Hydrogeological Assessment

FINAL REPORT

Dancor Construction Limited

Project Name:
Hydrogeological Assessment
1766 Wilton Grove Road
London, Ontario

Project Number:
LON-22006771-A0

Prepared By:
EXP Services Inc.
405 Maple Grove Road
Unit 6
Cambridge, Ontario, N3E 1B6
t: +1.519.650.4918
f: +1.519.650.4603

Date Submitted:
February 20, 2025

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EXP Services Inc.
405 Maple Grove Road, Unit 6
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Canada
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f: +1.519.650.4603

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Hagit Blumenthal, M.Sc., P.Geo
Hydrogeologist, Earth and Environment

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Heather Jaggard, M.Sc., P.Geo.
Hydrogeologist, Earth and Environment

Date Submitted:

February 20, 2025

Executive Summary

EXP Services Inc. (EXP) was retained by **Dancor Construction Limited** to conduct a hydrogeological assessment in support of a proposed industrial development located at 1766 Wilton Grove Road in London, Ontario (herein referred to as the 'Site'). The proposed development consists of three (3) industrial warehouse buildings along with associated parking at ground level and servicing.

The objective of the hydrogeological investigation was to assess the hydrogeological characteristics of the Site by reviewing the Ministry of the Environment, Conservation and Parks (MECP) Water Well Records (WWR), reviewing the soil and groundwater information provided from a series of sampled boreholes and monitoring wells at the Site, and collecting groundwater and surface water elevations to identify any seasonal variations, and assess the natural heritage features on the property. The assessment provides comments pertaining to potential impacts on hydrogeological conditions at the Site resulting from the proposed development and provides recommendations and design/construction measures, where applicable, to mitigate potential impacts. It is understood that the hydrogeological assessment will be submitted for review and approval by the City of London and the Upper Thames River Conservation Authority (UTRCA).

The study scope and report have been completed in general accordance with the standard Hydrogeological requirements as outlined in the Conservation Authority Guidelines for Hydrogeological Assessments (2013).

Based on the results of the hydrogeological assessment, the following findings are presented:

- The Site is located in the Dingman Creek watershed. The northern portion of the property is mapped within the boundaries of the Westminster Wetland Complex provincially significant wetland (PSW) and a woodland bordering Highway 401. The Hampton-Scott Drain, a tributary of Dingman Creek flows south through the PSW and along the eastern property boundary. An additional unnamed tributary to the Drain runs from west to east along the southern boundary of the PSW before it joins the Drain. The Hampton-Scott Drain is a tributary of Dingman Creek located further south of the Site;

- UTRCA screening areas associated with the PSW and the Hampton-Scott Drain encompass the majority of the Site with the exception of the southwest corner;

- Surface drainage follows Site topography and generally flows towards the Hampton-Scott Drain, the unnamed tributary and the PSW. The southern portion of the Site drains to the south;

- The stratigraphy at the Site is characterized by sandy silt to clayey silt at surface and clayey silt/silt till at depth. Coarser material such as sand or sand and gravel was not encountered;

- Based on the manual groundwater measurements, groundwater elevations at the Site ranged between 6.12 and 0.14 m below ground surface (bgs) and groundwater elevations ranged between 262.12 and 270.77 m above mean sea level (amsl). Groundwater levels declined during the summer months and increased in the winter and spring months;

- Based on the seasonal shallow groundwater levels within the mini-piezometers and seasonal fluctuations at the unnamed tributary and the Hampton-Scott Drain, the PSW is likely fed seasonally by both shallow groundwater and surface water runoff;

- Based on the groundwater elevations and soil permeability across the Site it is determined that shallow groundwater flow is generally downward with a horizontal component following topography towards the PSW and the Hampton-Scott Drain;

- The northern portion of the Site is mapped as a significant groundwater recharge area (SGRA) and a highly vulnerable aquifer (HVA);

- Based on the MECP WWR, there are no water supply wells within a 500 m radius of the Site that are installed into the shallow overburden (<10 m bgs);

- Single Well Response Tests (SWRT) were completed on two (2) of the monitoring wells. Based on the test results, the estimated hydraulic conductivities were 1.2×10^{-7} m/s for sandy silt and 8.5×10^{-9} m/s for silt till and clayey silt till;

- Groundwater sampling results indicate the Ontario Drinking Water Quality Standards, Objectives and Guidelines (ODWQS) Maximum Acceptable Concentrations (MAC) were not exceeded in any of the sampled wells;

- Exceedances of the Provincial Water Quality Objectives (PWQO) guidelines for the sampled surface water stations include total phosphorous, total aluminum and total iron;

- Overall, due to the increase in impervious areas post-development, the total infiltration deficit across the Site is estimated to be 12,592 m^3/year. The infiltration deficit specifically for the unnamed tributary and PSW is estimated to be 1,190 m^3/year. Clean roof runoff will be directed from Area B3 towards the PSW as a mitigation measure to achieve water balance to the significant features; and

- Based on the observed groundwater conditions, the shallow groundwater table may be encountered during construction. Given the low hydraulic conductivity observed, the volume of groundwater requiring management is expected to be minimal. A dewatering assessment can be completed at the detailed design stage once the installation details of the services and the finished floor elevations are finalized.

<u>Summary of Recommendations</u>

- To ensure the proposed works will not impact the quantity of runoff or infiltration the PSW receives under existing conditions, clean rooftop runoff will be directed to unpaved areas;

- The requirement for a dewatering assessment should be reviewed upon finalizing the Site design. In the event water supply wells fall within the predicted radius of influence, a monitoring program that includes contingencies may be necessary; and

- Monitoring stations to assess during and post-development changes to water quality may be considered; however, the specific purpose and long-term responsibility for servicing and maintenance of the monitoring stations would need to be established.

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Appendices

Tables (in text)

Drawings (Appendix A)

1. Introduction and Background

1.1 Background

EXP Services Inc. (EXP) was retained by **Dancor Construction Limited** to conduct a hydrogeological assessment in support of a proposed industrial development located at 1766 Wilton Grove Road in London, Ontario (herein referred to as the 'Site'). The Site Location Plan is provided on **Drawing 1** in **Appendix A**.

The objective of the hydrogeological investigation was to assess the hydrogeological characteristics of the Site by reviewing the Ministry of the Environment, Conservation and Parks (MECP) Water Well Records (WWR), reviewing the soil and groundwater information provided from a series of sampled boreholes and monitoring wells at the Site, and collecting groundwater and surface water elevations to identify any seasonal variations, and assess the natural heritage features on the property. The assessment provides comments pertaining to potential impacts on hydrogeological conditions at the Site resulting from the proposed development and provides recommendations and design/construction measures, where applicable, to mitigate potential impacts.

The northern portion of the property is mapped within the boundaries of the Westminster Wetland Complex provincially significant wetland (PSW) and a woodland bordering Highway 401. The Hampton-Scott Drain, a tributary of Dingman Creek, flows south through the PSW and along the eastern property boundary. An additional unnamed tributary to the Drain runs from west to east along the southern boundary of the PSW before it joins the Drain. These natural features are shown on **Drawing 2**. UTRCA screening areas associated with the PSW and the Hampton-Scott Drain encompass the majority of the Site with the exception of the southwest corner (**Drawing 3**).

It is understood that the hydrogeological study and water balance assessment will be submitted for review and approval by the City of London as part of the Draft Plan Approval for the proposed development. The study design and report have been compiled in accordance with the City of London Design Specification & Requirements Manual (2019) as well as the Conservation Authority Guidelines for Hydrogeological Assessments (2013).

The UTRCA administers a regulation made under Section 28 of the Conservation Authorities Act, known as Development, Interference with Wetlands and Alterations to Shorelines and Watercourses (O.Reg. 157/06). The regulation was approved by the Minister of Natural Resources and Forestry on May 4, 2006. This regulation allows the UTRCA to ensure that proposed development and other activities have regard for natural hazard features. The UTRCA implements the regulation by issuing Section 28 permits for works in or near watercourses, valleys, wetlands, or shorelines, when required.

Property owners must obtain permission and/or a letter of clearance from the local Conservation Authority before beginning any development, site alteration, construction, or placement of fill within the regulated area. Permits are also required for any wetland interference, or for altering, straightening, diverting or interfering in any way with the existing channel of a creek, stream or river. It is EXP's understanding that the Site is subject to this regulation, and requires a Section 28 permit, as the Site contains a water feature.

1.2 Development Plans and Stormwater Management Plan

A Draft Site Plan prepared by Architectural Design Inc. dated May, 2024 is provided in **Appendix B**. As shown, the proposed development consists of three (3) industrial warehouse buildings along with associated parking at ground level and servicing. The proposed development will be serviced by municipal watermain and sanitary sewer.

According to the Functional Servicing and Stormwater Management Report completed for the Site by Greck and Associates Limited dated September 16, 2024, surface water runoff will drain overland into catch basins and catch basin manholes into the proposed storm sewer system. It will then be directed to a dry stormwater management pond and ultimately discharge into the Hampton-Scott Drain, a tributary of Dingman Creek, along the eastern property boundary. Runoff storage will also be provided via an oversized pipe storage and ponding storage. Roof runoff will be collected and directed into roof storage before being discharged into the storm sewers ultimately discharging into the Drain. A debris/sediment trap and Oil and Grit Separator (OGS) will be utilized to treat the water before discharging into the Drain. Clean roof runoff will be directed to the PSW on Site to ensure the proposed works will not impact the quantity of runoff the PSW receives under existing conditions. Additional discussion of the water balance for the Site is provided in **Section 5**.

1.3 Terms of Reference and Scope of Work

Scoping meetings with the City of London and the UTRCA were held on August 17, 2022 and September 9, 2022, to review the hydrogeological scope and requirements of the investigation. A copy of the meeting minutes from September 9, 2022 is provided in **Appendix C**. The investigation was completed in accordance with the scope of work.

The scope of work for the Hydrogeological Assessment consisted of the following:

1. <u>Desktop Study</u>: This task consisted of a review of existing information including Site plans, previous reports (where available), geological maps, geological cross sections, groundwater level information, borehole logs, and MECP WWR.

2. <u>Field Program</u>:

    a. The drilling program was completed in 2022 and included the advancement of eight (8) boreholes across the Site to facilitate the geotechnical investigation also being completed for the Site. A total of four (4) boreholes were completed as groundwater monitoring wells to facilitate the hydrogeological investigation;
    b. A total of two (2) mini-piezometers (P1 and P2) were installed within the PSW and two (2) additional staff gauges (SG1 and SG2) were installed within the unnamed tributary (upstream) and the Hampton-Scott Drain (downstream) on September 20, 2022;
    c. Manual groundwater and surface water measurements were collected between May 2022 and October 2023. Electronic pressure transducers (data loggers) were installed within two (2) monitoring wells and one (1) mini-piezometer;
    d. Single well response tests (SWRT) were completed on selected monitoring wells to assist in characterizing the geological units the wells are screened within; and
    e. A total of two (2) rounds of water quality samples were collected and analyzed for general chemistry parameters to document the water chemistry prior to construction and development of the Site.

3. Data Evaluation: Compilation and evaluation of the collected field and laboratory data.

4. Reporting: This task consisted of preparing this Hydrogeological Assessment report. In preparing this report, EXP has considered the guidance material available in the Conservation Ontario Guidelines for Hydrogeological Assessments (Conservation Ontario, 2013).

2. Methodology

2.1 Borehole Drilling and Monitoring Well Installations

Borehole drilling and monitoring well installations were completed on April 20 and May 10, 2022. The drilling program consisted of the advancement of eight (8) boreholes with four (4) completed as groundwater monitoring wells at the locations shown on **Drawing 2**.

The borehole and monitoring well installations were completed by a specialist drilling subcontractor under the supervision of EXP staff. The boreholes were advanced using a track-mounted drill rig equipped with continuous flight solid and hollow stem augers, soil sampling and soil testing equipment. Disturbed soil samples were recovered from each borehole, at depth intervals of 0.75 m and 1.5 m using conventional split spoon sampling equipment and Standard Penetration Test (SPT) methods or auger samples.

The stratigraphy in the boreholes was examined during the drilling and logged in the field by EXP technical personnel. Copies of the borehole logs are provided in **Appendix D**.

Groundwater monitoring wells were constructed from 51 mm (2") diameter, schedule 40, polyvinyl chloride (PVC), flush-threaded casing. The appropriate number of risers were coupled with screen sections via threaded joints to construct the well. Well screens consisted of 1.5 m long lengths of PVC pipe with 0.010-inch factory-generated slots. A primary filter pack consisting of silica sand was placed around the well screen in the borehole and extended above the top of the well screen. Hole Plug, a swelling Bentonite clay that forms an effective barrier to the vertical movement of fluids when installed in a boring, was used as a seal above the filter pack. A summary of the well installation details is provided in **Table 1**.

The ground surface and top of well pipe elevations were surveyed in May, 2022 with a Sokkia GPS unit, capable of collecting accurate location and elevation measurements to the mm scale.

The monitoring wells were constructed in accordance with Ontario Regulation 903 (as amended) as administered by the MECP.

When no longer required, the monitoring wells installed at the Site should be properly decommissioned in accordance with Ontario Regulation 903, under the Ontario Water Resources Act. This regulation identifies minimum standards and proper abandonment/decommissioning of existing domestic wells, as well as regulations for licensing well contractors and well technicians. Further, the decommissioning work must be undertaken by a licensed contractor.

Table 1 – Monitoring Well Construction Details

Well ID	Ground Surface Elevation (m amsl)	Top of Standpipe Elevation (m amsl)	Borehole Completion Depth (m bgs)	Well Screen Interval (m)	Screened Strata
BH1/MW	268.54	269.63	8.1	4.6-6.1	Sandy Silt
BH3/MW	266.44	267.32	5.0	1.2-2.7	Sandy Silt; Clayey Silt
BH5/MW	271.17	271.96	6.6	4.6-6.1	Clayey Silt Till
BH6/MW	267.90	268.78	8.1	6.1-7.6	Silt Till; Clayey Silt Till

Table Notes:
m amsl – meters above mean sea level
m bgs – meters below ground surface

2.2 Mini-piezometer and Staff Gauge Installations

A total of two (2) mini-piezometers (P1 and P2) were installed within the PSW and two (2) additional staff gauges (SG1 and SG2) were installed within the unnamed tributary (upstream) and the Hampton-Scott Drain (downstream) on September 20, 2022. Due to dry conditions, no staff gauges were installed in the vicinity of P1 and P2. The staff gauges were installed in order to capture monthly surface water elevations. The locations of each station are shown on **Drawing 2**. The following **Table 2** outlines the surface water station details.

The mini-piezometers were installed with a 6-inch Solinst drive point end (6-inch screen length). The Solinst drive point piezometer ends have a stainless steel, 50 mesh cylindrical filter screen, within a ¾" (20mm) stainless steel drive-point body.

The elevations of the mini-piezometers and staff gauges were surveyed in November, 2022 with a Sokkia GPS unit, capable of collecting accurate location and elevation measurements to the mm scale.

Table 2 – Surface Water Station Details

Station ID	Ground Surface Elevation (m amsl)	Top of Piezometer Elevation (m amsl)	Completion Depth (m bgs)	Screen Length (m)	Staff Gauge Installed
P1	267.89	269.01	1.16	0.15	No – Dry Conditions
P2	265.76	266.78	1.01	0.15	No – Dry Conditions
SG1	268.25	269.25	N/A	N/A	Yes
SG2	264.53	265.53	N/A	N/A	Yes

Notes: 1. N/A – Not Applicable
2. m amsl denotes metres above mean sea level.
3. m bgs denotes metres below ground surface.

2.3 Well Development and Groundwater Sampling

Monitoring well development consisted of purging 10x the well volume, purging the well dry, or adding clean water and surging the well with a Waterra™ surge block to remove fine sediments within the well screen. Water was immediately removed from the well following surging.

Monitoring wells were developed to:

- remove fine soil particles adjacent to the well screen;
- restore the groundwater properties that may have been disturbed during the drilling process;
- improve the hydraulic communication between the well and the geologic materials; and
- remove water, if any, added during the drilling process.

Groundwater samples were collected on July 28, 2022 and April 13, 2023 from monitoring well locations BH1/MW, BH3/MW and BH6/MW. Prior to sampling, at least three (3) well volumes were purged from the wells. Groundwater samples were submitted to an accredited laboratory for analysis of general chemistry parameters (i.e. pH, total dissolved solids, conductivity), nutrients, and dissolved metals.

2.4 Surface Water Sampling

Surface water samples were collected on April 13, 2023 from the unnamed tributary (upstream) adjacent to mini-piezometer P2 and from the Hampton-Scott Drain downstream at staff gauge SG2. The surface water samples were submitted to an accredited laboratory for analysis of general chemistry parameters (i.e. pH, total dissolved solids, conductivity), nutrients, total and dissolved metals.

2.5 Long-Term Groundwater and Surface Water Elevation Monitoring

Site-wide manual groundwater levels were measured in monitoring wells BH1/MW, BH3/MW, BH5/MW and BH6/MW monthly from installation in May 2022 to October 2023. Groundwater and surface water levels were measured in mini-piezometers P1 and P2 and staff gauges SG1 and SG2 monthly from installation in September 2022 to October 2023.

Two (2) monitoring wells and one (1) mini-piezometer were instrumented with data loggers (BH3/MW, BH6/MW, and P2), set to record a reading daily for continuous groundwater level monitoring. Datalogger readings are available from monitoring well BH3/MW until June 2023 when the logger was detached in the well and could not be retrieved.

2.6 Hydraulic Conductivity Testing

Single well response tests (SWRTs) were completed on monitoring locations BH1/MW and BH6/MW to evaluate the hydraulic characteristics of the screened overburden. Monitoring well BH3/MW could not be tested due to limited water within the well.

The test method consisted of a recovery test (i.e. rising head test) whereby the wells were either purged dry, or a volume of water was removed with a bailer. The water level recovery was then monitored using an electronic data logger until it was observed to reach at least 90% recovery.

The mathematical solution by Hvorslev (1951) was used to interpret the data and involved matching a straight-line solution to water-level displacement data collected during the recovery test.

Hvorslev (1951) was selected as the analytical method since research has shown that the Hvorslev analysis typically results in higher K estimates compared to several other analytical methods, including Bouwer and Rice (1976), and Dagan (1978) (Ismael, 2016). Ismael (2016) also states:

> *Larger K values typical of pump tests are generally known to be superior to smaller values from slug tests, largely due to inadequate development of wells that are slugged (Butler and Healy, 1998). Butler (1998) says that "the hydraulic-conductivity estimate obtained from a slug test should virtually always be viewed as a lower bound on the hydraulic conductivity of the formation in the vicinity of the well." That is why larger K values are considered to be inherently better or more potentially true than smaller values*.

Assumptions in the Hvorslev method for estimating K are:

- The aquifer has infinite aerial extent;
- The aquifer is homogeneous and of uniform thickness;
- The tested well is fully or partially penetrating;
- Flow to the well is quasi-steady-state (storage is negligible); and
- Water is injected into or discharged from the well instantaneously.

3. Regional Hydrogeological Setting

In addition to the shallow groundwater information collected from the boreholes completed at the Site, the following documents were reviewed to gain an understanding of the hydrogeological conditions in the area:

- Dillon Consulting Limited and Golder Associates Ltd. Middlesex-Elgin Groundwater Study, Final Report, submitted to Middlesex and Elgin Counties, dated July 2004, henceforth referred to as the Middlesex-Elgin Groundwater Study;
- Goff, K and D.R. Brown, 1981. Ground-Water Resources. Thames River Basin Water Management Study Technical Report. Ontario Ministry of the Environment, Water Resources Report 14;
- MECP Well Records within 500 m of the Site boundary; and,
- Thames-Sydenham and Region Source Protection Committee. 2011. Upper Thames River Source Protection Area, Approved Updated Assessment Report. 12 August.

3.1 Regional Geology

3.1.1 Bedrock Geology

The Site is underlain by limestone, dolostone and shale of the Dundee Formation (Ontario Geological Survey; OGS, 2011). Bedrock topography mapping (Drawing 4) indicates the bedrock surface is at an elevation of about 200 m amsl beneath the Site. The bedrock surface generally slopes to the west-southwest in this area. Review of the Ontario MECP WWR within 500 m from the Site (Appendix E) indicates a minimum overburden thickness of 24 m. Bedrock was not noted in the Ontario MECP WWR within 500 m of the Site nor was it encountered during the drilling program completed as part of this investigation.

3.1.2 Physiography and Overburden Geology

The physiography of Southwestern Ontario was altered significantly by the glacial and interglacial periods that took place throughout the Quaternary period. The overburden deposits present in the study area were formed by numerous glacial events during the late Wisconsinan glacial stage approximately 10,000 to 23,000 years before present. There were two distinct glacial lobes present in Southwestern Ontario during this period. The Huron Lobe advanced from Lake Huron southwards, and the Erie Lobe advanced from the northeast, receding to the east. The physiography of the Site was influenced by the Huron Lobe.

During the advancement of the glacial ice sheets, bedrock and unconsolidated sediments were eroded. During the recession of the glaciers, the eroded materials were deposited in lakes, rivers and along spillways, contributing to the present configuration of moraines, abandoned spillways, drumlins, eskers, abandoned shorelines, and various still-water sediment deposits.

The surficial deposits were mapped and categorized into several physiographic regions by Chapman and Putnam (1984). The physiographic mapping for the area indicates the site is situated within the Mount Elgin Ridges, as shown on **Drawing 5**.

Physiographic landform mapping (**Drawing 6**) indicates that the Site is located within an area characterized by undrumlinized till plains.

Surficial geology mapping (OGS, 2010; **Drawing 7**) indicates the Site is underlain by coarse-textured glaciolacustrine deposits consisting of sand, gravel, minor silt and clay in the northern half of the Site and clay to silt-textured till derived from glaciolacustrine deposits or shale in the southern half of the Site (**Drawing 7**).

3.2 Regional Aquifer

Goff and Brown (1981) described the potential for four regional aquifers in the study area; shallow unconfined overburden aquifer, intermediate and deep confined aquifers, and a bedrock aquifer.

3.2.1 Overburden Aquifers

The uppermost shallow and unconfined overburden aquifer was described by Goff and Brown (1981) as consisting of lacustrine or glacio-fluvial sands that may, in some locations, be overlain by lower permeability silts and clays. Shallow overburden aquifers are discontinuous in nature and are expected to be linked more directly to precipitation and recharge, compared to the intermediate and deep overburden aquifers.

Intermediate depth (15 to 30 m bgs) and deep overburden aquifers (>30 m bgs) aquifers are reported by Goff and Brown (1981) to generally consist of saturated sand and gravel deposits and are very discontinuous in nature due to the heterogeneous nature of glacial deposits. The intermediate depth and deep overburden aquifers are generally confined by overlying silt, clay and glacial till deposits which limit vertical migration of shallow groundwater.

Shallow groundwater flow is expected to follow the local topography. On a regional scale, the deep overburden aquifer flow direction is reported to be towards the south-southwest (Dillon and Golder, 2004).

3.2.2 Bedrock Aquifer

The bedrock aquifer consists of limestone from the Dundee Formation (OGS, 2011). As with the intermediate depth and deep overburden aquifers, the bedrock aquifer is confined by the overlying soils, which is indicated to be at least 24 m thick in the vicinity of the Site based on the Ontario MECP WWR. Wells extending into the shallow fractured bedrock (up to about 3m) are typically considered to be hydraulically connected to the overlying sand and gravel deposits that are present at the bedrock-overburden interface.

Flow direction in the deeper confined aquifer(s) and regional groundwater system has not been assessed as part of this investigation. However, as part of the Middlesex-Elgin Groundwater Study (Dillon and Golder, 2004), groundwater flow within the deeper aquifer was generally in a south-southwest direction towards Lake Erie.

3.3 Local Water Use

A search of the online Ontario MECP WWR database identified 18 records within 500 m of the Site boundaries. The following provides a summary of the well records identified:

- 6 records were listed a water supply wells. Of these:
    - 3 records were listed with the primary use as domestic or domestic and livestock;

- 2 records were listed with the primary use as livestock; and
- 1 record were listed with the primary use as other.

- 6 records were listed as monitoring, test holes or observations wells;
- 4 records were listed as unknown use; and
- 2 records was listed as abandoned.

In the event additional details are required to confirm the presence of a private water well and ascertain well details, a water supply well questionnaire can be provided to the property owner.

The approximate locations of identified wells, as provided by the MECP Water Well Information System (WWIS), are shown on **Drawing 8**, with a summary provided in **Appendix E**.

4. Site Description and Geologic Setting

4.1 Site Location and Description

The Site is a rectangular shaped parcel of land comprising an area of 26.63 hectares, located at 1766 Wilton Grove Road in London, Ontario (**Drawing 1**). It is currently an agricultural land with an existing residence and commercial building located on the south side of the Site. The Site is bounded by Highway 401 to the north and Wilton Grove Road to the south and agricultural lands to the east and west of the Site.

4.2 Topography and Drainage

The Site relatively hilly ranging from a topographic high of approximately 272 m amsl in the north to a topographic low of 264 m amsl in the east along the Hampton-Scott Drain.

The northern portion of the property is mapped within the boundaries of the Westminster Wetland Complex PSW and a woodland bordering Highway 401. The Hampton-Scott Drain flows south through the PSW and along the eastern property boundary. An additional unnamed tributary to the Hampton-Scott Drain runs from west to east along the southern boundary of the PSW before it joins the Drain. The Drain is a tributary of Dingman Creek located further south of the Site. The natural features on Site are presented in **Drawing 2**. Based on topographic mapping, surface drainage follows Site topography and generally flows towards the Hampton-Scott Drain, the unnamed tributary and the PSW. The southern portion of the Site drains to the south.

The Site is located within Dingman Creek watershed. UTRCA screening areas associated with the PSW and the Hampton-Scott Drain encompass the majority of the Site with the exception of the southwest corner (**Drawing 3**).

4.3 Wetlands and Ecology

Based on an Environmental Impact Study completed by Pinchin Ltd. (2025), the wetland communities on Site include Mineral Meadow March (MAM2), Alder Mineral Thicket Swamp (SWT2-1) and Reed-Canary Grass Mineral Meadow March (MAM2-2).

The unnamed tributary and the Hampton-Scott Drain are tributaries of Dingman Creek. The Hampton-Scott Drain was observed to be permanently wet and the unnamed tributary was intermittently wet with a dry period observed during the fall surveys. Both watercourses flow south into Dingman Creek through the PSW. Fish were not observed in these watercourses during the ecology field assessment.

To accommodate the proposed development, a 30 m buffer from the PSW, 15 m buffer from the valleylands and watercourse, and a 10 m buffer from the woodland are proposed.

4.4 Site Specific Surficial Geology

A total of eight (8) boreholes were completed by EXP across the Site, with the installation of monitoring wells in four (4) borehole locations. The locations of the boreholes are provided in **Drawing 2**. The boreholes were terminated at a maximum depth of between 5.0 and 8.1 m bgs. Borehole logs and particle size distribution curves are provided in **Appendix D**.

Overall, the stratigraphy at the Site is characterized by sandy silt to clayey silt at surface and clayey silt/silt till at depth. Coarser material such as sand or sand and gravel was not encountered. Generalized stratigraphic cross sections through the Site, as shown in **Drawing 9**, are provided in **Drawings 10 to 11**.

As shown in cross section A-A' (**Drawing 10**) extending north to south, the north portion of the Site consists of alternating layers of clayey silt, sandy silt and clayey silt till/silt till. The till material becomes exposed at surface in the central portion of the Site.

As shown in cross section B-B' (**Drawing 11**) extending east to west, the stratigraphy across the Site is relatively homogenous consisting of clayey to sandy silt overlying clayey silt till/silt till.

The detailed soil profiles encountered in each borehole are provided on the borehole logs in **Appendix D**. It should be noted that the soil boundaries indicated on the borehole logs are inferred from non-continuous soil sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones for the hydrogeological investigation and shall not be interpreted as exact planes of geological change.

4.5 Site Specific Groundwater and Surface Water Elevations

4.5.1 Monitoring Wells

Manual groundwater levels, groundwater elevations, and hydrographs for monitoring wells BH3/MW and BH6/MW are included in **Appendix F**.

Based on the manual groundwater measurements, groundwater elevations at the Site ranged between 6.12 and 0.14 m bgs and groundwater elevations ranged between 262.12 and 270.77 m amsl.

Hydrographs have been compiled for monitoring well locations BH3/MW and BH6/MW which are included in **Appendix F**. Precipitation data reported from the London CS weather station (ID 6144478) and temperature data collected from the loggers are also shown on the hydrographs. The following sections provide a description of the groundwater trends at these locations based on the hydrographs.

Hydrograph 1 illustrates the groundwater trends within BH3/MW, screened at an interval of 2.7 to 1.2 m bgs within sandy silt and clayey silt, installed immediately adjacent to the PSW feature. Groundwater levels declined from spring to summer with dry conditions in late summer and fall of 2022. Groundwater levels increased in the winter and spring months. A direct response to precipitation events was observed throughout the monitoring program.

Hydrograph 2 illustrates the groundwater trends within BH6/MW, screened at an interval of 7.6 to 6.1 m bgs within silt till and clayey silt till, installed adjacent to the Hampton Scott Drain. The highest groundwater levels are observed in winter and spring (the spring freshet) followed a decline from spring to summer. A direct response to precipitation was observed following a significant rain event (80.1 mm) on July 2, 2023. Also shown on the hydrograph is the response of groundwater levels to well development and testing.

4.5.2 Surface Water Stations

A total of two (2) mini-piezometers (P1 and P2) were installed within the PSW and two (2) additional staff gauges (SG1 and SG2) were installed on September 20, 2022. Staff gauge SG1 was installed upstream in an unnamed tributary to the Hampton-Scott Drain and SG2 was installed downstream within the Drain. A datalogger was installed in the shallow groundwater mini-piezometer P2 in order to capture readings on a daily basis. Manual water levels and Hydrograph 3 for mini-piezometer P2 are included in **Appendix F**.

Manual groundwater level monitoring indicated minimal to dry conditions at both P1 and P2 installed within the PSW in summer and fall and elevated groundwater levels close to ground surface in winter and spring.

Hydrograph 3 for mini-piezometer P2 illustrates the groundwater trends within the PSW with dry conditions in summer and fall and groundwater levels at or near ground surface in winter and spring. Direct response to precipitation was not observed during the monitoring period.

At the staff gauges, the Hampton-Scott Drain was wet throughout the monitoring period with surface water of up to 0.7 m at SG2. Whereas in the unnamed tributary, dry conditions were noted in fall 2022 at SG1. Surface water was generally deeper at SG2 located downstream in the Hampton-Scott Drain than at SG1 located at the unnamed tributary further upstream. These observations are consistent with the watercourse assessment completed by Pinchin (2025).

Based on the seasonal shallow groundwater levels within the mini-piezometers and seasonal fluctuations at the unnamed tributary and the Hampton-Scott Drain, the PSW is likely fed seasonally by both shallow groundwater and surface water runoff.

4.6 Wetland Hydroperiod

The hydroperiod of a wetland is defined as the length of time and portion of the year a wetland holds ponded water (Tarr and Babbitt) and the TRCA (2018) states “The hydroperiod of a wetland is the seasonal pattern of water level fluctuation”.

The PSW was assessed for its hydroperiod. Two (2) mini-piezometers (P1 and P2) were installed within the PSW and both inside (groundwater) and outside (surface water) measurements were collected throughout the monitoring period at these locations. Based on water level measurements and field observations, the PSW was predominantly dry and retained surface water only on few occasions in late winter and early spring (in February, March and May 2023).

4.7 Groundwater Flow

Shallow groundwater flow across the Site is affected by hydraulic conductivity, topography, drainage, and geology. The surficial geological unit at the Site generally consists of silty clay/silt till interlayered with sandy and clayey silt as shown on the geological cross-sections. This till unit is interpreted to behave as an aquitard unit as evidenced by the slow recoveries and available information from neighbouring properties.

The predominant groundwater flow direction in aquitards is vertical (downward) while the predominant groundwater flow direction across aquifers is horizontal (Cherry, et. al., 2006). Completion of water table mapping within aquitards it typically not practical since the head in the well is dependent on the screened interval and depth, more than the location (Midwest Geosciences Group, 2018). As such, mapping the water table within aquitards can result in many peaks and closed depressions that do not represent the water table. Since the predominant groundwater flow direction is vertical, water table mapping may not be representative of groundwater flow paths in aquitards (Midwest Geosciences Group, 2018).

Notwithstanding the above, a groundwater flow map was created based on groundwater measurements collected on May 2, 2023 representing a seasonal high groundwater table. It is inferred that the shallow horizontal groundwater flow direction is towards the Hampton-Scott Drain and PSW following topography. Groundwater elevations and flow direction is presented in **Drawing 12**.

4.8 Hydraulic Conductivity (k)

As stated in **Section 2.6**, SWRTs were completed on monitoring locations BH1/MW and MW6/MW to evaluate the hydraulic characteristics of the screened overburden.

The hydraulic conductivity estimates for the tested monitoring wells are summarized in **Table 3** below:

Table 3 – Hydraulic Conductivity Testing Results Summary

Well ID	Soil Description	Hydraulic Conductivity (m/s)	Screened Unit
BH1/MW	Sandy Silt	1.2×10^{-7}	Aquitard
BH6/MW	Silt Till, Clayey Silt Till	8.5×10^{-9}	Aquitard

These results are generally consistent with the estimated range of hydraulic conductivity values for their respective lithologies reported by Freeze and Cherry (1979). The SWRT analyses are provided in **Appendix G**.

Given that an aquifer was not encountered on Site and groundwater flow in the low permeability aquitard unit is predominantly downward, the horizontal hydraulic gradient and the average linear groundwater velocity were not calculated.

4.9 Groundwater Chemistry

Groundwater samples were collected from monitoring locations BH1/MW, BH3/MW and BH6/MW screened in an aquitard on July 28, 2022 and April 13, 2023. The groundwater samples were submitted for analysis of general chemistry parameters to document the groundwater chemistry prior to construction and development of the Site. The groundwater quality results were compared to the Ontario Drinking Water Quality Standards (ODWQS) Maximum Acceptable Concentrations (MAC), and Aesthetic/Operational Guidelines (A/O). The Groundwater Analytical Results Summary and Laboratory Certificates of Analysis are provided in **Appendix H**.

4.9.1 General Chemistry & Dissolved Metals

All groundwater samples reportedly contained hardness levels (as $CaCO_3$) above the ODWQS A/O. Dissolved aluminum collected from BH6/MW and dissolved manganese collected from BH3/MW were also above their respective ODWQS A/O. There were no reported concentrations above the ODWQS MAC.

The proposed development will be serviced via municipal water supply; therefore, the elevated concentrations above the ODWQS A/O are not considered a concern.

4.9.2 Anions and Nutrients

Nitrite was reported at concentrations ranging from below the detectable limit to 0.026 mg/L in BH3/MW and nitrate concentrations ranged from below detection limit to 2.29 mg/L at BH3/MW. Concentrations of both nitrite and nitrate were below their respective ODWQS MAC of 1mg/L for nitrite and 10 mg/L for nitrate. Due to the presence of cultivated agricultural fields in the vicinity of the Site, these concentrations may fluctuate annually if nitrate-containing fertilizers are applied to these agricultural properties.

4.10 Surface Water Chemistry

Surface water samples were collected on April 13, 2023 from the unnamed tributary (upstream) adjacent to mini-piezometer P2 and from the Hampton-Scott Drain downstream at staff gauge SG2. Surface water quality results were compared to Ontario Provincial Water Quality Objectives (PWQO) (MOEE 1994). As shown in the tabulated results in **Appendix H**, exceedances of the PWQO guidelines for the sampled surface water stations include total phosphorous, total aluminum and total iron. Results were generally similar between the unnamed tributary (upstream) and the Hampton- Scott Drain (downstream).

4.10.1 Schoeller Diagrams

Schoeller Diagrams were also prepared for the groundwater and surface water samples for major and minor ions, included in **Appendix H**. Results show three (3) distinct chemical signatures including groundwater chemical signature of monitoring wells BH1/MW and BH3/MW, groundwater chemical signature of monitoring well BH6/MW and surface water chemical signature of the unnamed tributary (sample adjacent to P2) and the Hampton-Scott Drain (sample SG2). Monitoring well BH6/MW had a significantly lower concentration of chloride and a higher concentration of strontium compared to monitoring wells BH1/MW and BH3/MW. Monitoring well BH6/MW is screened at a greater depth and in lower permeability till material compared with monitoring wells BH1/MW and BH3/MW. This may result in less dilution with surface water and a different chemical signature.

The surface water samples collected from the unnamed tributary (adjacent to P2) and the Hampton-Scott Drain (SG2) show a distinct chemical signature as well with elevated sodium and chloride suggesting direct connection to surface water runoff and impacts from road salt application.

4.10.2 Piper Diagram

A Piper Diagram was prepared for the groundwater and surface water quality samples, provided in **Appendix H**. Groundwater samples plot within the calcium-magnesium bicarbonate type of the Piper Diagram whereas the surface water quality samples plot within the mixed type with elevated chloride concentration as a result of road salt impacts on surface water.

5. Feature-Based Water Balance Assessment

This section of the report is a summary of a water balance assessment completed by Greck and Associates Ltd. as part the Functional Servicing and Stormwater Management Report dated September 16, 2024. This water balance was completed for the entire Site excluding the area north of the unnamed tributary which is a future development block. The assessment provides details of pre- and post- development conditions within catchments of the Hampton-Scott Drain, the unnamed tributary and PSW on Site. As part of this study four (4) catchment areas were delineated on Site under existing conditions:

- Area A (5.82 ha) – draining south towards a roadside ditch servicing Wilton Grove Road;
- Area B (7.39 ha) – draining east towards the Hampton-Scott Drain;
- Area C (3.43 ha) – draining north towards the unnamed tributary and the PSW; and
- Area EXT1 (0.55 ha) – external area draining from the west towards Area B in the east.

Under proposed conditions, the development was delineated into four (4) catchment areas:

- Area A (8.67 ha) will consist of asphalt and parking lots. Runoff from this area will be captured by catch basins and directed via storm sewers to be discharged into the Hampton-Scott Drain;
- Area B (5.68 ha) was divided into three (3) sub-drainage areas. Areas B1 and B2 represent the industrial building roofs in the centre and south portion of the development area. Runoff from these areas will be collected into storm sewers and discharged into the Hampton-Scott Drain. Area B3 represents industrial building roof where runoff will be collected into storm sewers and discharged into the unnamed tributary and the PSW;
- Area C (2.29 ha) will consist of landscaped areas draining north towards the unnamed tributary and the PSW; and
- Area EXT-1 (0.55 ha) consists of agricultural fields. This area will drain east via overland flow towards Area A where it will be collected by storm sewers and discharged into the Hampton-Scott Drain.

The results of the water balance assessment completed by Greck and Associates Ltd are summarized in **Table 4** below.

Table 4 - Summary of Water Balance Estimates

Drainage Area	Area A and B	Area A, B1 and B2	Area C (to PSW)	Area B3 and C (to PSW)
Land Use	Pre-Development	Post Development	Pre-Development	Post-Development
Estimated Runoff (m^3/year)	32,705	100,783	7,733	17,108
Estimated Infiltration (m^3/year)	13,263	1,862	3,572	2,382

Overall, due to the increase in impervious areas post-development the total infiltration deficit within the development area of the Site is estimated to be 12,592 m^3/year. The infiltration deficit for the unnamed tributary and PSW is estimated to be 1,190 m^3/year. Infiltration facilities to mitigate the infiltration deficit are not feasible on Site due to the seasonally shallow groundwater table. As a result, Greck and Associates Ltd. recommended to direct clean roof runoff from Area B3 towards the PSW as a mitigation measure. A total proposed runoff of 17,108 m^3/year was proposed in the Functional Servicing and Stormwater Management Report to be directed to the PSW compared to 7,733 m^3/year runoff under existing conditions. EXP recommends modifying the runoff towards the PSW with consultation with the ecology team to maintain pre-development conditions.

6. Impact Assessment

6.1 Source Water Protection Considerations

6.1.1 Significant Groundwater Recharge Areas (SGRA)

Groundwater recharge is largely controlled by soil conditions, and typically occurs in upland areas.

As defined in the Clean Water Act (2006), an area is a significant groundwater recharge area if,

1. the area annually recharges water to the underlying aquifer at a rate that is greater than the rate of recharge across the whole of the related groundwater recharge area by a factor of 1.15 or more; or,

2. the area annually recharges a volume of water to the underlying aquifer that is 55% or more of the volume determined by subtracting the annual evapotranspiration for the whole of the related groundwater recharge area from the annual precipitation for the whole of the related groundwater recharge area.

The Source Water Protection Information Atlas (SWPIA) online mapping shows the northern half of the Site is located within the mapped boundaries of SGRA as shown on **Drawing 13**.

6.1.2 Highly Vulnerable Aquifers (HVA)

The susceptibility of an aquifer to contamination is a function of the susceptibility of its recharge area to the infiltration of contaminants. As defined in the *Clean Water Act (2006)*, the vulnerability of groundwater within a source protection area shall be assessed using one or more of the following groundwater vulnerability assessment methods:

- Intrinsic susceptibility index (ISI).
- Aquifer vulnerability index (AVI).
- Surface to aquifer advection time (SAAT).
- Surface to well advection time (SWAT).

In the Thames-Sydenham and Region, HVAs were mapped using the ISI method. The ISI method is an indexing approach using existing provincial WWIS database. The ISI method is described in detail in the MOECC's Technical Terms of Reference (2001). However, in short, the ISI method is a scoring system that takes into consideration the unique hydrogeologic conditions at a particular location. The scores are determined using a combination of the saturated thickness of each unit and an index number related to the soil type, and as such, the scores reflect the susceptibility of the aquifer to contamination. As defined in the MOECC's 2001 Technical Rules,

- an area having an ISI score of less than 30 is considered to be an area of high vulnerability;
- an area having an ISI score greater than or equal to 30, but less than or equal to 80, is considered to be an area of medium vulnerability; and,

- an area having an ISI score of greater than 80 is considered to be an area of low vulnerability.

The SWPIA online mapping shows that the northern half of the Site is located within an HVA as shown on **Drawing 14**.

6.1.3 Wellhead Protection Areas (WHPAs)

Wellhead Protection Areas are located surrounding municipal supply wells and delineate travel times to the well using both qualitative and quantitative assessments of geology and groundwater flow. There are four WHPA zones, defined as:

- WHPA A: 100 m radius around the municipal supply well
- WHPA B: time of travel to the well is 2 years or less
- WHPA C: time of travel to the well is greater than 2 years and equal to or less than 5 years, and
- WHPA D: time of travel to the well is greater than 5 years and equal to or less than 25 years.

The SWPIA online mapping indicates the Site is not located within a WHPA. The closest WHPA is located approximately 6.7 km southeast of the Site (Belmont Well Supply).

6.1.4 Intrinsic Vulnerability

The assessment of an aquifer intrinsic vulnerability takes into consideration the land uses in the area and the ability of surface or near-surface sources of contamination to infiltrate to the ground surface and reach the aquifer through various transport pathways (e.g. wells, septic systems, stormwater infiltration, etc.). The presence of transport pathways increases the likelihood of contamination of an aquifer as they facilitate the downward movement of contaminants. The intrinsic vulnerability scores range from low, medium, and high.

Map 4-3-1 (Aquifer Vulnerability) of the Upper Thames River Source Protection Area Approved Assessment Report (dated August 18, 2010) indicates the Site is located within an area with medium to high aquifer vulnerability.

6.1.5 Issue Contributing Areas (ICAs)

Issue contributing areas are delineated around municipal supply well intake areas where issues have been identified that may negatively impact drinking water supplies. Issues include various types of parameters (pathogens, chemical parameters, aesthetic parameters, etc.).

The SWPIA online mapping indicates the Site is not located within an ICA.

6.2 Private Water Well Users

6.2.1 Private Well Survey

Shallow wells interpreted to be located hydraulically up-gradient of the Site have a higher likelihood of being impacted by dewatering activities at the Site. As shown in **Appendix E**, based on the MECP water well records database there are six (6) records listed as water supply wells. None of the water supply wells within 500 m of the Site are installed at a depth of less than 10 m.

Based on the wells construction details and the low permeability shallow soils in the area, impacts to the water supply wells in the vicinity of the Site as a result of dewatering activities is unlikely.

6.3 Surface Water Features

The northern portion of the property is mapped within the boundaries of the Westminster Wetland Complex PSW and a woodland bordering Highway 401. The Hampton-Scott Drain flows south through the PSW and along the eastern property boundary. An additional tributary to the Hampton-Scott Drain runs from west to east along the southern boundary of the PSW before it joins the Drain. The natural features on Site are presented in **Drawing 2**.

Based on the seasonal shallow groundwater levels within the mini-piezometers and seasonal fluctuations at the unnamed tributary and the Drain, the PSW is likely fed seasonally by both shallow groundwater and surface water runoff.

As previously discussed, surface water runoff will be directed to a dry stormwater management pond and ultimately discharge into the Hampton-Scott Drain. Clean roof runoff will also be directed to the PSW to ensure the proposed works will not impact the quantity of runoff the PSW receives under existing conditions.

The following general comments are provided with recommendations to help minimize impact to surface water features in the vicinity of the Site during construction:

- During the site grading work, suitable sedimentation controls will be required to help control and reduce the turbidity of run-off water which may flow towards the surface water features;
- A Best Management Practice (BMP) and spill contingency plan (including a spill action response plan) should be in place for fuel handling, storage, and onsite equipment maintenance activities to minimize the risk of contaminant releases as a result of the proposed construction activities;
- Re-establishing vegetative cover in disturbed areas following the completion of the construction work; and,
- Limit the use of salts or other additives for ice and snow control on the roadways.

6.4 Groundwater Separation Distances and Preliminary Construction Dewatering Considerations

Groundwater elevations at the Site ranged between 6.12 and 0.14 m bgs with elevations ranging between 262.12 and 270.77 m amsl. Based on the observed groundwater conditions, the shallow groundwater table may be encountered during construction. Given the low hydraulic conductivity observed, the volume of groundwater requiring management is expected to be minimal.

Construction dewatering water takings between 50,000 and 400,000 litres per day (LPD) require registration on the online Environmental Activity and Sector Registry (EASR) while construction dewatering water takings exceeding 400,000 LPD require a Category 3 Permit to Take Water (PTTW). A Category 3 PTTW report is reviewed by the MECP prior to approval and involves a review period of up to 3 months or longer.

A dewatering assessment can be completed at the detailed design stage once the installation details of the services and the finished floor elevations are finalized. The dewatering assessment would include detailed dewatering volume calculations based on the finalized finished floor and servicing elevations, the estimated Radius of Influence (ROI) from the dewatering activities, and an assessment of potential impacts from the construction dewatering activities which may include the completion of a private well survey.

6.5 Water Quality Monitoring Considerations

It is typical for groundwater monitoring to be recommended during the construction and post-construction phases of development projects to assess potential impacts of the development on groundwater levels and quality. There are several items that can be considered to reduce the likelihood of negative impacts to the groundwater during construction, outlined below. These comments are provided for consideration, but are not intended as an exhaustive list in this regard:

- In the event that imported materials are required to support the proposed development, analytical testing of the imported material will be required as per the Ontario On-Site and Excess Soil Management Regulation (O. Reg. 406/19);
- Contractors working at the Site should ensure that construction equipment is in good working order. Equipment operators should have spill-prevention kits, where appropriate; and,
- Chemical application in landscaped and grassed areas should be limited. Consideration may be given to using grass varieties which are heartier and require less extensive watering or fertilizers.

Monitoring stations to assess during and post-development changes to water quality may be considered; however, the specific purpose and long-term responsibility for servicing and maintenance of the monitoring stations would need to be established.

7. Recommendations

Based on the findings of the Hydrogeological Investigation, the following summary of recommendations is provided:

- The infiltration deficit for the unnamed tributary and PSW is estimated to be 1,190 m^3/year. To ensure the proposed works will not impact the quantity of runoff or infiltration the PSW receives under existing conditions, clean rooftop runoff will be directed to unpaved areas. Runoff volumes are recommended to be determined in consultation with the ecologist team.

- A dewatering assessment including a door-to-door private well survey, is outside the scope of this hydrogeological investigation. The requirement for a dewatering assessment should be reviewed upon finalizing the Site design. In the event water supply wells fall within the predicted radius of influence, a monitoring program that includes contingencies may be necessary.

- Monitoring stations to assess during and post-development changes to water quality may be considered; however, the specific purpose and long-term responsibility for servicing and maintenance of the monitoring stations would need to be established.

8. Qualifications of Assessors

EXP Services Inc. provides a full range of environmental services through a full-time Earth and Environmental Services Group. EXP's Environmental Services Group has developed a strong working relationship with clients in both the private and public sectors and has developed a positive relationship with the Ontario MECP. Personnel in the numerous branch offices form part of a large network of full-time dedicated environmental professionals in the EXP organization.

This report was authored by Ms. Hagit Blumenthal M.Sc., P.Geo. Ms. Blumenthal has experience in conducting hydrogeological assessments. Ms. Blumenthal is a hydrogeologist and environmental geoscientist with more than 8 years' experience in the environmental field, and is a licensed Professional Geoscientist (P.Geo.) in Ontario. She obtained a Master of Science (M.Sc.) in 2010 from the University of Waterloo and has worked in the Hydrogeological and Environmental fields since then.

This report was reviewed by Ms. Heather Jaggard, M.Sc., P. Geo. Ms. Jaggard is a hydrogeologist and environmental geoscientist with more than 12 years in the environmental field and is a licensed Professional Geoscientist (P. Geo.) in Ontario. She obtained a Master's of Science (M.Sc.) in 2012 from Queen's University in Kingston, and is a Qualified Person (QP) registered with the Ontario MECP. She has worked in the Hydrogeological and Environmental fields since that time. In her professional career for the past few years, Ms. Jaggard has completed numerous hydrogeological assessments and modelling works for land development sites. Environmental site assessments and preparation of submissions for PTTW have been part of her routine assignments.

9. References

Chapman, L.J. and Putnam, D.F. 1984. The Physiography of Southern Ontario, Ontario Geological Survey, Special Volume 2, 270p.

Cherry, J. A., Parker, B. L., Bradbury, K. R., Eaton, T. T., Gotowitz, M. B., Hart, D. J., & Borchardt, M. A. (2006). Contaminant Transport Through Aquitards: A State-of-the-Science Review. Awwa Research Foundation.

Conservation Ontario. 2013. Hydrogeological Assessment Submissions - Conservation Ontario Guidelines to Support Development Applications. June.

Corporation of the City of London. 2019. Design Specifications & Requirements Manual. Updated August 2019.

Dillon Consulting Limited and Golder Associates Ltd. (Dillon and Golder). 2004. Middlesex-Elgin Groundwater Study, Final Report, submitted to Middlesex and Elgin Counties.

Freeze, R. A. and J.A. Cherry. 1979. Groundwater. Prentice-Hall Inc. New Jersey. 604 pp

Goff, K. and D.R. Brown, 1981. Ground-Water Resources – Summary. Thames River Basin Water Management Study Technical Report. Ontario Ministry of the Environment, Water Resources Report 14.

Greck and Associates Limited. 2024. 1766 Wilton Grove, London, Ontario, Functional Servicing and Stormwater Management Report. Project 23-967. Dated September 16, 2024.

Hvorslev, M.J. 1951. Time Lag and Soil Permeability in Ground-Water Observations, Bull. No. 36, Waterways Exper. Sta. Corps of Engrs, U.S. Army, Vicksburg, Mississippi, pp. 1-50.

Ismael, R. I. 2016. Slug Tests in Unconfined Aquifers. Master's Theses. 699.
https://scholarworks.wmich.edu/masters_theses/699

Midwest Geosciences Group. 2018. *Hydrogeology of Aquitards and Low-Permeability Materials Part 2: Head Distributions, Vertical Gradients and Solute Transport.* Presented by Madeline Gotkowitz, PhD., and David Hart, PhD., Hydrogeologists with the Wisconsin Geological and Natural History Survey.

Ministry of the Environment: Water Well Records. https://www.ontario.ca/environment-and-energy/map-well-records.

Ministry of the Environment (MOE). 2001. Groundwater Studies 2001/2002, Technical Terms of Reference

Ontario Geological Survey (OGS). 2010. Surficial geology of Southern Ontario, Miscellaneous Release--Data 128-REV.

Ontario Geological Survey (OGS). 2011. Bedrock Geology of Ontario, 1:250 000 scale, Miscellaneous Release Data 126-Revision 1.

Ministry of Environment, Conservation and Parks (MECP) 2025. Source Protection Information Atlas. https://www.lioapplications.lrc.gov.on.ca/SourceWaterProtection/index.html?viewer=SourceWaterProtection.SWPViewer&locale=en-CA.

Pinchin Ltd. 2025. Scoped Environmental Impact Study. 1766 Wilton Grove Road, London, Ontario. DRAFT. Dated February 10, 2025.

Tarr, M. and Babbitt, K. (n.d.) University of New Hampshire Cooperative Extension. The Importance of Hydroperiod in Wetland Assessment.

Thames-Sydenham and Region Source Protection Committee. 2011. Upper Thames River Source Protection Area, Approved Updated Assessment Report. 12 August.

10. General Limitations

The information presented in this report is based on a limited investigation designed to provide information to support an assessment of the current environmental conditions within the subject property. The conclusions and recommendations presented in this report reflect Site conditions existing at the time of the investigation. Consequently, during the future development of the property, conditions not observed during this investigation may become apparent. Should this occur, EXP Services Inc. should be contacted to assess the situation, and the need for additional testing and reporting. EXP has qualified personnel to provide assistance in regards to any future geotechnical and environmental issues related to this property.

Our undertaking at EXP, therefore, is to perform our work within limits prescribed by our clients, with the usual thoroughness and competence of the engineering profession. It is intended that the outcome of this investigation assist in reducing the client's risk associated with environmental impairment. Our work should not be considered 'risk mitigation'. No other warranty or representation, either expressed or implied, is included or intended in this report.

The comments given in this report are intended only for the guidance of design engineers. The number of test holes required to determine the localized underground conditions between test holes affecting construction costs, techniques, sequencing, equipment, scheduling, etc. would be much greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

EXP Services Inc. should be retained for a general review of the final design and specifications to verify that this report has been properly interpreted and implemented. If not afforded the privilege of making this review, EXP Services Inc. will assume no responsibility for interpretation of the recommendations in this report

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We trust this report is satisfactory for your purposes. Should you have any questions, please do not hesitate to contact this office.