

MEMO



TO: Ms. Sonya Scarrow, Saleville Limited Partnership, c/o Paul Gingrich
FROM: Natalie Szponar, MSc., P.Geo, Dillon Consulting Limited
cc: Sara Ross, BES, Dillon Consulting Limited
DATE: February 29, 2016
SUBJECT: Hydrogeological Assessment Memo for the Saleville Property located on Elgin Park Drive in the Township of Uxbridge in the Municipality of Durham, Ontario
OUR FILE: File #15-2274

Dillon Consulting Limited (Dillon) is pleased to provide the following hydrogeological assessment of the Saleville Property located on Elgin Park Drive in the Township of Uxbridge and in the Municipality of Durham, Ontario (see **Figure 1** for site location). The purpose of this hydrogeological assessment was to develop an understanding of the groundwater resources for the site and within 1 km of the site boundaries (referred to as the Study Area). To fulfill this objective, several tasks were performed, including:

1. Identifying major aquifers and aquitards in the Study Area and characterizing the general groundwater flow patterns;
2. Assessing aquifer vulnerability through a review of areas of significant groundwater recharge and wellhead protection areas within the Study Area as identified by available source protection related studies;
3. Reviewing data relating to the existing use of the groundwater resource;
4. Assessing the capabilities of the groundwater resource to be used for potable supply; and,
5. Assessing if there are any sensitive surface water features in the Study Area that may rely on groundwater inputs.

The approach for the hydrogeological assessment included a desktop review of available sources for the Study Area, and did not involve the collection of additional field data. The following available sources of information were reviewed:

- Chapman, L.J. and Putnam, D.F. 1984. Physiography of Southern Ontario; Ontario Geological Survey, Preliminary Map P.2715, scale 1:600 000.
- Barnett, P.J., Cowan, W.R. and Henry, A.P. 1991. Quaternary geology of Ontario, southern sheet; Ontario Geological Survey, Map 2556, scale 1:1 000 000.
- Egorov, Igor P. 2002. The Oak Ridges Moraine: Evaluation of Groundwater Resources in the Uxbridge Area. Master's Thesis submitted to the Ottawa-Carleton Geoscience and Department of Earth Sciences.
- Lake Simcoe Region Conservation Authority (LSRCA), 1997. Uxbridge Brook Watershed Plan, prepared for the Township of Uxbridge.

- LSRCA, 2015. Lake Simcoe and Couchiching –Black River Source Protection Area Approved Assessment Report.
- Ministry of Environment and Climate Change (MOECC) Water Well Record database
- Ontario Geological Survey, 1991. Bedrock geology of Ontario, southern sheet; Ontario Geological Survey, Map 2544, scale 1: 1 000 000.
- Sharpe, D.R., 1980. Quaternary Geology of Toronto and Surrounding Area, southern Ontario; Ontario Geological Survey Preliminary Map 2204, scale 1:100 000.
- Sharpe, D.R., Barnett, P.J., Brennand, T.A., Finley, D., Gorrell, G., Russell, H.A.J. and Stacey, P. 1997. Surficial Geology of the Greater Toronto and Oak Ridges Moraine Area, Southern Ontario. Geological Survey of Canada. Open File 3062, Scale 1:200 000.
- South Georgian Bay Lake Simcoe Source Protection Region, January 2015, Approved Source Protection Plan.

Regional Topography and Geology

The topography of the site slopes to the northwest with the surface elevation changing from approximately 290 meters (m) above sea level (asl) in the southeast to 275 m asl in the northwest.

The Study Area is located within two physiographic regions (see **Figure 2**). These regions are the Oak Ridges Moraine (ORM) and the Peterborough Drumlin Field (Chapman and Putnam, 1984). Approximately 500 m north of the site are clay plains associated with the Peterborough Drumlin Field (Chapman and Putnam, 1984). The Peterborough drumlin field is characterized as a rolling drumlinized till plain. The drumlins are composed of a stone-rich, slightly silty to medium grained sand till. The site is located in the ORM physiographic region and consists of the kame moraines formed during the Late Wisconsin glaciation time period (Chapman and Putnam, 1984). The ORM generally rises in elevation from east to west peaking in elevation near the community of Uxbridge, as a result of the western portion of the moraine receiving earlier and more frequent sedimentary deposition than the eastern portion.

Within the Study Area, the surficial geology consists of coarse-textured glaciolacustrine deposits (foreshore and basinal deposits composed of sand gravel, minor silt and clay), organic deposits (peat, muck and marl, 1-7 m thick), modern and older alluvial deposits (clay, silt, sand, gravel, and may contain organic remains), and ice-contact stratified deposits (sand and gravel, minor silt, clay and till; Barnett et al., 1991; Sharpe et al., 1997). The surficial geology in the area is illustrated on **Figure 3**. The surficial geology at the site consists of approximately 70% modern and older alluvial deposits located on the western portion of the site; and approximately 30% ice-contact stratified deposits located on the eastern portion of the site (Barnett et al., 1991; Sharpe et al., 1997).

Bedrock geology mapping for the area indicates that the site is underlain by the Georgian Bay Formation, the Blue Mountain Formation and the Billings Formation of the Collingwood and Eastview Members, consisting of shale, limestone, dolostone and siltsone (OGS, 1991). In the northern part of the Region, the bedrock surface elevation slopes gently northeast.

Based on MOECC water well records available for the Study Area, the soil stratigraphy generally consists of sand from 0 to 25.9 m, silt and clay with intermitted sand from 12 to 115 m, and shale from 96 to 137 m and the static water level depth ranges from 0.9 to 24 m. Based on the available water well records

for the site, the inferred stratigraphy for the site consist of sand and gravel to 3 m and sand (intermitted with silt and clay) to 31 m; and the static water level depth ranges from 5 to 9 m.

The Study Area is located in the Uxbridge Brook subwatershed (i.e., part of the Lake Simcoe watershed), approximately 28 kilometers (km) south of Lake Simcoe and 32 km north of Lake Ontario. All of the lands within the Lake Simcoe watershed ultimately drain into Lake Simcoe, via one of the tributary rivers. The Uxbridge Brook subwatershed has a drainage area of 178 km² and is drained by the Uxbridge Brook, which flows generally in a northerly direction to Pefferlaw Brook, and eventually drains into Lake Simcoe. The headwaters originate from discharge springs and seepages along the northern flanks of the Oak Ridges Moraine.

The Uxbridge Brook is located on the western portion of the site. Based on the topography of the site and distance to the closest water body (i.e., the Uxbridge Brook), the inferred shallow groundwater flow on the site is northwest towards the Brook.

Aquifers / Aquitards and Groundwater Flow

The Study Area is located in Lake Simcoe and Couchiching-Black River Source Protection Area (SPA), which is part of the South Georgian Bay-Lake Simcoe (SGBLS) Source Protection Region (SPR). Three aquifers (lower, intermediate, and upper) are located in the subwatershed and are considered a regionally significant groundwater resource (LSRCA, 1997). Based on the surficial geology for the site, the site is likely underlain by all three aquifers.

The upper aquifer consists of an unconfined sand and gravel layer up to 25 m thick and is located above 259 m asl. The aquifer flows in a northerly direction and discharges towards Uxbridge Brook. The aquifer receives recharge from the headwater areas of the Beaver River to the east and Pefferlaw Brook to the west (LSRCA, 1997).

The intermediate aquifer (244 to 259 m asl) consists of fine to medium sand with locally cemented gravel up to 27 m thick. However, in some locations it may be intermittent or combined with the lower aquifer. Groundwater flow patterns in the intermediate aquifer generally follow those of the upper aquifer (LSRCA, 1997). Recharge occurs from the upper aquifer along the moraine and discharge occurs from the intermediate aquifer to the upper aquifer.

The lower aquifer (198 to 216 m asl) is confined and consists of a sand and gravel layer up to 20 m thick. This aquifer has similar flow characteristics to the upper and intermediate aquifers and receives recharge from upper and intermediate aquifers.

The regional direction of groundwater movement for all three aquifers is to the north, towards Lake Simcoe (LSRCA, 1997).

The upper aquifer system and lower aquifer is separated by a regional aquitard formed by clayey sediments of the Newmarket Till (Sibul et al., 1977). The Newmarket Till occurs is a consolidated diamict composed of a mixture of pebble and boulder sized clasts suspended in a silt to silty-sand matrix and can range from 0 to 60 m in thickness. The Newmarket Till contains breaches where it has been eroded by melt water activity (i.e., tunnel channels).

The intermediate and upper aquifers have been reported to be connected to a deep semi-confined leaky aquifer system referred to as the Thorncliffe Aquifer Complex (TAC) which underlies the Newmarket Till, via a tunnel channel (LSRCA, 2015).

Groundwater Use

A total of 98 MOECC water supply well records were identified within the Study Area for domestic, commercial and industrial use (see **Figure 1** for locations of wells). Approximately 76 % of the wells are drilled into overburden consisting of sand to depths of 25.9 m and likely obtain groundwater from the upper aquifer; and 24% of the wells are drilled into overburden consisting of sand silt and clay to depths of 137 m and likely obtain groundwater from the lower aquifer. Two domestic water supply wells were identified on the western portion of the site, drilled into overburden consisting of sand. The static water level depth in these wells ranged from 5 to 9 m, indicating that groundwater to these wells is supplied from the upper aquifer.

Properties surrounding the site are also municipally serviced. The Uxbridge community obtains water from three municipal water supply wells: MW5, MW6 and MW7. None of the Uxbridge municipal wells have been identified as Groundwater under the Direct Influence (GUDI) of Surface Water. These municipal wells are deep (58.2 m to 76.5) and extract groundwater from the lower aquifer. The site is located approximately 670 m from MW6 and approximately 1.4 km from MW5 and MW7.

Aquifer Vulnerability

Areas that are vulnerable to contamination are demonstrated by delineating Wellhead Protection Areas (WHPA) for wells and Intake Protection Zones (IPZ) for surface water intakes, Significant Groundwater Recharge Areas (SGRAs), and Highly Vulnerable Aquifers (HVAs). Factors that affect vulnerability include:

- Depth/thickness of the aquifer and overlying aquitard;
- Type(s) of soils present;
- Groundwater travel time; and,
- Transport pathways.

The aquifer vulnerability delineation is described below.

Well Head Protection Area (WHPA)

A Well Head Protection Area (WHPA) is the area of land surrounding a municipal well, which contributes to water to the well. The size of the area is determined by how quickly water travels to the well measured in years (e.g., 2 yrs., 5 yrs., 10 yrs., and 25 yrs.). According to the Lake Simcoe and Couchiching-Black River SPA Assessment Report, three wells are located in the Township of Uxbridge (MW5, MW6 and MW7) and services approximately 10,220 people.

The aquifer pumped by the municipal Uxbridge well system is partially connected to the ORM Aquifer Complex where recharge predominantly occurs in the upland areas of the moraine. Municipal wells MW5 and MW7 obtain their water supply from a deep semi-confined leaky aquifer system referred to as the Thorncliffe Aquifer Complex (TAC). It has been interpreted that near MW5 and MW7, the TAC is connected to the intermediate and shallow aquifers via a tunnel channel that breached the Newmarket

Till (LSRCA, 2015). Municipal well MW6 is also located in the TAC; however, in this location the aquifer is confined by Newmarket Till suggesting that the tunnel channel is not present (LSRCA, 2015).

Two WHPAs have been identified surrounding Uxbridge municipal wells: one in the vicinity of well MW6 located south of Regional Road 8 and west of Main Street, and one in the vicinity of wells MW5 and MW7 located south of Regional Road 8 and east of Main Street (LSRCA, 2015).

Groundwater flow in the WHPA reflect the direction of local groundwater flow towards the municipal well (i.e., northeast towards MW6 and northwest towards MW5 and MW7) and regional groundwater flow to the north within the Uxbridge subwatershed.

The west half of the site is located within the 25 year time of travel WHPA for municipal well MW6. The west half of the site falls within a WHPA (i.e., 25 year time of travel) of low aquifer vulnerability for municipal well MW6.

Based on the groundwater vulnerability mapping for the Uxbridge Brook Watershed Study, the site and surrounding area is located in a low vulnerability aquifer area (vulnerability score of 2/10). The groundwater vulnerability is considered to be low in the areas near the municipal wells because the municipal wells are relatively deep and the overburden above the aquifer is relatively thick (LSRCA, 2015).

Intake Protection Zone (IPZ)

The Intake Protection Zone is the area of water and land where activities have the potential to affect the quality of water being taken up by the surface water intake. According to the Lake Simcoe and Couchiching –Black River SPA Approved Assessment Report no IPZ are located within the Uxbridge Brook Subwatershed (LSRCA, 2015). Therefore, IPZs were not further assessed for the site.

Highly Vulnerable Aquifers (HVA)

A Highly Vulnerable Aquifer (HVA), as defined by Ontario Regulation 287/07, is as an aquifer on which external sources have or are likely to have a significant adverse effect, and includes the land above the aquifer. A HVA will consist of source granular aquifer materials (e.g. sand and/or gravel) or fractured rock that has a high permeability and is exposed near the ground surface with a relatively shallow water table. The vulnerability of the aquifer will typically be lower where a greater thickness of fine-grained lower permeability soils covers the aquifer.

According to the regional groundwater vulnerability mapping for the Uxbridge Brook subwatershed, the Study Area is located in a high aquifer vulnerability area (LSRCA, 2015). The HVA in the Study Area is attributed to the upper aquifer which consists of an unconfined sand and gravel unit located in the ORM physiographic region. According to the MOECC water well records available for the Study Area, the majority of water wells are drilled into the upper aquifer. The upper aquifer is approximately 25 m thick and contains the water table. The intermediate and lower aquifer is considered to be less vulnerable, given that they are confined and overburden aquifer is relatively thick.

Based on available MOECC water well records and geological mapping for the site, the site is also considered to be located in a high aquifer vulnerability area, attributed to the unconfined upper aquifer (i.e., HVA) underlying the site consisting of gravel and sand, and fine to medium sand.

Significant Groundwater Recharge Areas (SGRA)

Significant Groundwater Recharge Areas (SGRA) is characterized by permeable soils, such as sand or gravel that allow the water to seep easily into the ground and flow to an aquifer. A recharge area is considered significant when it helps maintain the water level in an aquifer that supplies a community with drinking water, or supplies groundwater recharge to a cold water ecosystem that is dependent on this recharge to maintain its ecological function.

Groundwater recharge in the Study Area occurs in the upper aquifer located in ORM region which is considered a SGRA. This aquifer has a high recharge potential (approximately 360 mm/yr) and recharges the underlying aquifers (LSRCA, 2015). Groundwater recharge areas for all three aquifers (upper, intermediate and lower) also include areas outside of the watershed boundaries, including headwaters from the Beaver River in the east and headwaters of Pefferlaw Brook in the west (LSRCA, 1997). According to the regional mapping for the Uxbridge Brook subwatershed, the Study Area is located in a SGRA (LSRCA, 2015). Given the site is located in the ORM region; it is likely that the site is also located within a SGRA.

Groundwater Recharge and Surface Water Interaction

The closest surface water feature in the Study Area is Uxbridge Brook (i.e., part of the Uxbridge Brook Headwater Wetland Complex). A portion of the Uxbridge Brook is located on the west side of the site and flows north towards Pefferlaw Brook and eventually drains into Lake Simcoe (approximately 28 km north of the Study Area). The site is considered to be located in a SGRA and therefore it is likely that the site supplies water to the Brook.

Summary

Based on a review of the available sources for the Study Area, the hydrogeological assessment pertaining to the site identified the following:

- The site is located in Lake Simcoe and Couchiching-Black River Source Protection Area, which is part of the South Georgian Bay-Lake Simcoe (SGBLS) Source Protection Region;
- Groundwater within the Study Area is municipally supplied and/or via private water wells;
- Three sets of aquifer systems were identified in the Study Area: i) an upper unconfined aquifer; ii) an intermediate aquifer; and iii) a lower confined aquifer. The municipal wells obtain groundwater from the deep confined aquifer, whereas, the upper unconfined aquifer provides a source of water to water supply wells at the site and surrounding properties;
- The Uxbridge Brook is located on the western portion of the site. Shallow groundwater flow at the site is inferred to follow topography at the site and flow northwest towards the Brook. The regional direction of groundwater movement for all three aquifers is to the north, towards Lake Simcoe;
- Based on information provided by LSRCA, the site is located in a HVA and SGRA and therefore highly vulnerable to groundwater contamination. This is attributed to the site being situated in the ORM and the presence of upper unconfined aquifer at the site which consists of gravel and sand, and fine to medium sand and contains the water table;
- It is likely that the site is located in a groundwater recharge area and supplies water to the Uxbridge Brook.