REPORT

Level 1 and Level 2 Water Report

Proposed East Oxford Pit, Ontario

Submitted to:

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1 INTRODUCTION

WSP Canada Inc. (WSP) was retained by R.W. Tomlinson Limited (Tomlinson) to conduct hydrogeological and hydrological studies at the proposed East Oxford Pit at a property located on Part of Lots 13 and 14, Concession 8, Municipality of North Grenville, in the United Counties of Leeds and Grenville, Ontario (the ‘Site’) (see Figure 1). The purpose of these studies is to provide supporting documentation for a licence application for a Class ‘A’ licence for a Pit below the Groundwater Table, under the *Aggregate Resources Act* (ARA).

The reader is referred to the “Important Information and Limitations of This Report” included in Appendix A which follows the text but forms an integral part of this document.

1.1 Site Description

The proposed pit has an area of approximately 44.1 hectares (ha) and is bounded by O’Neill Road to the northwest, Pattersons Corners Road to the northeast, Leeds and Grenville Road 20 to the southeast and a wetland to the southwest (Figure 1). There is a small grouping of buildings on Site located in the northern corner near the intersection of O’Neill Road and Pattersons Corners Road. The Site currently consists of active agricultural operations. The land uses around the Site include rural residential properties, forested areas and agricultural lands. Licensed pits owned by Raymond Finley (ALPS ID #3985) and the Township of North Grenville (ALPS ID #4039) are located 0.1 kilometres (km) east and 1.3 km northeast of the Site, respectively, and a pit owned by G. Tackaberry & Sons (ALPS ID #624958 & #3914) is located about 1 km southeast of the Site. The approximate locations of water well records included in the Ministry of the Environment, Conservation and Parks (MECP) Water Well Information System (WWIS) (UTM Reliability Code of 5 or less), within 500 metres of the proposed licensed extraction area are shown on Figure 2.

The ground surface elevation within the Site area ranges from approximately 105 to 111 metres above sea level (asl) and is highest in the middle of the Site (see Figure 1). Topography declines rapidly to the west of the Site to an elevation of approximately 101 metres asl.

There are no surface water features within the proposed licensed area. A wetland is present to the southwest of the Site. The topography in the vicinity of the wetland feature is approximately 101 to 104 metres asl. The wetland is fed primarily by groundwater infiltration and, to a lesser degree, by surface runoff from a small portion of the Site. Historically, the wetland discharged via a waterway to the west of the Site into the adjacent farmland property. The waterway eventually discharges into Kemptville Creek.

1.2 Site Development

The Site consists of a 44.1 ha area proposed to be licensed under the ARA, of which the proposed extraction area occupies 37.2 ha. The property is owned by the applicant (Tomlinson). Based on the nature of the subsurface materials, the approximate pit base elevation will be at 98.5 metres asl.

It is understood from Tomlinson that extraction operations below the groundwater table will not involve dewatering of the excavation. The final rehabilitation plan includes a permanent pond located within the proposed limit of extraction area. Based on the groundwater level data collected at the Site between August 2021 and September 2025, the predicted elevation of the permanent pond will be approximately 106 metres asl.

1.3 Study Objectives

The objective of this study was to fulfill the requirements of a Level 1 and 2 Hydrogeological and Hydrological Assessment for the licensing of a Class ‘A’, Pit Below the Groundwater Table, under the ARA as well as applicable policies in the Municipality of North Grenville Official Plan. The study includes a hydrogeological and hydrological assessment to establish the groundwater conditions and water balance for the Site. The results of the hydrogeological and hydrological investigation are used to assess the potential for adverse effects to groundwater users and surface water resources as a result of the proposed extraction below the groundwater table. The qualifications and experience of the report authors are presented in Appendix B.

2 SITE GEOLOGY AND HYDROGEOLOGY

2.1 Surficial Geology

The surficial geology in the vicinity of the Site is shown on Figure 3. Published surficial geology mapping indicates the presence of coarse textured glaciomarine deposits (i.e., sand, gravel, minor silt and clay) throughout the entire site. The Site is also mapped as a sand and gravel deposit in the County of Leeds and Grenville Official Plan Schedule “B” – Mineral & Mineral Aggregate Resources Map. Previous borehole and test pitting programs completed at the Site as part of the preliminary aggregate resource assessment and hydrogeology study (Golder Associates Ltd. 2022) confirmed the presence of overburden consisting of sand and gravelly sand deposits and silty sand, as discussed further in Section 4.1.2.

Beyond the Site, published surficial geology mapping indicates the further presence of fine textured glaciomarine deposits (silt and clay) to the north of the Site and glacial till (i.e., stone-poor, sandy silt to silty sand) to the southwest of the Site (see Figure 3).

2.2 Bedrock Geology

Published bedrock geology mapping indicates the upper bedrock unit in the vicinity of the Site consists of dolostone, minor shale and sandstone of the Oxford Formation (see Figure 4).

A review of the Ministry of Environment, Conservation and Parks (MECP) Water Well information System (WWIS) well records within 500 metres of the Site indicates that the majority of the bedrock primarily consists of limestone and dolostone. Some well records identify white to gray limestone, although this is not evident in the published mapping. The local depth to bedrock indicated in the WWIS well records varies from 4 to 20 metres below ground surface (bgs).

2.3 Hydrogeology

2.3.1 Overburden Aquifer

Deposits of fine to coarse and permeable overburden capable of supplying sufficient quantities of groundwater exist locally in the area on and around the Site. The majority of the area is mapped as glaciomarine deposits, which includes fine to coarse-grained sediments comprised of primarily sand, gravely sand, silty sand, and sandy silt. Based on the depth to bedrock noted on the water well records in the MECP WWIS, the overburden in the vicinity of the Site ranges between 4 and 20 metres thick (average about 10 metres thick). The thickness of overburden present may be capable of providing water of sufficient quantity for a water supply and could possibly serve as a source of potable groundwater in the area of the proposed pit.

2.3.2 Bedrock Aquifer

The bedrock is the primary source of potable groundwater in the area of the proposed pit. Typical well yields reported for the aquifer in the Oxford Formation are between 45 to 115 L/min (Geo-Analysis and J.L. Richards and Associates Limited, 1992). Drillers’ records indicate that water bearing zones occur at distinct depths within the formation, with water being found within a network of fractures, possibly enhanced by carbonate dissolution, and possibly associated with shale partings (Williams, 1991).

Aquifer testing of three wells completed in the Oxford Formation found a range in transmissivity between 9 m^2/day and 248 m^2/day, with an average of 90 m^2/day (Golder Associates Ltd. 2006). A study completed by Geo-Analysis Inc. in 1991 consisting of aquifer testing of eleven test wells found the transmissivity of the Oxford Formation aquifer in the Village of Richmond ranged between 5 m^2/day to greater than 100 m^2/day, with an average of 46 m^2/day.

A bedrock aquitard is interpreted to lie within the lower part of the Oxford Formation and the upper part of the March Formation (Raven Beck, 1996). Its presence is indicated by strong vertical gradients across this zone and by flowing artesian conditions observed in some wells completed below the aquitard, (i.e., the Alfred Street municipal well in Kemptville (Oliver, Mangione, McCalla and Associates Ltd., 2000) and the Village of Richmond sentinel wells (Golder Associates Ltd. 2005).

Based on the MECP WWIS, 24 of the 25 water supply wells located within 500 metres of the Site boundary are completed in the bedrock. Based on the MECP WWIS, local water supply wells completed in bedrock generally range in depth from 13 to 40 metres bgs, and had static water levels generally ranging between 1 and 8 metres bgs at the time of drilling. The yield of the MECP WWIS bedrock wells within 500 metres of the Site range between 19 and 95 litres per minute.

3 NATURAL ENVIRONMENT CONSIDERATIONS

WSP (2025) prepared a Natural Environment Report (NER) for the proposed pit, in accordance with Section 2.2 of the Aggregate Resources of Ontario: Technical Reports and Information Standards (Ontario 2020), provided under separate cover. The NER should be read in conjunction with this Level 1 and Level 2 Water Report, but the key findings of the NER have been reproduced below to provide context on what natural features are present at the Site.

Through the studies completed as part of the NER, no significant natural features were confirmed on the Site. Immediately southwest of the Site is an evaluated, non-provincially significant wetland. This wetland is generally shallow, and is unlikely to provide habitat for any endangered or threatened species that is protected under the *Endangered Species Act* (ESA; Ontario 2007). Within the wetland is an unnamed tributary of Kemptville Creek, which is confirmed warmwater fish habitat (based on WSP's thermal monitoring). The Study Area also contains forests that are assumed to be significant woodlands, located northeast of the Site. Significant wildlife habitat may be present off-Site, and the presence of one provincially rare species [whorled milkwort (*Polygala verticillate*)] was confirmed more than 120 m west of the proposed extraction area.

The authors of the NER have worked closely with the authors of this report to identify which natural features may be affected by the predicted changes to surface and groundwater conditions at the Site discussed in this report, and identify mitigation measures, where necessary.

4 STUDY METHODS AND RESULTS

4.1 Hydrogeological Investigation

A hydrogeological assessment in support of the application was completed for the Site. The hydrogeological assessment involved the following tasks:

- Review of available data/information and Site visit

- MECP Water Well Inventory
- Borehole investigation and monitoring well installation program
- Groundwater monitoring program
- Nearby Private Well Identification
- Assessment of potential impacts related to the development and rehabilitation of the proposed pit

4.1.1 Borehole Drilling and Monitoring Well Installation

Aggregate resource investigations and a preliminary field hydrogeological investigation were carried out by Golder Associates Ltd. (now a part of WSP) at the Site in 2021 (Golder Associates Ltd. 2022). The objectives of the subsurface investigations were to determine the extent and nature of the aggregate resource in the area and to install monitoring wells for the characterization of hydrogeological conditions at the Site. The locations of the boreholes advanced at the Site are shown on Figure 1.

The borehole drilling for this investigation was completed from July 9 to 16, 2021, and hydraulic testing was completed on July 20 and 21, 2021. As a part of the field program, eight boreholes were advanced across and to the west of the Site. The boreholes are identified as 21-01 through 21-08. The boreholes were advanced using a track-mounted hollow stem auger drill supplied and operated by Marathon Drilling Company Ltd. of Ottawa, Ontario. The boreholes were advanced to depths of 4.3 to 11.6 metres bgs. This corresponds to elevations ranging from 94.3 metres asl to 101.8 metres asl.

Samples of the soils encountered were recovered using split spoon sampling equipment (primarily 2-inch). Monitoring wells consisting of 50-millimetre diameter Schedule 40 PVC screen and riser were installed in the overburden in boreholes 21-01 through 21-08. The monitoring wells were developed following well installation using dedicated tubing and inertial development methods. On July 20 and 21, 2021, Golder measured groundwater levels and completed hydraulic conductivity testing in the monitoring wells installed in BH21-01 through BH21-08.

All field work was monitored by Golder staff who staked the boreholes in the field in advance of drilling, monitored drilling operations, logged the boreholes and samples, and took custody of the soil samples retrieved. Samples of the soil encountered within the boreholes were returned to our laboratory for examination by the project engineer and for laboratory testing. The initial laboratory testing program included 15 grain size distribution tests (LS-602) on representative samples from boreholes 21-01, 21-02, 21-03, 21-05, 21-06 and 21-08.

Golder carried out a geodetic survey of the new monitoring well locations (i.e., 21-01 through 21-08) on August 16, 2021.

Borehole logs summarizing the subsurface conditions encountered in the boreholes put down for the Site investigations completed by Golder are included in Appendix C.

4.1.2 Site Stratigraphy

The subsurface conditions encountered in the boreholes put down for the investigation are shown on the Record of Borehole Sheets in Appendix C. Three stratigraphic cross-sections running through the property are provided as Figures 5, 6 and 7 (refer to Figure 1 for cross-section locations).

In general, the subsurface conditions in which the boreholes were advanced consist of a thin topsoil layer, underlain by sand deposits ranging from fine to fine-to-coarse sand, followed by silty sand, and in turn by glacial till and/or clayey silt silty clay.

As shown by the cross-sections, the ground surface on the Site ranges from approximately 105 to 111 metres asl. The ground surface elevation decreases notably along the southwestern boundary of the Site. The surface of the glacial till or silty clay underlying the sand deposits in the Site boreholes ranges from approximately 99 to 102 metres asl.

In the boreholes on the Site (i.e., all boreholes except 21-04, 21-07 and 21-08), the combined thickness of the sand units (ranging from fine to fine-to-coarse sand) is approximately 6.0 to 8.0 m. At boreholes 21-01, 21-03 and 21-06, the sand units include a layer of gravelly sand measuring 2.1 to 3.4 m thick. At most of the boreholes on the Site, there is a silty sand deposit underlying the sand deposit at a depth of 6.0 to 8.1 metres bgs. Below the silty sand (or, where the silty sand is absent, below the sand) is glacial till or clayey silt at a depth of 6.3 to 11.3 metres bgs. The bedrock surface was not encountered in any of the boreholes.

Boreholes 21-04, 21-07 and 21-08 are located outside of the southwestern boundary of the Site. At these boreholes, the sand deposit measured 0.9 to 2.0 m thick, followed by silty sand at 1.2 to 2.3 metres bgs and glacial till or silty clay at 2.2 to 4.2 metres bgs.

4.1.3 Hydraulic Conductivity Testing

A total of 8 well response tests were carried out in the monitoring wells installed in 21-01, 21-02, 21-03, 21-04, 21-05, 21-06, 21-07 and 21-08 using the rising/falling head method. The completed well response tests provide an estimate of the horizontal hydraulic conductivity of the overburden materials adjacent to the monitoring well interval. The response testing was performed by displacing water by inserting/removing a plastic slug and monitoring the recovery to the static water level by measuring the depth to the water using a water level tape and/or pressure transducer and datalogger at frequent intervals.

For analysis, the intervals for response testing were defined as the monitoring well screen. This definition of screen length was used to maintain the assumption for horizontal flow to the piezometer screen. The details regarding the locations of the test interval for each monitoring well are provided on the borehole logs in Appendix C. The well response test analyses are provided in Appendix D. The hydraulic conductivity value from each test was calculated using either the Hvorslev (1951) or Bouwer and Rice (1976) method.

A summary of the well response testing results from monitoring is provided in the following table:

Table 1: Hydraulic Conductivity Estimates from Hydraulic Testing

Borehole No.	Estimated Hydraulic Conductivity (metres per second)	Stratigraphy of Screened Interval
21-01	4×10^{-5}	gravelly sand; fine sand
21-02	6×10^{-5}	fine to medium sand; fine to coarse sand
21-03	8×10^{-5}	fine to medium sand
21-04	4×10^{-7}	silty sand; glacial till
21-05	4×10^{-5}	fine to medium sand
21-06	2×10^{-4}	fine to medium sand; fine to coarse sand
21-07	3×10^{-6}	fine to medium sand; fine sand
21-08	4×10^{-5}	fine to coarse sand; silty sand

These estimates are relatively consistent with the range of hydraulic conductivity values reported for silty sand to sand (Freeze and Cherry, 1979). The hydraulic conductivity values derived from the single-well response tests completed in the monitoring wells screened within the sand deposits vary from 3×10^{-6} metres per second (m/s) to 2×10^{-4} m/s and have a geometric average of 4×10^{-5} m/s. These values indicate a high hydraulic conductivity as expected for the permeable sand materials. The hydraulic conductivity of the silty sand and glacial till at 21-04 was slightly lower (4×10^{-7} m/s).

4.1.4 Groundwater Monitoring and Flow Direction

Groundwater monitoring sessions were undertaken between July 20, 2021 and September 5, 2025. Groundwater levels were measured on a monthly basis by Tomlinson staff and provided to WSP. The top of the piezometer at each monitoring well location was surveyed to a Geodetic datum in order to allow for calculation of the groundwater elevation based on the measured depth to groundwater and to determine the groundwater level fluctuation in the area that occurs within the overburden.

The water level elevations are provided in Table E-1 Appendix E and plotted against time on Figure 8.

As shown on Figure 8, the pre-development groundwater elevations (excluding 21-04 and 21-07), which represent background groundwater elevation conditions to the southwest of the Site, ranged from a low of 104.28 metres asl at 21-08 in August 2025 to a high of 107.29 metres asl at 21-01 in April 2023. Groundwater depths range from 0.15 to 5.02 metres bgs along the western boundary (i.e., at 21-03, 21-05 and 21-08) to 0.48 and 4.68 metres bgs along the eastern boundary of the Site (i.e., at 21-01, 21-02 and 21-06). Groundwater elevations in all monitoring wells show seasonal variations, with the highest elevations observed in spring, and the lowest generally observed during the summer and winter months.

Based on groundwater elevation data collected during the pre-development period, the general groundwater flow direction in the vicinity of the Site is influenced by the topography of the Site and seasonal water table fluctuations. The direction of groundwater flow in the shallow overburden appears to be to the southwest across the Site (refer to Figure 9).

Based on the available groundwater elevation data, the maximum predicted water table on the Site is 107.3 metres asl on the northern corner (as measured at 21-01). Based on the groundwater elevation data measured at 21-03, 21-05 and 21-08 located along the western boundary of the Site, the water table slopes downwards from the northeast to the southwest within the sand unit, and the maximum predicted water table on the western side of the Site is approximately 105.5 metres asl.

4.1.5 Predicted Radius of Influence

As discussed in Section 1.2, the proposed East Oxford Pit will not be dewatered during operations, but extraction will continue below the groundwater table. Based on the groundwater level data collected at the Site between July 2021 and September 2025 and the grade along the west side of the pit as per the Operational Site Plan, the predicted elevation of the pond during operations and after rehabilitation will be at about 106 metres asl. To remain conservative, for the purpose of assessing groundwater drawdown in the vicinity of the Site, the lake level was assumed to be 106 metres asl.

Because the surface of the lake within the pit will be flat, there will be minor changes in the pre-development groundwater table in the area adjacent to the sides of the proposed pit. In areas where the existing groundwater table is above the estimated elevation of the lake, drawdown of the groundwater table will be observed during extraction operations and during rehabilitation, whereas in areas where the existing groundwater table is below the estimated elevation of the lake, an increase in the groundwater table would be observed.

The worst-case drawdown will occur along the northern side of the pit where the existing groundwater table is the highest. Along the northern extraction boundary, the highest measured groundwater elevation is approximately 107.3 metres asl (based on measurements at 21-01). As such, the worst-case drawdown at the edge of the extraction area is estimated to be 1.3 metres. The average measured groundwater elevation at 21-01 between July 2021 and September 2025 is approximately 106.4 metres asl, so the average drawdown at the north edge of the extraction area is estimated to be 0.4 metres.

4.1.5.1 Marinelli and Niccoli (2000)

The approach outlined by Marinelli and Niccoli (2000) for inflow to an open pit was used to develop an analytical model to conservatively estimate the radius of influence associated with the flattening of the groundwater table at the Site. Two worst-case drawdown scenarios were contemplated based on the highest groundwater elevation measured at the site, using either the geomean hydraulic conductivity of the sand deposit, or the maximum hydraulic conductivity of the sand. Table 2 lists the information used during the analytical modelling.

Table 2: Summary of Predicted Radius of Influence Analytical Modeling Input Parameters

Scenario	Initial Saturated Thickness Above the Base of Zone 1 (m)	Saturated Thickness at the Pit Wall (m)	Drawdown (m)	Extraction Area (m^2)	Equivalent Radius (m)	Hydraulic Conductivity (m/s)
1 - Geomean K, maximum drawdown	5.8	4.5	1.3	381,000	348	7×10^{-5}
2 - Maximum K, maximum drawdown	5.8	4.5	1.3	381,000	348	2×10^{-4}

For each scenario, the initial saturated thickness above the base of Zone 1 (i.e., the sand deposit) was based on the largest value for the difference between the highest groundwater elevation and the elevation of the bottom of the sand (determined to be at 21-01). The saturated thickness at the pit wall was calculated to be the difference between the lake elevation and the bottom of the sand deposit at 21-01. The hydraulic conductivity used for the analytical modelling was either the geometric mean of the values measured at the Site (excluding 21-04 and 21-07, located outside the extraction area; i.e., 7×10^{-5} m/s) or the highest value measured at the Site (i.e., 2×10^{-4} m/s at 21-06).

As summarized in Table 3, the radius of influence (1 metre of drawdown) associated with the flattening of the groundwater table at the Site was estimated to range from 29 metres to 45 metres for these two scenarios. Calculation sheets for each scenario are included in Appendix F.

Table 3: Summary of Predicted Radius of Influence, Marinelli and Niccoli (2000)

Scenario	Radius of Influence of Dewatering Beyond Pit Wall (m)
1 - Geomean K, maximum drawdown	29
2 - Maximum K, maximum drawdown	45

4.1.5.2 Empirical Formulae

The radius of influence associated with the flattening of the groundwater table at the Site was also estimated with several empirical formulae compiled in Druid, 2022. The equations used included Sichardt (1930) and Kusakin (in Bear, 1979). The equations were deemed suitable since they are widely-used steady-state models that provide a long-term estimate of the radius of influence in unconfined aquifers. The parameters incorporated in these formulae include drawdown, hydraulic conductivity and aquifer thickness as further described in Druid, 2022. The Wrobel (1980) equation (described in "*Effects of a Gravel Pit Lake on Groundwater Hydrodynamic*" Hydrology 2023, 10(7)) was also used to estimate the radius of influence, assuming a pit lake length (equivalent diameter of the pit) of about 700 metres. As summarized in Table 4, the radius of influence associated with the flattening of the groundwater table at the Site was estimated to range from 15 metres to 80 metres for these two scenarios using the empirical formulae. Calculation sheets for each scenario are included in Appendix F.

Table 4: Summary of Predicted Radius of Influence, Empirical Formulae

Scenario	Radius of Influence of Dewatering Beyond Pit Wall (m)		
	Sichardt (1930)	Kusakin (in Bear, 1979)	Wrobel (1980)
1 - Geomean K, maximum drawdown	32	15	45
2 - Maximum K, maximum drawdown	56	26	80

4.1.5.3 Summary

Using a variety of methods, the radius of influence associated with the flattening of the groundwater table at the Site was estimated to range from 15 metres to 80 metres. The most conservative estimated radius of influence for drawdown of about 80 metres (i.e., the highest estimated value) has been carried forward in the assessment of potential impacts.

The estimated radius of influence for groundwater drawdown is shown on Figure 9. The maximum groundwater levels measured at the Site are contoured on Figure 9. The westerly extent of the predicted radius of influence is cut off at the 106 metres asl contour presented on Figure 9. Because the lake level is 106 metres asl, there would be no potential for drawdown where the groundwater table is already below 106 metres asl.

The estimated groundwater drawdown radius of influence shown on Figure 9 is used to complete the impact assessment for local water supply wells presented in Section 6.1 and the wetland feature presented in Section 6.4.

4.1.6 Nearby Private Well Identification

WSP screened available aerial and streetside imagery to identify potential groundwater users that are not included in the MECP WWIS (i.e., drilled and/or dug wells) for the properties located within the predicted radius of influence for the Site. The screening included an attempt to verify the publicly available data in the WWIS for the private water wells located at the nine residential properties adjacent to the Site situated on Pattersons Corners Road and O'Neill Road. No structures were identified within the predicted radius of influence at properties adjacent to the site on County Road 20. All of the WWIS records that could be correlated with the properties were for wells completed in the bedrock. A summary of the data gathered for these nine properties is presented in Table 5.

Table 5: Summary of Private Well Identification Findings

Address	Observation
805 Pattersons Corners Road	Two well casings visible in streetside imagery. WWIS 7262957 (well abandonment) and 7262946 (bedrock well) correlate with this address.
1411 O'Neill Road	New residence (~2023). WWIS 7456095 (no data) correlates with this address.
1445 O'Neill Road	No well casings visible in streetside imagery. WWIS 2409305 (bedrock well) correlates with this address.
1455 O'Neill Road	No well casings visible in streetside imagery. No WWIS records could be correlated with this address.
1471 O'Neill Road	One well casing visible in streetside imagery. WWIS 2404599 (bedrock well) and 7165177 (bedrock well) correlate with this address.
1485 O'Neill Road	No well casings visible in streetside imagery. WWIS 2405927 (no data) correlates with this address.
1495 O'Neill Road	No well casings visible in streetside imagery. WWIS 2407676 (plotted incorrectly in the WWIS) and 7124561 (bedrock wells) correlate with this address.
1505 O'Neill Road	Property falls outside of but is immediately adjacent to the predicted radius of influence. Possible well casing located in a planter. Snowmobile club building dates to 2016; presumed to use the private well of the demolished residence formerly located on this property. No WWIS record found.
1506 O'Neill Road	One well casing visible in streetside imagery. WWIS 2402489 (bedrock well) correlates with this address.

4.1.7 Temperature Monitoring

Three water pressure/temperature transducers and a barometric pressure transducer were installed on and adjacent to the Site by WSP personnel on July 5, 2024 to monitor groundwater and surface water temperatures and water levels. The dataloggers were installed at SG-1, SG-3 and 21-03. Data was downloaded from the dataloggers periodically. The loggers were removed in the fall of 2024 to prevent damage during frozen conditions and were reinstalled on April 2, 2025. Plots of the surface water temperatures recorded at SG-1, SG-3 and 21-03 are provided on Figure 10.

4.2 Hydrological Investigation and Water Balance Analysis

A hydrological investigation of existing conditions and a water balance assessment for existing, operational and rehabilitation conditions were completed for the area inside the licensed boundary (41.7 ha)

4.2.1 Surface Water Monitoring

Staff gauges were installed at surface water monitoring locations SG-1 and SG-2 by Golder personnel in July 2022 in the wetland feature located to the west of the Site. A staff gauge was also installed at surface water monitoring location SG-3 on July 5, 2024. A geodetic survey of staff gauges SG-1 and SG-3 was completed by Tomlinson personnel in October 2024, and a geodetic survey of staff gauge SG-2 was completed by WSP personnel in October 2025. The locations of the staff gauges are shown on Figure 1.

4.2.1.1 Surface Water Levels

Three staff gauges were installed to assess the water levels within the wetland located to the west of the Site. Surface water levels were measured on an approximate monthly basis by Tomlinson and WSP (August 31, 2022 to September 5, 2025). As described in Section 4.1.7, pressure transducers were installed on July 5, 2024 at SG-1 and SG-3. The manually measured water level readings collected on an approximately monthly basis are summarized in Table E-2 in Appendix E and hydrographs of the surface water levels for SG-1, SG-2 and SG-3 are provided on Figure 11.

The monitoring results shows the staff gauge water levels (ranging from approximately 100 metres asl to 102.5 metres asl) consistently lower than the groundwater level (approximately 105 metres asl at 21-03), which is interpreted to be related to the wetland feature primarily being fed by groundwater inputs instead of surface water.

The available water level data show higher elevations in the spring, followed by a decreasing trend throughout the summer. Fall and winter water levels are expected to remain low, marked with high water events likely caused by short melt events. It should be noted that water levels are not available during frozen conditions.

4.2.2 Water Quality Assessment

A water quality sample was collected from the waterway that historically discharged from the wetland to the west of the Site into the adjacent farmland. This water feature appears to be manmade and is associated with the lowest topography surrounding the Site (see Figure 1). One baseline water quality sample was collected by Golder personnel on July 21, 2022 from the SG-1 (Figure 1) and submitted for the analysis of total suspended solids (TSS), oil and grease, total metals including dissolved aluminum, pH, organochlorine pesticides, total PCB and inorganics.

The results of the sample collected from the water quality sample showed that there were no Provincial Water Quality Objectives (PWQO) exceedances for the analyzed parameters. The water quality results from the July 21, 2022 baseline sampling event are included in Appendix G.

4.2.3 Water Balance Methodology

The water balance assessment relied on meteorological data obtained from Environment and Climate Change Canada (ECCC) for the Ottawa International Airport (ID 6106000) Meteorological Station for the period 1939 to 2019. The water balance was based on land use data and existing soil types as identified through the subsurface investigation activities at the Site and available mapping.

Water balance calculations are based on the following equation, which is described in more detail below:

$$P = S + ET + Surplus$$

Where: P = precipitation
S = change in soil water storage
ET = evapotranspiration
Surplus = Surplus water (available for runoff or infiltration)

Precipitation data obtained from ECCC for the Ottawa International Airport station indicate a mean annual precipitation (P) of 904 millimetres per year (mm/yr).

Short-term or seasonal changes in soil water storage (S) are anticipated to occur on an annual basis as demonstrated by the typically dry conditions in the summer months and the wet conditions in the winter and spring. Long-term changes (e.g., year to year) in soil water storage are considered negligible in this assessment.

Evapotranspiration (ET) refers to water lost to the atmosphere from vegetated surfaces. The term combines evaporation (i.e., water lost from soil or water surfaces) and transpiration (i.e., water lost from plants and trees).

Potential evapotranspiration (PET) refers to the loss of water from a vegetated surface to the atmosphere under conditions of an unlimited water supply. The actual rate of ET is typically less than the potential rate under dry conditions (e.g., during the summer months when there is a moisture deficit). The mean annual PET for the study area is approximately 610 mm/yr based on data provided by ECCC.

The mean annual water surplus (Surplus) is the difference between P and the actual ET. The water surplus represents the total amount of water available for either surface runoff (R) or groundwater infiltration (I) on an annual basis. On a monthly basis, surplus water remains after actual evapotranspiration has been removed from the sum of rainfall and snowmelt, and maximum soil or snowpack storage is exceeded. Maximum soil storage is quantified using a water holding capacity (WHC) specific to the soil type and land use.

Annual surplus values generated from the water balance method may be further divided into annual estimates of runoff and infiltration values. This is done by estimating an infiltration coefficient (based on topography, soil type and land cover) based on literature values, then multiplying the infiltration coefficient by the surplus estimate to produce an approximate value for annual infiltration. The remaining surplus not accounted for in the infiltration is assumed to run off. For this analysis, the infiltration estimates from Table 3.1 of the MOE manual (MOE, 2003) were used to estimate an infiltration coefficient for each land use and soil type.

4.2.4 Water Balance Scenarios

The following scenarios were considered in this assessment:

- Existing Conditions: Currently, the majority of the Site includes cultivated fields, with some portions of mature forest, tree stands and hedgerow.
- Operational Conditions: The full area within the proposed licensed area of extraction is assumed to be below water and therefore considered as a flooded pit. For the purposes of this assessment, it is assumed that the setback allowance area will remain unchanged compared to existing conditions. It is also assumed that the surplus from the flooded pit will not be discharged or pumped during operations.
- Rehabilitated Conditions: The footprint for the rehabilitated pit lake is reduced from the peak during operations, with the areas immediately around the pit left open as pasture for potential future development (the development is not assessed in this water balance). The pasture area around the rehabilitated pit lake is assumed to flow towards the rehabilitated pit lake (and thus only contribute to infiltration). A small wetland area is also included in the northwest corner of the Site, also with no surface discharge (i.e. only contributing to infiltration).

4.2.5 Water Balance Parameters

The maximum soil storage is quantified using a WHC that is based on guidelines provided in Table 3.1 of the MOE *Stormwater Management Planning and Design Manual* (MOE 2003). The WHC represents the practical maximum amount of water that can be stored in the soil void space and is defined as the difference between the water content at the field capacity and wilting point (the practical maximum and minimum soil water content), respectively.

WHCs are specific to the soil type and land use, whereby values typically range from approximately 10 mm for bedrock to 400 mm for mature forest over silt loam. For temperate region watersheds, soil storage is typically relatively stable year-round, remaining at or near field capacity except for the typical mid- to late-summer dry period. As such, the change in soil storage is a minor component in the water budget, particularly at an annual scale. Surplus water is caused after actual ET has been removed (ET demand is met) and the maximum WHC is exceeded (soil-water storage demand is met).

For the open water areas (flooded pit and wetland), it was assumed surplus equals the difference between the precipitation and PET. For the purposes of this assessment, we are conservatively assuming a null (i.e., 0%) infiltration factor adopted for the wetland given the predominantly organic substrate found at its bottom, recognizing that there is possibly some leakage downwards from the wetland to the groundwater system.

Under existing conditions, the majority of the Site includes cultivated fields. A portion of the Site includes treed habitat such as forest stands (maple, white pine, mixed forest and hardwood deciduous forest), isolated tree stands, as well as areas of gravel around buildings. Similar land uses were grouped together for the purposes of completing the water balance assessment.

As seen on Figure 3, the Site is primarily composed of coarse grained glaciomarine sediments (sand, gravel, minor silt and clay). Fine sand was used as the soil type for the proposed pit under operational conditions based on existing borehole results as discussed in Section 4.1.2.

Water holding capacities at the Site were estimated using the values in Table 3.1 of the MOE manual (MOE, 2003). Areas are summarized by land use, WHC, soil type and infiltration coefficient in Table 6 for existing conditions, operational conditions and rehabilitated conditions.

Table 6: Summary of Water Balance Parameters

Land Use	Water Holding Capacity (mm)	Infiltration Coefficient			
		Topography	Soil	Cover	Total
Forest	250	0.3	0.4	0.2	0.9
Rehabilitation Wetland Area	(Precip-PET)[1]				1.0[3]
Agricultural, Pasture and Shrubs	100	0.3	0.4	0.1	0.8
Pasture Areas to Rehabilitation Pit Lake	100				1.0[3]
Gravel	10				0.5[2]
Flooded Pit	(Precip-PET)[1]				1.0[3]
Rehabilitation Pit Lake	(Precip-PET)[1]				1.0[3]

Notes:

1) Surplus from open water areas (including wetlands and the pit lake) is assumed to be the average annual precipitation minus the average annual potential evaporation

2) Infiltration from the gravel surfaces is assumed as 50% of surplus

3) The infiltration factor for the operations flooded pit, rehabilitation pit lake, and rehabilitation wetland area is 1.0 (i.e., 100% infiltration) as the pit and wetland are assumed to be a closed depression with no surface outlet for the purpose of the water balance assessment. Therefore, all available surplus from areas draining to the pit and wetland is expected to infiltrate.

For the pit area in the proposed operational and rehabilitated conditions, the active area was assumed as open water with the surplus assumed as the difference between the sum of the inputs (rain and melt) minus the PET. This method does not account for any groundwater flow through the pit; actual groundwater inflows will be additive to the precipitation surplus predicted by this method.

An infiltration coefficient of 1.0 (indicating 100% infiltration with no runoff) was applied to the proposed extraction area in the operational and rehabilitated conditions. This infiltration coefficient was used to acknowledge that with no dewatering or surface water outflow (for water balance assessment purposes only), and assuming the amount of water in the pit does not change on an annual basis, the total annual surplus from the pit area must leave the pit through infiltration.

4.2.6 Water Balance Results

This section presents the water balance results under existing, operational and rehabilitation conditions. A discussion of the potential impacts to surface water features as a result of changes to the water balance during pit development is presented in Section 6.4. Details of the water balance calculations are presented in Appendix H.

4.2.6.1 Existing Conditions

The results from the existing conditions water balance are shown in Table 7.

Table 7: Existing Conditions Water Balance Results

Component	Average Annual Volume - Site Wide	
	mm/yr	m^3/yr
Precipitation (P)	904	398,600
Evapotranspiration (ET)	548	241,800
Total Surplus (S)	356	156,800
Infiltration (I)	287	126,500
Runoff (R)	69	30,300

The total average annual surplus for the Site area under existing conditions was estimated to be approximately 356 mm or 156,800 m^3 per year (m^3/year) and the estimated infiltration is approximately 287 mm or 126,500 m^3/year. Runoff was calculated as the difference between surplus and infiltration and was estimated to be approximately 69 mm or 30,300 m^3/year.

4.2.6.2 Operational Conditions

The results from the operational conditions water balance are shown in Table 8.

Table 8: Operational Conditions Water Balance Results

Component	Average Annual Volume – Site Wide	
	mm/yr	m^3/yr
Precipitation (P)	904	398,600
Evapotranspiration (ET)	602	265,700
Total Surplus (S)	301	132,900
Infiltration (I)	293	129,000
Runoff (R)	9	3,900

The total average annual surplus for the proposed extraction area under operational conditions was estimated to be approximately 301 mm or 132,900 m^3/year and the estimated infiltration is approximately 293 mm or 129,000 m^3/year. Runoff was calculated as the difference between surplus and infiltration and was estimated to be approximately 9 mm or 3,900 m^3/year.

4.2.6.3 Rehabilitated Conditions

The results from the rehabilitated conditions water balance are shown below in Table 9.

Table 9: Rehabilitated Conditions Water Balance Results

Component	Average Annual Volume – Site Wide	
	mm/yr	m^3/yr
Precipitation (P)	904	398,600
Evapotranspiration (ET)	573	252,900
Total Surplus (S)	330	145,700
Infiltration (I)	322	141,800
Runoff (R)	9	3,900

The total average annual surplus for the proposed extraction area under rehabilitation conditions was estimated to be approximately 330 mm or 145,700 m^3/year and the estimated infiltration is approximately 322 mm or 141,800 m^3/year. Runoff was calculated as the difference between surplus and infiltration and was estimated to be approximately 9 mm or 3,900 m^3/year.

4.2.7 Hydrological Summary

Under operational conditions, infiltration increases by 2% and runoff decreases by 87% compared to Existing conditions. Under rehabilitation conditions, infiltration increases by 12% and runoff decreases by 87% compared to existing conditions.

5 RECEPTOR IDENTIFICATION

5.1 Water Supply Wells

The MECP WWIS includes records for 25 private water supply wells located within 500 metres of the Site based on a UTM Reliability Code of 5 (i.e., the well is located 300 metres or less of the actual location). Nine residential properties are adjacent to the Site along Pattersons Corners Road and O'Neill Road and within the predicted radius of influence. All of the WWIS records that could be correlated with these nine properties were for wells completed in the bedrock. The locations of the nearby well locations are shown on Figure 9.

5.2 Source Water Protection, Vulnerable Aquifers and Significant Recharge Areas

Published mapping from the Rideau Valley Conservation Authority was reviewed to identify other significant groundwater features. The Site is not located within a mapped Wellhead Protection Area. The Site is located within a significant recharge area, and the area is mapped as a vulnerable aquifer.

5.3 Surface Water Features

Surface water features adjacent to the proposed licensed area include a wetland present to the southwest of the Site. The topography in the vicinity of the wetland feature is approximately 102 to 104 metres asl. The wetland is fed primarily by groundwater infiltration and, to a lesser degree, by surface runoff from a small portion of the Site. The wetland discharges via a waterway, west of the Site into the adjacent farmland property. The waterways appear to be manmade, eventually discharging into Kemptville Creek.

As a result of the proposed operation of the East Oxford Pit, the waterway and wetland will remain undisturbed, along with the majority of the of surface water catchment area reporting to them.

6 ASSESSMENT OF POTENTIAL IMPACTS OF PROPOSED PIT

Based on the nature of the subsurface materials, the approximate pit base elevation will range between 101 and 102 metres. Based on the groundwater level data collected at the Site between June 2021 and September 2025, the predicted elevation of the permanent pond will be approximately 106 metres asl.

6.1 Potential Impact to Groundwater Users

Approximately 25 private water supply well users have been confirmed in the MECP WWIS within the 500 metres of the proposed boundary area to be licensed (with a UTM Reliability Code of 5 or less). A review of the completion details available for the 25 water supply wells listed in the MECP WWIS provided the following information:

Table 10: MECP WWIS Water Supply Well Information

Well Type	Well ID	Depth of Well (m)	Depth to Bedrock (m)	Depth(s) to Water Found (m)	Depth to Static Water Level (m)	Available Drawdown[1] (m)
Overburden	2402471[2]	11.6	-	11.6	1.5	10.1
Bedrock	2401510	39.6	15.8	38.1	7.6	30.5
	2401913	27.7	6.4	27.4	3.0	24.4
	2402489	28.7	9.1	26.2	1.8	24.4
	2402997	24.4	6.1	22.9	3.7	19.2
	2403590	19.5	10.7	17.7	3.0	14.7
	2403659	21.9	20.1	21.3	7.6	13.7
	2403660	24.7	15.8	23.8	6.1	17.7
	2404478	25.6	11.0	23.8	4.6	19.2
	2404599	18.3	10.7	16.8	3.0	13.8
	2405070	19.8	11.0	18.3	3.0	15.3

Well Type	Well ID	Depth of Well (m)	Depth to Bedrock (m)	Depth(s) to Water Found (m)	Depth to Static Water Level (m)	Available Drawdown[1] (m)
	2405803	28.3	14.6	26.5	3.0	23.5
	2405927	-	-	-	-	-
	2406290	21.9	19.8	21.3	6.1	15.2
	2407611	20.7	10.4	16.8	7.6	9.2
	2407666	23.8	11.0	14.9, 21.3	7.6	7.3
	2407676	21.6	9.1	12.8, 17.7	3.0	9.8
	2407686	27.4	14.3	25.9	4.6	21.3
	2408548	21.6	8.2	18.0	3.7	14.3
	2409305	21.9	9.4	16.5	3.0	13.5
	2409990	18.6	6.7	11.6, 15.5	2.2	9.4
	7124561	24.7	10.1	19.8	2.4	17.4
	7165177	30.8	10.6	26.5	1.2	25.3
	7182913	36.9	16.5	24.1, 34.4	7.0	17.1
	7262946	29.0	6.1	27.1	4.8	22.3

Notes:
m = metres, asl = above sea level, - = information unavailable in MECP WWIS well record
1. Available drawdown estimated as the difference between the static water level and depth of water found.
2. Drilled overburden well (cable tool)

Table 11: Summary of MECP WWIS Water Supply Wells

Well Type	Parameter	Range in Values in MECP WWIS Wells
Overburden	Number of Water Supply Wells	1
	Bottom of Well (Depth)	11.6 metres
	Uppermost Water-Bearing Zone (Depth)	11.6 metres
Bedrock	Number of Water Supply Wells	24
	Bottom of Well (Depth)	18.3 to 39.6 metres
	Uppermost Water-Bearing Zone (Depth)	11.6 to 38.1 metres

As previously discussed in Section 4.1.6, nine residential properties are adjacent to the Site along Pattersons Corners Road and O'Neill Road and within the predicted radius of influence. All of the WWIS records that could be correlated with these nine properties were for wells completed in the bedrock.

Given that the aggregate extraction below the groundwater table will occur without dewatering, there will be minimal lowering of the groundwater table in the overburden and no drawdown in the underlying bedrock. As such, there is no potential for the proposed extraction activities to cause drawdown of the groundwater table such that it interferes with local water supply wells completed within the bedrock.

As the material is extracted from below the groundwater table, there would be a localized and temporary depression of the groundwater level as the aggregate material is extracted but this would rapidly recover given the permeable nature of the subsurface materials. Over the long-term, there will be a flattening of the groundwater table at the Site as a result of extraction activities. The estimated radius of influence associated with the flattening of the groundwater table is shown on Figure 9. The estimated radius of influence is about 80 metres (i.e., no drawdown is predicted beyond 80 metres). As shown on Figure 9, there are nine private properties located within the estimated radius of influence. All of the WWIS records that could be correlated with these nine properties were for wells completed in the bedrock; therefore, it is likely that the properties without a correlated WWIS are also supplied by wells constructed in the bedrock. As summarized in Tables 10 and 11, of the 25 WWIS water supply records available within 500 metres of the Site, only one (No. 2402471) was for a well completed in the overburden. As such, impacts to water supply wells as a result of the proposed development of the East Oxford Pit are not predicted.

To confirm the results of the impact assessment, a long-term groundwater level monitoring program is proposed in Section 7.0.

6.2 Source Water Protection

The proposed East Oxford Pit falls outside of the mapped Wellhead Protection Areas (A through D) within the Mississippi-Rideau Source Protection Region protection plans. Impacts to groundwater quality or quantity at the water supply wells, where Wellhead Protection Areas have been established, as a result of the proposed development of the East Oxford Pit are not predicted.

The Site lies outside of the identified Intake Protection Zones 1, 2 and 3 within the Mississippi-Rideau Source Protection Region protection plans. As such, impacts to the water quality or quantity at surface water supplies as a result of the proposed development of the East Oxford Pit are not predicted.

Published mapping indicates that the site has been identified as Significant Groundwater Recharge Areas by MECP. The Significant Groundwater Recharge Area lies both within the proposed extraction area as well as the setbacks within the licensed area. Areas within the setbacks will not be altered, with the exception of areas along the western side some site grading is proposed.

Both within the setback area and the extraction area, groundwater recharge will still occur as the proposed pit will not be dewatered. Infiltration will take place through the overburden (in the case of the area within the setbacks) or through the bottom and sides of the pit lake.

6.3 Potential Impacts to Groundwater Flow Directions

In general, extraction of aggregate material from below the established water table has the potential for interference with local groundwater flow directions in the vicinity of a Site. However, given that no dewatering is proposed during the extraction below the water table and because the radius of influence associated with the development of the Site is small (see estimated radius of influence on Figure 9), significant impacts to groundwater flow directions in the vicinity of the Site are not predicted.

6.4 Potential Impact to Existing Surface Water Features

As discussed above, the existing water features lay outside the limits of extraction of the proposed East Oxford Pit. There is a wetland located approximately 15 metres west from the proposed limit of extraction and outside of the estimated drawdown radius of influence associated with the flattening of the water table at the Site. As a result, impacts to the wetland as a result of lowering of the water table are not predicted.

A portion of the Site within the west sub-catchment (refer to Figure 12), approximately 8.6 ha or 20% of the Site, contributes to the overall west catchment which ultimately drains west to Kemptville Creek. The west sub-catchment has an estimated total catchment area, based on the Ontario Watershed Information Tool (OWIT), of 230 ha (at the outlet to Kemptville Creek). Under operational and rehabilitated conditions, approximately 6.4 ha (i.e., 74% of the total area within the Site reporting to the west sub-catchment) will be subject to changes in land use. At the larger scale, the area subject to changes in land use (6.4 ha) represents only 3% of the overall west sub-catchment area estimated using OWIT. The wetland located west of the Site is assumed to be fed primarily by groundwater flow from the east (Figure 1), and the water balance in Section 4.2.7 shows the infiltration from the Site increasing slightly (2% to 12%) in operations and rehabilitation

A portion of the Site within the east sub-catchment (refer to Figure 12), approximately 35.5 ha or 80% of the Site, contributes to the overall east sub-catchment which ultimately drains north via an unnamed creek to Kemptville Creek. The east sub-catchment has an estimated total catchment area, based on OWIT, of 300 ha (at the outlet to Kemptville Creek). Under operational and rehabilitated conditions, approximately 30.8 ha (i.e., 87% of the total area within the Site reporting to the east sub-catchment) will be subject to changes in land use. At the larger scale, the area subject to changes in land use (30.8 ha) represents only 10% of the overall east catchment area estimated using OWIT.

The proposed East Oxford Pit excavation will convert approximately 37.2 ha to a closed depression without a perennial surface outlet to the environment. The water balance assessment in Section 4.2.7 shows that there is an overall decrease in water available given the estimated reductions of 15% and 7% in surplus (for operations and rehabilitation, respectively) than under existing conditions as a direct consequence of increased evaporation from the waterbody (compared to the existing agricultural and treed surface). Although the pit area will no longer be directing a substantial amount of runoff to the corresponding east and west catchments, the water surplus collecting in the pit will infiltrate in volumes approximately 2% and 12% larger (for operations and rehabilitation, respectively) than under existing conditions, and this infiltration will continue reporting to the environment as shallow groundwater flow.

Operation of the proposed pit area is also not predicted to contribute to flooding in the receiving environment. The presence of the pit lake is expected to result in a minor overall reduction of peak flows relative to existing conditions during operations and rehabilitated conditions as no off-Site surface discharges from the pit lake will occur.

Overall, the surface water impacts associated with the proposed pit that are discussed in this report are expected to be minor based on the information available at this time and the results of this assessment.

7 COMPLAINTS RESPONSE PROGRAM

Based on the results of the groundwater modelling and the review of local water supply wells, it is concluded that water well interference complaints attributable to the development of the proposed East Oxford Pit are unlikely. Water well interference complaints will be responded to in light of the collected monitoring data and under the *Complaints Response Program* described below.

A comprehensive complaints response program has been developed for the purpose of responding to well interference complaints from local water supply well users. Each complaint will be dealt with on a case-by-case basis.

When a complaint is received by Tomlinson, the Complaints Response Program detailed below shall be initiated. As soon as can be arranged, a representative of Tomlinson and/or their agent will visit the Site to make an initial assessment of the complaint. This will include a well/system inspection (where accessible) by a licensed pump maintenance contractor to determine the groundwater level, pump depth setting and condition of the well system. The available groundwater level data from the existing monitoring well network will be reviewed by a licensed professional hydrogeologist/engineer to develop an estimate of the potential groundwater level drawdown at the potentially affected well that is the subject of the complaint response. The information obtained by the contractor from the well/well system inspection and the review of the available groundwater level data will be used by the professional hydrogeologist/engineer to prepare an opinion on the likelihood that the well interference complaint is related to pit operation.

If it is concluded that the well interference complaint is most likely attributable to Site activities and the water supply is at risk, then a temporary supply will immediately be arranged, and a water supply restoration program will be implemented. The decision as to whether to proceed with the water supply restoration program will be based on a review of groundwater level information by the professional hydrogeologist/engineer and well construction and performance information from the licensed pump maintenance contractor as noted above.

The water supply restoration program consists of the following measures which are applicable for local water supply wells where the operation of the water supply wells may have been compromised by pit operation or based on the analysis of all monitoring data, are assessed to likely be compromised in the near future:

- Well System Rehabilitation – The well system could be rehabilitated by replacement or lowering of pumps, pump lines flushing, well deepening, etc. to improve performance. Where water is unavailable in the shallow bedrock and a well in deeper bedrock is being considered, a water sample(s) would be taken from the existing well for chemical, physical and bacteriological analyses prior to deepening the well to provide a basis of comparison. If the groundwater in the deeper bedrock is found to be of acceptable quality by the homeowner, either directly from the well or with treatment, it will be developed as the domestic supply. Any modifications to a well would be conducted in accordance with *Ontario Regulation 903*.
- Well Replacement or Additional Well(s) – The well could be replaced or augmented with a new well(s) that could be located further from the pit excavation. The feasibility of well replacement would be based on a test drilling program that could include more than one test well. Where water is unavailable in the shallow bedrock/overburden and a well in deeper bedrock (compared to the original water supply well) is being considered, a water sample(s) would be taken from the existing well for chemical, physical and bacteriological analyses to provide a basis of comparison. If the groundwater in the deeper bedrock is found to be of acceptable quality by the homeowner, either directly from the well or with treatment, it will be developed as the domestic supply. Construction of a new well(s) would be conducted in accordance with *Ontario Regulation 903*.
- Water Treatment Considerations – Appropriate water treatment will be incorporated into any restored water supply as discussed above.

Tomlinson would be responsible for all costs associated with the water supply restoration program. It is important to note that water supply restoration activities undertaken to address an adverse effect would be done so in consultation with the affected property owner in order to ensure a mutually agreeable solution is implemented.

8 MONITORING PROGRAM

A Site-specific water level monitoring program has been developed to measure and evaluate the actual effects on potential receptors associated with long-term development of the proposed East Oxford Pit, and to allow for a comparison of the actual effects measured during the monitoring program and those predicted as part of the impact assessment provided in Section 6.

8.1 Proposed Groundwater Level Monitoring Program

The proposed groundwater level monitoring program would include existing monitoring wells. Table 12 includes a description of the monitoring locations proposed for inclusion in the groundwater level monitoring program, as well as the rationale for inclusion. The groundwater level monitoring program would commence once the pit proceeds below the groundwater table. The locations of the proposed monitoring wells are shown on Figure 2.

Table 12: Proposed Groundwater Monitoring Locations

Location	Rationale for Inclusion
21-01	Long-term monitoring location to assess changes in groundwater levels in the overburden between the Site and private wells located to the north of the Site.
21-03	Monitoring location to assess changes in groundwater levels in the overburden between the Site and wetland located to the west of the Site.
21-04	Long-term monitoring location to assess changes in groundwater levels in the overburden under the wetland located west of the Site.
21-05	Long-term monitoring location to assess changes in groundwater levels in the overburden between the Site and private wells located to the north of the Site.
21-06	Long-term monitoring location to assess changes in groundwater levels in the overburden between the Site and private wells located to the east of the Site.
21-07	Long-term monitoring location to assess changes in groundwater levels in the overburden under the wetland located west of the Site.
21-08	Long-term monitoring location to assess changes in groundwater levels in the overburden between the Site and private wells located to the south of the Site.

Monitoring wells 21-02, 21-03 and 21-05 fall within the proposed extraction area. With the exception of 21-05, it is not proposed to replace these wells if they are removed as a part of extraction activities.

8.2 Proposed Surface Water Monitoring Program

The proposed surface water level monitoring program would include the existing staff gauges SG-1, SG-2 and SG-3. The collection of water levels at these locations will allow for long-term monitoring of the water level near the wetland located to the west of the property.

8.3 Monitoring Frequency

Water levels at the identified monitoring well and staff gauge locations (during ice free conditions) would be measured manually on a quarterly basis. Dataloggers will be installed at SG-1 and SG-3 during ice free conditions to record water level measurements at least once per day.

9 SUMMARY AND CONCLUSIONS

A Level 1 and 2 Water Report was completed for the proposed Tomlinson East Oxford Pit located on Part of Lots 13 and 14, Concession 8, Municipality of North Grenville, in the United Counties of Leeds and Grenville, Ontario. Based on the results of the investigation, the following summary and conclusions are presented:

- The local overburden deposits on the Site consist primarily of sand and gravel materials that range between 6 and 8 metres thick.
- The majority of the bedrock primarily consists of limestone and dolostone. The local depth to bedrock indicated in the WWIS well records varies from 4 to 20 metres.
- Aggregate resource investigations and a preliminary field hydrogeological investigation were carried out by Golder Associates Ltd. (Golder; now a part of WSP) at the Site in 2021 which included the drilling of eight boreholes (21-01 through 21-08). A single monitoring well was installed in each of the eight boreholes, and well response tests were carried out in the monitoring wells using the rising/falling head method. Water levels were measured on a monthly basis from July 2021 to September 2025.
- Staff gauges were installed at surface water monitoring locations SG-1 and SG-2 by Golder personnel in July 2022 in the wetland feature located to the west of the Site. A staff gauge was installed at surface water monitoring location SG-3 in July 2024. Surface water levels were measured on a monthly basis during ice-free conditions between August 2022 and September 2025.
- Groundwater depths range from 0.15 to 5.02 metres bgs along the western boundary (i.e., at 21-03, 21-05 and 21-08) to 0.48 and 4.68 metres bgs along the eastern boundary of the Site (i.e., at 21-01, 21-02 and 21-06). Groundwater elevations in all monitoring wells show seasonal variations, with the highest elevations observed in spring, and the lowest generally observed during the summer and winter months.
- Based on groundwater elevation data collected during the pre-development period, the general groundwater flow direction in the vicinity of the Site is influenced by the topography of the Site and seasonal water table fluctuations. The direction of groundwater flow in the shallow overburden appears to be to the southwest across the Site. Based on the available groundwater elevation data, the maximum predicted water table on the Site is 107.3 metres asl on the northern corner (as measured at 21-01). Based on the groundwater elevation data measured at 21-03, 21-05 and 21-08 located along the western boundary of the Site, the water table slopes downwards from the northeast to the southwest within the sand unit, and the maximum predicted water table on the western side of the Site is approximately 105.5 metres asl.
- Over the long-term, there will be a flattening of the groundwater table at the Site as a result of extraction activities. Given that the aggregate extraction below the groundwater table will occur without dewatering, there will be minimal lowering of the groundwater table in the overburden and no drawdown in the underlying bedrock. As such, there is no potential for the proposed extraction activities to cause drawdown of the groundwater table such that it interferes with local water supply wells completed within the bedrock. There are nine private properties located within the estimated groundwater level drawdown radius of influence. All of the WWIS records that could be correlated with these nine properties were for wells completed in the bedrock; therefore, it is likely that the properties without a correlated WWIS are also supplied by wells constructed in the bedrock. As such, impacts to water supply wells as a result of the proposed development of the East Oxford Pit are not predicted.
- Under both operational and rehabilitated conditions, surplus is predicted to decrease compared to existing (by 15% in operations and 7% in rehabilitation), while runoff from the Site will decrease (by approximately 87% in

both operations and rehabilitation) and infiltration will increase (by 2% in operations and 12% in rehabilitation). The increase in infiltration and decrease in runoff is the result of all remaining surplus from the pit footprint infiltrating in this condition. Operation of the proposed pit area is also not expected to contribute to flooding problems in the receiving environment, as water will not be discharged from the pit, and in fact, operating the pit is expected lead to a minor overall reduction in peak flows.

- For receiving features, the catchment to the wetland feature to the west will see some land use changes, but will continue to be fed by groundwater flow, with only a slight increase in infiltration reporting to the western boundary of the Site. The catchment for the unnamed creek feature receiving flow to the east of the Site will also see some land use changes, but those changes are approximately 10% of the total catchment for the feature.
- The proposed water level monitoring program will permit the collection of long-term groundwater and surface water level data as the proposed East Oxford Pit develops. These data will show the actual changes in water levels within the monitoring wells completed around the extraction area as the pit expands laterally and vertically. In the unlikely event that complaints are received regarding interference to water wells in the vicinity of the Site, the complaints response plan would be implemented.
- Based on the findings of this assessment, no adverse effects to groundwater and surface water resources and their uses are anticipated as a result of the operation and rehabilitation of the proposed East Oxford Pit.

10 RECOMMENDATIONS

Based on the results of the hydrogeological and hydrological assessments for the proposed East Oxford Pit, the following recommendations are provided for inclusion on the Site plans:

The following water level monitoring program shall be implemented by the Licensee.

- Quarterly water levels shall be collected from groundwater monitoring wells 21-01, 21-03, 21-04, 21-05, 21-06, 21-07, 21-08 and surface water staff gauge locations SG-1, SG-2 and SG-3 (during ice free conditions) once aggregate extraction proceeds below the groundwater table. Dataloggers will be installed at SG-1 and SG-3 to record water level measurements at least once per day during ice free conditions.
- In the event of a well interference complaint, the Licensee shall implement the Complaints Response Program outlined in Section 7 of this report.

11 CLOSURE

We trust this report meets your current needs. If you have any questions regarding this report, please contact the undersigned.

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https://wsponline.sharepoint.com/sites/gld-148378/project files/6 deliverables/water report/final/21471757-r-rev0_water_rpt_2025-12-04.docx

12 REFERENCES

Bear, J., 1979 *Hydraulics of Groundwater, McGraw-Hill Series in Water Resources and Environmental Engineering.* McGraw-Hill, New York.

Bouwer, H. and R.C. Rice, 1976. A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells. *Water Resources Research*, vol. 12, no. 3, pp. 423-428.

Druid, S, 2022. Comparing Groundwater Drawdown with Estimated Influence Radius – A Case Study of Infrastructural Projects in Sweden. *Examensarbete vid Institutionen för geovetenskaper, Degree Project at the Department of Earth Sciences*, ISSN 1650-6553 Nr 583.

Freeze, R.A. and Cherry, J.A., 1979. *Groundwater*. Prentice-Hall Inc., Englewood Cliffs.

Geo-Analysis Inc., 1991. *Hydrogeologic Evaluation – Potential for Village Expansion Based on Private Individual Services, Village of Richmond.* May 1991.

Geo-Analysis Inc. and J.L. Richards & Associates Limited. 1992. *File No. G9105. Private Individual Services in the Rural Area*, Submitted to the Regional Municipality of Ottawa-Carleton and Ministry of Municipal Affairs.

Golder Associates Ltd., 2005. *Construction of Multi-Level Sentinel Wells for the King's Park Communal Wells, Village of Richmond (Ottawa), Ontario*. September 2005.

Golder Associates Ltd., 2006. *Hydrogeological Investigation – Proposed Residential Subdivision, Lot 24 and 25, Concession III, Village of Richmond, Ottawa, Ontario.*

Golder Associates Ltd., 2022. Aggregate Resource Evaluation and Hydrogeological Investigation Program, East Oxford, Ontario. Technical Memorandum No. 21471757-TM-Rev0, dated March 16, 2022.

Hvorslev, M.J., 1951. Time lag and soil permeability in groundwater observations. *U.S. Army Corp Engrs. Waterways Exp. Sta. Bull. 36*, Vicksburg, Miss.

Marinelli, F., and W.L. Niccoli., 2000. Simple analytical equations for estimating groundwater inflow to a mine pit. Groundwater 38, no. 2: 311-314.

Ministry of the Environment. 2003. *Stormwater Management Planning and Design Manual*, March 2003.

Oliver, Mangione, McCalla & Associates, 2000. *Municipal Well Head Protection Study, Town of Kemptville, Township of North Grenville*. November 2000.

Ontario, Government of (Ontario). 2007. *Endangered Species Act*, R.S.O. 2007.

Ontario, Government of (Ontario). August 2020. *Aggregate Resources of Ontario Standards: A compilation of the four standards adopted by Ontario Regulation 244/97 under the Aggregate Resources Act. Part 2: Aggregate Resources of Ontario: Technical Reports and Information Standards.* ISBN 978-1-4868-4700-6 PDF. 52 pp

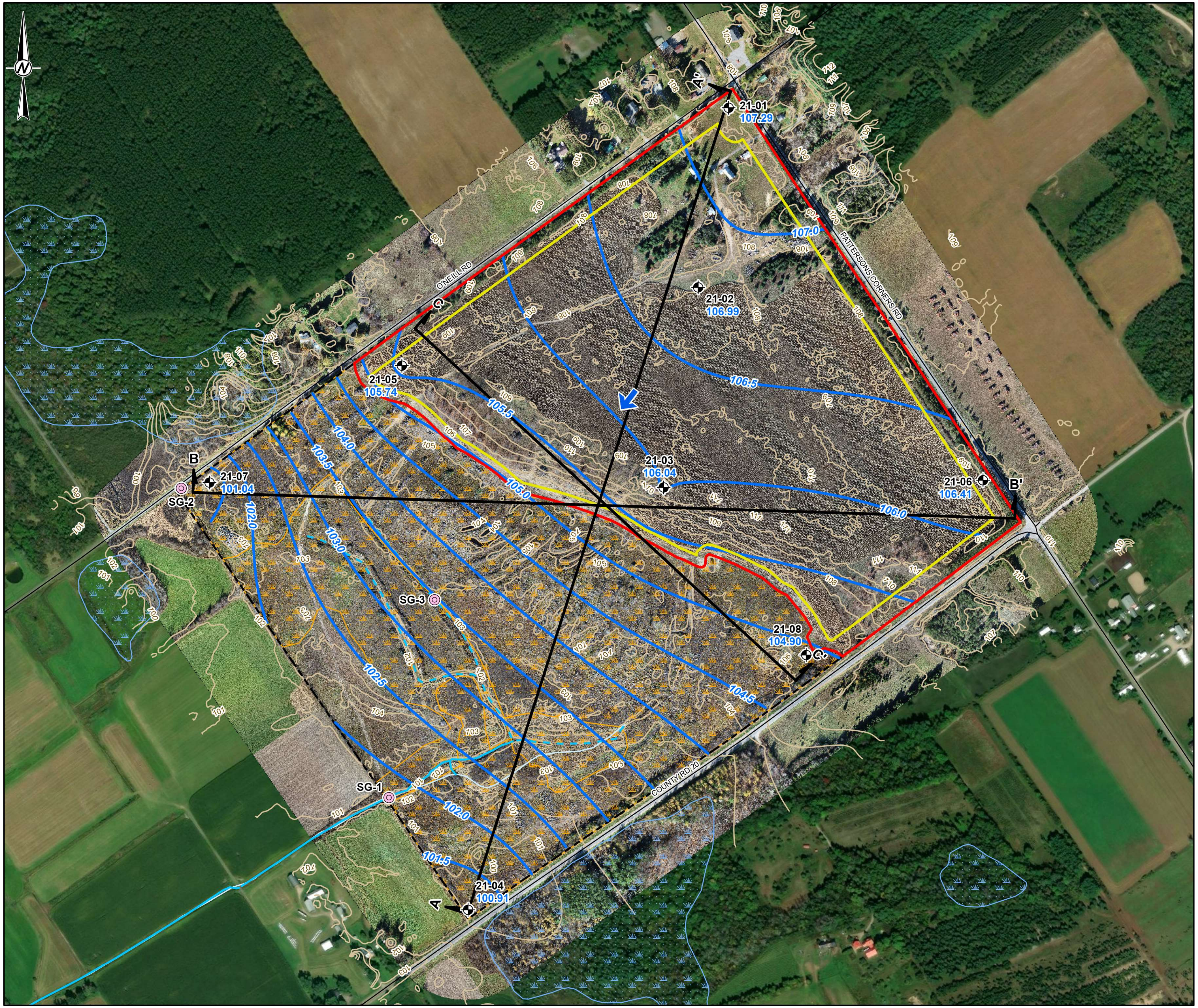
Raven Beck Environmental Ltd., 1996. *Supplementary Bedrock Hydrogeologic Investigation of PCE Contamination, Village of Manotick.* Final Report prepared for the Ontario Ministry of the Environment and Energy.

Sichardt, W., 1930. Grundwasserabsenkung bei Fundierungsarbeiten, Springer, Berlin.

Williams, D.A., 1991. *Paleozoic Geology of the Ottawa-St Lawrence Lowland, Southern Ontario*; Ontario Geological Survey, Open File Report 5770, 292p.

Wrobel, J.P. 1980, Wechselbeziehungen zwischen Baggerseen und Grundwasser in gut durchlassigen Schottern. GWF Wasser/Abwasser 1980, 121, 165-173.

WSP Canada Inc., 2025. Natural Environment Report and Environmental Impact Study, Proposed East Oxford Pit, North Grenville, Ontario. Report No. 21471757. December 2025.



KEY MAP

SCALE: 1:200,000

LEGEND

- APPROXIMATE BOREHOLE LOCATION
- STAFF GAUGE LOCATION
- INTERPRETED GROUNDWATER FLOW DIRECTION
- GROUNDWATER ELEVATION CONTOUR, MASL
- CROSS SECTION
- PROPOSED LICENCED BOUNDARY
- PROPOSED LIMIT OF EXTRACTION
- APPROXIMATE BOUNDARY OF TOMLINSON PROPERTY
- ROADWAY
- TOPOGRAPHIC CONTOUR, METRES
- PERMANENT STREAM
- INTERMITTENT STREAM
- WATERCOURSE
- 2025 WSP EVALUATED - NOT SIGNIFICANT WETLANDS
- UNEVALUATED WETLANDS

0 50 100 200

1:6,000 METRES

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - ONTARIO
2. BASE MAP: VANTOR, ESRI, NASA, NGA, USGS, SOURCES: ESRI, TOMTOM, GARMIN, FAO, NOAA, USGS, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
3. COORDINATE SYSTEM: NAD 1983 CSRS UTM ZONE 18N

CLIENT
R.W. TOMLINSON LIMITED

PROJECT
WATER REPORT
EAST OXFORD, ONTARIO

TITLE
SITE PLAN

CONSULTANT

wsp

YYYY-MM-DD	2025-12-02
DESIGNED	SG
PREPARED	BR
REVIEWED	CAMC
APPROVED	BH

PROJECT NO.	CONTROL	REV.	FIGURE
21471757	0003	0	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

KEY MAP

SCALE: 1:200,000

LEGEND

- MECP WWIS WATER WELL LOCATION
- APPROXIMATE BOREHOLE LOCATION
- PROPOSED LICENCED BOUNDARY
- PROPOSED LIMIT OF EXTRACTION
- 500 METRE BUFFER
- ROADWAY
- PERMANENT STREAM
- INTERMITTENT STREAM
- WATERCOURSE
- 2025 WSP EVALUATED - NOT SIGNIFICANT WETLANDS
- UNEVALUATED WETLANDS

0 50 100 200

1:7,500 METRES

NOTE(S)
1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)
1. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - ONTARIO
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3. COORDINATE SYSTEM: NAD 1983 CSRS UTM ZONE 18N

CLIENT
R.W. TOMLINSON LIMITED

PROJECT
WATER REPORT
EAST OXFORD, ONTARIO

TITLE
WATER SUPPLY WELLS (500 METRE RADIUS)

CONSULTANT

wsp

YYYY-MM-DD	2025-12-02
DESIGNED	SG
PREPARED	BR
REVIEWED	CAMC
APPROVED	BH

PROJECT NO.	CONTROL	REV.	FIGURE
21471757	0003	0	2

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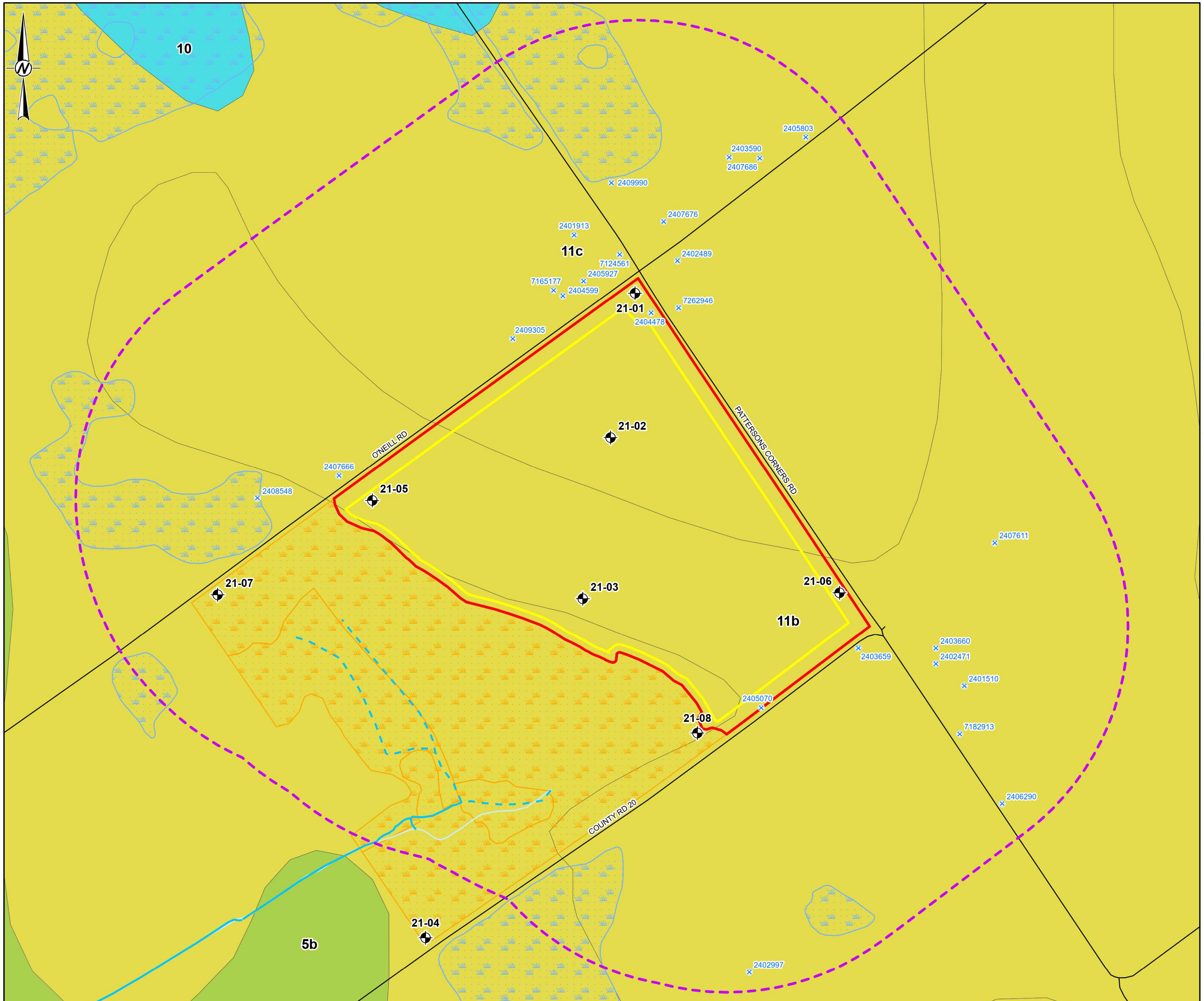
25mm



KEY MAP

SCALE: 1:200,000

LEGEND

- MECP WWIS WATER WELL LOCATION
- APPROXIMATE BOREHOLE LOCATION
- PROPOSED LICENCED BOUNDARY
- PROPOSED LIMIT OF EXTRACTION
- 500 METRE BUFFER
- ROADWAY
- PERMANENT STREAM
- INTERMITTENT STREAM
- WATERCOURSE
- 2025 WSP EVALUATED - NOT SIGNIFICANT WETLANDS
- UNEVALUATED WETLANDS
- 5b. **TILL:** STONE-POOR, SANDY SILT TO SILTY SAND-TEXTURED TILL ON PALEOZOIC TERRAIN
- 10. **FINE-TEXTURED GLACIOMARINE DEPOSITS:** SILT AND CLAY, MINOR SAND AND GRAVEL
- 11b. **COARSE-TEXTURED GLACIOMARINE DEPOSITS:** SAND, GRAVEL, MINOR SILT AND CLAY; LITTORAL DEPOSITS
- 11c. **COARSE-TEXTURED GLACIOMARINE DEPOSITS:** SAND, GRAVEL, MINOR SILT AND CLAY; FORESHORE AND BASINAL DEPOSITS

0 100 200 400

1:7,500 METRES

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. ONTARIO GEOLOGICAL SURVEY 2010. SURFICIAL GEOLOGY OF SOUTHERN ONTARIO; ONTARIO GEOLOGICAL SURVEY, MISCELLANEOUS RELEASE--DATA 128-REV
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - ONTARIO
3. BASE MAP: ESRI, NASA, NGA, USGS, SOURCES: ESRI, TOMTOM, GARMIN, FAO, NOAA, USGS, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
4. COORDINATE SYSTEM: NAD 1983 CSRS UTM ZONE 18N

CLIENT
R.W. TOMLINSON LIMITED

PROJECT
WATER REPORT
EAST OXFORD, ONTARIO

TITLE
SURFICIAL GEOLOGY

CONSULTANT

YYYY-MM-DD	2025-12-02
DESIGNED	SG
PREPARED	BR
REVIEWED	CAMC
APPROVED	BH

PROJECT NO.	CONTROL	REV.	FIGURE
21471757	0003	0	3

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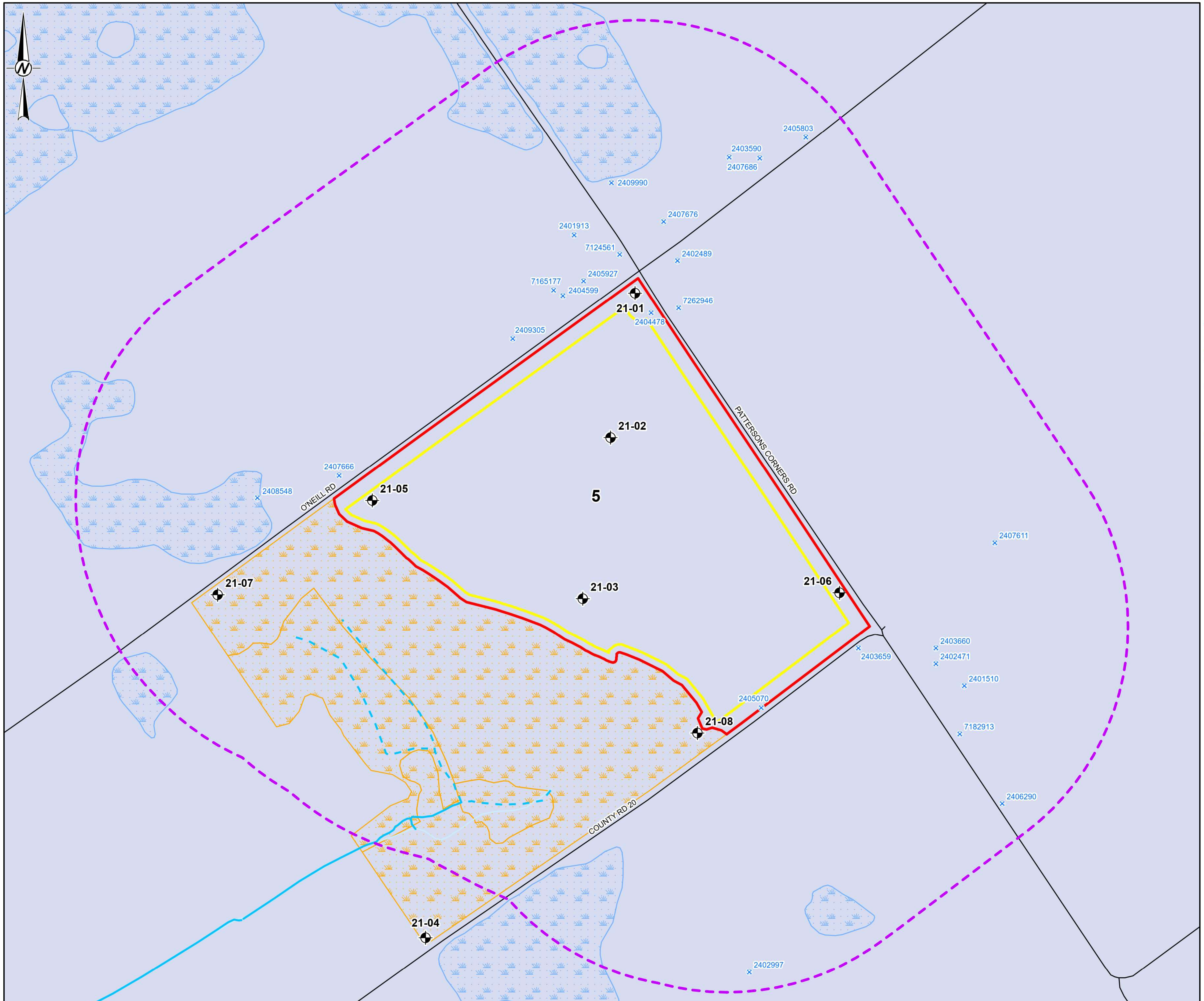
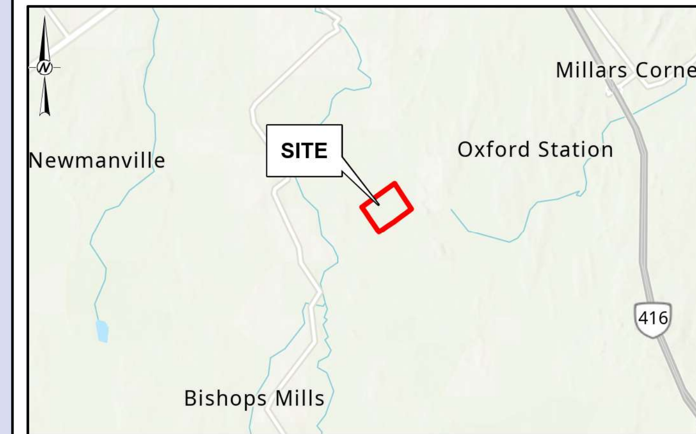


KEY MAP



SCALE: 1:200,000

LEGEND

- MECP WWIS WATER WELL LOCATION
- APPROXIMATE BOREHOLE LOCATION
- PROPOSED LICENCED BOUNDARY
- PROPOSED LIMIT OF EXTRACTION
- 500 METRE BUFFER
- ROADWAY
- PERMANENT STREAM
- INTERMITTENT STREAM
- WATERCOURSE
- 2025 WSP EVALUATED - NOT SIGNIFICANT WETLANDS
- UNEVALUATED WETLANDS
- 5: OXFORD FORMATION - DOLOSTONE, MINOR SHALE AND SANDSTONE

0 100 200 400

1:7,500 METRES

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. ARMSTRONG, D.K. AND DODGE, J.E.P. 2007. PALEOZOIC GEOLOGY OF SOUTHERN ONTARIO; ONTARIO GEOLOGICAL SURVEY, MISCELLANEOUS RELEASE--DATA 219
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - ONTARIO
3. BASE MAP: ESRI, NASA, NGA, USGS, SOURCES: ESRI, TOMTOM, GARMIN, FAO, NOAA, USGS, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
4. COORDINATE SYSTEM: NAD 1983 CSRS UTM ZONE 18N

CLIENT
R.W. TOMLINSON LIMITED

PROJECT
WATER REPORT
EAST OXFORD, ONTARIO

TITLE
BEDROCK GEOLOGY

CONSULTANT

wsp

YYYY-MM-DD	2025-12-02
DESIGNED	SG
PREPARED	BR
REVIEWED	CMC
APPROVED	BH

PROJECT NO.	CONTROL	REV.	FIGURE
21471757	0003	0	4

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