GeoPro Consulting Limited

Geotechnical-Hydrogeology-Environmental-Materials-Inspection

Preliminary Hydrogeological Assessment

Proposed Road Improvements on First Avenue (from Simcoe Street South to Drew Street) and McNaughton Avenue (from Drew Street to Ritson Road South)

City of Oshawa, Ontario

Prepared For:

Parsons Corporation

GeoPro Project No.: 24-4656H
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Professional, Proficient, Proactive

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GeoPro CONSULTING LIMITED

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1.0 INTRODUCTION

GeoPro Consulting Limited ("GeoPro") was retained by Parsons Corporation and The City of Oshawa (the "Client") to conduct a preliminary hydrogeological assessment for the proposed road improvements (the "Project") on First Avenue from Simcoe Street South to Drew Street, and McNaughton Avenue from Drew Street to Ritson Road South, City of Oshawa, Ontario (the "Site"). The approximate site location is shown on Drawing No. 1. It should be noted that this preliminary hydrogeological report was prepared based on the design information provided at the time of preparing this report. In the event the design information is modified or updated, this report should be reviewed by GeoPro, and further recommendations will be provided as needed.

1.1 Purposes

The purposes of this preliminary hydrogeological assessment are to characterize the subsurface soil and groundwater conditions in the limited number of boreholes at the Site and to assess temporary dewatering and groundwater control needs (if any) in order to facilitate the design of the Project.

It should be noted that the preliminary hydrogeological assessment was completed concurrently with a geotechnical investigation carried out by GeoPro at the Site. The results of the geotechnical investigation were summarized in a separate report.

1.2 Scope of Work

In conjunction with the geotechnical investigation, the preliminary hydrogeological assessment comprised the following tasks:

1) Conducting a search and review of the available geology and hydrogeology data resources, including Ministry of the Environment, Conservation and Parks ("MECP") Water Well Records ("WWR"), Ontario Geological Survey ("OGS") and Ontario Source Water Protection Program;
2) Conducting a site visit to observe the site features and potential source(s) of contamination;
3) Completing a borehole elevation survey, groundwater monitoring and testing; and
4) Completing data processing, interpretation and report preparation.

This report has been prepared for the Client. Third party use of this report without GeoPro's consent is prohibited. The limitation conditions presented in this report form an integral part of the report and they must be considered in conjunction with this report.

1.3 Previous and Concurrent Investigations and Reports

A geotechnical investigation was carried out concurrently by GeoPro, which consisted of advancement of nine (9) boreholes (BH1 to BH9) drilled to depths ranging from about 6.4 to 6.9 m below the existing ground surface ("mBGS"). Additionally, three (3) monitoring wells were installed in the advanced Boreholes BH2, BH5 and BH8.

The information or data obtained from GeoPro's geotechnical investigation has been incorporated in this hydrogeological investigation report. The approximate borehole and monitoring well locations are shown on Drawing No. 2, and Borehole Logs from the geotechnical investigation are included in Appendix A.

2.0 SITE CONDITIONS

2.1 Site Feature Observations

A site visit was conducted in March 5, 2024 to observe the general site features and sources of potential contamination and/or environmental concern.

The Site consists of sections of roadways along First Avenue between Simcoe Street South and Drew Street, and along McNaughton Avenue from Drew Street to Ritson Road South which is situated in an area consisting predominantly of residential, institutional and commercial properties, and parkland.

Catch basins and manholes were noticed along the roadways on or near the Site.

Oshawa Creek was noticed located approximately 150 m west of the Site.

Railway was noticed located approximately 320 m north of the Site.

Dry cleaners, gas stations and auto garages (auto service shops) were noticed in the area within a 500 m radius from the Site based on Google Maps review and are also summarized below:

- Super Coin Laundromat (at 433 Simcoe Street South) is located approximately 270 m north of the Site.
- Bloor Coin Laundry (at 45 Bloor Street East) is located approximately 480 m south of the Site.
- Oshawa Gas Bar (at 44 Bloor Street East) is located approximately 410 m south of the Site.
- Ultramar - Gas Station (at 674 Simcoe Street South) is located approximately 460 m south of the Site.
- Esso (at 531 Ritson Road South) is located approximately 60 m east of the Site.
- AutoZhai (at 434 Simcoe Street South) is located approximately 240 m north of the Site.
- All Right Auto Repair (at 100 Bloor Street East) is located approximately 390 m south of the Site.
- NEW MIDWEST AUTO COLLISION (at 164 Bloor Street East) is located approximately 400 m south of the Site.
- A Professional Collision Clinic (at 227 Toronto Avenue) is located approximately 200 m south of the Site.
- Autotech Collision (at 356 Dean Avenue) is located approximately 260 m north of the Site.
- Aim auto service (at 434 Simcoe Street South) is located approximately 250 m north of the Site.

2.2 Physiography and Drainage

The Site is located within the Iroquois Plain physiographical region in an area comprised of Drumlinized Till Plains according to the "Physiography of the South Central Portion of Southern Ontario" prepared by the Ontario Department of Mines and Northern Affairs, and based on the database maintained by the Ontario Geological Survey ("OGS").

The Site is located between the Oshawa Creek and Harmony Creek Subwatershed in the Central Lake Ontario Watershed, under the jurisdiction of Central Lake Ontario Conservation Authority ("CLOCA"). The Oshawa Creek located about 150 m west of the Site and flows south to southeasterly and drain into Lake Ontario approximately 2.5 km southeast of the Site.

2.3 Geology

2.3.1 Bedrock Geology

The bedrock beneath the Site consists of Upper and Middle Ordovician shale, limestone, dolostone, siltstone, arkose and sandstone at the depth ranging from approximately 6 to 12 mBGS, according to the "Bedrock Geology of Southern Ontario" prepared by the Ontario Ministry of Northern Development and Mines and based on the database maintained by the OGS.

2.3.2 Surficial Geology

As shown on Drawing No. 3, the Site and its surrounding area are generally located in an area covered with sandy silt to silty sand-textured till, fine- and coarse-textured glaciolacustrine deposits and modern alluvial deposits according to the "Surficial Geology of Southern Ontario" database maintained by the OGS.

2.3.3 Site Stratigraphy

As indicated in the Borehole Logs, the soil stratigraphy at the Site generally consists of fill materials below pavement structure or topsoil, underlain by cohesive clayey soils, cohesionless silty/sandy/gravelly soils, and till deposits. No bedrock was encountered at the maximum drilled depth of approximately 6.9 mBGS.

Detailed descriptions of soil strata encountered in the boreholes drilled at the Site are provided on the Borehole Logs in Appendix A.

2.4 Hydrogeology

The hydrogeological conditions at the Site were evaluated based on the information obtained from the Ministry of Natural Resources and Forestry Natural Heritage Areas Map, the Ministry of Environment, Conservation, and Parks, the Source Protection Information Atlas, and relevant regional and conservation authority interactive maps, the water well data collected from the MECP database, the information obtained during the geotechnical investigation, and the data collected from the additional work conducted at the Site.

2.4.1 Regulated Areas

Regulated Area	Located within the Site	Located within 500 m Radius from the Site
Highly Vulnerable Aquifer (HVA)	Yes	Yes
Wellhead Protection Area (WHPA) A, B, C or D	No	No
Recharge Management Area Q	No	No
Wellhead Protection Area (WHPA) Q1 and Q2	No	No
Intake Protection Zone (IPZ)	No	Yes, IPZ 3 is located approximately 50 m west of the Site
Significant Groundwater Recharge Area (SGRA)	No	No
Watercourse	No	Yes, Oshawa Creek located approximately 150 m west of the Site
Wetland	No	Yes, unevaluated wetlands are located 140 m southwest and 330 m north of the Site
Oak Ridges Moraine (ORM)	No	No
Wellhead Protection Area (WHPA) E	No	No

2.4.2 MECP WWR

A search of the MECP WWR database was conducted focusing on a 500 m radius from the Site. The locations of the MECP water wells are shown on Drawing No. 4. A summary of water well records is included in Appendix B and presented in the following table.

Type of Well Record	Number of Records
Monitoring	57
Monitoring and Test Hole	37
Test Hole	15
Unknown	58
Not Used	3
Total	170

No well records are identified in the MECP WWR database as water supply wells. No bedrock was encountered at the maximum depth of about 13.7 mBGS, and water was reported at recorded depths ranging from about 0.6 to 7.6 mBGS in overburden deposits.

The MECP WWIS coordinate data was not verified by a well survey, thus the well locations and types should be considered as reference only. If more accurate information are needed for the wells, a door-to-door well survey may be considered.

2.4.3 Groundwater Levels

Groundwater conditions were observed in the advanced boreholes during and immediately upon completion of drilling. The observations are included on the Borehole Logs in Appendix A.

Groundwater levels were measured in March 5 and 13, 2024 in the monitoring wells.

The monitoring well construction details and the measured groundwater levels are recorded on the Borehole Logs and summarized in the following table.

Monitoring Well ID	Screen Interval (mBGS)	Groundwater Level (mBGS)	
		March 5, 2024	March 13, 2024
BH2	3.3 ~ 4.8	3.75	3.43
BH5	4.8 ~ 6.3	1.83	1.79
BH8	4.5 ~ 6.0	1.70	1.59

As shown in the above table, groundwater levels ranged from 1.59 to 3.75 mBGS during the monitoring period.

Groundwater is expected to flow westward towards the Oshawa Creek; however, the extensive underground infrastructure in this urban setting may influence local groundwater flow patterns.

It should be noted that groundwater levels can be expected to vary over time and are subject to seasonal fluctuations.

3.0 ESTIMATED HYDRAULIC CONDUCTIVITY

Hydraulic conductivity (K-value) of the soils was estimated based on the results obtained from grain size analyses of selected soil samples and from single well response tests (slug tests).

3.1 Grain Size Distribution Method

Grain size analysis (sieve and hydrometer) of three (3) soil samples collected from Boreholes BH2, BH5 and BH8 were conducted, and the grain size analysis results are presented in Figure No. 1.

The hydraulic conductivity values of the selected soil samples were estimated using applicable empirical equations based on the particle size gradations. As shown in the table below, the estimated K values for the tested soils ranged from about 2.8×10^{-8} to 1.3×10^{-3} cm/s.

Borehole ID	Sample #	Soil sample Depth (mBGS)	Soil Type	K Value (cm/s)
BH2	SS4	2.3 – 2.6	Sand and Gravel	1.3×10^{-3}
BH5	SS5	3.0 – 3.5	Clayey Silt to Silty Clay	2.8×10^{-8}
BH8	SS5	3.0 – 3.5	Silty Sand	3.6×10^{-5}

3.2 Single Well Response Test (Slug Test) Method

Single well response testing (slug testing) was conducted in three (3) monitoring wells at the Site. Prior to the slug testing, initial water levels in each well were measured manually using a water level tape, and the monitoring wells were purged using Waterra inertial pumps (tubing and footvalves) to remove the sediments settled in the wells and in the sand pack around the well screens.

The field slug tests were completed either using a rising head method in which a known volume of groundwater was removed from the tested monitoring well or using a falling head method in which a known volume of potable water was added into the tested monitoring well, and the recovery of water level was measured and recorded. Before removing or introducing the water, a datalogger was placed in the monitoring well to record the change in water level (head) versus time throughout the test. The retrieved water level data was plotted on a semi-logarithmic scale using Hvorslev's method to estimate the hydraulic conductivity values.

Slug Test analysis graphs and calculations are included in Appendix C. A summary of K values estimated from the slug tests is shown in the following table.

Monitoring Well No.	Screen Depth (mBGS)	Soil Type	Estimated K-Value (cm/s)
BH2	3.3 ~ 4.8	Sand and Silt to Silty Sand; Sand	3.9×10^{-6}
BH5	4.8 ~ 6.3	Clayey Silt to Silty Clay	2.8×10^{-5}
BH8	4.5 ~ 6.0	Sand and Silt	9.7×10^{-7}

Based on the slug test results, the estimated hydraulic conductivity values of the screened soils ranged from 9.7×10^{-7} cm/s to 2.8×10^{-5} cm/s.

3.3 Preliminarily Estimated Infiltration Rates

The percolation times and soil infiltration rates for different locations and depths of soils at the Site were preliminarily evaluated using the obtained hydraulic conductivity values and modified based on our experience.

The preliminarily estimated soil percolation times and infiltration rates are presented in the following table.

Test Location	Tested Soil Depth (mBGS)	Hydraulic Conductivity (cm/s)	Percolation Time T, (min/cm)	Infiltration Rate 1/T, (mm/hr)
BH2 SS4	2.3 – 2.6	1.3×10^{-3}	14	43
BH5 SS5	3.0 – 3.5	2.8×10^{-8}	larger than 50	smaller than 12
BH8 SS5	3.0 – 3.5	3.6×10^{-5}	32	19

Based on preliminary estimation, the correlated percolation times for tested soils ranged from 14 min/cm to larger than 50 min/cm, and the correlated infiltration rates ranged from smaller than 12 mm/hour to 43 mm/hour.

Please note that the infiltration rate used to design an infiltration facility should incorporate a safety correction factor when less permeable soil horizons exist within 1.5 m below the proposed bottom elevation of the proposed infiltration facility. Where infiltration rates are less than 15 mm/hr, an underdrain or amendment of the facility would be required for most of the Low Impact Development ("LID") measures.

The proposed LID design shall consider an overflow outlet in case for large storm event. The subsurface conditions are anticipated to vary between and beyond the test locations, as such, a sufficient factor of safety may be considered by the designer.

In addition, it should be noted that for most of LID measures, the bottom of the facility should be set at least 1 m above the highest groundwater tables at the Site.

4.0 TEMPORARY DEWATERING REQUIREMENTS

Temporary dewatering is intended to lower the groundwater table within the excavation area in order to provide a "dry" working condition during excavation and installation operations.

The temporary dewatering flow rate generally depends on the design specifications of the proposed structures (such as invert elevation, length, depth, and/or size, etc.), the site hydrogeological conditions (such as existing groundwater levels and flow regime), and the drawdown levels required for maintaining dry working conditions and stable excavation bases and slopes.

4.1 The Project Concept

No detailed design of the proposed underground utilities was available at the time of preparing the report. Therefore, a 30 x 3 m daily excavation with depth of about 5 mBGS was assumed for the proposed underground utilities.

4.2 Excavation and Temporary Dewatering Requirements

Groundwater levels measured in the on-site monitoring wells ranged from about 1.59 to 3.75 mBGS during the monitoring period. Considering seasonal fluctuations, the initial water level for dewatering is assumed to be 1.5 m higher than the highest measured water level (e.g., 0.09 mBGS). The excavations for the Project are anticipated to occur below the groundwater table, and temporary dewatering or groundwater control is anticipated to lower the water level to at least 1 m below the excavation base to achieve dry work conditions for the excavation and installation.

Dewatering involves controlling groundwater by pumping to lower groundwater levels in the vicinity of the excavation. Sump pumping is the simplest form of dewatering, by which groundwater is allowed to enter the excavation, and is then collected in a sump and pumped away by robust solids handling pumps. Sump pumping can be effective in many circumstances, but seepage into the excavation may create the risk of instability and other excavation and installation problems.

To prevent significant groundwater seepage into the excavation and ensure stability of the excavation base and side slopes, it may be necessary to lower groundwater levels prior to excavation, which is known as 'pre-drainage'. The pre-drainage methods may include deep wells, wellpoints, eductors (ejectors), vacuum wells, horizontal wells, etc.

The excavations are expected to cut through fill materials, cohesionless silty/sandy/gravelly soils, cohesive clayey soils, and till deposits. Considering the relatively high permeability of the cohesionless soils, measures including a positive groundwater control by well points or deep extraction wells should be considered in conjunction with conventional sump pumping. Considering the heterogeneous nature of the soils at the Site, variation of the anticipated groundwater seepage should be considered in the dewatering system design and construction.

4.3 Preliminary Temporary Dewatering Estimation

The assumptions provided in the table below were used in the preliminary calculations for temporary dewatering requirements.

Excavation Section	Daily Anticipated Excavation Size (m)	Anticipated Initial Water Level (mBGS)	Anticipated Target Water Level (mBGS)	Anticipated K-Value (m/s)	Dewatering Requirement (Yes/No)
Utilities	Bottom Area: 30 x 3 Depth: 5	0.09	5.0	1.3×10^{-5}	Yes

The following Dupuit-Thiem equation was used to estimate the dewatering flow rate needed to drain the excavation trench, in an unconfined aquifer under steady-state conditions:

$$Q = \; [\pi \times K \times (H^2 - h_W^2)]/Ln(R_o/r_e) \; + 2[x \times K \times (H^2 - h_W^2)/2L]$$

Where:

Q = Flow Rate [m^3/s]

x = Trench length [m]

H = Initial Water Level [m]

h_w = Target water Level [m]

K = Hydraulic Conductivity [m/s]

r_e = effective radius [m], r_e = width of the excavation/2

$R_o = 3000*(H-h_w)*K^{1/2}$ [m]

$L = R_o/2$ [m]

Based on the calculation described above, the estimated steady-state groundwater inflow rate for the excavation sections is summarized in the following table:

Section Name	Steady-State Dewatering Rate (L/day)
Utilities	276,434

It should be noted that the dewatering requirement is expected to be highest at the beginning of the dewatering process, when the volume of groundwater stored within the pore space of the soil matrix must be removed. The additional pumping rates to be considered to allow removal of the overburden storage within a 14-day period for the excavation sections are summarized in the following table:

Section Name	Overburden Storage Removal Rate (L/day)
Utilities	622,922

During and after storm events, significantly higher dewatering flow rates are anticipated to account for direct precipitation and runoff into the excavation. The highest recorded daily rainfall at a nearby Environment Canada station (Oshawa WPCP) is 144.8 mm (based on data from Environmental Canada). Assuming removal of a 144.8 mm storm event within 24 hours, the additional pumping capacities for the Project are summarized in the following table:

Section Name	Removal of Precipitation (L/day)
Utilities	64,378

Based on the conservative assumptions described above, total maximum daily dewatering flow rates for the excavation sections were summarized in the following table:

Section Name	Estimated Total Dewatering Rate (L/day)
Utilities	963,734

Based on the conservative assumptions described above, the total maximum daily dewatering flow rate for a section would be more than 400,000 L/day, with consideration of removal of the aquifer storage within a 14-day period. The maximum estimated zone of influence would be 64 m from the edge of the excavation.

Please note that this dewatering estimation is specific to the taking of ground water and does not include storm water contribution. It is the responsibility of the contractor to ensure the occurrence of any precipitation events on the construction site are recorded and that pumping rates during and after a storm event are maintained within the permitted limit.

It should be noted that the assumed excavation depths and areas for the dewatering volume estimations are based on our understanding of the proposed development and the preliminary information provided by the Client. Should there be any modifications of the design or the assumed depths and areas, this office should be further consulted, and the dewatering estimation may need to be revised accordingly.

It is known that the subsurface soil conditions may change significantly between and beyond the on-site boreholes. As the information obtained and assumptions made in this assessment report are based on the results obtained from a limited number of investigated locations, unexpected water bearing zones with a hydraulic conductivity higher than that used in these calculations may be present. In addition, the above estimated dewatering volumes are based on the estimated hydraulic conductivities (K-values) from grain size analyses from limited soil samples and in-situ slug tests.

Please note that it is the responsibility of the contractor to ensure dry conditions are maintained within the excavation at all times and at all costs.

4.4 Permit-to-Take-Water/Regulatory Registration

According to O. Reg. 387/04, any water taking over 50,000 litres per day requires a Permit to Take Water (“PTTW”), which shall be obtained in accordance with the MECP’s PTTW Manual, dated April 2005.

According to O. Reg. 63/16, a PTTW will not be required for temporary dewatering at a construction site in an amount less than 400,000 L/day. However, the dewatering at a construction site in an amount between 50,000 L/day and 400,000 L/day shall be registered through the Environmental Activity and Sector Registry (“EASR”).

According to the dewatering rate estimations, the total temporary dewatering rate of the Project would more than 400,000 L/day, for which a Category 3 PTTW will be required.

5.0 POTENTIAL TEMPORARY DEWATERING IMPACTS

5.1 Potential Sources of Contamination

Based on the observations made during the site visit, there appeared to be no properties containing potentially contaminating activities within the zone of influence; there appeared to be no noticeable environmental concerns anticipated due to temporary dewatering; however, roadways and commercial properties are present adjacent to the site and within the study areaPlease note that the level of environmental issues observation outlined herein is meant to provide a broad indication of environmental concerns based on the visual observations during the site visit and searches on Google map. The observation results contained in this report should not be considered a warranty with respect to environmental evaluation or assessment of the subject site for any specific purpose. Furthermore, it should be noted that the hydrogeological report was prepared based on the preliminary observation of potential environmental concerns. The scope of work did not include any environmental evaluation or assessment of the subject site (such as a Phase One or Phase Two Environmental Site Assessment).

5.2 Highly Vulnerable Aquifer (“HVA”)

As discussed previously, the Site is located in an area with a HVA present beneath the Site, which indicates that contaminants could potentially affect the aquifer if contamination occurs at the Site.

Any drinking water quality threat activities may pose a risk to a municipal drinking water supply. Frequent monitoring of the excavation and installation activities should be carried out during the project. Any products considered flammable or corrosive or hazardous, or which may contain chemicals that could contaminate a drinking water source should be stored, used, and disposed of properly following a Spill Management Plan for the project. Waste which contains pathogens that can run into storm sewers during a rainstorm should be properly managed and disposed of following a Spill Management Plan for the project. Preventative measures (such as implementation of safe equipment fueling practices) should be in place during excavation and installation, and spill management equipment should be readily available on-site during the project.

5.3 Intake Protection Zone

As discussed previously, IPZ-3 is located within or close to the estimated zone of influence. Therefore, impact on a surface water intake source due to the temporary dewatering activities should be anticipated and mitigated following the guidelines outlined previously in Section 5.1.

5.4 Water Supply Wells near the Site Area

Based on the MECP water well records, no water supply wells are located within or close to the estimated zone of influence. Therefore, the impact on the water supply wells due to the temporary dewatering activities should not be anticipated. However, the data in the MECP WWR may not be up to date and may not be accurate, as such, a door-to-door well survey should be considered.

5.5 Wellhead Protection Area (“WHPA”)

As discussed, the Site and its neighbouring properties are not located within municipal Wellhead Protection Areas (“WHPA”). Therefore, no WHPA impacts due to the proposed temporary dewatering are anticipated.

5.6 Surface Water

As discussed previously, no surface water is located within the estimated zone of influence. Therefore, impact on surface water due to the temporary dewatering activities should not be anticipated.

5.7 Ground Subsidence in Adjacent Structures

Under certain conditions, dewatering activities can cause ground settlement or subsidence. When groundwater levels are lowered in saturated soil deposits, effective stresses will be increased, and consolidation and subsequent settlement may occur.

During the site visit, catch basins, manholes, residential, institutional and commercial properties were noted along the roadways on or near the Site within or close to the preliminarily calculated radius of influence of dewatering. Therefore, potential impacts associated with the temporary dewatering should be considered for the buildings, structures, roadways, and underground utilities which are located within the estimated zone of influence.

6.0 RECOMMENDATIONS

6.1 PTTW Application

- Based on the preliminary dewatering calculations presented above, the total temporary dewatering rate is more than 400,000 L/day, for which a Category 3 PTTW will be required.
- The PTTW application should be conducted in accordance with the Permit to Take Water Manual, dated April 2005, issued by Ministry of the Environment and Climate Change.
- The PTTW application process will generally take a minimum of three (3) months.

6.2 Point of Discharge

As discussed, catch basins and manholes were noted along the roadway on or near the Site during the site visit. Prior to start-up of dewatering operations, samples of groundwater shall be obtained from the dewatering system and submitted for analysis of the appropriate Sewer Use By-Law parameters. It should be noted that filtration and/or settlement of the pumped water prior to discharge would be expected to improve the water quality.

Installation of an appropriate water filtration/treatment system designed to address any measured exceedances will be necessary prior to start-up of dewatering. Should the treated water meet the Local Sewer Bylaw criteria, the water generated could be discharged into the local municipal sewer system provided a Municipal Sewer Use Permit is in place. In addition, during discharge, the water quality must be in compliance with the requirements set up in the Local Sewer Use By-Law.

As an option, the water generated could be hauled and disposed off-site in a licensed water treatment facility; however, a cost analysis would need to be performed to compare treatment and discharge costs to haulage costs.

6.3 Discharge Permit

Should discharge into the local sewer system be selected, prior to temporary dewatering consultations with the local municipality should be conducted to obtain a permit to use the selected sewer system for the water generated during the excavation and installation.

It should be noted that in support of applying for a discharge permit, a temporary dewatering plan may be required by the local municipality.

6.4 Temporary Dewatering Plan

Prior to the dewatering activities, a temporary dewatering and discharge plan shall be prepared by the selected contractor for GeoPro's review.

It should be noted that the design and installation of a temporary dewatering system is the responsibility of the construction contractor, including selection of a sump pump, wellpoint system or well system. The extent and details of the dewatering scheme (well size, spacing, pump level, screen size, wick gradation, etc.) and selected point of discharge are left solely to the contractor's discretion to achieve the performance objectives for stable slopes and dry conditions and will be based on their own interpretation and analysis of the site conditions, equipment, experience, and system efficiency.

Once the pumping system, header pipes and a decanter tank/holding tank are installed, a trial dewatering for a short period of time should be conducted to obtain a representative groundwater sample from the decanting tank for chemical analysis to confirm the water quality.

6.5 Building/Structure Settlement Monitoring

As discussed above, structures located within the zone of influence may be susceptible to potential settlement or subsidence due to the temporary dewatering. Therefore, the following monitoring and mitigative measures are recommended to be carried out before and during the temporary dewatering:

- Complete a pre-excavation condition survey and install settlement monitoring monuments for the existing buildings and roadways within the estimated zone of influence.
- The above settlement monitoring monuments should be surveyed prior to the dewatering to establish a baseline and surveyed on a daily basis during the dewatering. The survey results will be provided to the geotechnical engineer of GeoPro for evaluation. The estimated potential and actual settlements should also be reviewed by a structural engineer to assess the potential damage to the existing structures.
- If the settlement monitoring indicates an undesirable deformation, the dewatering will have to be reduced to a lower rate or ceased temporarily, and alternative measures may be considered for the excavation, which should be approved by the geotechnical engineer and project team.

6.6 Groundwater Monitoring and Contingency/Mitigation Measures

Prior to commencement of temporary dewatering, water level measurements shall be obtained from all on-site monitoring wells to verify the assumed water levels used in the calculations. If significant variation occurs, the dewatering volume calculations may be reviewed and updated.

6.6.1 Total Dewatering Volume

- The pumping rate and discharged volume shall be measured daily using a flow measuring device to ensure that the dewatering rate/volume does not exceed the approved or accepted limits.
- If the measured daily volume exceeds the approved limit, either the dewatering methodology or the construction methodology will need to be altered to ensure the maximum permitted rate is not exceeded.
- The contractor on behalf of the Client shall maintain a record of all water takings, including the dates and durations of water takings, and the rates and total measured volumes of water pumped per day for each day that water is taken under the PTTW/permit.

6.6.2 Water Quality

Depending on the selected point of discharge, water quality shall be regularly monitored during the temporary dewatering to ensure that discharge meets the relevant Local Sewer Use By-Law or PWQO quality criteria.

As TSS is an important parameter which may directly reflect the water quality, a treatment facility should be considered to reduce the concentration of suspended solids in the pumped water.

Prior to discharge of the treated water, a representative water sample shall be collected and analyzed for the parameters specified in the applicable standards or criteria. During the temporary dewatering, daily field monitoring of the TSS/turbidity in the water to be discharged is recommended.

In addition, groundwater quality shall be monitored via chemical testing for parameters as specified in the local Sewer Use By-Law or PWQO weekly for the first month. If the results demonstrate that groundwater quality consistently meets the applicable standards, the monitoring frequency can be reduced to once each month afterwards.

6.7 Surface Water Monitoring and Contingency/Mitigation Measures

As discussed above, PSW and Pringle Creek may be impacted due to the temporary dewatering activities because of their proximity from the excavation site. The following recommendations are provided for the assessment of potential impacts to the PSW, creek, river and its tributaries.

6.7.1 Baseline Study

A baseline study of the Creek and PSW within the estimated zone of influence should be conducted to establish the pre-dewatering water level, baseflow and water quality conditions, which may include chemical testing of surface water samples for general metals and inorganics or other parameters per recommendations from the local Conservation Authority.

6.7.2 Surface Water Level and Baseflow Monitoring

Visual observation of the Creek and PSW water levels should be conducted daily at a selected location upstream and downstream of the Site during the temporary dewatering. Should adverse impact be observed during the dewatering, the dewatering volume should be reviewed and modified appropriately. If required, water with acceptable water quality may be introduced to the Creek and PSW to maintain the baseflow in the Creek and PSW.

6.7.3 Surface Water Quality Monitoring

As the pumped water is not expected to be discharged to the Creek and PSW, the surface water quality impacts are not anticipated. However, if significant water level changes occur during temporary dewatering, water sampling and chemical testing may be required to assess any change in surface water quality. Should adverse impacts be observed during the temporary dewatering, the dewatering volume may need to be modified. If required, water with acceptable water quality may be introduced to the Creek and PSW to maintain the baseflow in the Creek and PSW.

6.8 Erosion Control/Sedimentation Mitigation Plan

It should be noted that the pumped water generated from the temporary dewatering cannot be discharged to the natural environment unless it meets PWQO criteria. If the pre-construction chemistry samples show exceedances of PWQO criteria, appropriate treatment methods will need to be implemented prior to start-up construction dewatering. When the treatment including filtration or decanting is carried out appropriately, sedimentation should not be an issue.

However, the dewatering discharge may result in the erosions on land surface and/or in the creek channel depending on the selected discharge points. Therefore, erosion control may have to be considered, which is discussed in the following table.

Period	Monitoring Location	Monitoring Frequency	Method	Triggers for Mitigation	Mitigation/ Contingency
Pre-dewatering	Water discharge points (swale,	Prior to discharge	Visual observation	None	All erosion and sediment controls should be in place prior to commencing discharge activities.

Period	Monitoring Location	Monitoring Frequency	Method	Triggers for Mitigation	Mitigation/ Contingency
	ditch, creek or overland locations)				The water should be dispersed through straw bales or Filtrexx Silt Soxx, when necessary combined with rock check dam.
During - dewatering	Water discharge points (swale, ditch, creek or overland locations)	Daily	Visual observation	Noted erosion	Disperse the discharge to the watercourse using overland flow. Reduce the flow/runoff velocity to a minimum. Select and apply optimal alternatives of erosion control methods.

6.9 Monitoring Well Decommissioning

According to Ontario Regulation 903 ("O. Reg. 903"), when the monitoring wells are no longer used, they should be decommissioned by a licensed water well contractor.

7.0 CLOSURE

We trust that the information contained in this report is complete within our terms of reference. If you have any questions or require further information, please do not hesitate to contact our office.

Sincerely,

GeoPro Consulting Limited
Geotechnical - Hydrogeology - Environmental - Materials Testing – Inspection

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