Clarington Transformer Station 2017 Annual Groundwater and Surface Water Monitoring Report

FINAL REPORT

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March 5, 2018

Sign-off Sheet

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Introduction

Construction of the Clarington Transformer Station was completed in 2017 on a Hydro One owned property located within 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.

The 11 ha Station Site includes a shallow stormwater management (SWM) system to collect precipitation that falls within the Station Site in order to maintain dry ground and safe operating conditions. The shallow SWM system was constructed within the graded area within the Station Site limits.

The Ministry of the Environment and Climate Change (MOECC), approved Monitoring Program for the Clarington TS included installation of groundwater monitoring wells, implementation of groundwater, surface water, and private well monitoring programs, and annual reporting. The Monitoring Program objectives include defining the hydraulic conductivity of geologic units, documenting pre-station construction hydrogeologic conditions within the Project Area, and continued monitoring of the hydrogeologic conditions within the Project Area and for private wells within 1,200 m of the Station Site during and following station construction.

As of December 2017, the Clarington TS facility was successfully constructed. In fall 2017, the first 500 kV and 230 kV connections were completed, bringing the station into partial operation. The remaining 230 kV connections and other commissioning work will continue throughout the first few months in 2018 and the station is expected to be fully operational by April 2018.

Local Hydrogeology

Since issuing the Baseline Conditions Report in November 2014, additional on-site monitoring wells were installed in 2014, which included MW5-14S(2), and MW5-14D as a condition of the municipal resolution to provide a permanent easement for the Clarington TS access road. Monitoring well MW4-13D was replaced by MW4-15D in 2015; however, no new monitoring wells have since been installed. The drilling, monitoring well installation, and hydraulic testing associated with the borehole and monitoring well installations completed since November 2014 have been provided in the Clarington Transformer Station Baseline Conditions - Addendum 2 Report (Stantec, 2015b), which was submitted to the MOECC and is publicly available on Hydro One's project website along with the 2015 and 2016 Clarington Transformer Station Annual Monitoring Reports (Stantec, 2015c; 2017).

Within the Project Area, shallow groundwater flows to the west and southwest towards the Harmony Creek tributaries and their associated branches. East of the Station Site, a shallow groundwater divide extends from north to south, dividing shallow groundwater lateral flow between the Harmony Creek and the Farewell Creek sub-watersheds. At the eastern extent of the Project Area, groundwater flow within the Farewell Creek Sub-watershed is to the southeast toward Farewell Creek and is consistent with the overall ground surface topography.

The recorded water level elevation fluctuations indicate the monitoring wells have responded to seasonal changes, consistent with the findings presented in the Baseline Conditions Report (Stantec, 2014) and the Clarington Transformer Station 2015 and 2016 Annual Monitoring Reports (Stantec, 2015c; 2017). Environment Canada climate data indicate seasonal climate changes were characterized by higher than normal annual precipitation, with elevated totals for May, June, and July; resulting in higher groundwater levels.

Site observations and recorded water level elevations at drivepoint piezometers within nearby surface water features and adjacent monitoring wells indicated that the Harmony Creek tributaries flowed intermittently, and were supported by a combination of surface water runoff and groundwater discharge.

No shallow private wells are located directly downgradient of the Station Site. All shallow private wells in the vicinity of the Clarington TS participating in the Private Well Monitoring Program are located in the Oshawa Creek Watershed and Farewell Creek sub-watershed, with the exception of two (2) private wells located north and upgradient of the Station Site and one (1) private well recently added to the monitoring program located beyond the Harmony Creek tributary. Monitoring wells at MW2-13, MW3-13, MW4-13, and MW5-14 are well positioned to serve as downgradient shallow groundwater monitoring wells for the Station Site.

Recorded October 2017 groundwater level elevations from pairs of shallow and intermediate depth wells were used to calculate vertical hydraulic gradients at monitoring well locations MW1, MW2, and MW5. The vertical hydraulic gradient within the shallow overburden across the Project Area in 2017 ranged from 0.0 m/m at MW2 to 0.27 m/m at MW5 (downward). Gradients at MW3 and MW4 could not be determined due to very slow deep well recovery from sampling events.

A downward vertical hydraulic gradient is interpreted between the surficial sand and weathered till units within the proposed Project Area. The large difference in recorded water levels in both deeper wells MW5-14I and MW5-14D, of approximately 25 m, in conjunction with the stratigraphic model understanding for the Site, indicates these wells have little to no direct hydraulic connection to each other or the shallow groundwater system. This data strongly suggests that the surficial sand and upper weathered Newmarket Till are not hydraulically connected to the lower parts of the Newmarket Till or the underlying Thorncliffe Aquifer.

Thorncliffe Aquifer monitoring wells indicate deeper groundwater levels increased in 2017, ranging from 208.6 m above mean sea level (AMSL) to 212.7 m AMSL in October, with an overall southerly groundwater flow direction consistent with historical monitoring results, and consistent with regional mapping CLOCA (2012) that indicates deep groundwater flow to the southeast across the Project Area.

Surface Water Quality

As part of the Monitoring Program, water quality monitoring was completed semi-annually in April and October 2017. Surface water level elevations and water quality was monitored at three (3) locations on the Site (SW2, SW3 and SW4) in 2017. Hydro One technicians, in conjunction with Stantec staff, completed surface water quality sampling within the nearby surface water features including the South Branch of the Tributary of Harmony Creek at SW2 and the Tributary of Harmony Creek at SW3 (adjacent to DP3-14). Surface water quality monitoring was attempted at a drainage swale located south of the Station Site at SW4, but was dry during both monitoring events.

The surface water quality monitoring data in 2017 indicates that water quality is generally characterized by low concentrations of sodium, chloride, and nitrate, with all parameters generally within the Provincial Water Quality Objectives (PWQO), with the following exceptions: elevated concentrations of aluminum (SW3), boron (SW2), copper (SW3), zinc (SW2), and DEHP (SW2 and SW3) were detected in at least one (1) sample above the PWQO in 2017.

Shallow Groundwater Quality

Since December 2013, a total of sixteen (16) Project Area groundwater monitoring wells (MW1-13S/D, MW2-13S/D, MW3-13S/D, MW4-13S/D, MW4-15D, MW5-14S(2)/S/I/D, MW6-14, MW7-14, and temporary well MW8-15 (now decommissioned)) were installed at seven (7) locations throughout the Project Area in order improve the understanding of the local geology and hydrogeology prior to construction, and to monitor groundwater and surface water during and following construction of the Clarington TS.

During Spring and Fall 2017 monitoring events, all monitoring wells were sampled as part of the semi-annual Monitoring Program, with the exception of MW4-13D, as it was replaced by MW4-15D; and MW8-15 in October 2015, as this well was decommissioned in May 2015.

Groundwater quality samples from the Project Area monitoring wells were analyzed for general inorganic chemistry, total metals, petroleum hydrocarbons (PHCs) (F1 to F4) and benzene, toluene, ethylbenzene and xylene (BTEX) compounds, polychlorinated biphenyls (PCBs), semi-volatile organic compounds (SVOC) and volatile organic compounds (VOC) parameters. Groundwater quality met the Ontario Drinking Water Standards (ODWS) for all health-related parameters with the exception of nitrate in one (1) monitoring well, which is attributed to agricultural fertilizer.

Historically, benzo(a)pyrene has been detected within some monitoring wells above the ODWS. As presented in the Baseline Conditions Addendum Report (Stantec, 2015a), this compound adsorbs to soil particles and it was concluded that these detections are associated with the sediment collected within the sample. Stantec (2015a) recommended that water quality sampling protocols be amended to include low-flow sampling. This sampling protocol was adopted in 2015 and continued through the 2017 sampling events.

Limited phthalate, PAH, and VOC compounds were detected at low concentrations that remained below the ODWS and Ontario Regulation 153/04 (O. Reg.153/04) Table 6 and/or Table 8 Site Condition Standards. The number of detections and the concentration of detections of PAH and VOC compounds remained very low in 2017, as compared to 2014, as a result of further well development and continued implementation of low-flow sampling methods. These results are consistent with the understanding that historic PAHs detections were associated with the sediment and not representative of dissolved groundwater concentrations.

Private Well Water Quality

Stantec completed semi-annual groundwater quality sampling at private wells that participated in the program in April and October 2017 for general inorganic chemistry, total metals, PHCs (F1 to F4) and BTEX compounds, PCBs, SVOC and VOC, and bacteriological water quality. Well owner consent was obtained from the owners of 25 private wells (24 well owners) as of October 2017.

Bacteriological water quality was generally poor within the raw water samples collected from shallow private wells with 12 of the 14 wells (86%) having total coliforms present and 8 of 14 samples (57%) having *E.Coli* present on at least one occasion. Water quality for wells completed deeper than 40 m had only 1 (10%) detection of total coliform, and no detections of *E.Coli*. The total coliform and *E.Coli* detections within the shallow dug wells are interpreted to be related to local sources associated agricultural activities (fertilizer, manure storage, and animal feedlots), septic systems, or potential surface influences. Shallow private well inorganic water quality monitoring detected the following parameters above the ODWS-AO or ODWS-MOH on at least one occasion: sodium in 12 wells (4 well samples following a water softener), chloride in two (2) wells, and total dissolved solids in seven (7) wells. Deep private well inorganic water quality monitoring detected the following parameters above the ODWS-AO or ODWS-MOH on at least one occasion: iron in eight (8) wells, total dissolved solids in one (1) well of intermediate depth, turbidity in five (5) wells, and sodium in three (3) wells (including 1 following treatment).

Low level detection of THMs were detected within at least one (1) sample from seven (7) shallow private wells and one (1) deep private well, with the highest concentrations well below the ODWS-MAC. Carbon tetrachloride was detected over the ODWS MAC in April at one (1) shallow private well. All of these detections are interpreted to be related to disinfection of wells to address bacteriological detections.

Conclusions and Recommendations

Based on the results presented in this Groundwater and Surface Water Baseline Conditions Report, the following conclusions are provided:

- The Monitoring Program, initiated in December 2013, and completed through October 2017, allowed for annual characterization and monitoring of groundwater and surface water conditions within the Project Area.
- The Monitoring Program continues to monitor water levels continuously and water quality data semi-annually for participating private wells within 1,200 m of the Station Site.
- Groundwater levels within the shallow overburden mimic topography, with the shallow groundwater flow direction within the Station Site to the west and southwest towards the tributary of Harmony Creek and its associated branches. Monitoring wells at MW2-13, MW3-13, MW4-13, and MW5-14 are well positioned to serve as downgradient shallow groundwater monitoring wells for the Station Site. No shallow private wells are located immediately downgradient of the Station Site.

- Precipitation totals in the Oshawa area in 2017 were significantly higher than in 2016, and above climate normals.
- Groundwater and surface water level elevation and water quality monitoring through to October 2017 indicates no adverse effects on the shallow groundwater system or in shallow or deep private wells as a result of Station Site grading and construction of the Clarington TS.

The following recommendations are provided:

- Continuous water level and semi-annual water quality monitoring should continue during station construction and post-station construction, as detailed in the Monitoring Program.
- Sampling procedures for Project Area wells should continue with low-flow sampling protocols, as recommended in the Baseline Conditions Report Addendum.
- The need for removing or adding monitoring wells to the Monitoring Program should be reviewed annually.
- The condition of all monitoring wells and drive-point piezometers should be inspected as part of the regular Monitoring Program with upgrades/replacement completed, as necessary.

Abbreviations

AMSL	above mean sea level
BGS	below ground surface
BTEX	benzene, toluene, ethylbenzene and xylene
BTOC	below top of casing
Class EA	Class Environmental Assessment
CLOCA	Central Lake Ontario Conservation Authority
DEHP	Bis(2-Ethylhexyl) phthalate
EA	Environmental Assessment
ECA	Environmental Compliance Approval
GTA	Greater Toronto Area
Ha	hectares
Hydro One	Hydro One Networks Inc.
ID	inner diameter
LDPE	low density polyethylene
Lotowater	Lotowater Technical Services Inc.
Maxxam	Maxxam Analytics Inc.
MAC	Maximum Acceptable Concentration
Monitoring Program	Groundwater and Surface Water Monitoring Program
MNRF	Ministry of Natural Resources and Forestry
MOECC	Ontario Ministry of Environment and Climate Change
OD	outer diameter
ODWS	Ontario Drinking Water Standards
OGS	Ontario Geological Survey

O. Reg. 153/04	Ontario Regulation 153/04
O. Reg. 903	Ontario Regulation 903
OWRA	Ontario Water Resources Act
PAH	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PHCs	petroleum hydrocarbons
Project Area	lands owned by Hydro One in the vicinity of the Clarington TS
PWQO	Provincial Water Quality Objectives
SCS	site condition standard
Stantec	Stantec Consulting Ltd.
Station Site	land area of the Clarington Transformer Station
SVOCs	semi-volatile organic compounds
TS	Transformer Station
VOCs	volatile organic compounds
WIRP	Well Interference Response Plan

1.0 INTRODUCTION

In 2014, Hydro One Networks Inc. (Hydro One, 2014) completed a Class Environmental Assessment for Minor Transmission Facilities (Class EA) for the construction of the Clarington Transformer Station (TS). The Clarington TS is required to ensure an adequate and reliable supply 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 power supply. The Clarington TS has been 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).

1.1 BACKGROUND

In a letter dated January 2, 2014, the MOECC informed Hydro One that an Individual Environmental Assessment (EA) was not required, and provided six (6) conditions to be undertaken during the detailed design and construction of the Clarington TS.

A condition of the MOECC letter required the submission of a Groundwater Monitoring Plan to the MOECC Central Region Director for review and approval. The Groundwater Monitoring Plan was to include water level and water quality monitoring from wells located within the Project Area and adjacent private wells to document pre- and post-station construction conditions and to confirm no adverse effects are associated with the Clarington TS. To satisfy this condition, Stantec Consulting Ltd. (Stantec) was retained by Hydro One to prepare the monitoring plan. The Groundwater and Surface Water Monitoring Program (Monitoring Program) was submitted to the MOECC on June 13, 2014 (Appendix C).

Approval of the Monitoring Program was received from the MOECC Central Region Director on June 24, 2014 (Appendix C).

The first monitoring report to be prepared under the Monitoring Program was the Pre-Station Construction Groundwater and Surface Water Baseline Conditions Report (Baseline Conditions Report, Stantec, 2014). As per one of the recommendations of the Baseline Conditions Report, additional assessment of sampling methodology and the role of sediment in water quality results was completed, with the findings presented in an Addendum Report (Stantec, 2015a). Subsequent to the Baseline Conditions Report, additional drilling and installation of monitoring wells, hydraulic testing, and soil sampling were completed; with the findings of these investigations presented in an Addendum 2 Report (Stantec, 2015b).

The 2015 Annual Groundwater and Surface Water Monitoring Report (Stantec, 2015c) was completed and issued in November 2015. Following completion of Station Site grading and associated temporary water taking, a Clarington Transformer Station Permit to Take Water Monitoring Report (Stantec, 2016a) was submitted to the MOECC in April 2016. The 2016 Annual Monitoring Report (Stantec, 2017) presented data collected during the Spring and Fall semi-annual sampling events completed in April and October-November 2016. All of the above reports are available on Hydro One's Clarington TS Project Website.

This 2017 Annual Monitoring Report presents water quality data collected during the Spring and Fall semi-annual sampling events completed in April and October 2017. This report also includes a summary of groundwater levels collected to date from Project Area groundwater monitoring wells and private wells. Given that Station construction was completed in mid-2017, the post-construction monitoring phase of the program will begin with the Spring 2018 sampling and monitoring event.

1.2 REPORT OUTLINE

The following 2017 Annual Groundwater and Surface Water Monitoring Report presents the results of the Monitoring Program for the Clarington TS. This report is arranged into seven (7) sections, including this introduction. Section 2 presents an overview and schedule of the infrastructure and construction tasks for the Project Area. Section 3 presents a summary of the Groundwater and Surface Water Monitoring Program. Section 4 presents the study methods, and Section 5 presents the results of the baseline monitoring. Section 6 presents conclusions and recommendations, and Section 7 presents report references.

Figures and Tables referenced throughout the report are presented in Appendices A and B, respectively. Appendix C contains a copy of the approved Groundwater and Surface Water Monitoring Program, associated correspondence from the MOECC, and well owner notification letters. Appendices D and E include Private Well Hydrographs and a CD of Laboratory Certificate of Analyses, respectively. Appendix F includes a CD with historic monitoring data for the Site from 2013 through to 2017.

2.0 CLARINGTON TRANSFORMER STATION

The following Clarington TS overview and summary of construction staging is provided by Hydro One.

2.1 OVERVIEW

The Clarington TS has been constructed on a Hydro One owned property located at 2745 Townline Road North, Oshawa within 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). 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 area that will be occupied by 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 2), and lies within the Harmony Creek sub-watershed (Figure 3).

The Clarington TS transforms electricity voltages from 500 kV to 230 kV by connecting to two (2) of four (4) existing 500 kV circuits and to all five (5) of the existing 230 kV circuits located on or adjacent to the proposed Station Site. The Clarington TS consists of two (2) 500/230 kV transformers, a 500 kV switchyard, a 230 kV switchyard, two (2) relay buildings, one (1) electrical panel building, and associated buswork and equipment.

The 230 kV wood pole structures originally located on the property have been relocated and replaced with new 230 kV steel lattice structures. An access road off Townline Road North has been constructed on the western edge of the Project Area. The access road is located at the municipal boundary between the Municipality of Clarington and the City of Oshawa. The Station Site includes a shallow stormwater management (SWM) system to collect precipitation that falls within the Station Site in order to maintain dry ground and safe operating conditions. In the unlikely event of a release of mineral insulating oil from a transformer, a spill containment system and oil-water separator have been included in the transformer station design to prevent the loss of transformer mineral insulating oil from entering the surrounding natural environment. The shallow SWM system and spill containment system have received *Environmental Compliance Approval* (ECA) for Industrial Sewage Works, as per the *Ontario Water Resources Act* (OWRA).

2.2 CURRENT STATION SITE CONSTRUCTION STAGING

Prior to construction of the Clarington TS, site preparation and 230 kV tower construction activities were required to relocate the existing 230 kV lines to the north and west of the proposed Clarington TS.

The following provides a summary of the construction staging schedule for the Clarington TS:

Complete	Relocation of 230 kV transmission lines and construction of the access road.
Complete	Construct 500 kV Tower Foundations
Complete	Relocation of 500 kV lines
June 2015	Construction on the Clarington TS initiated
Complete	Grading (cut/fill) of the Station Site (completed December 2015)
Complete	Delivery and Assembly of Two (2) 500/230 kV Transformers
Complete	Installation of Two (2) Relay Buildings
Complete	Installation of 500 and 230 kV Switchyards and Equipment
Complete	Installation of Shallow Stormwater Management (SWM) System
Complete	230 kV & 500 kV Connections and Commissioning
May 2017	Station Construction Completed
November 2017	First 230 kV connections made and commencement of operation
April 2018	Final 230 kV connections; station fully operational
2017 – 2018	Habitat Creation and Visual Screening

As of May 2017, construction of the Clarington TS was complete, with the completion of the station perimeter fence, and finished grade topdressing. The first of the 500 kV connections were made in October 2017, and the first 230 kV connection was made in November of 2017, marking the commencement of operation of the Clarington TS.

Work planned for 2018 includes the final 230 kV connections, which will bring the station fully operational. Also, planned for 2018 are the removal of temporary access roads and laydown areas, and the continuation of habitat creation and visual screening work throughout the Project Area.

Construction of the adjacent Enfield TS will continue within the Project Area throughout 2018 and is expected to conclude near the end of the year.

3.0 GROUNDWATER AND SURFACE WATER MONITORING PROGRAM

The approved Groundwater and Surface Water Monitoring Program (Monitoring Program) is included in Appendix C along with the approval letter for the program from the MOECC Central Region Director. The Monitoring Program consists of the following main components:

- Installation, development, and hydraulic testing of new groundwater monitoring wells
- Implementation of a private well monitoring program
- Surface water and groundwater monitoring
- Annual reporting

Groundwater and surface water data collected prior to Station construction have been used to define the relationship between the shallow and intermediate groundwater systems within the Project Area. The data also provide a baseline to which monitoring data collected during and post construction will be compared in order to evaluate potential effects of station construction on the natural environment and surrounding private wells. Specifically, the objectives of the Monitoring Program are to:

- Define our understanding of the geology within the Station Site prior to construction of the Clarington TS.
- Define shallow and intermediate depth hydraulic conductivity of geologic units.
- Document seasonal shallow and intermediate groundwater levels within monitoring wells and private wells, including vertical hydraulic gradients between shallow and intermediate groundwater systems and surface water features within the Project Area.
- Document seasonal groundwater quality of the shallow and intermediate groundwater system within the Project Area.
- Document the shallow groundwater conditions during planned Station Site grading and shallow SWM system installation activities, including the potential radius of influence and potential for impact to adjacent private wells.

The following sections provide a summary of the specific monitoring requirements, including any changes to the Monitoring Program that have been implemented since the program was approved in June 2014.

3.1 MONITORING WELLS

Monitoring well installations MW1-13 to MW4-13 were completed in the late fall of 2013 (Figure 4). Based on the results of the borehole and monitoring well drilling, four (4) additional monitoring wells were installed in 2014, and were added to the monitoring program. These wells include MW5-14S/I, located just beyond the southwest corner of the Station Site; and MW6-14 and MW7-14, located along the northeastern boundary of the Project Area (Figure 4). Details of the drilling, monitoring well installation, and hydraulic testing associated with these twelve (12) wells were provided in the Baseline Conditions Report (Stantec, 2014).

Since issuing the Baseline Conditions Report in November 2014, two additional Project Area monitoring wells were added to the Monitoring Program: MW5-14S(2) was installed in December 2014 as part of the adaptive nature of the Monitoring Program, and MW5-14D was installed as part of an agreement between Hydro One and the Municipality of Clarington. A deep bedrock depth well at MW5-14D(2) was installed as part of a separate agreement between Hydro One and the Municipality of Clarington, and is not part of the Monitoring Program for the Clarington TS. CLOCA assumed ownership of this bedrock depth monitoring well in 2017.

In 2015, monitoring well MW4-15D was installed to verify the low groundwater level and slow recovery recorded in MW4-13D. Temporary monitoring well MW8-15 was installed to confirm the borehole log results of the geotechnical borehole BH7D, and borehole BH9-15 was drilled in the presence of staff from CLOCA, MOECC Central Region and SLR Consulting to confirm geologic conditions at the location of the Clarington TS planned oil/water separator location.

The drilling, monitoring well installation, and hydraulic testing associated with the borehole and monitoring well installations completed since November 2014 have been provided in the Clarington Transformer Station - Addendum 2 Report (Stantec, 2015b), which was submitted to the MOECC and is publicly available on Hydro One's project website. Monitoring well details related to all Project Area monitoring installations, are provided in Table 1 of this report.

There were no changes to the Monitoring Program in 2017. A previous change to the Monitoring Program in 2016 was at the request of the MOECC; to complete Fall monitoring later in the fall than in previous years. Subsequent Fall monitoring events will be attempted to be completed in early November, in an effort to better record the typical fall seasonal recharge of groundwater conditions. In 2017, water levels recovered early in Fall, so sampling was completed in mid-October. Project Area groundwater and surface water monitoring has now been completed for the pre-station construction (2013-2014) phase, the station construction (2015-2017) phase, and will continue through the planned post-construction phase (2018-2019).

3.2 PRIVATE WELL MONITORING

The Private Well Monitoring Program included the completion of door to door visits to property (well) owners within 1,200 m of the Station Site (Figure 3). Details of the initial notification were presented by Stantec in the Baseline Conditions Report (Stantec, 2014). By October 2014, well owner consent was obtained from the owners of 23 private wells (22 well owners). Details of the process to commence the residential monitoring program are as follows:

- An introductory letter was hand-delivered to each residence within 1,200 m of Clarington TS on June 13, 2014.

- Hydro One and Stantec completed door to door visits to all residents within 1,200 m of the station on June 18, 19, and 24, 2014 to follow-up and provide a copy of the letter and consent form. For residents that were not home at the time of these visits, copies of the introductory letter and consent form were left at the residence (typically in a mailbox, if available).
- If well owners did not return a signed Consent Form for the Private Well Monitoring Program by September 9, 2014, the Private Well Monitoring Program Letter and Consent Form were sent to them via Canada Post Registered Mail. A copy of Canada Post's Registered Mail record of delivery receipt indicates 22 of 23 registered letters were delivered to residents between September 11-12, 2014, as one letter was unable to be delivered. This particular resident later authorized their participation in the Monitoring Program. The registered letters were only sent to residents that had not already returned a signed Consent Form by September 9, 2014.

Two (2) additional private well owners provided their consent to be added to the Monitoring Program in 2015. One well owner elected to no longer participate in the Monitoring Program in 2016; and one (1) additional private well owner provided their consent to be added to the Monitoring Program in 2017; making 25 participating private wells.

For private well owners that agreed to participate in the Monitoring Program, the following was completed in 2017:

- Automatic pressure transducers were accessed in Spring and Fall 2017 by a licensed water well contractor to retrieve recorded continuous (hourly) water level measurements.
- Water quality samples were collected semi-annually in 2017 (Spring and Fall).
- Following each Spring and Fall monitoring event, a letter was sent to each of the well owners presenting their individual well monitoring results. To maintain confidentiality, we have included the results of the private well monitoring in this report but have not included the well identifications.

Private well monitoring has now been completed for the pre-station construction (2013-2014) and station construction (2015-2017) phases of the project, and will continue through the planned post-construction period (2018-2019).

3.3 REPORTING

As noted above, the first monitoring report to be prepared under the Monitoring Program was the Pre-Station Construction Groundwater and Surface Water Baseline Conditions Report (Stantec, 2014). The findings of a subsequent assessment of sampling methodology and the role of sediment in water quality results were presented in an Addendum Report (Stantec, 2015a). An Addendum 2 Report (Stantec, 2015b) presents a summary of additional drilling and installation of groundwater monitoring wells, hydraulic testing, and soil sampling complete since issuing the Baseline Conditions Report. The 2015 Annual Monitoring Report was issued in November 2015. The 2016 Annual Monitoring Report presented data collected during the Spring and Fall semi-annual sampling events completed in April and October-November 2016.

This 2017 Annual Monitoring Report presents data collected during the Spring and Fall semi-annual sampling events completed in April and October 2017. This report includes a summary of Project Area groundwater monitoring well and private well monitoring data collected during these semi-annual monitoring events.

Subsequent annual monitoring reports will continue to be prepared following the annual fall monitoring event. The 2018 annual report will be the first monitoring report to include a full year of post-construction monitoring data.

4.0 METHODS

The Monitoring Program included the following components in 2017:

- Groundwater and Surface Water Level Monitoring
- Groundwater and Surface Water Quality Monitoring
- Private Well Monitoring
- Climate Monitoring

Methodologies employed during borehole drilling, well installations, and hydraulic testing completed following the Baseline Conditions Report (Stantec, 2014) are presented in the Addendum 2 Report (Stantec, 2015b). The following sections present a summary of the study methodology for water level and water quality monitoring.

4.1 MONITORING WELL INSTALLATION

Since December 2013, a total of sixteen (16) monitoring wells (MW1-13S/D, MW2-13S/D, MW3-13S/D, MW4-13S/D, MW4-15D, MW5-14S(2)/S/I/D, MW6-14, MW7-14, and temporary well MW8-15 (now decommissioned) were installed at eight (8) locations throughout the Project Area in order refine the understanding of the local geology and hydrogeology prior to construction and to monitor groundwater and surface water during and following construction of the Clarington TS.

Monitoring wells MW1-13S/D, MW2-13S/D, MW3-13S/D, and MW4-13S/D were installed in December 2013. Monitoring wells MW5-14 S/I, MW6-14, and MW7-14 were installed in October 2014, MW5-14S(2)/D in December 2014, and MW4-15D and MW8-15 (temporary) were installed and added to the Monitoring Program in 2015 as part of the adaptive nature of the Monitoring Program. MW8-15 was drilled to provide geological information beneath the footprint of the station and was decommissioned in April 2015 in order to construct the station.

No changes to the on-Site groundwater monitoring locations occurred in 2017. The monitoring well locations are presented on Figure 4. Well completion details are presented in Table 1.

4.2 DRIVE-POINT PIEZOMETER INSTALLATION

Three (3) drive-point piezometers (DP2-14, DP3-14 and DP4-13) were installed within surface water features / drainage swales within the Project Area to provide an indication of groundwater levels and vertical hydraulic gradients beneath the surface water features. These were named after the monitoring wells beside which they were installed. A drive-point piezometer was not installed adjacent to MW1-13 as there is no directly adjacent surface water feature. The drive-point piezometer locations are presented on Figure 4.

In April 2015, Stantec replaced the drive-point at SW2 (DP2-14 replaced by DP2-15), as the initial drive-point was installed at an angle due to difficult ground conditions and it was difficult to obtain accurate water level readings. In April 2015, Stantec also replaced the drive point piezometer at SW3 (DP3-14 replaced by DP3-15), as this monitor was found to be within a dry creek bed in 2014. No changes to the on-Site surface water monitoring locations occurred in 2016. In 2017, two (2) new drive-point piezometers were installed (DP5-17, DP6-17) within the Harmony Creek tributary. DP5-17 was installed upgradient of the Site and DP6-17 downgradient of the Site. The surface water monitoring locations are shown on Figure 4. Installation details are summarized in Table 1.

4.3 GROUNDWATER AND SURFACE WATER LEVEL MONITORING

Groundwater level monitoring was completed using a combination of manual and automated techniques, while surface water level monitoring was completed using manual techniques alone. Monitoring wells and drive-point piezometers were instrumented by Stantec with Solinst® LT Leveloggers® and were set to record at 1-hour intervals. The Leveloggers® are not vented to the atmosphere and therefore, record total pressure. As a result, data obtained from the Leveloggers® were corrected for atmospheric pressure to obtain the actual height of water above the sensor. The atmospheric corrections were made using data collected from a Solinst Barologger®, which was located at MW1-13D. For the period of time from December 2013 to May 2014, the Barologger malfunctioned, and atmospheric corrections were completed using data from Environment Canada's Oshawa Climate Station located at the Oshawa Airport.

Manual water level measurements were collected at all wells using a battery-operated probe and calibrated tape. Water depths were recorded in metres below the top of the well casing (BTOC) and later corrected for well stick-up. Water level hydrographs for the monitoring wells and surface water drive-point piezometers within the Project Area are presented in Figures 5 through Figure 8.

4.4 GROUNDWATER AND SURFACE WATER QUALITY MONITORING

4.4.1 Surface Water

Surface water quality monitoring was attempted at three (3) locations on Site (SW2, SW3 and SW4) in 2017. Stantec staff, or Hydro One technicians under the direction of Stantec staff, completed surface water quality sampling in April and October 2017 within the nearby surface water features; including, the South Branch of the Tributary of Harmony Creek at SW2 (adjacent to DP2-14), the Tributary of Harmony Creek at SW3 (adjacent to DP3-14). The drainage swale located south of the Station Site (SW4) was dry during both the April and October sampling events.

Surface water samples were collected directly from the creek into laboratory-provided sample containers. Sample containers for mercury were field-filtered. All other samples collected were not field-filtered. Field measurements of specific conductivity, temperature and pH were recorded using a YSI 556 multi-parameter meter. The meters were calibrated prior to use according to the manufacturers' specifications with the appropriate calibration standards. Following sampling, a bottle was filled for field analysis of dissolved oxygen.

All samples collected were packed into sample coolers, which were refrigerated using ice, and delivered to Maxxam Analytics Inc. (Maxxam) for laboratory analyses. All surface water samples were analyzed for general inorganic chemistry, total metals, PHCs (F1 to F4) and BTEX compounds. The lab also analyzed for dissolved calcium, magnesium, potassium and sodium as part of ion balance calculations. Chain of custody forms were completed and included with the sample submissions. The results of the surface water quality testing are presented in Table 3 with copies of the Laboratory Certificates of Analysis provided in Appendix E.

4.4.2 Groundwater Monitoring Wells

Stantec staff, or Hydro One technicians under the direction of Stantec staff, completed groundwater quality sampling within the shallow and deep monitoring wells within the Project Area. Results of previous water level and water quality monitoring were detailed by Stantec (2014, 2015a, 2015b, 2017).

Water quality samples were collected at all Project Area monitoring wells as part of the Monitoring Program during semi-annual monitoring events, with two exceptions. First, in Spring 2017, MW4-13D was not sampled because it had insufficient water volume from which to collect a full suite of samples and MW4-15D had a larger groundwater volume from which to collect the laboratory required sample volumes. Second, in Fall 2017, MW4-15D was not sampled because it had insufficient water volume and MW4-13D had a larger water volume from which to collect laboratory samples. Both MW4-13D and MW4-15D have had extremely slow groundwater recovery since installation. Screened at a greater depth, MW4-15D only recovers slightly faster than MW4-13D, but both have demonstrated similar water quality.

For the Spring and Fall 2017 monitoring events, and prior to sampling Project Area monitoring wells MW1-13S/D, MW2-13S, MW4-13S, MW5-14S MW5-14S(2), MW5-14S, MW5-14D, MW6-14 and MW7-14, pre-purging occurred where between one (1) and three (3) volumes of water were removed using the Waterra™ inertial lift system, depending on rate of well recovery. Well sampling was completed after pre-purging using a GeoTech Bladder Pump for low flow sampling with Teflon-lined, bonded low-density polyethylene (LDPE) tubing. Where well water level recovery was extremely slow, sampling was completed immediately with no prior purging (MW2-13D, MW3-13S/D, MW4-14S, and MW4-15D (Spring 2017 only), MW4-13D (Fall 2017 only), and MW5-14I). A bailer was used to sample low yield wells MW4-13D and MW4-15D.

Field measurements of specific conductivity, temperature, and pH were recorded using a YSI 556 multi-parameter meter. Meters were calibrated prior to use according to the manufacturers' specifications with the appropriate calibration standards. Field parameters were monitored during purging and following sampling. A laboratory sample bottle was filled for field analysis of dissolved oxygen.

Following purging, groundwater samples were collected directly from the Teflon-lined LDPE tubing, or bailers into the sample containers. Groundwater samples for metals were field filtered and preserved.

All collected groundwater samples were packed into sample coolers, which were refrigerated using ice, and delivered to Maxxam for laboratory analyses. Groundwater samples were analyzed for general inorganic chemistry, dissolved metals, PHCs (F1 to F4), BTEX compounds, PCBs, VOCs and SVOCs. Chain of custody forms were completed and included with the sample submissions. The results of the groundwater quality testing at the monitoring wells are presented in Table 4 with a copy of the Laboratory Certificates of Analysis being provided in Appendix E.

4.4.3 Quality Control Protocol

During the 2017 semi-annual groundwater sampling events, QA/QC sampling was completed and included one or more field duplicates, field blanks, and/or trip blanks to evaluate potential sources of error during sample collection. The following QA/QC samples were completed:

- Field blank for VOCs, SVOCs, BTEX and PHCs parameters for Spring and Fall 2017; and
- Trip blank for VOCs, SVOCs, BTEX and F1 parameters for Spring and Fall 2017.

Field duplicate samples for groundwater were also collected at a frequency of one (1) field duplicate per ten (10) samples during each sampling event. For surface water samples, field duplicates were collected during the Spring and Fall 2017 sampling events. The analytical results for the field and trip blanks are included in Table 4.

Maxxam followed internal QA/QC protocols, which included internal replicates, process blanks, process recovery, and matrix spike analyses. A surrogate spike was added for the SVOC analysis to document recovery within lab filtered samples. Maxxam reported that the results for their internal QA/QC were within acceptable limits, and these results were considered acceptable for use in the report. The results of the lab replicates are not presented in Table 1; however, they are included in the detailed laboratory certificates of analyses in Appendix E.

4.5 PRIVATE WELL MONITORING

The following sections present the details of the 2017 Private Well Monitoring Program completed semi-annually in Spring (April) and Fall (October) 2017.

4.5.1 Water Level Monitoring

Lotowater Technical Services Inc. (Lotowater), a licensed well contractor, completed water level monitoring, data logger (Solinst Levelogger®) installation and downloading within the private wells. All equipment was disinfected prior to use within each of the private wells.

All data loggers were downloaded during the Spring and Fall monitoring events in 2017. Groundwater levels remained above the level of data loggers in all wells in 2017.

Construction details for the private wells are presented in Table 2, with private well hydrographs included in Appendix D.

4.5.2 Water Quality Monitoring

The Private Well Monitoring Program was initiated in 2014, with sampling completed to document conditions prior to, and during Station Site construction. In 2017, Stantec completed semi-annual groundwater quality sampling in the spring (April) and fall (October) from the private wells participating in the Monitoring Program.

All private wells were sampled during the Spring and Fall 2017 sampling events, with the exception of PW-09 which due to scheduling wasn't sampled in April but instead in May 2017.

Stantec attempted to collect water quality samples from a raw water tap; however, this was not always feasible. Based on water quality results, it is concluded that water samples from some locations were collected following treatment (sediment filter, water softener, and / or ultra-violet).

The sample location was typically an outdoor tap or a kitchen faucet, depending on accessibility. Prior to sample collection, the tap was disinfected with a dilute solution of chlorine and allowed to run for approximately 10 minutes or until water quality stabilized. Water samples were collected directly into laboratory supplied containers. The samples were not filtered, and results represent total concentrations.

All private well water samples collected were packed into sample coolers, which were refrigerated using ice packs, and delivered to Maxxam for laboratory analyses. Groundwater samples from private wells were analyzed for bacteriological analyses, general inorganic chemistry, total metals, petroleum hydrocarbons and BTEX compounds, PCBs, VOCs and SVOCs. Chain of custody forms were completed and included with the samples. The results of the groundwater quality testing at the private wells are presented in Table 5 with a copy of the Laboratory Certificates of Analysis being provided in Appendix E.

Maxxam followed internal QA/QC protocols, which included internal replicates, process blanks, process recovery, and matrix spike analyses. Maxxam reported that the results for their internal QA/QC were within acceptable limits, and these results were considered acceptable for use in the report. The results of the lab replicates are not presented in Table 5, but included in the detailed laboratory certificates of analyses in Appendix E.

4.5.3 Well Interference Response Plan

Initiated in 2014, the Clarington TS Well Interference Response Plan (WIRP) continued to be implemented in 2017. The WIRP fulfills Hydro One's commitment to private well owners within 1,200 metres of the Clarington Transformer Station to respond to and assess the nature of well-related complaints. The WIRP was reviewed at the end of 2017, with no recommended changes to the process, implementation, but an update was made to the contact information.

4.6 CLIMATE MONITORING

Seasonal fluctuations in groundwater elevations are expected; typically, with water levels rising during the spring freshet due to increased precipitation and warmer temperatures resulting in snow melt, followed by lowering of water levels during drier and warmer summer months. Water levels then generally increase again in the cooler and wetter fall months, and then lower again during the winter due to freezing ground conditions.

Environment Canada's Oshawa Climate Station data were used to represent precipitation and temperature at the Clarington TS. Occasionally, the Oshawa climate station is missing daily precipitation totals on specific days. Where daily precipitation totals were not available, the Oshawa climate station data were supplemented on those days with data from the next closest Environment Canada stations at Blackstock, Oshawa WPCP station, and Oshawa Airport data from the Weather Network website, respectively.

5.0 RESULTS

The following sections present the results of the Monitoring Program based on data collected from 2017 monitoring activities as part of the approved program.

5.1 LOCAL HYDROGEOLOGY

Groundwater and surface water level monitoring continued in 2017, with the following presenting results of groundwater and surface water monitoring completed within the Project Area from Fall 2015 to Fall 2017 as part of the Monitoring Program. The groundwater elevation data consist of water level measurements from three (3) drive-point piezometers, fifteen monitoring wells, and twenty-three available private wells (2 private wells were inaccessible) as presented on Figure 4.

The following sections present the groundwater and surface water level data. Hydrographs of the data are shown on Figure 5 through Figure 8. Shallow groundwater contours and an interpretation of shallow groundwater flow are provided on Figure 9, with Thorncliffe depth well water level elevations shown on Figure 10.

5.1.1 Shallow Groundwater Level Monitoring

5.1.1.1 Shallow Monitoring Wells

Shallow groundwater level elevations within the Project Area were obtained from the date of well completion through to Fall 2017 from eight (8) groundwater monitoring wells installed within the Upper Aquifer/Aquitard (MW1-13S, MW2-13S, MW3-13S, MW4-13S, MW5-14S/S(2), MW6-14, and MW7-14).

Water level elevations in 2017 rebounded to historically monitored norms, following a period of greatly reduced precipitation beginning in summer 2016. Overall, water level elevations were observed to sharply increase in all shallow monitoring wells in the final week of 2016 and into early 2017, in response to increased precipitation. In 2017, shallow groundwater elevations generally fluctuated through mid-summer in response to precipitation events, then generally began to fall leading up to the October sampling event. MW3-13S and MW4-13S followed this same pattern but had a rebound in water level elevation in early October.

Shallow Well Hydrographs

Shallow monitoring wells MW1-13S, MW6-14, and MW7-14 are located approximately 20 m upgradient of the graded slope on the east side of the Station Site, and showed similar groundwater level trends in response to seasonal changes and precipitation as historically monitored levels, aside from the low precipitation period during 2016.

MW2-13S is located on the north side of the Station Site, within Wetland Area 1 and beside the South Branch of the Tributary of Harmony Creek. Shallow water level elevations recorded within this monitoring well remained slightly above ground surface throughout 2017, fluctuating up to 0.4 m over the course of the year (Figure 6).

MW3-13S is located west of the Station Site and on the top of the eastern bank of the Tributary of Harmony Creek. MW4-13S is located south of the Station Site in a drainage swale that has intermittent flow during spring snow melt and during periods of significant precipitation, but is otherwise dry for most of the year. Groundwater elevations at MW3-13S and MW4-13S in 2017 fluctuated with precipitation and as in 2014 and 2015, generally remained just below ground surface (Figure 6).

Shallow monitoring wells MW5-14S and MW5-14S(2) are installed immediately adjacent to the southwest corner of the Station Site. Shallow water level elevations in these two wells responded similarly to other shallow wells installed across the Project Area since their installation in late 2014 and early 2015, respectively. Similarly, to other shallow monitoring wells across the site, these wells responded to seasonal changes, with water levels dropping into the fall (Figure 7). MW5-14S(2) and MW5-14S responded to precipitation events slightly more slowly than some of the other shallow wells, but each fluctuated up to 1.7 m during 2017.

Shallow Well Hydraulic Gradients

Recorded water level elevations from pairs of shallow and intermediate or deep wells were used to calculate vertical hydraulic gradients at monitoring well nest locations MW1, MW2, MW3, MW4, and MW5.

Predominantly neutral to weak downward vertical hydraulic gradients were calculated for 2017 at monitoring well pairs MW1-13S/D and MW2-13S/D, ranging from 0.0 m/m (MW2-13) to 0.09 m/m (MW1-13), averaging 0.06 m/m. A downward vertical hydraulic gradient ranging from 0.15 to 0.27 m/m, averaging 0.2 m/m was noted at shallow monitoring wells MW5-14S(2)/S. Vertical gradients could not be calculated at MW3-13S/D and MW4-13S/D, because the deeper wells at MW3 and MW4 are installed within a dense till, slowing the well's recovery following installation and subsequent sampling events. At the time of Fall 2017 monitoring, the deep wells were still recovering from previous sampling events.

A difference in recorded water levels of about 25 m between the deeper wells, MW5-14I and MW5-14D, in conjunction with the stratigraphic model understanding for the Site, indicates these wells have no direct hydraulic connection with each other. This data strongly suggests that the surficial sand and upper weathered Newmarket Till are not hydraulically connected to the lower parts of the Newmarket Till or the underlying Thorncliffe Aquifer.

The overall downward vertical hydraulic gradients observed within shallow wells across the Project Area in 2017 are consistent with those presented in the Baseline Conditions Report (Stantec, 2014).

The horizontal hydraulic gradients across the Station Site calculated from average groundwater elevations in 2017 are consistent with historical gradients. Using water level elevations recorded during the October 2017 sampling events, horizontal gradients are 0.028 m/m (MW6 to MW2-13S), 0.030 m/m (MW1-13S to MW3-13S), and 0.047 m/m (MW7-14 to MW4S-13), and remain consistent with horizontal hydraulic gradients measured in 2014 to 2016, which ranged from 0.03 m/m to 0.05 m/m.

5.1.2 Groundwater / Surface Water Interaction

Drive-point piezometers were installed at three (3) locations throughout the Project Area to evaluate groundwater / surface water interaction in the immediate vicinity of the surface water features associated with the Tributary of Harmony Creek. Two (2) new drive-points that were also installed during the Fall 2017 monitoring event (DP5-17 and DP6-17) do not yet have data to report. Observations at each of the three (3) original locations are discussed below with respect to the groundwater contours.

5.1.2.1 Tributary of Harmony Creek

Drive-point piezometers were installed at surface water monitoring locations within the South Branch of the Tributary to Harmony Creek at SW2, and within the Tributary to Harmony Creek at SW3 (Figure 4). Hydrographs for DP2 and DP3 are presented on Figure 8.

There are two (2) drive-point piezometers installed within Wetland Area 1 at SW2, DP2-14 and DP2-15. DP2-15 is a replacement to DP2-14 due to a partially plugged screen which affected its response to seasonal changes. Since the installation of DP2-15, groundwater levels were consistently higher at DP2-15 compared to DP2-14. DP2-14 was destroyed sometime between Fall monitoring in 2016 and Spring monitoring in 2017, and the logger was not recovered. Groundwater levels within DP2-15 were higher than ground surface elevation throughout the year. DP2-15 does not respond quickly to seasonal or individual precipitation events, indicating it is installed within fine-grained soil within the wetland. Water levels in DP2-15 in 2017 increased in spring then fell slowly through summer and fall (Figure 8).

There are two (2) drive-point piezometers installed within the Tributary of Harmony Creek at SW3, DP3-14 and DP3-15. DP3-15 is a replacement to DP3-14 due to a partially plugged screen which affected its response to seasonal changes. During the monitoring period of 2017, groundwater elevations were consistently lower at DP3-14 compared to DP3-15until August.

Manual surface water elevations at both DP2-15 and DP3-15 in 2017 were slightly lower in spring and fall than groundwater elevations, indicating slight upward vertical gradients and weak groundwater discharge conditions at these times, unlike historical monitoring results. This may be due to the combined effect of higher precipitation amounts in 2017 (40% higher just from January through October 17, 2017 compared to all of 2016).

In Fall 2017, two (2) new drivepoints (DP5-17 and DP6-17) were installed in the Tributary to Harmony Creek. DP5-17 and DP6-17 were installed near the upgradient and downgradient boundaries of the Site, respectively, to improve monitoring in this area (Figure 2).

5.1.2.2 Drainage Swale

A drive-point piezometer was installed within a mapped drainage swale to the south of the Project Area at SW4. At the time of installation in December 2013, there was some surface water drainage noted due to recent snow melt; however, surface water was not present at this location during further field visits in 2014 or 2017. In both 2015 and 2016, surface water was only present in the Spring, but not in the Fall. In 2017, the groundwater elevation at DP4-14 reacted as it has historically and remained predominantly below ground surface. It responds quickly to precipitation events, indicating the drainage swale receives surface water runoff during spring snow melt and precipitation events (Figure 8) and is an area of groundwater recharge.

Historical site observations and recorded water level elevations at nearby drive-points and monitoring wells indicated that Harmony Creek tributaries were supported primarily by surface water runoff, with the potential for seasonal groundwater discharge in the wetland near SW2. In 2017, monitoring data from drive points DP2 and DP3 suggest that Harmony Creek tributaries in these areas received some input from groundwater discharge. Within the low-lying valley associated with the tributary of Harmony Creek on the north side of the Project Area, shallow water levels recorded within the surficial silty sand and the upper portion of the weathered till indicated predominantly downward vertical hydraulic gradient with the potential for short term seasonal upward vertical hydraulic gradients occurring. Due to the limited thickness and discontinuous nature of the surficial silty sand and low permeability of the underlying weathered till, limited groundwater discharge occurs in surface water features within the Project Area sufficient to sustain consistent baseflow conditions. This is consistent with the findings presented in the Baseline Conditions Report (Stantec, 2014).

5.1.3 Shallow Private Wells

Shallow groundwater level data were also available from nearby private wells installed at depths of less than 16 m below ground surface (BGS). These wells are interpreted to be screened within thin sand layers within the surficial sand or the underlying weathered to compact Newmarket Till. Water level data from the shallow private wells show effects due to regular daily well use, which was characterized by rapid, regular drawdown and recovery (Figures 1 to 16; Appendix D). Similar to onsite monitoring wells, private well water levels generally showed an increase early in the year, followed by steady groundwater elevations into mid-year which then decreased into October. Groundwater level changes observed in shallow private wells are interpreted to be a result of seasonal temperature and precipitation fluctuations, and not due to station construction activities.

5.1.4 Shallow Groundwater Flow

Shallow groundwater level elevations within the Project Area are presented on Figure 9. Water level data presented were collected during the October 2017 monitoring event.

Within the Station Site, shallow groundwater flows to the west and southwest towards the tributary of Harmony Creek and its associated branches. East of the Station Site, a shallow groundwater divide shown as a dashed line on Figure 9 extends from north to south, dividing shallow groundwater lateral flow between the Harmony Creek and the Farewell Creek sub-watersheds. The shallow groundwater flow direction observed in 2017 remained consistent with historical observations, including both pre- and during Station Construction.

Water levels recorded in shallow private wells closest to the Project Area are located within the Farewell Creek watershed (Figure 9) and generally indicate higher groundwater levels typically ranging from of 0.4 m to 1.7 m, with one well having groundwater levels 4.6 m higher than the previous year.

Similarly, higher groundwater levels on the order of 1.2 m were observed in shallow private wells within the Harmony Creek watershed situated upgradient of the Project Area recorded in October 2017 as compared to October 2016. These wells are also located further upgradient of the Project Area, with a smaller catchment available to provide water to the wells. Overall, there was a general increase of water level elevations within shallow wells in the area due to seasonal and climate effects that were significantly wetter and slightly cooler than climate normals (discussed further in Section 5.3).

Based on the shallow groundwater contours and surface water features, the area downgradient of the Station Site is shaded in light blue (Figure 9). Monitoring wells at MW2-13, MW3-13, MW4-13, and MW5-14 are well positioned to serve as downgradient shallow groundwater monitoring wells for the Station Site.

All shallow private wells in the vicinity of the Clarington TS participating in the Private Well Monitoring Program are located in the Farewell Creek Watershed, with the exception of two (2) wells located north and upgradient of the Station Site. Two (2) additional wells are located in the Oshawa Creek watershed to the west of the Harmony Creek sub-watershed. At the eastern extent of the Project Area, groundwater flow within the Farewell Creek Sub-watershed is to the southeast toward Farewell Creek and is consistent with the overall ground surface topography.

5.1.5 Thorncliffe Aquifer

In December 2014, monitoring well MW5-14I and MW5-14 D were added to the Monitoring Program, allowing for water levels within the Newmarket Till (MW5-14I) and a deeper sandy aquifer unit within a transition between the Newmarket Till and the Thorncliffe Aquifer (MW5-14D) to be monitored. In addition, several nearby private wells are interpreted to be installed within the Thorncliffe Aquifer (Figure 10). Continuous water level data were obtained at eight (8) nearby private wells completed at a depth greater than 50 m. One of the private wells located north east of the site had the levelogger removed for well repairs and therefore continuous water level data for this well are not available between June and October 2016 (logger re-installed during Fall monitoring).

Water level elevation data from the deep private wells typically indicated well use effects due to operation of the private well pump, which was characterized by rapid, regular drawdown and recovery (Figures 17 to 24; Appendix D). Effects due to water use were more clearly visible in these drilled wells due to the smaller well diameter as compared to shallow dug wells. Fluctuations due to deep private well use ranged from approximately 0.5 m up to 20 m (Appendix D). The extent of water level fluctuation due to well use was generally consistent within each deeper private well over the monitoring period, and available data did not suggest any change in well performance since monitoring began. Water level trends in the deep private wells are characterized by muted responses to individual precipitation events, and steady changes in water level in response to seasonal changes in precipitation.

Interpreted static groundwater levels within the Thorncliffe Aquifer through the Project Area are presented on Figure 10. Water level data presented were collected during the October 2017 monitoring event. Groundwater levels range from 208.6 m AMSL to 212.7 m AMSL, with an overall south to southeasterly groundwater flow direction that is consistent with historical monitoring results and with regional mapping that indicates groundwater flow to the southeast across the Project Area (CLOCA, 2012).

A downward vertical hydraulic gradient is interpreted from water level elevations recorded in the surficial sand and weathered till units within the Project Area to the underlying Thorncliffe Aquifer. Assuming a shallow groundwater level of250.0 m AMSL within the Station Site in the vicinity of MW5-14S (Figure 9) and a groundwater level of 212.7 m AMSL from MW5-14D (Figure 10); the difference in recorded water levels in these monitoring wells, in conjunction with the stratigraphic model understanding for the Site, indicates these wells have little to no direct hydraulic connection.

5.2 GROUNDWATER AND SURFACE WATER QUALITY

As part of the Monitoring Program, water quality monitoring has been completed within surface water and groundwater monitoring wells from the Project Area since December 2013. In 2017, water quality was monitored semi-annually in the Spring and Fall both onsite and in private water wells. Surface water quality data are presented in Table 3, with groundwater quality data from Project Area monitoring wells presented in Table 4, and water quality data from the private wells in Table 5. To maintain confidentiality for the private well results, the well identification has been removed from Table 5. Laboratory certificates of analysis for all water quality sampling are included in Appendix E. The following section presents a review of the available water quality data.

5.2.1 Surface Water Quality

Surface water quality data are discussed below and are presented in Table 3 with results compared to PWQO, which are the applicable regulatory criteria for surface water within the Project Area.

The South Branch of the Tributary of Harmony Creek flows through Wetland Area 1, and is approximately 0.2 to 0.3 m wide at SW2. During the field visits, surface water at SW2 (adjacent to DP2-14/DP2-15), were consistent in depth, at 0.23 m in the Spring and 0.26 m in the Fall, 2017. Due to the limited amount of water present, it is challenging to collect samples without allowing some sediment to enter the bottles. The surface water samples were not field filtered, with the exception of mercury. As a result, the water quality results for metals, except mercury, are considered representative of total metals water quality and not the dissolved phase. The field filtered samples for mercury analysis are representative of the dissolved phase.

Surface water quality at SW2 in 2017 was characterized by:

- The water quality results exceeded the PWQO criteria for boron in Spring and Fall, 2017, and zinc in Spring, 2017.
- Low level detection of sodium (up to 31 mg/L in April 2017).

- The water quality results exceeded the PWQO criteria for bis(2-Ethylhexyl) phthalate (DEHP) in Spring, 2017.
- All other parameters were found to be below the PWQO criteria in 2017.

The surface water sample at SW3 was collected from the tributary of Harmony Creek along the western Project Area boundary. At this location, the creek ranged from 0.5 to 1.0 m in width, with the actual channel being approximately 1.5 m wide. Surface water was flowing at SW3 during the two (2) sampling rounds in 2017, with a creek depth ranging from 0.13 m in Spring to 0.07 m in Fall. Surface water quality at SW3 in 2017 was characterized by:

- The water quality results exceeded the PWQO criteria for aluminum in Spring, 2017 and copper exceeded the PWQO criteria in Fall, 2017
- Low level detection of sodium (up to 16 mg/L in October 2017)
- The water quality results exceeded the PWQO criteria for DEHP in Spring, 2017
- All other parameters were found to be below the PWQO criteria in 2017

Surface water was present at SW4 (within surficial drainage swale adjacent to DP4-13) at the time of drive-point installation in 2013; however, it was noted as being dry during several historical sampling events, including both in 2017.

Surface water quality monitoring data indicates that water quality is generally characterized by low concentrations of sodium (up to 31 mg/L at SW2and 16 mg/L at SW3), chloride (up to 29 mg/L at SW2 and 21 mg/L at SW3), and nitrate (< 4 mg/L) and all tested parameters generally below the PWQO. The detection of aluminum, copper, boron, and DEHP above the PWQO is attributed to sediment within the samples.

5.2.2 Monitoring Well Water Quality

Semi-annual groundwater quality sampling of the on-Site groundwater monitoring wells was completed in Spring and Fall 2017 sampling events. The following presents the results from semi-annual monitoring completed in April and October 2017.

Groundwater quality results from 2017 are presented in Table 4, and are compared to the ODWS. Historical data from 2013 through to and including 2017 are provided in the accompanying CD-ROM of the report in Appendix F. For a number of SVOC and VOC, there are no criteria in the ODWS; and as a result, the results were also compared to applicable criteria under O. Reg. 153/04. Tables 6 and 8 of the Soil, Groundwater and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, dated April 15, 2011 (henceforth the site condition standard (SCS)) were selected as the applicable criteria for the Project Area as the Station Site is located within 30 m of tributaries of Harmony Creek, has a shallow groundwater table, and is situated in an area in which groundwater is used as a potable source. Criteria for coarse grained material were used, as more than 33% of material is sand or coarser, even though the matrix is till.

5.2.2.1 Inorganic Water Quality

Groundwater quality from the Project Area monitoring wells in 2017 met the ODWS maximum acceptable concentration (MAC) for all health related inorganic parameters with the exception of nitrate which was detected at MW1-13S (up to 13.4 mg/L in Fall 2017), and DEHP at MW3-13D (0.04 mg/L in Spring, 2017, 0.03 mg/L in Fall, 2017). The elevated nitrate concentration at this location is attributed to agricultural fertilizer and consistent with previous results.

Nitrate in groundwater is common in agricultural communities, with potential sources including nitrate from fertilizers, septic system leaching, and the natural decaying process of vegetation and animal matter. As reported in the 2015 Annual Monitoring Report, nitrate concentrations in the shallow groundwater system decreased from east to west and southwest across the Project Area. The same trend was observed in the 2017 shallow groundwater quality data. Though shallow groundwater upgradient of the Station Site was found to have nitrate concentrations above the ODWS of 10 mg/L in Fall 2017 monitoring, shallow groundwater leaving the Project Area remained well below 10 mg/L. In each of the shallow monitoring wells, nitrate concentrations have been trending lower each year.

The following inorganic parameters were detected above the ODWS aesthetic objective (AO), ODWS operational guideline (OG) or ODWS Medical Officer of Health (MOH) guidelines on at least one (1) occasion in 2017:

- Hardness (80 to 100 mg/L OG) within all monitoring wells
- Sodium (20 mg/L MOH) within MW2-13D, MW3-13S/D, MW4-13S/D, MW4-15D, MW5-14S, MW5-14I, MW5-14D, and MW5-14D(2)
- Sulphate (500 mg/L AO) within MW3-13D
- Total Dissolved Solids (TDS) (500 mg/L AO) within MW1-13S, MW3-13D, MW4-13S and MW5-14S
- Turbidity (5 NTU AO) within MW2-13D, MW3-13D, MW4-13D, MW5-14D, and MW7-14

These 2017 detections are generally consistent with previous 2013 to 2016 results, and do not indicate any significant change in groundwater quality in 2017 during construction of the Clarington TS.

To visually compare 2017 water quality results, inorganic water quality data from the monitoring wells are presented as a piper plot on Figure 11 and include results from Fall 2017 sampling. The water quality distribution within the piper plot is consistent with historical results (Stantec, 2014, Stantec, 2015, Stantec, 2016). Results indicated that water quality at MW6-14 and MW7-14 was similar to other shallow monitoring wells, with the water characterized as calcium and magnesium bicarbonate water. The deep monitoring wells indicate greater variation in water quality, primarily due to differences in sulphate and sodium concentrations. Results indicated similar groundwater chemistry at deeper monitoring wells MW5-14D, and MW5-14I.

5.2.2.2 Organic Water Quality

Groundwater samples from the monitoring wells were also analyzed for petroleum hydrocarbons, BTEX compounds, PBCs, VOCs and SVOCs and compared to ODWS (Table 4). Historically in 2014, benzo(a)pyrene has been detected above the ODWS in some monitoring wells. As presented in the Addendum Report (Stantec, 2015a), this compound adsorbs to soil particles and it was concluded that these detections are associated with the sediment collected within the sample. The Addendum Report recommended that water quality sampling protocols be amended to include low-flow sampling. This sampling protocol has been adopted since the 2015 Spring sampling round. In 2015, no detections of benzo(a)pyrene were noted in any of the Project Area monitoring wells. However, benzo(a)pyrene was detected in a Spring 2016 sample from MW4-15D (0.02 µg/L) as well as Fall 2016 (0.06 µg/L) and Spring (0.04 µg/L) and Fall 2017 (0.03 µg/L) from MW3-13D. For each of these samples, suspended sediments were noted during sampling. The elevated benzo(a)pyrene is likely due to the effect of sediment entrained within the samples from MW3-13D and MW4-15D, as the lab-filtered samples for the same monitoring locations during the same monitoring events did not detect benzo(a)pyrene.

Certain other VOC and SVOC compounds were detected within the monitoring wells in Spring and/or Fall 2017 sampling in low concentrations either below the ODWS criteria, or there were no applicable ODWS criteria. The following provides a summary of these organic parameters and a comparison with respect to the SCS criteria.

Water Quality – Upgradient of Station Site

Monitoring Wells MW1-13S/D, MW6-14 and MW7-14 are located upgradient (East) of the Station Site and indicated the following groundwater quality results in 2017:

- No PCBs were detected within any of the samples.
- No PHCs were detected within any of the samples.
- No phthalate compounds were detected within any of the samples.
- No PAH compounds were detected within any of the samples.
- No VOC compounds were detected within any of the samples.

Water Quality – North of Station Site

Monitoring Wells MW2-13S/D are located at the northern extent of the Station Site and indicated the following groundwater quality results in 2017:

- No PCBs were detected within any of the samples.
- No PHCs were detected within any of the samples; however, toluene was detected at low levels within MW2-13D in Spring, with concentrations below the SCS criteria. Overall, the concentration of BTEX compounds show a decrease from those observed historically.

- No detection of phthalate compounds.
- No PAH compounds were detected within either wells.
- No VOC compounds were detected within any of the samples.

Water Quality – Southwest of Station Site

Monitoring Wells MW3-13S/D, MW4-13S, MW4-13D, and MW4-15D (replacing MW4-14D) are located downgradient of the Station Site and indicated the following water quality results in 2017:

- No PCBs were detected within any of the samples.
- No PHCs or BTEX compounds were detected within any of the samples.
- Low level detection of phthalate compounds within MW3-13D and MW4-13D, with concentrations remaining below the ODWS and SCS criteria.
- Benzo(a)pyrene exceeded the ODWS and SCS MAC criteria (0.01 µg/L) within Spring and Fall samples at MW3-13D (0.04 µg/L) and a Fall sample at MW3-13D (0.06 µg/L). Additional low level detections of pyrene within MW3-13D were detected, with concentrations remaining below the ODWS and SCS criteria in both the Spring and Fall, 2017 sampling rounds.
- No VOC compounds were detected within any of the samples.

Water Quality – Adjacent to Station Site

The four monitoring wells at MW5 (MW5-14S(2)/S/I/D are located immediately on the southwest side of the Station Site and generally central to the Project Area. Water quality results indicated the following water quality results:

- No PCBs were detected within any of the samples.
- No PHCs or BTEX compounds were detected within any of the samples.
- No detection of phthalate compounds.
- No PAH compounds were detected.
- No VOC compounds were detected within any of the samples.

Summary

The organic water quality results for on-site monitoring wells continued to show a general decrease in detections and concentrations. The 2017 results did not indicate any exceedances of the ODWS or SCS criteria, with the exception of benzo(a)pyrene in MW3-13D which is considered to be the result of sediments captured within the samples, as lab-filtered samples did not detect the compound.

5.2.3 Private Well Water Quality

Water quality monitoring was completed at private wells participating in the Monitoring Program in the Spring and Fall of 2017. During sample collection, Stantec attempted to collect a raw water quality (untreated) sample at each residence; however, based on discussions with well owners and water quality results, it is evident that treated samples were collected at select locations. Water quality results are presented in Table 5 and compared to the ODWS, which are the applicable criterion for drinking water in Ontario. For privacy reasons, sample identifications are not given and the samples are labeled based on aquifer unit and either raw or treated, as appropriate.

Following receipt of the water quality results, Stantec notified individual well owners of any health related exceedances within their water sample. A follow-up letter was provided to each well owner following each monitoring event detailing the full water quality results. The sections below summarize key raw water quality characteristics only.

5.2.3.1 Bacteriological Water Quality

Water quality trends for shallow private wells that were installed to a maximum depth of 16 m BGS indicated that 12 of the 14 wells (86%) sampled during the Spring and Fall 2017 rounds had total coliforms present on at least one occasion. This is consistent with historical sampling results. *E.Coli* was detected in eight (8) of 14 wells (57%) on at least one occasion in 2017. The higher number of wells having bacteriological detections in 2017 is attributed to increased infiltration resulting from the above average precipitation.

Of the ten (10) drilled wells completed at depths below 40 m BGS, including one drilled well completed at intermediate depth over 16 m BGS, only one (1) well (10%) had detections of total coliform in 2017. *EColi* was not detected in any of the samples collected from these wells in 2017. These results are consistent with historical sampling results.

A greater number of total coliform detections were noted within shallow dug wells when compared to drilled wells completed at depths greater than 40 m. The total coliform and *EColi* detections within the shallows dug wells are interpreted to be related to local sources associated agricultural activities (fertilizer, manure storage, and animal feedlots), septic systems, or potential surface influences. All residents were notified by Stantec of positive detection of bacteriological results and directed to follow any recommendations from the Durham Region Health Unit regarding water and well treatment, follow-up sampling, and well maintenance.

Of note, some laboratory bacteriological results were identified as *no data due to bacterial overgrowth*. This result indicates the target bacterial growth (total coliform and *E. Coli*) on the laboratory petri plate could not be counted due to excessive growth of either non-target bacteria (NDOGN), or excessive growth of the target bacteria, *E. Coli*. or total coliforms (NDOGT), thereby preventing the target bacteria cultures to be counted. Results of NDOGT are considered a positive detection, and NDOGN are considered as a potential positive result. Well owners were notified of these results and directed to follow recommendations from the Durham Region Health Unit.

5.2.3.2 Inorganic Water Quality

Water quality from the 14 shallow private wells participating in the Monitoring Program did not exceed the ODWS-MAC for any tested inorganic parameter in both the Spring and Fall 2017 sampling rounds. Hardness was above the ODWS-OG in all shallow wells, which is common in groundwater quality from southern Ontario. The following parameters were detected above the ODWS-AO or ODWS-MOH on at least one (1) occasion within shallow private wells:

- Sodium exceeded the ODWS - MOH of 20 mg/L in twelve wells, with water quality results from one (1) well also exceeding the ODWS-AO of 200 mg/L, with four (4) of these wells reported as treated by a water softener.
- Chloride exceeded the ODWS-AO guideline of 250 mg/L in two (2) wells.
- Total Dissolved Solids (TDS) (500 mg/L ODWS-AO) in seven (7) wells with concentrations of up to 1,070 mg/L.

Water quality for all ten (10) deeper wells completed below 40 m BGS, including one well completed at an intermediate depth over 16 m, BGS did not exceed the ODWS-MAC for any tested inorganic parameter in both the Spring and Fall 2017 sampling rounds. Hardness was above the ODWS-OG in the raw water from all deeper wells except one (1) that is treated (softener), which is common in groundwater quality from southern Ontario. The following parameters were detected above the ODWS-AO or ODWS-MOH on at least one (1) occasion in 2017 sampling within the deeper private wells:

- Iron exceeded the ODWS-AO (0.3 mg/L) in eight (8) wells with concentrations up to 2.2 mg/L. Elevated iron is common in Thorncliffe-derived water in many areas in Southern Ontario, including within the Harmony Creek watershed (CLOCA, 2011).
- Total Dissolved Solids (TDS) (500 mg/L ODWS-AO) in one (1) well of intermediate depth with a concentration of 536 mg/L.
- Turbidity exceeded the ODWS-AO (5 NTU) in five (5) of 10 deeper wells.
- Sodium was above the ODWS-MOH guideline in the three (3) deeper wells one (1) of which corresponds to treated water (softener).

5.2.3.3 Organic Water Quality

Water quality samples from private wells were tested for VOCs, SVOCs, PHCs and PCBs and results compared to ODWS. A summary of results is detailed below with the data presented in Table 5.

Low level concentrations of trihalomethanes (THMs) including bromoform, bromodichloromethane, dibromochloromethane and chloroform were detected within at least one (1) sample from seven (7) shallow private wells and one (1) deep private well, with the highest concentrations well below the ODWS-MAC. Carbon tetrachloride was detected over the ODWS MAC in April (4.9 µg/L). The concentrations measured during follow-up testing in May (0.62 µg/L) and Fall (<0.20 µg/L) were below the ODWS MAC of 2.0 µg/L. All of these compounds are commonly the by-product of disinfection and are created by the reaction of chlorine with organic carbon within the groundwater. Discussions with well owners, including the ODWS MAC exceedance, indicated that prior to sampling, several of the well owners had recently disinfected their wells to address bacteriological detections.

5.2.4 Well Interference Responses

Hydro One did not receive any complaints in 2017 from private well owners participating in the Private Well Monitoring Program. This is believed to be related to the rebound in private well water levels due to increased annual precipitation in 2017 compared to 2016.

5.3 CLIMATE MONITORING

Summer months in Southern Ontario are typically warmer drier months; however, the months of May, June, and July were the wettest in 2017 with 160 mm, 160mm, and 113 mm, respectively. The total precipitation in 2017 was 955 mm, which is above the long-term precipitation normal of 872 mm and significantly higher than the 624 mm, 759 mm, and 774 mm total from the last three (3) years, respectively.

Groundwater recharge relies on precipitation to infiltrate into the shallow groundwater system, and eventually provide recharge to deeper groundwater systems. While a number of factors influence groundwater recharge, available recharge from precipitation and evapotranspiration are two important factors. Increased summer temperatures will typically increase evapotranspiration, and therefore, reduce the amount of water available for infiltration into the shallow groundwater system. Environment Canada temperature data for the same Oshawa Airport climate station indicates that there was an overall mean daily temperature increase over the six-month period of May to October from 15.8°C in 2014, to 16.1°C in 2015, a notable increase to 17.4°C in 2016. In 2017, average temperatures from May through October were 16.3°C.

The combination of significantly increased precipitation and decreased temperature in 2017 compared to 2016 lead to a rebound in water levels in monitoring wells across the site and in nearby private wells.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the results presented in this 2017 Groundwater and Surface Monitoring Report, the following conclusions are provided:

- The Groundwater and Surface Water Monitoring Program, initiated in December 2013, and completed through October 2017, allowed for annual characterization and monitoring of groundwater and surface water conditions within the Project Area.
- The Monitoring Program continues to monitor water levels and water quality data for participating private wells within 1,200 m of the Station Site.
- Site observations and recorded water level elevations at surface water monitoring locations SW2, SW3, and SW4 and nearby monitoring wells indicate that Harmony Creek tributaries have been historically supported primarily by surface water runoff. Due to the limited thickness and discontinuous nature of the surficial silty sand and low permeability of the underlying weathered till, limited groundwater discharge occurred in surface water features within the Project Area sufficient to sustain continuous baseflow conditions, which was consistent with the findings presented in the Baseline Conditions Report (Stantec, 2014) and 2015 Annual Monitoring Report (Stantec, 2015c).
- Groundwater levels within the shallow overburden mimic topography, with shallow groundwater flow direction within the Station Site to the west and southwest towards the tributary of Harmony Creek and its associated branches. Monitoring wells at MW2-13, MW3-13, MW4-13, and MW5-14 are well positioned to serve as downgradient shallow groundwater monitoring wells for the Station Site.
- No shallow private wells are located immediately downgradient of the Station Site, as all shallow wells in the vicinity of the Clarington TS participating in the Private Well Monitoring Program are located in the Farewell Creek Watershed, with the exception of two (2) wells located north and upgradient of the Station Site, in the adjacent Oshawa Creek watershed, and one (1) newly monitored well located beyond the Harmony Creek tributary.
- Recorded October 2017 groundwater level elevations from pairs of shallow and intermediate depth wells were used to calculate vertical hydraulic gradients at monitoring well locations MW1, MW2, and MW5. The neutral to downward vertical hydraulic gradient within the shallow overburden across the Project Area in 2017 ranges from 0.0 m/m at MW2 to 0.27 m/m at MW5. Vertical hydraulic gradients at MW3 and MW4 could not be determined due to very slow deep well recovery from sampling events. Neutral to downward vertical hydraulic gradients were consistently present within the shallow and deep pairs of monitoring wells within the surficial sand and underlying weathered till.
- Groundwater levels from private wells and Project Area wells completed within the Thorncliffe Formation indicate a southerly flow direction consistent with regional mapping by CLOCA (2012).
- The surface water quality monitoring data in 2017 indicates that water quality is generally characterized by low concentrations of sodium, chloride, and nitrate, with all parameters generally within the PWQO, with the following exceptions: elevated concentrations of aluminum (SW3), boron (SW2), copper (SW3), zinc (SW2), and DEHP (SW2 and SW3) were detected in at least one (1) sample above the PWQO in 2017.

- Groundwater quality from the Project Area monitoring wells were analyzed for general inorganic chemistry, dissolved metals, PHCs (F1 to F4) and BTEX compounds, PCBs, and SVOC and VOC parameters. Groundwater quality met the ODWS for all health-related parameters (ODWS-MOH) with the exception of nitrate in one (1) monitoring well, which is attributed to agricultural fertilizer.

- The source of nitrate within the Project Area is interpreted to be former land use prior to construction, and potential existing fertilizer use on farmed lands immediately upgradient of the Project Area. In each of the shallow monitoring wells, nitrate concentrations have been trending lower year over year. Further, monitoring data indicates that Station Site construction and land use within the Project Area have not contributed, and will not contribute to increasing nitrate concentrations in the shallow groundwater system.

- Low level detection of phthalate compounds and several PAHs were detected at concentrations well below the SCS with the exception of benzo(a)pyrene which was detected in MW3-13D (0.04 and 0.03 µg/L), in which turbidity and some suspended sediments were noted during sampling. The elevated benzo(a)pyrene is interpreted to be due to the effect of sediment entrained within the samples from MW3-13D, as the lab-filtered samples for the same monitoring locations during the same monitoring events did not detect the compound.

- Historically, benzo(a)pyrene has been detected within some monitoring wells above the ODWS. As presented in the Addendum Report (Stantec, 2015a), this compound adsorbs to soil particles and it was concluded that these detections are associated with the sediment collected within the sample. Stantec (2015a) recommended that water quality sampling protocols be amended to include low-flow sampling. This sampling protocol was adopted in 2015 and continued through 2017 sampling events.

- Private well water quality monitoring was completed within the private wells in Spring and Fall 2017, with samples collected at each location and submitted for general inorganic chemistry, total metals, PHCs (F1 to F4) and BTEX compounds, PCBs, and SVOC and VOC, and bacteriological water quality. Bacteriological water quality was generally poor within the raw shallow private well samples with 12 of the 14 wells (86%) having total coliforms present and 8 of 14 samples (57%) having *E.Coli* present on at least one occasion. Water quality for wells completed within wells deeper than 40 m had only 1 (10%) detection of total coliform, and no detections of *E.Coli*. The total coliform and *E.Coli* detections within the shallow dug wells are interpreted to be related to local sources associated agricultural activities (fertilizer, manure storage, and animal feedlots), septic systems, or potential surface influences.

- Shallow private well inorganic water quality monitoring detected the following parameters above the ODWS-AO or ODWS-MOH on at least one occasion: sodium in 12 wells (4 well samples following a water softener), chloride in two (2) wells, and total dissolved solids in seven (7) wells.

- Deep private well inorganic water quality monitoring detected the following parameters above the ODWS-AO or ODWS-MOH on at least one occasion: iron in eight (8) wells, total dissolved solids in one (1) well of intermediate depth, turbidity in five (5) wells, and sodium in three (3) wells (including 1 following treatment).

- Low level detection of THMs were detected within at least one (1) sample from seven (7) shallow private wells and one (1) deep private well, with the highest concentrations well below the ODWS-MAC. Carbon tetrachloride was detected over the ODWS MAC in April. All of these detections are interpreted to be related to disinfection of wells to address bacteriological detections.

- Precipitation totals in the Oshawa area in 2017 were significantly higher than in 2016, and above climate normals.
- Water level and water quality monitoring through to October 2017 indicates no adverse effects on the shallow groundwater system or in shallow or deep private wells as a result of Station Site grading and construction of the Clarington TS.

The following recommendations are provided:

- Water level and water quality monitoring should continue semi-annually during station construction and post-station construction, as detailed in the Monitoring Program. Given that Station construction was completed in mid-2017, 2018 will represent the first full year of post-construction monitoring and data collection.
- Sampling procedures for Project Area wells should continue with low-flow sampling protocols, as recommended in the Baseline Conditions Report Addendum.
- The condition of all monitoring wells and drive-point piezometers should be inspected as part of the regular Monitoring Program and upgrades/replacement completed, as necessary.

7.0 REFERENCES

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