Hydrogeological Assessment

FINAL REPORT

2060 Dundas Street Joint Venture

Project Name:
Hydrogeological Study
2060 Dundas Street
London, Ontario

Project Number:
KCH-21006317

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Date Submitted:
July 29, 2022

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Executive Summary

EXP Services Inc. (EXP) was retained by **2060 Dundas Street Joint Venture** to conduct a hydrogeological assessment in support of a proposed development at 2060 Dundas Street in London, Ontario, hereinafter referred to as the 'Site'.

The objective of the hydrogeological assessment was to examine the hydrogeological characteristics of the Site in support of the proposed development. The study included reviewing the Ministry of the Environment, Conservation and Parks (MECP) Water Well Records (WWR), reviewing the soils and groundwater information provided from a series of sampled boreholes and monitoring wells at the Site, compiling a feature based water balance for the wetland on the Site, collecting groundwater elevations, and assessing the natural heritage features on the property. 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).

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

- A total of three (3) monitoring wells were installed on Site in June 2021. Groundwater elevations across the Site are shallow and close to surface, with highest elevations measured at 0.54 meters below ground surface (mbgs) in monitoring well BH2/MW in April 2022;

- Two (2) surface water stations were installed on the Site. One in the wetland in May 2021 and one in the drain to the east of the Site in December 2021;

- Local hydrostratigraphy includes a low permeability silt till across the Site. A pocket of wet sand was noted beneath the till on the east side of the Site (BH3/MW). The till in this area is also overlain by thin layers of fill and sandy silt;

- Water supply in the local domestic wells is typically from shallow to intermediate aquifers, which consist of confined sand and gravel. Site activities associated with the residential development are not expected to impact the potable aquifers in the area due to the thickness of the overlying confining till layer;

- Single Well Response Tests (SWRTs) were conducted on select monitoring wells screened in the silt till and the area of wet sand layering at BH3/MW, and resulted in estimated hydraulic conductivities of 2.4×10^{-7} m/s and 2.0×10^{-7} m/s, respectively;

- Areas of Mineral Deciduous Swamp (SWD4), Mineral Cultural Thicket (CUT1), and Mineral Cultural Woodland (Black Locust; CUW1) have been identified by MTE on the Site. A surface water monitoring station was established in the SWD4 area as part of the field program;

- Drainage from the Site is expected to be primarily through the municipal drain flowing north alongside the east edge of the Site, which flows to the north and then west into Pottersburg Creek. Drainage from the Swamp is expected to flow to the north;

- The local shallow groundwater flow direction is interpreted to be northwesterly towards Pottersburg Creek;

- Based on groundwater levels observed to date, groundwater inflow to excavations should be expected during construction. Preliminary calculations suggest the dewatering requirement will be less than 50,000 L/day, however this should be reassessed when detailed designs are available;

- The monitoring wells on Site have been maintained for ongoing study past the completion of this report. When the wells are no longer required, they should be decommissioned in accordance with O. Reg. 903;

- The proposed development will introduce various impermeable surfaces (i.e. roofs, roadways, etc.), which is expected to impact the post-development infiltration levels. The Conservation Ontario pre- vs post-development infiltration rate is targeted at 80%. To meet this target an additional 71 m^3 of infiltration will be provided to the wetland annually by directing clean rainwater runoff from 10% of the rooftop area to the wetland.

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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 **2060 Dundas Joint Venture** to conduct a hydrogeological study and water balance assessment in support the proposed development to be located at 2060 Dundas Street in London, Ontario, hereinafter referred to as the 'Site' (**Appendix A, Drawing 1**).

The north portion of the Site where development will occur is currently forested in the west and contains shrubs in the east. The northeast part of the Site is proposed to be developed for residential use that includes a six-storey apartment building and associated parking lot and roadway. The western half of the Site is proposed to be maintained as a mature forest, with all construction taking place on the eastern portion of the Site. The development plan has been included in **Appendix B**.

The objective of the hydrogeological study was to examine 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, compiling a feature-based water balance for the wetland, collecting groundwater elevations, and assessing the natural heritage features on the property. The assessment provides comments pertaining to potential impacts on hydrogeological conditions at the Site and provides recommendations and design/construction measures, where applicable, to mitigate this potential for impact.

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

An Unnamed Municipal Drain is present within the east-adjacent property, approximately 5 m east of the Site. This Drain flows north and then west to Pottersburg Creek. The area surrounding this drain is designated Regulated Land by the UTRCA (**Drawing 3**).

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 a portion of the Site is within UTRCA regulated lands.

1.2 Development Plan and Stormwater Management Details

The development plan for the Site includes the north portion of the property located at 2060 Dundas Street and is currently proposed to include a six-storey, 78-unit residential apartment building and associated surface parking lot and roadways. An existing woodlot and Mineral Deciduous Swamp (ELC classification SWD4) is located to the west of the development area and is planned to be maintained and protected with appropriate tree protection barriers implemented during site development. The total proposed development area is approximately 0.90 hectares (ha) and the woodlot and Mineral Deciduous Swamp to be maintained is approximately 0.37 ha. The current Site Plan, dated April 21, 2022, is included in **Appendix B**.

A Stormwater Management (SWM) Report has not yet been completed for the Site, however a preliminary Servicing Brief was completed by MTE Consultants (MTE) in June 2022. The following summary provides details from the Servicing Brief (MTE, 2022).

An existing 300mm diameter watermain and 300mm diameter sanitary sewer are present on the north side of Dundas Street adjacent to the Site and will provide adequate flow and capacity for the proposed development. A private laneway (Sydorko Road) will be located within the existing road allowance on the east side of the Site and will have a private water service located adjacent to it and a private sanitary service located under the laneway to connect the proposed development to the watermain and sanitary sewer on Dundas Street.

The west portion of the Site which contains a woodlot and the Mineral Deciduous Swamp (SWD4) Wetland will remain undeveloped and drainage for this portion of the Site will remain as-is in post-development. It is currently very flat and overflows to the north. The drainage for the developed portion of the Site will be conveyed to the open ditch on Sydorko Road via internal private storm sewers. There is an option to convey a portion or all of the rooftop runoff to the woodlot through an underground storm sewer if required for water balance to the woodlot. Overland flow for the developed area is expected to be split in post-development, with a portion draining to the woodlot and a portion draining to the adjacent ditch on Sydorko Road. On-site quantity and quality controls will be provided prior to discharge to the woodlot. SWM and servicing details will be finalized during the future site plan stage of the process.

1.3 Terms of Reference and Scope of Work

EXP held a pre-consultation meeting with the UTRCA on April 21, 2021, to determine the monitoring requirements for the Site. Due to the Mineral Deciduous Swamp in the western portion of the Site, it was determined that 12 months of monitoring would be required for the study length. The end of this 12 month period was in May 2022. A follow-up pre-consultation meeting with the City of London was held on August 19, 2021 and it was determined that a second surface water station should be installed within the municipal drain located to the east of the Site, with sampling completed twice annually. This station was installed in December 2021 and was sampled in December 2021 and May 2022. **Appendix C** includes email summaries of these consultation meetings held with UTRCA and City of London staff.

The scope of work for the Hydrogeological and Water Balance Assessment consisted of the following tasks:

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

2. Field Program: Installation of three (3) monitoring wells in June 2021 was completed as part of the Hydrogeological field program. A surface water station (SW1) was installed in the wetland in May 2021 and an additional surface water station (SW2) was installed in the municipal drain to the east of the Site in December 2021. Each surface water station includes a shallow piezometer and a staff gauge. Manual groundwater and surface water levels have been collected monthly for a period of 12 months at all monitoring locations except for SW2, which remains in place for continued monitoring. Electronic pressure transducers (dataloggers) were installed in P1 on May 13, 2021, BH3/MW on June 18, 2021, and P2 on December 10, 2021, set to record daily readings to facilitate the collection of continuous groundwater level measurements at these locations. Single well response tests (SWRT) were completed on selected monitoring wells for the purposes of characterizing the hydrogeological conditions at the Site. Groundwater samples were collected from BH1/MW and BH3/MW on November 17, 2021 and May 31, 2022, and SW samples were collected from SW2 on December 10, 2021 and May 31, 2022. Groundwater and surface water samples were analyzed for general chemistry parameters.

3. Data Evaluation: Evaluation of the available field and laboratory data, assessment of the dewatering requirements and potential dewatering effects on the surrounding environment, as applicable.

4. Water Balance: This task consisted of the preparation of a feature-based water balance for the natural feature on Site and evaluating pre- and post-development conditions. Consideration was given to at-source infiltration opportunities at the subject site, to enhance post-development infiltration levels.

5. 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) and City of London Design Specification & Requirements Manual (2019).

2. Methodology

2.1 Borehole Drilling and Monitoring Well Installations

Borehole drilling and monitoring well installations were completed on June 8, 2021. The investigation consisted of the advancement of three (3) boreholes completed as monitoring wells at the locations shown on **Drawing 2** as BH1/MW, BH2/MW, and BH3/MW. A summary of the well installation details is provided in **Table 1**.

The boreholes and monitoring well installations were completed by a specialized drilling subcontractor under the full-time supervision of EXP geotechnical staff. The boreholes were advanced utilizing a track-mounted drill rig equipped with continuous flight solid and hollow stem augers, soil sampling and soil testing equipment. In each borehole, disturbed soil samples were recovered at depth intervals of 0.75 m and 1.5 m using conventional split spoon sampling equipment.

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

The location of each borehole was established in the field in conjunction with a site plan provided by the client. Ground surface elevations at each borehole location were surveyed by EXP using Sokkia survey equipment.

All 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 1.52 m length screen sections via threaded joints to construct the well. The well screens consisted 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**, with well locations shown on **Drawing 2.**

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 maintaining 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)	Completion Depth (m bgs)	Screen Length (m)	Screened Strata
BH1/MW	270.03	270.81	6.10	1.52	Silt Till
BH2/MW	270.31	271.24	7.62	1.52	Silt Till
BH3/MW	270.47	271.33	7.62	1.52	Sand (wet layering); Silt Till

Notes: 1. m AMSL denotes metres above mean sea level.
2. m bgs denotes metres below ground surface.

2.2 Surface Water Monitoring

One (1) surface water monitoring station was installed within the Mineral Deciduous Swamp in May 2021 (SW1). An additional surface water station was installed in the municipal drain located immediately east of the Site in December 2021 (SW2). Each surface water station consists of a shallow piezometer (P1 and P2), a staff gauge (SG1 and SG2), and a datalogger set to record water level readings every 24 hours. The following **Table 2** outlines the surface water station construction details.

The piezometers have 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" (20 mm) stainless steel drive-point body.

The staff gauges were installed within the surface water bodies to capture monthly changes to surface water elevations.

Table 2 – Surface Water Station Construction Details

Station ID	Piezometer ID	Ground Surface Elevation (m amsl)	Top of Piezometer Elevation (m amsl)	Completion Depth (m bgs)	Screened Strata	Staff Gauge Installed	Datalogger Installed
SW1	**P1**	269.86	271.07	0.89	Unknown	Yes (SG1)	Yes
SW2	**P2**	270.25	271.78	0.61	Clayey Silt	Yes (SG2)	Yes

Notes: 1. m AMSL denotes metres above mean sea level.
2. m bgs denotes metres below ground surface.

2.3 Well Development and Groundwater Sampling

Wells were generally developed by removing a minimum of ten times the volume of water contained in the well casing (casing volume), where possible, using rigid high-density polyethylene (HDPE) tubing fitted with Waterra™ inertial pumps. The 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 from monitoring wells BH1/MW and BH3/MW on November 17, 2021 and May 31, 2022 for analysis of groundwater quality. Groundwater chemistry results are presented and discussed in **Section 4.4**.

2.4 Surface Water Sampling

Surface water samples were collected from SW2 on December 10, 2021 and May 31, 2022 for analysis of surface water quality. Surface water chemistry results are presented and discussed in **Section 4.4**. There was no surface water present at station SW1 during the sampling events and was therefore not sampled.

2.5 Long-Term Groundwater Elevation Monitoring

Manual water level monitoring was completed on a monthly basis from June 2021 to June 2022. Measurements were manually collected using a battery-signal water level tape.

Dataloggers were installed in monitoring well BH3/MW and in piezometers P1 and P2 for continuous water level monitoring. The datalogger in BH3/MW was installed on June 18, 2021, the datalogger in P1 was installed on May 13, 2021, and the datalogger in P2 was installed on December 10, 2021. The datalogger in P2 remains in place for continued monitoring.

2.6 Hydraulic Conductivity Testing

Single well response tests (SWRTs) were completed at BH2/MW and BH3/MW to evaluate the hydraulic characteristics of the screened overburden. The test method consisted of an initial purging of the well and subsequently monitoring the rise in the water level in the well over time.

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. The time required for the water level in the well to reach 37% of the initial change (T_o) is determined from the plot, and used in the following equation to estimate the hydraulic conductivity (K);

$$\mathbf{K\ (m/s) = [r^2 \ln(L/R)] / [2\ L\ T_o]}$$

where: r is the radius of the well casing;
R is the radius of the well screen; and,
L is the length of the well screen.

3. Site Description and Geologic Setting

3.1 Site Location and Description

The Site is located at 2060 Dundas Street in the northeastern area of the City of London, between Veterans Memorial Parkway and Clarke Road (**Drawing 1**). The Site is irregular in shape and includes a proposed development area of 0.90 hectares. Lands to the south, east and west are a mix of residential and commercial properties. The area immediately north of the Site is forested and the CN Railroad is present approximately 140 m north of the Site. Additional forested and agricultural lands are present beyond the Railroad.

3.2 Topography and Drainage

The Site is relatively flat with elevations ranging from 270 to 271.5 m amsl and generally slopes towards the northwest. The Site is situated within the Pottersburg Creek sub-watershed and the municipal drain located immediately to the east of the Site is regulated by the UTRCA (**Drawing 3**). Drainage from the Site is primarily through surface infiltration as well as overland flow. Runoff in the eastern portion of the Site follows topography and flows towards the municipal Drain which flows in a northerly direction immediately east of the Site. The westerly portion of the Site drains to the west and outlets to the existing woodlot (**Drawing 4**).

3.3 Wetlands and Ecology

The ecology of the Site has been studied by MTE and a drawing outlining the vegetation communities found on the Site has been included in **Appendix E**. For the purposes of this investigation, a brief discussion of the ecology of the property is included in order to assess the connection between the surface and shallow groundwater environment at the Site.

Vegetation on the Site was characterized using the Ecological Land Classification (ELC) System for Southern Ontario. The ELC protocol identified three (3) communities across the development area of the Site. The west side of the Site has been identified as a Mineral Deciduous Swamp (SWD4) which is 0.3 ha in size. The east side of the Site is classified as a Mineral Cultural Thicket (CUT1) and is also 0.3 ha. The north portion of the Site is a Mineral Cultural Woodland (Black Locust, CUW1) and is 0.2 ha. This CUW1 area also extends into the area to the north of the Site.

3.4 Site Geology

3.4.1 Bedrock Geology

The Site is underlain by limestone, dolostone and shale of the Dundee Formation (OGS, 2011). Topography mapping (**Drawing 5**; OGS, 1980) indicates the bedrock surface is at an elevation of about 213 to 221 m (700 to 725 feet) at the Site. The bedrock surface generally slopes to the south in this area. A review of MECP Well records for the area (**Appendix F**) showed only one well which was drilled to bedrock and had an overburden thickness of 38 m. Bedrock was not encountered during this investigation.

3.4.2 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 which are 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 regional mapping for the area indicates that the site and surrounding area are situated within the Caradoc Sand Plains and London Annex (Chapman and Putnam, 1984), as shown on **Drawing 6**.

Review of physiographic landform mapping (**Drawing 7**) indicates that the Site and surrounding area are located within an area characterized by sand plains.

Review of surficial geology mapping (**Drawing 8**) indicates that the Site is with an area of ice-contact stratified deposits. Till is present to the south and east of the Site and an area of modern alluvial deposits is present to the northwest.

Review of the MECP Water Well records for the area (discussed below) indicates that the surficial geology of the immediate area generally consists predominantly of clay overlain with thin layers of sand and gravel.

3.4.3 Site Specific Surficial Geology

Generally, the Site consists of a thin layer of topsoil underlain by silt till which is continuous throughout the Site. In the eastern portion of the Site (BH3/MW), a layer of fill and sandy silt were observed overlying the till. A pocket of wet sand layering was also observed within the silt till in this area at approximately 264 m amsl.

Borehole logs are provided in **Appendix D**. The location of a stratigraphic cross section through the Site is provided in **Drawing 9**, with the cross section illustrated on **Drawing 10**.

4. Hydrogeologic 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 perimeter of the Site; and,
- Thames-Sydenham and Region Source Protection Committee. 2011. Upper Thames River Source Protection Area, Approved Updated Assessment Report. 12 August.

4.1 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.

4.1.1 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. Based on the well record information and on-site findings, there are no shallow overburden water supply wells in the immediate vicinity of the Site.

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.

The shallow local groundwater flow direction is interpreted to be northwesterly (**Drawing 11**), generally following topography, flowing towards Pottersburg Creek. On a regional scale, the deep overburden aquifer flow direction is reported to be towards the south-southwest (Dillon and Golder, 2004).

4.1.2 Bedrock Aquifer

The bedrock aquifer consists of limestone from the Dundee Formation (OGS, 2011). Water quality in this formation is generally good with elevated levels of iron, sodium and chloride in some wells. As with the intermediate depth and deep overburden aquifers, the bedrock aquifer is confined by the overlying till material, which had a thickness of approximately 38 m bgs in the vicinity of the subject site according to the MECP WWR database. 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.

4.2 Site Specific Groundwater Elevations and Flow

Manual water levels in the monitoring wells have been collected monthly from June 2021 to June 2022. The monthly water levels are provided in **Appendix G**.

Dataloggers were installed in monitoring well BH3/MW in June 2021, in P1 in May 2021, and in P2 in December 2021 to provide continuous groundwater elevation monitoring. Data collected from the dataloggers is presented in **Appendix G**. Manual measurements generally correlate well with the datalogger results.

The BH3/MW datalogger data shows that groundwater elevations within this location were lowest in August and September 2021 and increased from October 2021 to late December 2021. Groundwater elevations then decreased until a large precipitation event on February 17, 2022 at which point they began increasing again. The highest groundwater elevation recorded in this well was 270.10 m amsl (0.37 mbgs), measured on May 4, 2022. The lowest groundwater elevation recorded in the well was 267.93 m amsl (2.54 mbgs), measured on September 7, 2021. A groundwater elevation seasonal range of 2.17 m was observed in BH3/MW. Also presented on this hydrograph are precipitation data collected from the London CS Station and the ground surface elevation at the well. A slight response to precipitation can be seen in this well following large rainfall events, in particular the large rainfall events that occurred on September 22, 2021, and on February 17, 2022. The response is evident from the increase in groundwater elevation immediately following the rainfall event.

Manual groundwater elevations were collected from monitoring wells BH1/MW and BH2/MW throughout the monitoring period. The highest groundwater elevations collected from BH1/MW was 267.51 m amsl (2.52 mbgs) on February 17, 2022, and from BH2/MW was 267.77 m amsl (0.54 mbgs) on April 30, 2022. The lowest groundwater elevations collected from BH1/MW was 266.34 m masl (3.69 mbgs) on September 9, 2021, and from BH2/MW was 267.40 m amsl (2.91 mbgs) on September 9, 2021. A groundwater elevation seasonal range of 1.17 m was observed in BH1/MW, and a seasonal range of 2.37 m was observed in BH2/MW. The water levels collected are included in **Appendix G**.

The SW Station 1 hydrograph includes the water level data collected from the datalogger installed in P1, as well as manual measurements from P1 and SG1. There are gaps in the continuous water level data from July 21 to October 21, 2021 when the water level in the piezometer was too low and the datalogger was suspended above the water, and from February 17 to March 29, 2022 when the datalogger was frozen and could not provide accurate measurements. Based on the data collected, significant responses to precipitation events are not apparent in this area of the Site within the swamp. The highest groundwater elevation measured by the datalogger in this piezometer was 270 m amsl, measured on May 18, 2022. The continuous water level data shows that groundwater elevations have been generally increasing since October 22, 2021, and have been within 1.0 m of ground surface for the entire monitoring period. Above ground surface water level measurements were collected in March and June 2022.

The SW Station 2 hydrograph includes the water level data collected from the datalogger installed in P2, as well as manual measurements from P2 and SG2. A response to the precipitation event on February 17, 2022 is visible on this hydrograph, shown by the sharp increase in groundwater elevation on that day. The highest groundwater elevation measured by the datalogger in this piezometer was 270.48 m amsl, measured on February 17, 2022. The continuous water level data shows that groundwater elevations have been consistently above ground surface since this station was installed in December 2021.

A groundwater flow map was created for the Site using the high manual water elevations collected in April 2022 (**Drawing 11**). The local shallow groundwater flow direction is interpreted to be northwesterly, towards Pottersburg Creek.

4.3 Hydroperiod

By definition, the hydroperiod is the seasonal pattern of water level fluctuation. It is the result of inflow and outflow, surface contours of the landscape, substrate, and groundwater conditions. Defining the existing surface water and groundwater conditions within the natural features on Site and within the surrounding area is essential in order to provide recommendations, mitigation strategies, and contingency measures during the development of the property.

Water level monitoring on the Site occurred monthly from June 2021 to June 2022. The range in groundwater elevations measured across the Site (a measurable component of a hydroperiod) throughout the monitoring period is shown in **Table 3** below. The water levels provided for BH3/MW, P1 and P2 were obtained from the datalogger data.

Table 3: Hydroperiod as defined by Groundwater Measurements

Location ID	Minimum Water Elevation (m AMSL)	Maximum Water Elevation (m AMSL)	Range
BH1/MW	266.34	267.51	1.17
BH2/MW	267.40	269.77	2.37
BH3/MW	267.93	270.10	2.17
P1	269.19	270.00	0.81
P2	270.23	270.48	0.25

As shown in **Table 3**, the largest variation in manual water levels occurs at BH2/MW with a range of 2.37 m and the smallest variation is at P2 with a range of 0.25 m. It should be noted that P2 has not yet been installed for a full year and may not be representative of the full annual range in groundwater elevations.

4.4 Groundwater and Surface Water Quality

Groundwater sampling was completed on November 17, 2021 and May 31, 2022, and surface water sampling was completed on December 10, 2021 and May 31, 2022. A total of two (2) groundwater monitoring wells (BH1/MW and BH3/MW) and one (1) surface water location (SW2) were selected for sampling. As previously mentioned, surface water location SW1 was not sampled as there was not enough surface water present to collect a sample. Water quality tables and complete laboratory chain of custody results are provided in **Appendix H**.

Groundwater quality was compared to the Ontario Drinking Water Quality Standards, Objectives and Guidelines (ODWQS) (O. Reg. 169/03). Although the groundwater on Site is not planned for use as drinking water, these guidelines are used for comparison's sake only. As demonstrated in the tabulated results in **Appendix H**, there were no exceedances of the ODWQS criteria.

Surface water quality was compared to Ontario Provincial Water Quality Objectives (PWQO) (MOEE 1994). The December 2021 samples had surface water quality exceedances for aluminum (1300 ug/L, PWQO 75 ug/L), cobalt (1.9 ug/L, PWQO 0.9 ug/L), iron (12000 ug/L, PWQO 300 ug/L) and zinc (85 ug/L, PWQO 20 ug/L). The only exceedance for the May 2022 sample was iron (410 ug/L).

Complete chain of custody results are provided in **Appendix H**.

A Piper Diagram was prepared for groundwater and surface water samples and is shown in **Drawing 12**. The water quality results generally plot within the magnesium bicarbonate zone of the Piper Diagram, with the monitoring wells having no dominant cation type. The groundwater and surface water results were similar across both sampling events, however, surface water quality differs from groundwater quality, indicating some chemical separation.

Schoeller Diagrams were also prepared for the groundwater and surface water quality samples and have been divided into Major and Minor Ions (**Drawings 13a and 13b**). The monitoring wells show similar patterns, with slightly higher concentrations of all parameters except for boron in BH1/MW for the November 2021 sampling event. The groundwater results in May 2022 were nearly identical. The surface water sample shows more variation from the groundwater samples with higher concentrations of calcium and bicarbonate, and lower sodium and sulphate concentrations.

4.5 Hydraulic Conductivity

Single Well Response Tests (SWRT) were carried out on April 30, 2021 in monitoring wells BH2/MW and BH3/MW to evaluate the hydraulic characteristics of the overburden. The results of the tests are presented in **Appendix I**. Based on the mathematical solution by Hvorslev (1951) as detailed in **Section 2.6**, the hydraulic conductivities at BH2/MW and BH3/MW were estimated at 2.4×10^{-7} m/s and 2.0×10^{-7} m/s, respectively. These results are generally consistent with the estimated range of hydraulic conductivity values reported by Freeze and Cherry (1979) for similar soils.

Table 4 – Hydraulic Conductivity Testing Results

Sample ID	Lithology	Hydraulic Conductivity (m/s)
Single Well Response Testing		
BH2/MW	Silt Till	2.4×10^{-7}
BH3/MW	Sand (wet layering); Silt Till	2.0×10^{-7}

5. Feature-Based Water Balance Assessment

5.1 Background Information

The feature-based water balance assessment for the Mineral Deciduous Swamp (SWD4) feature on the Site was completed in accordance with the recommendations indicated in the guidance document "Hydrogeological Assessment Submissions: Conservation Authority Guidelines to Support Development Applications" (Conservation Ontario, 2013), and using appropriate site condition values obtained from Table 3.1 of the MOE Stormwater Management Planning and Design Manual (MOE, 2003).

The water balance is based on estimates for a typical annual period, as an expression of the mean annual precipitation, change in groundwater storage, evapotranspiration, surficial run-off and infiltration. The relationship in these factors can be balanced, as shown in the following equation:

Mean Annual Precipitation - Change in Groundwater Storage - Evapotranspiration = Runoff + Infiltration

where:

- Total annual precipitation (1011 mm/yr) is based on data provided by Environment Canada, based on the 30-year average data for climate normals, using local weather station information (London, ON).
- Long term changes in groundwater storage are assumed to be negligible (i.e. no significant groundwater pumping or withdrawal from the aquifer). Seasonal changes are expected to balance out over the course of a full year.
- Evapotranspiration combines evaporation and transpiration and refers to the water lost to the atmosphere. The rate of evapotranspiration is a function of the water holding capacity of the soil and varies with soil and vegetation type and amount of impermeable surface cover. The evapotranspiration values are obtained using the method described by Thornthwaite and Mather (1957) but are sourced from Environment Canada Data using values for water holding capacity derived from Table 3.1 of the MOE Stormwater Management Planning and Design Manual (MOE, 2003).

The difference between the annual precipitation and the annual evapotranspiration represents the surplus water which is available for infiltration and surface run-off. Distribution of the surplus water to infiltration is based on an infiltration factor based on site conditions for topography, cover vegetation and soil.

5.2 Pre-development and Post-development Calculations

Water balance calculations have been carried out based on the development plan provided in **Appendix B**. At this time, estimates and assumptions have been made to provide a rough estimate of post-development conditions. It is understood that the west half of the Site will be maintained as a mature forest.

The wetland and its pre-development catchment comprise a land area of approximately 0.46 ha (**Drawing J1**). The current wetland and catchment are vacant and consist of mature forest, shrubs, and an area of urban lawn. The post-development wetland and catchment will be 0.32 ha, due to the increase in impermeable surfaces graded away from the wetland. Post-development permeable areas will consist of the maintained SWD4 feature and associated wooded area, and a vegetative cover classification of urban lawns within the developed part of the Site. The wooded area and the buffer area within the catchment will contribute both infiltration and runoff to the wetland, and the small pervious islands in the parking lot and along the building that fall within the catchment will contribute infiltration only. These areas are shown on **Drawing J2**.

The drilling program completed at the Site indicates that the near surface soils at the Site consist of silt till. There is no information on the Ministry of Agriculture, Food and Rural Affairs mapping for the Site, so on Site findings have been used to categorize the Site as Hydrologic Soil Group (HSG) "C". In order to follow the Conservation Authorities Guidelines, the water balance calculations are assuming HSG C-type soils are encountered across the Site.

The soil water holding capacities and infiltration rates were determined using values presented in Table 3.1 of the MOE Stormwater Management Planning and Design Manual (MOE, 2003) based on the vegetative cover and the HSG, as discussed above. The values based on the Site conditions are presented in the calculation sheets provided in **Appendix J**.

Evapotranspiration values were determined using the method described by Thornthwaite and Mather (1957). It is common practice and an accepted method by most Conservation Authorities to provide estimates of surplus using the Thornthwaite and Mather approach, where surplus is estimated based on precipitation minus evapotranspiration (Steenhuis and Van Der Molen, 1986). The distribution of runoff and infiltration from the surplus water is determined from the infiltration factor for the site. The infiltration factor for the mature forest was estimated at 0.6, the shrubbed area was estimated at 0.5, and the urban lawn was estimated at 0.45 in the pre-development water balance with the difference being topography (0.3 for the wetland, 0.25 for the catchment), and cover (0.2 for mature forests, 0.15 for shrubs, and 0.1 for urban lawn). The post development infiltration factor for the west side of the Site is the same (0.6) and for the development area is 0.5, with the difference being the cover which will consist of cultivated land in post-development.

Several assumptions were made to complete the water balances and include the following:

- Evapotranspiration occurs year-round despite freezing temperatures in the winter months, as fluctuation above and below the freezing temperature of water does occur;
- Precipitation falling when the temperature is above 3.3°C is rain and below -10°C falls as snow. When average monthly temperature falls between these values precipitation form is derived by assuming a linear interpolation between these values;
- Surplus is calculated as the sum of precipitation as rain and actual snow melt, minus estimated evapotranspiration;
- Snow storage melts fully each month;
- Negative surplus values are possible in the summer months as water storage in the vadose zone of the soil is subject to evapotranspiration; and,
- Infiltration does not occur in December, January, February and half of March as frost is typically present during these months.

Table 5 provides a summary of the pre- and post-development water balance calculations. Calculation worksheets are provided in **Appendix J**.

Table 5: Summary of Feature Based Water Balance Estimates

	Pre-Development	Post-Development	Added Rooftop Infiltration	% of Pre-Development Conditions
Estimated Runoff (m^3/year)	1,453	1,679	-	67%
Estimated Infiltration (m^3/year)	794	568	71	80%

Conservation Ontario Guidelines (Conservation Ontario, 2013) suggest a target of 80% of the pre-development infiltration being maintained in the post-development conditions. To achieve this target an additional 71 m^3 of runoff will need to be directed to the wetland. Added rooftop runoff from approximately 100m^2 of rooftop area via a downspout system or similar directed to the wetland will be sufficient to meet the target of 80%.

The calculations included in **Table J3** demonstrate that a rooftop area of 100 m^2 will provide the additional 71 m^3 required to meet the target. The total rooftop area of the proposed apartment building is approximately 984 m^2, meaning that directing 10% of the rooftop area to the woodlot will be sufficient to meet the infiltration target of 80%.

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.

An assessment report for the Upper Thames River Source Protection Area was completed by the Thames-Sydenham and Region Source Protection Committee. As defined by the Clean Water Act (2006) and identified by the Thames-Sydenham and Region Source Protection Committee, the entire Site is within a defined SGRA (**Drawing 14**).

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 Water Well Information System (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 Thames-Sydenham and Region Source Protection Committee has determined, using the ISI method, that the entire Site is located within an HVA (**Drawing 15**).

6.2 Water Well Users

A search of the Ontario Ministry of the Environment, Conservation and Parks (MECP) water well record (WWR) database resulted in the identification of 30 records for an area within approximately 500 m of the perimeter of the Site with the majority located west of the Site. Water uses in the area include monitoring/observation or test holes (20 wells), domestic water supply (7 wells), industrial water supply (2 wells), and unknown well use (1 well). The approximate locations of identified wells are shown on **Drawing 16**, with a summary of the well completion details provided in Table E1 in **Appendix E**.

Water supply wells in the local area are generally installed in the confined sand and gravel aquifers which underlie the clay and clayey silt till overburden. Well records for the area indicate water supply wells range in depth from 6 to 45 m bgs. Four (4) of the domestic water supply wells are installed to depths less than 10 mbgs (Well IDs 4101353, 4101361, 4101458, and 4101468). These shallow wells were all installed in 1965 or earlier and may no longer be in use. The area is also fully serviced by municipal water so it is further assumed that private well water is no longer necessary in the area.

The glacial silt till strata noted in the boreholes will effectively limit both the vertical and horizontal zone of influence impacting possible wells due to the low permeability of the founding soils. Any temporary dewatering operations which may be required to limit groundwater seepage from the overburden till soils are not expected to cause any long-term impacts to the deeper overburden and bedrock aquifers supplying the water supply wells near the Site.

When the monitoring wells installed at the Site are determined to be no longer required, they should be properly decommissioned in accordance with Ontario Regulation 903. Decommissioning a well which is no longer in use helps to ensure the safety of those in the vicinity of the well, prevents surface water infiltration into an aquifer via the well, prevents the vertical movement of water within a well, conserves aquifer yield and hydraulic head and can potentially remove a physical hazard.

6.3 Surface Water Features

The western half of the Site has been classified by MTE as a Mineral Deciduous Swamp. There was measurable surface water at SW1 within this area in May, October and December 2021, and frozen water in January and March 2022. This area will be maintained as is and is not expected to be influenced by Site construction activities.

There is also a municipal drain located approximately 5 m east of the Site, which is regulated by the UTRCA. This drain flows to the north and then west to Pottersburg Creek. An additional surface water station (SW2) was established within this surface water feature in December 2021 and measurable surface water has been present since installation. Ongoing monitoring of surface water station SW2 is continuing until 12 months of monitoring is complete (December 2022).

The following comments are provided with recommendations to help minimize impact to surface water features observed at the site:

- 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;
- Provide a 30m buffer around wetland areas to limit impacts;
- Limit the use of commercial fertilizers in landscaped areas which border a habitat feature; and,
- Limit the use of salts or other additives for ice and snow control on the roadways.

6.4 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 and post-development, 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 restore onsite excavations, or to raise grades in portions of the Site, analytical testing of the imported material may be considered to ensure that any material brought to the Site meets the applicable standards under Ontario Regulation 153 for residential lands;
- 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.

Consideration may be given to carrying out water quality testing during construction, where construction activities are in close proximity to surface water features, where a concern for potential impact is identified.

Monitoring stations to assess 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.

6.5 Construction Dewatering Considerations

Based on groundwater levels observed to date, groundwater inflow to excavations should be expected during construction. Shallow groundwater conditions (i.e. less than 2 mbgs) were noted in monitoring wells BH2/MW and BH3/MW on several occasions and therefore dewatering will likely be needed in and around these areas.

It is noted that where construction dewatering volumes are between 50,000 and 400,000 litres per day (LPD), the water taking activity is required to be registered on the Environmental Activity and Sector Registry (EASR). Where volumes exceed 400,000 LPD a Category 3 Permit to Take Water (PTTW) is required to be completed and approved by the Ministry prior to commencement of the dewatering activities.

For the preliminary dewatering calculations, a groundwater level of 0.54 mbgs was used to provide a worst-case scenario. This was the measured water level at BH2/MW on April 30, 2022.

Dewatering calculations were completed based on the following conservative assumptions:

- sanitary sewer excavations of 5 x 50 m;
- steady state unconfined flow conditions are occurring;
- a groundwater elevation at 0.54 m bgs (269.77 m amsl) was assumed based on high shallow groundwater levels at BH2/MW in April 2022;
- dewatering target is assumed to be 0.5 m below base of excavation at 3.5 m bgs (sanitary sewer);
- the base of the water bearing zone was estimated to be 262.35 m amsl (8 m bgs) based on well records in the vicinity of the Site;
- the saturated till with wet sand layering is assumed to be encountered with a hydraulic conductivity of 2.0 x 10^{-7} m/s.

The Dupuit Forcheimer Equation for unconfined flow into a radial excavation for the linear excavation for the sanitary sewer (Powers et al., 2007) was used to estimate lateral flow into the proposed excavations. Based on the assumptions above, the estimated maximum dewatering rate at the proposed excavations will be approximately 12,250 LPD which is below the permit threshold of 50,000 LPD. Dewatering calculations are provided in **Appendix K**.

Based on available groundwater levels and hydraulic conductivities of soils at the Site and assuming typical servicing depths of 3.5 m bgs, an EASR will not be required for construction activities. Dewatering estimates will need to be updated once a detailed design for the Site becomes available.

Any collected water from service trenches and temporary excavations should be discharged a sufficient distance away from the excavated area to prevent the discharge water from returning to the excavation. Sediment control measures should be provided at the discharge point of the dewatering system.

During construction, short term impacts to the near surface and shallow groundwater quantity may be anticipated as a result of construction dewatering where wet soils are present in open excavations. The length of time where this impact would occur would be limited to the time when active pumping of the groundwater is being carried out. Once construction activities are complete, the shallow groundwater levels would be expected to stabilize.

The following comments are provided with recommendations to help minimize impact to shallow groundwater documented in the monitoring wells:

- 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, particularly in close proximity to the UTRCA regulated areas;

- The use of BMPs to enhance post development infiltration can be considered at the site. These measures will have limited effectiveness in areas with low permeability silt and glacial till soils. However, opportunities are discussed in the Water Balance section of this report. Where infiltration of run-off from roads or driveways is considered, additional measures to treat the water may be required to minimize potential for groundwater contamination;

- Re-establishing vegetative cover in disturbed areas following the completion of the construction work;
- Limit the use of commercial fertilizers in landscaped areas which border the open-space area and wetland pockets; and,
- Limit the use of salts or other additives for ice and snow control on the roadways.

Collected water from service trenches and temporary excavations should be discharged a sufficient distance away from the excavated area to prevent the discharge water from returning to the excavation. Discharge locations should also account for potential impact to the wetland area. Sediment control measures should be provided at the discharge point of the dewatering system.

7. 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 Ministry of the Environment, Conservation and Parks (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 prepared by Kelli Dobbin, B.Sc., G.I.T. Ms. Dobbin has experience in conducting hydrogeological assessments. Ms. Dobbin is a hydrogeologist with more than 8 years' experience in the environmental field. She obtained a Bachelor of Science (B.Sc.) in 2013 from the University of Waterloo and has worked in the Hydrogeological and Environmental fields since then. Ms. Dobbin has authored reports for numerous projects including residential developments that require hydrogeological input, groundwater impact assessments and calculated groundwater removal quantities for short- and long-term construction.

This report was reviewed by Ms. Heather Jaggard, M.Sc., P.Geo. Ms. Jaggard is a hydrogeologist and environmental geoscientist with more than 9 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 Ministry of Environment, Conservation and Parks (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 Permit to Take Water (PTTW) have been part of her routine assignments.

8. References

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9. 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

This report was prepared for the exclusive use of **2060 Dundas Street Joint Venture** and may not be reproduced in whole or in part, without the prior written consent of EXP, or used or relied upon in whole or in part by other parties for any purposes whatsoever. Any use which a third party makes of this report, or any part thereof, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. EXP Services Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

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

Appendix A - Drawings

Appendix B – Proposed Development Plan

Appendix C – Pre-consultation Meeting

Appendix D – Borehole Logs

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Appendix E – Site Ecology

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Appendix F – MECP Water Well Record Summary

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Appendix G – Water Levels and Hydrographs

Appendix H – Water Quality Analysis

Appendix I – Single Well Response Tests

Appendix J – Water Balance Assessment

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Appendix K – Dewatering Calculations

LIMITATIONS AND USE OF REPORT

BASIS OF REPORT

This report ("Report") is based on site conditions known or inferred by the geotechnical investigation undertaken as of the date of the Report. Should changes occur which potentially impact the geotechnical condition of the site, or if construction is implemented more than one year following the date of the Report, the recommendations of EXP may require re-evaluation.

The Report is provided solely for the guidance of design engineers and on the assumption that the design will be in accordance with applicable codes and standards. Any changes in the design features which potentially impact the geotechnical analyses or issues concerning the geotechnical aspects of applicable codes and standards will necessitate a review of the design by EXP. Additional field work and reporting may also be required.

Where applicable, recommended field services are the minimum necessary to ascertain that construction is being carried out in general conformity with building code guidelines, generally accepted practices and EXP's recommendations. Any reduction in the level of services recommended will result in EXP providing qualified opinions regarding the adequacy of the work. EXP can assist design professionals or contractors retained by the Client to review applicable plans, drawings, and specifications as they relate to the Report or to conduct field reviews during construction.

Contractors contemplating work on the site are responsible for conducting an independent investigation and interpretation of the test pit results contained in the Report. The number of test pits necessary to determine the localized underground conditions as they impact construction costs, techniques, sequencing, equipment, and scheduling may be greater than those carried out for the purpose of the Report.

Classification and identification of soils, rocks, geological units, contaminant materials, building envelopment assessments, and engineering estimates are based on investigations performed in accordance with the standard of care set out below and require the exercise of judgment. As a result, even comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations or building envelope descriptions involve an inherent risk that some conditions will not be detected. All documents or records summarizing investigations are based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated. Some conditions are subject to change over time. The Report presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, these should be disclosed to EXP to allow for additional or special investigations to be undertaken not otherwise within the scope of investigation conducted for the purpose of the Report.

RELIANCE ON INFORMATION PROVIDED

The evaluation and conclusions contained in the Report are based on conditions in evidence at the time of site inspections and information provided to EXP by the Client and others. The Report has been prepared for the specific site, development, building, design or building assessment objectives and purpose as communicated by the Client. EXP has relied in good faith upon such representations, information and instructions and accepts no responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of any misstatements, omissions, misrepresentation or fraudulent acts of persons providing information. Unless specifically stated otherwise, the applicability and reliability of the findings, recommendations, suggestions or opinions expressed in the Report are only valid to the extent that there has been no material alteration to or variation from any of the information provided to EXP.

STANDARD OF CARE

The Report has been prepared in a manner consistent with the degree of care and skill exercised by engineering consultants currently practicing under similar circumstances and locale. No other warranty, expressed or implied, is made. Unless specifically stated otherwise, the Report does not contain environmental consulting advice.

COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment form part of the Report. This material includes, but is not limited to, the terms of reference given to EXP by its client ("Client"), communications between EXP and the Client, other reports, proposals or documents prepared by EXP for the Client in connection with the site described in the Report. In order to properly understand the suggestions, recommendations and opinions expressed in the Report, reference must be made to the Report in its entirety. EXP is not responsible for use by any party of portions of the Report.

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