CATEGORY 3 PTTW HYDROGEOLOGIC ASSESSMENT REPORT, HYDRO ONE NETWORKS INC., CLARINGTON TRANSFORMER STATION, CLARINGTON, ONTARIO

FINAL REPORT

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Table of Contents

LIST OF APPENDICES

LIST OF FIGURES

LIST OF TABLES

Abbreviations

AMSL	above mean sea level
BGS	below ground surface
BTEX	benzene, toluene, ethylbenzene and xylene
Class EA	Class Environmental Assessment
CLOCA	Central Lake Ontario Conservation Authority
ECA	Environmental Compliance Approval
GTA	Greater Toronto Area
ha	hectares
HDPE	high-density polyethylene
Hydro One	Hydro One Networks Inc.
MNRF	Ministry of Natural Resources and Forestry
MOECC	Ontario Ministry of Environment and Climate Change
OGS	Ontario Geological Survey
OWRA	Ontario Water Resources Act
Project Area	lands owned by Hydro One in the vicinity of the Clarington TS
PTTW	Permit to take water
PWQO	Provincial Water Quality Objectives
PSW	Provincially Significant Wetlands
Stantec	Stantec Consulting Ltd.
Station Site	Land area of the Clarington transformer station
SVOCs	semi-volatile organic compounds
TS	Transformer Station
TSS	Total suspended solids
VOCs	volatile organic compounds
WIRP	Hydro One Well Interference Response Plan
WWR	Water Well Record
YPDT-CAMC	York, Peel, Durham, Toronto and the Conservation Authorities Moraine Coalition

1.0 INTRODUCTION

In 2014, Hydro One Networks Inc. (Hydro One) completed a Class Environmental Assessment for Minor Transmission Facilities (Class EA) for the Clarington Transformer Station (TS). The Clarington TS is required to facilitate the delivery of power to the eastern portion of the Greater Toronto Area (GTA) as a result of the shutdown of the Pickering Nuclear Generating Station and to reinforce the regional reliability of the power supply. The Clarington TS will be constructed on Hydro One owned property located in the Regional Municipality of Durham, in the Municipality of Clarington, bordering the east side of the City of Oshawa, northeast of Concession Road 7 and Townline Road North (Figure 1; Appendix A).

For the purposes of this report, the lands owned by Hydro One in the vicinity of the Clarington TS are referred to as the Project Area, within which the transformer station itself is referred to as the Station Site. The Station Site represents approximately 11 ha of the total 63 ha Project Area (Figure 1).

1.1 BACKGROUND

Construction of the Clarington TS is scheduled to commence in December 2014 with completion anticipated in early 2017. In support of the proposed construction activity, Stantec Consulting Ltd. (Stantec) completed a Pre-Station Construction Groundwater and Surface Water Baseline Conditions Report for the Clarington TS (Stantec, 2014). The report presented results of 2013/2014 groundwater and surface water monitoring, which included borehole drilling, groundwater and surface water level monitoring and water quality sampling. The report provided a detailed description of the geology and hydrogeology within the Project Area prior to construction of the Clarington TS, and included private well monitoring for participating well owners within 1,200 m of the Station Site.

The proposed construction of the Clarington TS requires regrading of the Station Site. The pre-station construction monitoring confirmed that the regrading will extend below the elevation of the shallow groundwater level at the eastern extent of the Station Site, and groundwater seepage is expected during construction activities. Initial estimates indicated that seepage rates would be close to 50,000 L/day and as a result a Permit to take Water (PTTW) was likely required to deal with groundwater seepage and precipitation/runoff during construction.

Based on the expected groundwater seepage during Station Site construction activities, Stantec prepared the following report in support of a Category 3 PTTW to allow management of water during construction. The following report was completed with the following main objectives:

- Describe the geologic and hydrogeologic setting;
- Outline the proposed Station Site construction activity and water management strategy, as available;
- Estimate average and maximum day pumping rates for groundwater seepage, including impacts from precipitation and runoff; and
- Assess potential adverse effects on nearby private wells and the natural environment due to the proposed pumping.

1.2 REPORT OUTLINE

The following report is arranged in seven (7) sections, including this introduction. Section 2 details the construction activity at the Clarington TS. Section 3 presents the site setting, including the geology and hydrogeology. Section 4 presents expected groundwater seepage and water management with mitigation measures and monitoring detailed in Section 5. The study conclusions and references are presented in Sections 6 and 7, respectively.

All figures and tables referenced in the report are presented in Appendices A and B, respectively. Appendices C through E contain the engineering drawing for proposed work, applicable borehole logs and photos, and dewatering calculations, respectively.

2.0 CLARINGTON TRANSFORMER STATION

2.1 OVERVIEW

The Clarington TS will transform electricity voltages from 500 kV to 230 kV by connecting to two of four existing 500 kV circuits and to all five of the existing 230 kV circuits located on or adjacent to the proposed Station Site. The Clarington TS will consist of two 500/230 kV transformers, a 500 kV switchyard, a 230 kV switchyard, two relay buildings, one electrical panel building, the associated buswork and equipment. The proposed location of the new infrastructure is shown in Figure 2.

2.2 SITE GRADING AND DRAINAGE

The Station Site drainage plan and details are provided in Appendix C. Hydro One completed a detailed elevation survey in support of the project and prepared 0.25 m contours within the Station Area. Within the Station Area, the existing topography ranges from approximately 260 m above mean sea level (AMSL) at the eastern extent to 249 m AMSL at the western extent.

For the proposed Clarington TS, the Station Area will be regraded with the finished grade elevation of approximately 254.0 m AMSL within the center of the Station Area. Material from the eastern portion of the Station Area will be re-located to the western portion resulting in a generally flat graded area with a 0.5% slope from the center of the Station Area to the north and to the south. This regrading will require up to a 7.5 m cut at the eastern extent and approximate 4 m of fill within the western extent of the Station Area.

2.2.1 Permanent Water Management Systems

A permanent sub-drain system consisting of perforated high density polyethylene (HDPE) will be installed as shown in drainage plan provided in Appendix C. The purpose of the sub-drain system is to collect precipitation that falls within the Station Site as well as any minor groundwater seepage in order to maintain dry ground and safe operating conditions.

The drainage system will consist of a series of east-west oriented 150 mm diameter perforated HDPE pipes spaced approximately 12 m of 15 m apart that cover the full extent of the Station Site. These pipes are connected to one of two north-south (250 mm to 350 mm diameter HDPE) solid header pipes. The header pipes will convey flows to the north, converging at a single manhole (MH7) located at the northern extent of the Station Site. Discharge from this manhole will flow to the South Branch of the Tributary of Harmony Creek. The proposed location for the permanent discharge from the drainage system is shown on Figure 2.

The sub-drain system described above is generally situated between 252 and 253 m AMSL. For the purposes of estimating dewatering volumes, it was assumed that dewatering would need to occur to an elevation of 252 m AMSL.

The drainage system is subject to an Environmental Compliance Approval (ECA) for Industrial Sewage Works under the Ontario Water Resources Act (OWRA). Hydro One submitted an ECA application (Ref No. 6557-9NRR2T) to the MOECC in October 2013. The application is currently under review by the MOECC.

A chain-link fence will be installed around the Station Site for public safety. Along the eastern perimeter of the Station Site, a permanent drainage ditch (toe-drain) will be created outside of the fence to collect surface runoff or groundwater seepage from the graded slope to the east. The drainage ditch will be lined with 150 mm rip-rap material. The elevation of the bottom of the ditch will decrease from 253.5 m AMSL within the center of the eastern boundary to an elevation of 252.0 m AMSL at the northern extent and 252.9 m AMSL at the southeastern extent. At the northern extent, discharge from the ditch will flow to the South Branch of the tributary of Harmony Creek; while at the southern extent, discharge from the ditch will flow to the south towards a local surficial drain (Figure 2).

2.2.2 Water Management During Station Site Construction

During grading of the Station Site and installation of the permanent drainage system, temporary water management will be required, including:

- Managing groundwater seepage along the drainage ditch / toe drain along the eastern boundary;
- Managing direct precipitation onto the Station Site; and,
- Managing overland flow onto the Station Site from adjacent land due to precipitation and/or snow melt.

Hydro One has confirmed that the following measures will be employed to manage water during construction activities.

During initial grading, a cut slope and temporary drainage ditch will be created along the eastern boundary of the Station Site and will direct seepage and overland flow to the north and south, similar to the final design. The cut slope will have a 1:3 slope back to match existing grade to the east.

Groundwater seepage will be collected within this temporary drainage ditch / toe drain, along with precipitation, either as direct precipitation or as overland flow from the eastern graded slope. Straw bales will be installed within the drainage ditch / toe drain, as sediment traps and energy dissipation measures. Discharge from the drainage ditch / toe drain will collect within temporary settling areas. The exact location of the settling areas will be dependent on site conditions and construction activity. These settling areas will be constructed with an impermeable liner to prevent infiltration, with water contained using filter cloth/soil, straw bales or equivalent.

Water will be pumped from each of the settling areas on an as needed basis into one of two (2) collection points. Each collection point will consist of two (2) tanks, each with a capacity of 80,000 L. The tanks will be set up in series to provide additional storage capacity and promote settling. The approximate locations for the tanks are shown on Figure 2. Additional tanks will be obtained on an as-needed basis. All tanks will be cleaned by the supplier prior to delivery to the site.

All water from the tanks will be discharged through a geotextile filter bag as an additional filtration and energy dissipation measure. The discharge points will be located adjacent to the tanks in well-vegetated areas with minimal slopes to prevent erosion and scouring. Discharge will be inspected daily and the filter cloth bags will be replaced as needed.

At the northern collection point, discharge water will flow towards the South Branch of the tributary of Harmony Creek. At the southern collection point, discharge water will follow topography and flow towards the nearby surficial drain.

Water from direct precipitation and/or surface runoff may accumulate in graded areas outside of the cut portion of the Station Site. This water will be passively directed to separate settling areas and allowed to infiltrate into the overburden or flow overland to the adjacent wetland / tributary with appropriate erosion and sediment control.

2.3 CURRENT SITE DEVELOPMENT AND CONSTRUCTION STAGING

Prior to construction of the Clarington TS, site preparation and 230 kV tower construction activities are required to relocate the existing 230 kV lines to the north and west of the proposed Clarington TS. This work has been completed and does not require water management activities other than standard erosion and sediment control measures (i.e., silt fencing). Station Site construction water management is only required during the initial grading of the Station Site and construction of the drainage system.

Initial grading of the Station Site is proposed to commence in mid-December 2014. Station Site grading and installation of the drainage system are scheduled to be complete in June 2015. However, to account for any delays in start-up or unexpected conditions / interruptions during construction, it is requested that the permit extend for 334 days from the date of issue.

3.0 SITE SETTING

The Pre- Site Construction Groundwater and Surface Water Baseline Conditions Report (Stantec, 2014) provides details related to the site setting, geology, hydrogeology, and water quality and is included as supporting documentation for the PTTW application. The following sections summarize the site setting with respect to the PTTW application.

3.1 PHYSIOGRAPHY

The Project Area is occupied by the physiographic region defined by Chapman and Putnam (1984) as the *South Slope*, characterized by till plains with long, thin drumlins pointing upslope. The southern edge of the Oak Ridges Moraine administrative planning boundary extends just past the southern boundary of the Project Area. This boundary is defined by the 245 m ground surface elevation under the Oak Ridges Moraine Conservation Act, 2001, rather than by site-specific geologic or hydrogeologic characteristics.

Local topography for the Project Area was available based on 5 m contours from the Ministry of Natural Resources and Forestry (MNRF) 2006 Digital Elevation Model. The ground surface is hilly and generally decreases from north to south from 280 m AMSL just north of the Project Area to approximately 220 m AMSL along the southern boundary of the Project Area (Figure 1).

3.2 SURFACE WATER FEATURES

The Project Area falls within the Black/Harmony/Farewell Creek Watershed and is located within the jurisdiction of the Central Lake Ontario Conservation Authority (CLOCA).

Precipitation and runoff from the northern portion of the Project Area drains to the woodlot and wetland area (Wetland Area 1) north of the Station Site and to the tributary of Harmony Creek that flows west of the Station Site within the valley lands (Figure 2). In the southern portion of the Project Area drainage flows overland to a surficial drainage feature with no defined channel. This drainage feature flows south across Concession Road 7 and discharges to the tributary of Harmony Creek that originates west of the Station Site.

Wetland Area 1 is located at the northern extent of the Project Area and has been determined to not be of suitable quality to be classified as Provincially Significant Wetland (PSW) (Hydro One, 2014). Wetland Area 1 is approximately 2 ha in size, and located adjacent to the forest in the northwest portion of the Project Area (Figure 2). It is composed primarily of a large, dry, low-diversity reed-canary grass meadow marsh with a smaller edge inclusion of red-osier dogwood mineral thicket swamp to the west and a small interior inclusion of cattail meadow marsh. This wetland is seasonally wet/moist and moves toward dryer conditions in the summer in a relatively short time as observed during field visits. The wetland was observed to offer limited storage capacity.

Based on observations and monitoring during the Class EA (Hydro One, 2014) and the pre- Site construction monitoring program, the surface water tributaries of Harmony Creek and the drainage channel within the Project Area are interpreted to be intermittent, with flow observed only during the spring and following significant precipitation events. No apparent groundwater seepage areas have been identified within the Project Area during numerous field investigations, suggesting these tributaries are supported primarily by overland flow.

3.3 HYDROSTRATIGRAPHY

A local conceptual hydrostratigraphic framework was developed based on the detailed investigations within the Project Area, and a comparison with available information, including the YPDT-CAMC Model, surficial geology mapping (Figure 3), and the MOECC Water Well Database (Stantec, 2014).

The surficial overburden material observed across the Project Area is composed of a thin layer of discontinuous, loose silty sand overlying a compact to dense silty sand to sandy silt till. The silty sand was identified in the northern and southern portions of the Project Area, and was generally absent in the western, central, and eastern portions of the Project Area. In the areas where the silty sand was absent, a thin (0.2 to 1.5 m thick) surficial layer of sandy clayey silt fill (agriculturally tilled soil) was identified.

The elevation of the underlying dense silty sand to sandy silt till generally mimics ground surface topography, decreasing from approximately 262 m AMSL along the eastern Project Area boundary, to 243 m AMSL in the west, and 235 m AMSL to the south of the Project Area, as shown in cross-sections in Figures 4 and 5. The cross-section locations are shown in Figure 1. The origin of this dense silty sand to sandy silt till is difficult to determine and may correspond to Halton Till, as mapped in the YPDT-CAMC Model, or potentially to a more weathered upper portion of the Newmarket Till, as identified in the OGS (2003) surficial quaternary geology mapping within the Project Area (Figure 3). With increasing depth, this silty sand to sandy silt till becomes very dense and difficult to drill, with cores from MW5-14 observed to have expanded by 5 to 10% upon recovery, indicating this till is highly over-consolidated, typical of the Newmarket Till.

No evidence of Oak Ridges Moraine Sediments was noted in any of the boreholes advanced as part of the Monitoring Program, indicating that this unit is not present beneath the Project Area to the depth of the investigation.

3.3.1 Local Geology - East Side of Project Area

Boreholes MW1-13, MW6-14, and MW7-14 were advanced along the eastern boundary of the Project Area (Figure 2). The ground surface elevation at these locations varies from 261 m AMSL to 263 m AMSL. At MW1-13 a pair of shallow (S) and deep (D) groundwater monitoring wells were installed in December 2013 as part of the Monitoring Program monitoring wells MW6-14 and MW7-14 were installed to provide further characterization of shallow soils and input for determining construction dewatering requirements anticipated within this portion of the Project Area.

Near the centre of the eastern boundary of the Project Area at MW1-13, a thin (0.20 m) layer of topsoil was encountered followed by thin layer of sand to 0.8 m below ground surface (BGS) (261.8 m AMSL). The sand is underlain by sand till consisting of fine grained sand with some silt to a depth of 3.0 m BGS (259.5 m AMSL). The sand till was underlain by very dense brown silty sand till, interpreted to be Newmarket Till to the bottom of the borehole. The upper sand till may potentially correspond to the Halton Till.

At MW6-14, a compact to dense silt till was encountered directly underlying the topsoil layer and extended to 6.1 m BGS (254.7 m AMSL) and was underlain by a very dense silty sand to sandy silt till interpreted to be the Newmarket Till. At MW7-14, silty sand to sandy silt till was encountered from beneath the topsoil and extended to the full depth of the borehole. Based on the change in colour from brown to grey and difficult drilling conditions, the Newmarket Till was interpreted at 6.1 m BGS (258.1 m AMSL).

Three (3) test pits were excavated on the eastern side of the Project Area to evaluate the upper soils in the vicinity of the proposed grading where construction dewatering is anticipated (Figure 2). Grab samples collected from the bottom of the test pits were selected for grain size distribution analyses. The test pit logs and grain size distribution results indicate soils are a silty fine sand till with gravel. Minor seepage was noted within TP-2 along the side of the test pit where increased gravel content was noted.

Monitoring well details are presented in Table 1. Monitoring well logs and test pit logs/photos/grains size analysis within the eastern portion of the Station Site are included in Appendix D.

3.3.2 Hydraulic Conductivity

Hydraulic testing was completed on all monitoring wells within the Project Area with the exception of MW3-13D and MW4-13D due to the limited water available within the wells. Results of the hydraulic conductivity analyses are summarized in Table 1 with calculations presented in the Pre-Station Construction Groundwater and Surface Water Baseline Conditions Report.

Wells MW1-13S/D, MW6-14 and MW7-14 are located immediately east of the proposed grading with hydraulic conductivity results ranging from $9x10^{-8}$ m/s to $8x10^{-7}$ m/s, and a geometric mean for the shallow wells of $3x10^{-7}$ m/s. These results are consistent with hydraulic conductivity estimates reported for weathered Newmarket Till (Gartner Lee, 2009).

Higher hydraulic conductivity values in the range of $1x10^{-5}$ m/s were calculated to the south (MW4-13S) and west (MW5-14S) of the Station Site. The well screens at these locations were connected to an overlying silty sand unit that is not prevalent in the proposed cut area of the Station Site.

3.3.3 Shallow Groundwater

Shallow groundwater level measurements within the Project Area were obtained from late fall 2013 through to fall 2014 from groundwater monitoring wells (MW1-13 to MW4-13) and from October 2014 from MW5-14S/I, MW6-14 and MW7-14 following installation.

Water level data from wells completed in the shallow silty sand to sandy silt till indicated shallow groundwater conditions at or near ground surface in spring, decreasing by 1 to 1.5 m over the summer, followed by a recovery in the fall in response to increased precipitation (Figure 6).

Shallow groundwater levels and available surface water levels indicate that within the Station Site, shallow groundwater flows to the southwest, west and south towards the tributary of Harmony Creek and its associated branches (Figure 7). The shallow groundwater flow conditions observed at the Project Area are consistent with regional interpretations of shallow groundwater flow (CLOCA, 2012).

3.3.4 Water Balance

Monthly water balance calculations were completed for the Project Area as part of the pre-station construction groundwater and surface water baseline conditions report. The calculated infiltration rates across the Project Area are estimated to range from 112 mm/year to 144 mm/year. These values fall within the range of groundwater recharge rates published by the MOECC (1995) for silt-textured based soils and are consistent with estimates for the Halton Till (100 to 250 mm/year) as reported in Gerber and Howard (2002).

4.0 GROUNDWATER AND STORMWATER MANAGEMENT

While it is proposed that water will be managed within the Station Area on an as-required basis, a MOECC PTTW application requires that a maximum pumping rate per minute, maximum pumping rate per day, and typical (average) pumping rate per day be determined. The rationale/methodology used to calculate these pumping rates are presented below.

4.1 GROUNDWATER SEEPAGE

The predicted groundwater seepage from the cut slope was estimated based on the modified Darcy equation and solutions from Edelman (1947), as detailed by ILRI (1994). The equations assume an unconfined aquifer of infinite extent, horizontal flow, no recharge and drawdown significantly less than aquifer thickness. The calculations also assume an instantaneous drop in water level following excavation. It is expected that grading will commence at the eastern extent of the Station Site, slowly decreasing ground surface elevation until the final grade is reached. The assumption of an instantaneous decrease in water will result in higher initial seepage rates that are not expected within the Station Site. The equations and detailed calculations are included in Appendix E.

The following assumptions were made when determining groundwater seepage rates and drawdown extent:

- The cut slope extends a total length of approximately 400 m as shown on Figure 2.
- The final grade of the Station Site will be approximately 253 to 254 m AMSL with the final grade of the perimeter ditch ranging from 252 m AMSL to 253.5 m AMSL. The proposed grading for the Station Site requires a maximum excavation to 252.0 m AMSL for installation of the drainage system (Section 2.2.1). Dewatering calculations were completed assuming the cut slope extends to an elevation of 252 m AMSL. It was further assumed that it would take two (2) weeks to grade the cut slope to this elevation;
- The excavation will primarily extend into the silty sand to sandy silt till interpreted as a clay-poor Halton Till or weathered Newmarket Till. The hydraulic conductivity of this material as measured at MW1-13S, MW6-14 and MW7-14 ranged from 9×10^{-8} m/s to 8×10^{-7} m/s, with a geometric mean of 3×10^{-7} m/s;
- Groundwater levels were assumed to be at ground surface at the eastern extent of the Station Site. Contour mapping indicates that the ground surface elevation at the top of the slope is 261 m AMSL; and,
- Groundwater seepage rates will be primarily controlled by the upper overburden material. An aquifer (in this application, a silty sand till) thickness of 18 m was assumed for calculation purposes and represents the total thickness of the dewatering plus the

estimated thickness of the upper portion of the Upper Aquitard beneath the area of grading.

4.1.1 Typical Seepage Conditions

It is expected that the groundwater seepage rate will be highest during initial excavation and decline gradually until steady-state equilibrium is reached. Based on above site specific information above, the groundwater seepage rate after 2 weeks of excavation was estimated at 206,400 L/day. After 100 days of excavation, groundwater seepage was estimated at 77,200 L/day with the rate decreasing to an estimated 40,400 L/day after 1 year, and to less than 12,800 L/day after 10 years. Detailed calculations are shown in Appendix E.

The extent of influence from the edge of the excavation was also estimated based on the above calculations and assumptions (Figure 9). One (1) year after excavation, a total drawdown of 0.5 m was predicted at a distance of 65 m from the cut slope with 0.1 m of drawdown at a distance of 85 m from the cut slope. In comparison, after ten (10) years of dewatering, a total drawdown of 0.5 m was predicted at a distance of 210 m from the cut slope with 0.1 m of drawdown at a distance of 275 m from the cut slope.

The above estimates of seepage and drawdown after 10 years assume that steady state conditions are not reached; and as a result, are considered to be very conservative estimates.

4.1.2 Maximum Seepage Conditions

To evaluate maximum seepage rates, the same calculations were also completed assuming a more conservative hydraulic conductivity of 1×10^{-6} m/day to represent more active flow within the sandy silt to silty sand till, or potential sandier zones within the till. Using the same assumptions as noted above, and a hydraulic conductivity of 1×10^{-6} m/s, the groundwater maximum seepage rate after 2 weeks of excavation was estimated to be 307,800 L/day, reducing to an estimated 138,700 L/day after 100 days, and 72,600 L/day after 1 year. After ten (10) years of dewatering the rate is estimated to reduce to about 23,000 L/day.

The extent of influence from the edge of the excavation was also estimated for the maximum seepage conditions (Figure 9). One (1) year after excavation, a total drawdown of 0.5 m was predicted at a distance of 120 m from the cut slope with 0.1 m of drawdown at a distance of 160 m from the cut slope. In comparison, after ten (10) years of dewatering, a total drawdown of 0.5 m was predicted at a distance of 375 m from the cut slope with 0.1m of drawdown at a distance of 500 m from the cut slope.

4.2 STORM WATER MANAGEMENT

During Station Site grading and construction of the drainage system, any precipitation or storm water runoff within the cut/grading area must be managed to maintain a safe work area and to prevent erosion and sediment transport within the Station Site and/or surrounding environment. Any precipitation that collects within the drainage ditch / toe drain will be managed along with groundwater seepage as discussed in Section 2.2.2.

The extent of storm water management will be dependent on construction conditions, precipitation and temperature. As the work may extend over a 6 to 7 month period, it is reasonable to assume that a significant rainfall event may occur during this time period, and the runoff may need to be managed by the Contractor. The ground surface may also freeze during winter months and not allow for infiltration.

To evaluate pumping requirements due to precipitation events, the potential impact due to a significant rainfall event was evaluated. A 25 mm precipitation event was selected for the calculations, as this value is used by the MOECC for erosion and water quality design (MOECC, 2003). The cut slope will extend 22 m in width and approximately 400 m in length as shown on Figure 2. The estimated volume of water generated due to direct precipitation along the cut slope is 220,000 L for a 25 mm rain event.

4.3 PTTW RATES

Estimated pumping rates required during construction to manage groundwater seepage and precipitation are described in the sections above and summarized below:

- The average pumping rate is assumed to be equivalent to the 100 day seepage rate from the excavation, and is estimated at 77,200 L/day. As a conservative estimate for the PTTW, a maximum seepage rate of 307,800 L/day was calculated. This rate corresponds to the seepage rate after two (2) weeks of excavation under worst-case hydraulic conductivity conditions of $1x10^{-6}$ m/s; and,
- Management of precipitation can have a significant effect on pumping requirements. Accounting for a 25 mm precipitation event during construction, an additional 220,000 L/day of precipitation may need to be managed within the drainage ditch / toe drain.

As a result, the maximum pumping rate from the drainage ditch / toe drain during construction due to combined groundwater seepage and precipitation is estimated at 527,800 L/day, with a seepage rate after approximately 1 year expected to decrease below the requirements for a PTTW (i.e., less than 50,000 L/day). Long term (after 10 years) average daily groundwater seepage conditions from the cut slope are expected to reduce to only 12,800 L/day.

To account for unexpected conditions or circumstances, such as additional surface runoff or large snow melt, during construction a safety factor of 50% was applied to the maximum rate calculation. The requested maximum daily pumping rate for the PTTW is 800,000 L/day. This requested rate is expected to provide the Contractor with adequate flexibility to manage groundwater seepage, precipitation and runoff within the drainage ditch.

4.3.1 Instantaneous Pumping Rate

Groundwater seepage will be directed to pool within settling areas and the Contractor will pump from these settling areas into tanks. The Contractor will be responsible for determining the type and size of pump(s) for managing water. Assuming the Contractor may wish to use two (2) pumps, one within each settling area, it is requested that the Contractor be permitted to pump at up to 1,400 L/min as long as the maximum day volume of 800,000 L/day is not exceeded.

4.3.2 Recording of Pumping Rates

During any pumping, the pumping rate will be monitored and recorded by the Contractor based on:

- pump size/rating curves, field measurements of flow rate as possible and duration of pumping each day;
- volume and flow through tanks;
- flow meter; and/or
- equivalent method as determined by the Contractor.

The Contractor will record pumping volumes for groundwater and storm water separately whenever possible. However, it is understood that depending on conditions, this may not be feasible and only a combined groundwater/storm water volume may be recorded.

5.0 MITIGATION MEASURES AND MONITORING

As described above, groundwater pumping will be completed on an as-required basis during Station Site grading construction activities. The following section details potential impacts to groundwater users and the surrounding environment and proposed mitigation measures and monitoring.

5.1 GROUNDWATER FLOW AND LEVELS

Shallow groundwater levels and available surface water levels indicated pre-station construction groundwater flow to the southwest, west and south across the Station Site towards the tributary of Harmony Creek and its associated branches (Figure 7). Along the eastern extent of the Site Station, pre-station construction groundwater flow was interpreted to be primarily in a westerly direction.

As shown on Figure 8, the proposed cut slope will decrease water levels within the eastern portion of the Station Site and result in groundwater drawdown (0.10 m) extending to the east beyond the cut slope to a distance of approximately 275 m after 10 years of dewatering under anticipated soil conditions. Under worst-case soil conditions the drawdown will extend 500 m beyond the edge of the cut slope. The interpreted post-construction groundwater flow direction is presented in Figure 8 and is not predicted to significantly change; with flow continuing in a westerly direction. However, the horizontal hydraulic gradient will increase in the vicinity of the cut slope and monitoring wells MW1-13S, MW6-14 and MW7-14 (Figure 8).

Monitoring Wells to the east of the Station Site are located approximately 25 m (MW1-13S/D) to 30 m (MW6-14 and MW7-14) from the top of the cut slope. Drawdown calculations based on a hydraulic conductivity of $3x10^{-7}$ m/s suggest drawdowns of 4.1 m and 3.4 m at MW1-13S and MW6-14/MW7-14, respectively, after 1 year of dewatering.

As part of the Clarington TS groundwater monitoring program, on-going groundwater level monitoring will be completed within all monitoring wells within the Project Area. Groundwater monitoring includes manual water level measurements and continuous logger data at all locations. Monitoring will continue during site construction and post-site construction to document levels and confirm the extent of impact due to the cut slope and grading.

5.2 GROUNDWATER QUALITY

As part of the Groundwater and Surface Water Monitoring Program, pre-station construction water quality monitoring was completed within adjacent surface water features from December 2013 to October 2014 and from groundwater within the monitoring wells from December 2013 to

October 2014. Water quality results and discussion for all locations are presented in the 2014 Monitoring Report (Stantec, 2014).

To evaluate potential water quality of groundwater seepage, water quality results from MW1-13S, MW6-14 and MW7-14 were reviewed as these wells are installed immediately east of the Station Site.

Water quality results from MW1-13S, MW6-14 and MW7-14 are presented in Table 2 and compared to provincial water quality objectives (PWQO) to evaluate water quality with respect to the proposed discharge to the adjacent tributary. During construction, any groundwater seepage will be allowed to accumulate within settling areas and flow through tanks and filter cloth bags. Discharge water will contain minimal sediment and water quality is expected to be similar to the concentration of filtered metals observed in the monitoring wells. As indicated in Table 2, results for the majority of parameters did not exceed the PWQO, with the following exceptions:

- Toluene levels within water quality samples at MW6-14 (2.5 µg/L) and MW7-14 (1.0 µg/L) exceeded the PWQO of 0.8 µg/L; and

- Phenanthrene levels within water quality samples at MW6-14 (0.6 µg/L in March 2014, 0.1 µg/L in May 2014) and MW7-14 (0.2 µg/L in October 2014) exceeded the PWQO of 0.03 µg/L.

As discussed in the Pre-Station Construction Groundwater and Surface Water Baseline Conditions Report, these detections may be associated with incomplete development, sampling equipment and/or sediment within the sample. Hydro One has committed to conducting further evaluation into the potential source of these detections and is currently scheduling additional groundwater sampling. Sampling procedures will be modified to evaluate potential impacts from sampling equipment and to reduce entrained sediment. The evaluation will include a comparison of filtered and non-filtered water quality. Water quality results will be reviewed to further understand these detections. Based on the results, the recommended monitoring and mitigation measures detailed below for the PTTW will be updated as needed.

The proposed water management plan includes settling areas, tanks and filter cloth bag, and it is expected that minimal sediment will be discharged to the environment. Based on water quality data from nearby shallow monitoring wells (MW1-13S, MW6-14 and MW7-14), it is expected that groundwater seepage, following adequate settling and filtration, would not exceed PWQO and be suitable for proposed discharge. Additional monitoring prior to, and during discharge is required to confirm water quality conditions.

5.2.1 Groundwater Sampling Program

To document water quality and confirm discharge options, the following monitoring program shall be completed:

- All groundwater seepage will be allowed to flow to settling area(s). Once groundwater has accumulated within the settling area(s), water will be pumped to the tanks. It is understood that some of this water may be due to precipitation;
- Collect a water quality sample during initial dewatering and submit to the laboratory as rush analyses. The sample shall be collected following any settling or filtration system set-up by the Contractor. Based on the water quality data from MW1-13S, MW6-14 and MW7-14, sampling shall be collected and submitted for laboratory analyses for comparison to PWQO parameters, including filtered and non-filtered metals analyses;
- Review water quality results with respect to PWQO and applicable regulations prior to discharge from the tank to the environment;
- If water quality does not meet criteria, discharge from the tanks to the environment cannot commence. Additional mitigation measures should be implemented, including treatment, or removal from the site to an accredited disposal/treatment facility;
- If the initial water quality results meet criteria, discharge to the environment may commence and additional monitoring during discharge completed as detailed below;
- Collect two (2) water quality samples at the discharge point during the first week of groundwater dewatering, and one (1) sample per week for any additional weeks of dewatering, as required. Samples shall be collected following any filtration system set-up by the Contractor and submitted for the laboratory analyses described above; and
- Groundwater discharge areas will be inspected on a daily basis to confirm that no erosion is occurring. Filter cloth bags will be inspected and replaced on an as needed basis.

5.3 STORM WATER MANAGEMENT

During station construction activities, water from direct precipitation and/or surface runoff may accumulate within the western portion of the Station Site. This water will be passively directed to settling areas and allowed to infiltrate or flow overland to the adjacent wetland / tributary. Hydro One will implement standard mitigation techniques for erosion and sediment control, such as silt fencing, which was installed prior to construction activity commencing.

To document site conditions, the following monitoring program shall be completed:

- Daily visual inspections shall be completed of the tributary of Harmony Creek, upstream and downstream of the South Branch and conditions documented. If impact is observed within the creek, discharge must immediately stop and additional settling, filtration measures and/or equivalent shall be put in place.

5.4 TRIBUTARIES OF HARMONY CREEK

There is no proposed net taking of water during station construction activities, as all water is to be returned to the natural environment within the same sub-watershed. Daily inspection of the Tributaries of Harmony Creek and Wetland 1 will be completed, as detailed above, to document that no erosion or unacceptable impact occurs. In the event of erosion or turbidity impacts, the Contractor must implement additional mitigation measures and/or reduce pumping rate.

5.5 PRIVATE WELLS

The Station Site is located within a rural area, with nearby residents relying on private water supply wells to supply their homes, livestock and agricultural usage. As part of the 2014 Monitoring Program, a door-to-door water well survey was completed for all residences within a 1,200 m radius of the Station Site. Based on the survey results and a review of MOECC water well records (WWR), a total of seven (7) wells (PW-04, PW-05, PW-10, PW-15, PW-16, PW-17, PW-22) are located within 500 m of the Station Site with the closest private well (PW-17) located 290 m to the northeast of the Station Site. All of these wells are installed within the lower Thorncliffe Formation, with only one (1) well (PW-16) installed within the shallow overburden.

PW-16 is located 440 m east of the top of the cut slope at the eastern extent of the Station Site. A drawdown of 0.1 m under typical seepage conditions is predicted to extend 275 m from the cut slope; and as a result, no change in groundwater level is predicted to occur at PW-16. Under the maximum seepage conditions, approximately 0.25 m of drawdown is predicted at PW-16.

PW-16 is a shallow well, consisting of a 762 mm diameter concrete casing that extends 4.6 m below ground surface. The static groundwater level in the well ranged from 249.8 m AMSL (0.89 m BGS) to 250.5 m AMSL (0.19 m BGS) between August and September 2014 with water level variations in response to pumping of 0.2 m to 0.4 m.

Based on this information, it is unlikely that a maximum pumping rate drawdown of 0.25 m would interfere with the normal usage of this well. The well has been equipped with a pressure transducer and will be monitored during and after construction to determine if any response occurs as a result of construction.

The Private Well Monitoring Program includes:

- Continuous water level monitoring prior to site construction, over the course of the Station Site construction period (2014-2017), and the post-construction period (2018-2019).

- Water quality samples were collected twice prior to station construction. Water quality samples will continue to be collected semi-annually over the course of the station construction period (2014-2017) and the post-construction period (2018-2019). Private well water quality samples were analyzed for general chemistry, turbidity, metals, petroleum hydrocarbons (PHCs)(F1-F4), BTEX, semi-volatile and volatile organic compounds (SVOCs and VOCs) and polychlorinated biphenyls (PCBs) and bacteriological analyses.

All seven (7) private wells located within a 500 m radius of the Station Site are included in the Private Well Monitoring Program as described above. Continuous water level monitoring cannot be completed within one (1) of these private wells, as the well cannot safely be accessed for water level monitoring. This well is installed within the lower Thorncliffe Formation and completed within a well pit. No additional private well monitoring is proposed with respect to the PTTW.

In the event of potential well interference, Hydro One has in place a Well Interference Response Plan (WIRP). The plan outlines Hydro One's commitment to well owners within 1,200 metres of the Clarington Transformer Station to respond to and assess the nature of well-related complaints; to define the criteria for recording a well interference complaint; and to provide an outline for the types of responses and mitigation measures that may be anticipated by local well owners, depending on the nature of the complaint.

5.6 INFRASTRUCTURE

The surrounding area within the Station Site is predominantly agricultural land. The closest infrastructure is the Hydro One owned towers, with the closest tower located 100 m to the southwest of the cut slope. Dewatering calculations indicate a steady state drawdown of 0.5 m at a distance of 65 m from the cut slope and 0.1 m at a distance of 85 m from the cut slope.

Hydro One will forward a letter signed by a geotechnical engineer detailing an evaluation of the proposed dewatering and any impacts or mitigation measures required with respect to the nearby infrastructure. This letter will be forwarded to the MOECC prior to the PTTW being issued.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the above, the following conclusions and recommendations are provided:

- It is anticipated that the proposed construction dewatering can be completed without causing adverse effects to groundwater and surface water conditions;

- Mitigation measures and monitoring is proposed to document conditions during construction activity,

- The PTTW requests a maximum instantaneous pumping rate of 1,400 L/min and a maximum day pumping rate of 800,000 L/day. It is requested that pumping be permitted for 24 hours per day provided the maximum daily rate is not exceeded,

- It is anticipated that station site construction will commence in mid-December 2014. Although construction can likely be completed within 6 to 7 months once initiated, it is recommended that the PTTW provide for an 11 month dewatering period from the date of issue to account for unexpected delays, and

- It is anticipated that seepage rafter approximately 1 year will decrease to rates below the requirements for a PTTW (i.e., less than 50,000 L/day).

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