail: info@viqua.com
www.viqua.com

ATTACHMENT N

Predictive Analysis – Graph



WELL TEST ANALYSIS

Data Set: C:\01_HLV2K\LRL220487\TW1_R2.aqt
Date: 11/08/24 Time: 15:27:45

PROJECT INFORMATION

Company: HLV2K Engineering
Client: Entrepreneur Holding Corp.
Project: LRL220487
Test Well: TW2
Test Date: July 30, 2023

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TW1	0	0

Observation Wells

Well Name	X (m)	Y (m)
□ TW1	0	0

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob

Q = 7.16 L/min
T = 3.486 m^2/day
r/B = 0.005
b = 49. m
S = 0.001158
Kz/Kr = 1.

Figure G.2. Pumping Test Analysis with the Pumping Rate 7.16 L/min

Data Set: C:\01_HLV2K\LRL220487\TW1_R2.aqt
Date: 11/08/24
Time: 15:36:28

PROJECT INFORMATION

Company: HLV2K Engineering
Client: Entrepreneur Holding Corp.
Project: LRL220487
Test Date: July 30, 2023
Test Well: TW2

AQUIFER DATA

Saturated Thickness: 49. m
Anisotropy Ratio (Kz/Kr): 1.
Aquitard Thickness (b'): 1. m
Aquitard Thickness (b"): 1. m

PUMPING WELL DATA

No. of pumping wells: 1

Pumping Well No. 1: TW1

X Location: 0. m
Y Location: 0. m

Casing Radius: 0.15 m
Well Radius: 1. m

Fully Penetrating Well

No. of pumping periods: 4

Pumping Period Data

Time (min)	Rate (L/min)	Time (min)	Rate (L/min)
0.	7.16	496.	0.
495.	7.16	1936.	0.

OBSERVATION WELL DATA

No. of observation wells: 1

Observation Well No. 1: TW1

X Location: 0. m
Y Location: 0. m

Radial distance from TW1: 0. m

Fully Penetrating Well

No. of Observations: 57

Observation Data

Time (min)	Displacement (m)	Time (min)	Displacement (m)
0.5	0.4	420.	3.63
1.	1.14	480.	3.64
1.5	1.4	495.	3.62
2.	1.65	496.	3.62
2.5	1.89	496.5	1.69
3.	2.1	497.	1.58
3.5	2.34	497.5	1.5
4.	2.52	498.	1.44
4.5	2.62	498.5	1.33
5.	2.69	499.	1.2

Time (min)	Displacement (m)	Time (min)	Displacement (m)
6.	2.77	499.5	1.07
7.	2.91	500.	0.95
8.	2.98	500.5	0.9
9.	3.06	501.	0.84
10.	3.12	502.	0.77
15.	3.27	503.	0.71
20.	3.36	504.	0.67
25.	3.415	505.	0.65
30.	3.45	506.	0.61
40.	3.5	511.	0.53
50.	3.52	516.	0.48
60.	3.57	521.	0.44
90.	3.58	526.	0.42
120.	3.59	536.	0.38
150.	3.6	546.	0.37
180.	3.59	556.	0.36
240.	3.61	1456.	0.26
300.	3.615	1936.	0.32
360.	3.6		

SOLUTION

Pumping Test
Aquifer Model: Leaky
Solution Method: Hantush-Jacob

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
T	3.486	m^2/day
S	0.001158	
r/B	0.005	
Kz/Kr	1.	
b	49.	m

K = T/b = 0.07114 m/day (8.233E-5 cm/sec)
Ss = S/b = 2.363E-5 1/m
K'/b' = 6.051E-8 min^{-1}
K' = 8.714E-5 m/day