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Hydrogeological Assessment and Water Balance
9229 5 Sideroad, Town of Caledon

Carantania Investments (BT) Inc.

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1.0 Introduction

R.J. Burnside & Associates Limited (Burnside) was retained by Carantania Investments (BT) Inc. to complete a hydrogeological assessment of their lands at 9229 5 Sideroad in the Town of Caledon (herein referred to as the Subject Lands) within the Region of Peel (Figure 1). As part of the Draft Plan of Subdivision application, the Region of Peel requires a hydrogeological assessment and water balance.

The Subject Lands are located within the Community of Bolton and comprised of an irregularly shaped property approximately 4.6 ha in size. The Subject Lands are roughly bounded by Queensgate Boulevard to the north, existing residential developments to the west, a park to the south and an existing residential developments and school property to the east (refer to Figure 1).

2.0 Scope of Work

The scope of work for this hydrogeological assessment involved characterization of the geological and hydrogeological conditions on the Subject Lands, identify potential development constraints and opportunities related to the local groundwater conditions and complete water balance calculations. The water balance calculations provide input to the stormwater management plans to be developed for the property by RAND Engineering Corporation (RAND) and provide recharge targets for the design of Low Impact Development (LID) measures to maintain, where possible, key hydrogeological functions.

The key tasks for the hydrogeology study included:

1. Review of the Ministry of the Environment, Conservation and Parks (MECP) well records: The MECP maintains a database that provides geological records of water supply wells drilled in the province. A list of the available MECP water well records for local wells is provided in Appendix A and the well locations are shown on Figure A1 in Appendix A. It is noted that the well locations listed in the MECP records are approximations only and may not be representative of the precise well locations.

2. Review of background geological and hydrogeological information: A review of existing mapping and reports for the area was completed including provincial surficial geology and bedrock geology maps.

3. Review of soils data: A geotechnical investigation completed for 9229 5 Sideroad included boreholes at five locations by EXP Services Inc. (exp) (2020). The locations of these boreholes and monitoring wells are shown on

Figure 4. The borehole logs (Appendix B) were reviewed to characterize the surficial sediments and stratigraphy.

4. Grainsize analyses: Soil samples collected by exp during drilling were submitted for grainsize analysis (Appendix C). These data were reviewed to characterize the shallow sediments and estimate the hydraulic conductivity of the soils encountered.

5. Hydraulic conductivity testing: A single well response test was completed in monitoring well BH5 to assess the in situ hydraulic conductivity of the shallow soils. The hydraulic conductivity field testing results are provided in Appendix C.

6. Review of groundwater levels: Monitoring of groundwater levels was initiated by Burnside on the Subject Lands to measure the depth to the water table and assess the horizontal and vertical groundwater flow conditions. Groundwater level measurements were obtained in on-site monitoring wells monthly from November 2020 to January 2021 and monthly monitoring will continue for a period of one year. Automatic water level recorders (dataloggers) were installed in the monitoring wells (BH2 and BH5) in order to record continuous water level fluctuations. A barologger was also installed to compensate the groundwater level data collected for effects of barometric variations. The compiled groundwater monitoring data and hydrographs are provided in Appendix D.

7. Piezometer installations: In order to investigate the shallow groundwater conditions, three piezometers (including one nest of two piezometers installed at different depths) were installed in selected locations. The locations of the piezometers are shown on Figure 4. A datalogger was installed in one of the piezometers in order to record continuous water level fluctuations.

8. Water balance calculations: Pre-development water balance calculations (based on existing land use conditions) and post-development water balance calculations (based on the proposed development concept) were completed to assess the potential impacts of land development on the local groundwater conditions. The local climate data and detailed water balance calculations are provided in Appendix E.

3.0 Physiography

The Subject Lands are located in the physiographic region known as the South Slope of the Oak Ridges Moraine (Chapman and Putnam, 1984). The South Slope physiographic region is characterized by rolling till plains sloping down from the Oak Ridges Moraine (Chapman and Putnam, 1984).

4.0 Topography and Drainage

The land surface regionally slopes to the southeast, with a maximum relief amplitude across the Subject Lands of about 3 m. The table lands are relatively flat with elevations ranging between 252 metres above sea level (masl) and 249 masl. In the north part of the Subject Lands the ground surface has been regraded around the single storey dwelling and 5 Sideroad (Figure 2).

The Subject Lands lie within the Humber River watershed under the jurisdiction of the Toronto and Region Conservation Authority (TRCA). The Humber River flows south about 1.5 km west of the Subject Lands. A stormwater channel lies approximately 150 m to the northeast of the Subject Lands that flows east towards a tributary of the Humber River (Figure 2).

Drainage across the Subject Lands itself generally flows south/southeast. The northern most portion of the Subject Lands are generally graded towards the nearest bordering street to the west, north or east.

5.0 Geology

5.1 Surficial Geology

Surficial geology mapping published by the Ontario Geological Survey (2010) shows that the majority of Subject Lands are covered by clay to silt till (derived from glaciolacustrine deposits; refer to Figure 3).

The boreholes from the exp drilling program and Burnside piezometer installation encountered topsoil and fill deposits at all locations to depths of 0.5 m to 1.8 m below ground surface (mbgs). Sandy silt till with some clay was found below the fill at all locations except BH5 to depths ranging from 2.3 mbgs to 4.1 mbgs. Silty clay till was encountered below the sandy silt till to the full depth of the boreholes. A wet seam was identified in the silty clay till at BH5.

To illustrate the subsurface soil conditions across the Subject Lands, a schematic cross-section has been prepared based on the borehole logs. The cross-section location is shown on Figure 4 and the interpreted cross-section is shown on Figure 5. Interpretation of the main stratigraphic layers has been made on this figure to show the surficial deposits of till.

5.2 Bedrock Geology

Bedrock underlying the Subject Lands is layered grey shale of the Georgian Bay Formation (OGS, 1991). Published bedrock topography maps and nearby well records suggest that the bedrock is at an elevation of approximately 190 masl (approximately 60 mbgs) in the area.

5.3 Soil Hydraulic Conductivity

There are various methods that can be used to assess soil hydraulic conductivity, i.e., the ability of the soil to transmit groundwater. Grainsize data and soil characteristics can be used to provide a general estimate of hydraulic conductivity. Single well bail-down (rising head) tests are used in groundwater monitoring wells to assess site-specific hydraulic conductivity. These methods have been used to estimate the hydraulic conductivity of the soils encountered in the Subject Lands as discussed below.

During the geotechnical investigations, representative soil samples were collected and four of these samples were analyzed for grainsize distribution (refer to Appendix C). The grainsize analyses indicate the four samples consist primarily of clay or silt with the portion of silt and clay size grains ranging from 77 to 93%. The hydraulic conductivity values are estimated to be less than 1.0×10^{-6} cm/sec, i.e., very low permeability for groundwater movement.

To assess the in situ hydraulic conductivity of the overburden sediments, a bail-down tests were completed at BH5 (refer to Figure 4 for monitoring well locations). The test results are provided in Appendix C. BH5 is screened in clayey silt till. The results of the bail-down test at BH5 suggests a very low hydraulic conductivity of 5.5×10^{-7} cm/sec (Appendix C).

6.0 Hydrogeology

6.1 Local Groundwater Use

The municipal water supply for the Village of Bolton is surface water obtained from Lake Ontario. There is currently no municipal groundwater supply in the vicinity of the Subject Lands and the proposed development will be municipally serviced from Lake Ontario. There is no proposed groundwater use for the development.

The lands surrounding the Subject Lands have previously been developed as residential subdivisions and are municipally serviced. However, the rural lands further to the east (±450 m) likely still rely on private wells for water supply and irrigation.

Review of the MECP well records (Appendix A) indicate that there are only two well records within 500 m of the Subject Lands. A review of MECP well records within 750 m of the Subject Lands identified 19 well records, although it assumed the supply well records located within the village of Bolton have been abandoned. The majority of supply wells (7 of 10) obtained water from the overburden. The three shallow overburden wells were constructed as bored or dug wells and obtained water from sandy layers encountered at depths ranging from 5 mbgs to 23 mbgs. Three deeper well completed in the overburden encountered groundwater from sandy deposits found from 60 mbgs to 80 mbgs.

A dug well was located on the Subject Lands that could not be identified within the MECP well records. The depth of the dug well was measured to be 29.6 mbgs. The approximate location of the dug well is shown on Figure 4.

Well Head Protection Areas (WHPAs) are zones around municipal water supply wells where land uses must be carefully planned and restricted to protect the quality of the water supply. Based on our review of WHPA mapping available from the Region of Peel, the Subject Lands are not located within a WHPA, and as such, the development is not considered to pose a significant threat to drinking water supplies.

6.2 Groundwater Monitoring

Two groundwater monitoring wells were installed on the Subject Lands as part of the geotechnical investigation completed by exp (refer to Appendix B for the well logs and Figure 4 for the well locations). In addition, three drive-point piezometers (one nest of two pipes and one single pipe) were installed by Burnside to investigate the shallow groundwater conditions.

The groundwater monitoring data are summarized in Table D-1 and hydrographs of the data are provided as Figures D-1 through D-5 in Appendix D. Automatic water level recorders were installed in BH2, BH5 and PZ2d to record continuous groundwater levels and the datalogger hydrographs of the groundwater elevations are also provided in Appendix D.

Groundwater levels have been monitored monthly since November 2020 and the monthly monitoring is scheduled to continue for a period of one year. The groundwater monitoring data collected to date show the following (refer to Figure 4 for the monitoring locations, and Table D-1 and hydrographs Figures D-1 through D-5 in Appendix D):

- Monitoring well BH2 has been dry since installation, indicating the silty clay till that the well is screened in has very low permeability. It is interpreted that the dry conditions observed at BH2 are not indicative of a groundwater level below the well but that the groundwater level in BH2 is still recovering (refer to Figure D-1, Appendix D).

- The groundwater levels at monitoring well BH5 ranged from 2.0 mbgs to 3.3 mbgs (refer to Figure D-2, Appendix D). A rapid water level change is observed in January after a period of precipitation and may indicate the shallow gravel and sand seams within the clayey silt till contribute to a quick response to precipitation events.

- The groundwater level in the dug well was measured to be at a depth of about 26.4 mbgs (refer to Figure D-3, Appendix D).

- The groundwater levels at the shallow piezometers have ranged from about 0.2 mbgs at PZ1s to 0.9 mbgs at PZ2 since installation. The piezometers were initially dry after installation, but groundwater measurements during subsequent monitoring events indicate the groundwater conditions appear to be slowly recovering and suggest that the soils have low permeability.

- The monitoring wells BH5 is located about 50 m from PZ2 and is installed to a depth of about 7.6 mbgs. Comparing groundwater levels in BH5 to PZ2 and between PZ1s and PZ1d indicates there is downward gradient (recharge condition) across the Subject Lands.

Groundwater levels in southern Ontario exhibit seasonal variations with higher elevations usually observed in spring during the wet season and declining levels through the drier season in summer to early fall. The continued monitoring will be used to confirm the seasonal water level patterns at the Subject Lands.

6.3 Interpreted Groundwater Flow Conditions

Areas where water from precipitation percolates or infiltrates into the ground and moves downward from the water table are known as recharge areas. These areas are generally in areas of relatively higher topographic elevation. Areas where groundwater moves upward are discharge areas and these generally occur in areas of relatively lower topographic elevation, such as along watercourses. Recharge and discharge may occur in local, intermediate and more regional flow systems. Infiltrating water at any given location may follow a shallow flow path and discharge a short distance away from the recharge area along the nearest slopes or in small watercourses, swales, agricultural ditches, wetlands, etc. This is referred to as a local groundwater flow system (i.e., flows that closely follow the existing topography with relatively short flow distances, e.g., up to a few hundred metres). Some water may follow much deeper and longer flow paths (hundreds to thousands of metres) to recharge underlying aquifers and discharge to more distant features and watercourses, possibly a very long way from the area of recharge. Such conditions may be referred to as intermediate and/or regional groundwater flow systems depending on the scale of analysis.

Groundwater flow conditions are expected to be influenced by the topography and the interpretation is that the water table and shallow groundwater flow patterns generally mimic the surface water flow patterns with flow moving downslope from the topographically higher areas toward the topographically lower areas. The limited groundwater data collected does not allow us to plot accurate groundwater elevation contours to illustrate the lateral groundwater flow directions through the shallow till deposits; however, groundwater flow is interpreted to mimic topography and flow to the south/southeast across the Subject Lands.

6.4 Discussion of Recharge and Discharge Conditions

As discussed in Section 6.2, the groundwater levels are interpreted to still be recovering in the BH2. The initial data suggests a downward gradient (recharge conditions) across the site, however the low permeability of the soils (as discussed in Sections 5.3 and 6.2) will limit the amount of recharge.

Significant Groundwater Recharge Areas (SGRAs) and Ecologically Significant Groundwater Recharge Areas (ESGRAs) have been mapped by TRCA. Review of this mapping shows that the Subject Lands are not located within a SGRA or ESGRA. This mapping is consistent with the site-specific data which show that the Subject Lands are covered by a layer of relatively low hydraulic conductivity sandy silt till overlying silty clay till (refer to Section 5.1). As such, the actual amount of water that infiltrates and moves through the subsurface over most of the area is expected to be limited by the relatively low hydraulic conductivity of the surficial silt and clay sediments.

6.5 Aquifer Vulnerability

The aquifer vulnerability was mapped by CTC for the Approved Updated Assessment Report: Toronto Region Source Protection Area (2015). The aquifer vulnerability designation for the Subject Lands, as mapped by CTC, is provided on Figure 6. Aquifer vulnerability refers to the susceptibility of the aquifer to potential contamination. Some degree of protection for groundwater quality from natural and human impacts is provided by the soil above the water table. The degree of protection is dependent upon the depth to the water table (for unconfined aquifers) or to the depth of the aquifer (for confined aquifers) and the type of soil above the water table or aquifer. As these two properties vary over any given area, the degree of protection or vulnerability of the groundwater to contamination also varies.

CTC developed the aquifer vulnerability map shown on Figure 6 using the water well records for the area to determine the soil types and depths to aquifer to develop an Aquifer Vulnerability Index (AVI). A small area at the southern limits of the Subject

Lands is identified as having “high groundwater vulnerability”. It is noted in the CTC report that this is a very regional scale map and also, due to the uncertainty in the water well records, the mapping should only be used as a guide, and not for site specific planning decisions. The block like pattern is an indication of the grid that was used to assess aquifer vulnerability and reflects the uncertainty of the assessment.

Impacts to the aquifer from the proposed development are not anticipated due to the thickness and low permeability of the sandy silt till and silty clay till.

7.0 Water Balance

7.1 Water Balance Components

A water balance is an accounting of the water resources within a given area. As a concept, the water balance is relatively simple and may be estimated from the following equation:

$$P = S + ET + R + I$$

where:

where:	P	=	precipitation
	S	=	change in groundwater storage
	ET	=	evapotranspiration/evaporation
	R	=	surface water runoff
	I	=	infiltration

The components of the water balance vary in space and time and depend on climatic conditions as well as the soil and land cover conditions (i.e., rainfall intensity, land slope, soil hydraulic conductivity and vegetation). Runoff, for example, occurs particularly during periods of snowmelt when the ground is frozen, or during intense rainfall events. Precise measurement of the water balance components is difficult and as such, approximations and simplifications are made to characterize the water balance of a property. Field observations of the drainage conditions, land cover and soil types, groundwater levels and local climatic records are important input considerations for the water balance calculations.

The groundwater balance components for the Subject Lands are discussed below:

Precipitation (P)

The reported long-term average annual precipitation for the period between 1981 and 2010 is 786 mm based on data from the Environment Canada Toronto Lester B. Pearson International Airport Climate Station climate station (Station 6158733 - 43° 40’.38.000 N, 79° 37’.50.000' W, elevation 173.4 masl). Average monthly records of precipitation and temperature from this station have been used for the water balance calculations in this study (Appendix E).

Storage (S)

Although there are groundwater storage gains and losses on a short-term basis, the net change in groundwater storage on a long-term basis is assumed to be zero so this term is dropped from the equation.

Evapotranspiration (ET)

Evapotranspiration and evaporation components vary based on the characteristics of the land surface cover (i.e., type of vegetation, soil moisture conditions, perviousness of surfaces, etc.). Potential evapotranspiration (PET) refers to the water loss from a vegetated surface to the atmosphere under conditions of an unlimited water supply. The actual rate of evapotranspiration (AET) is generally less than the PET under dry conditions (i.e., during the summer when there is a soil moisture deficit). In this report, the PET and AET have been calculated using a soil-moisture balance approach.

Water Surplus (R + I)

The difference between the mean annual P and the mean annual ET is referred to as the water surplus. Part of the water surplus travels across the surface of the soil as surface or overland runoff (R) and the remainder infiltrates the surficial soil (I). The infiltration is comprised of two end member components: one component that moves vertically downward to underlying aquifers (referred to as percolation, deep infiltration or net recharge) and a second component that moves laterally through the topsoil profile or shallow soils as interflow that re-emerges locally to surface (i.e., as runoff) at some short time following cessation of precipitation. As opposed to the “direct” component of surface runoff that occurs during precipitation or snowmelt events, interflow becomes an “indirect” component of the runoff. The interflow component of surface runoff is not accounted for in the water balance equation cited above since it is often difficult to distinguish between interflow and direct (overland) runoff, but both interflow and direct runoff together form the total surface water runoff component.

7.2 Approach and Methodology

The analytical approach to calculate the water balance involves monthly soil-moisture balance calculations to determine the pre-development (based on existing land use) infiltration volumes. A soil moisture balance approach assumes that soils do not release water as potential recharge while a soil moisture deficit exists. During wetter periods, any excess of precipitation over evapotranspiration first goes to restore soil moisture. Once the soil moisture deficit is overcome, any further excess water can then pass through the soil as infiltration and either become interflow (indirect runoff) or recharge (deep infiltration).

A soil moisture storage capacity of 250 mm was selected as a representative value for the existing open space area consisting of shrubs and pasture vegetation. Table E-1 in Appendix E details the monthly potential evapotranspiration calculations accounting for latitude and climate, and then calculate the actual evapotranspiration and water surplus components of the water balance based on the monthly precipitation and soil moisture conditions.

The MOE SWM Planning and Design Manual (2003) methodology for calculating total infiltration based on topography, soil type and land cover was used and a corresponding runoff component was calculated for the soil moisture storage conditions. The monthly water balance calculations show that a water surplus is generally available from January to April (Table E-1) for the open space area. Infiltration occurs during periods when there is sufficient water available to overcome the soil moisture storage requirements. In winter climates, frozen conditions may affect when the actual infiltration will occur, however, the monthly balance calculations show the potential volumes available for this water balance component. The monthly calculations are summed to provide estimates of the annual water balance component values (Table E-1). A summary of these values is provided below in Table 1.

Table 1: Water Balance Component Values

Water Balance Component	**Open Space (Shrubs & Pasture)***
Average Precipitation	786 mm/year
Actual Evapotranspiration	617 mm/year
Water Surplus	169 mm/year
Infiltration	102 mm/year
Runoff	68 mm/year

*It is acknowledged that the infiltration and runoff values presented in Table 1 are estimates. Single values are used for the water balance calculations, but it is important to understand that infiltration rates are dependent upon the hydraulic conductivity of the surficial soils which may vary over several orders of magnitude. As such, the margins of error for the calculated infiltration and runoff component values are potentially quite large. These margins of error are recognized, but for the purposes of this assessment, the numbers used in the water balance calculations are considered reasonable estimates based on the site-specific conditions and useful for comparison of pre- to post-development conditions.

7.3 Pre-Development Water Balance (Existing Conditions)

The pre-development water balance calculations based on the existing land use are presented in Table E-3 in Appendix E. The total area of the proposed development is approximately 4.49 ha. The water balance component values from Table E-1 was used to calculate the average annual volume of infiltration and runoff for the Subject Lands.

The pre-development average annual infiltration volume on the Subject Lands was calculated to be about 4,000 m^3/year and the total runoff volume from the Subject Lands was calculated to be about 6,300 m^3/year (Table E-3, Appendix E).

7.4 Potential Urban Development Impacts to Water Balance

Development of an area affects the natural water balance. The most significant difference is the addition of impervious surfaces as a type of surface cover (i.e., roads, parking lots, driveways, and rooftops). Impervious surfaces prevent infiltration of water into the soils and the removal of the vegetation removes the evapotranspiration component of the natural water balance. The evaporation component from impervious surfaces is relatively minor (estimated to be 10% to 20% of precipitation) compared to the evapotranspiration component that occurs with vegetation (78% of precipitation in the study area). So, the net effect of the construction of impervious surfaces is that most of the precipitation that falls onto impervious surfaces becomes surplus water and direct runoff, and the infiltration is reduced.

A calculation of the potential water surplus for impervious areas is shown at the bottom of Table E-1 (Appendix E). For the purposes of the calculations in this study, the evaporation from impervious surfaces has been estimated to be 15% of precipitation. The remaining 85% of the precipitation that falls on impervious surfaces is assumed to become runoff. Therefore, assuming an evaporation/loss from impervious surfaces of 15% of the precipitation, there would be a potential water surplus from impervious areas of 668 mm/year.

It is noted that the proposed development will be serviced by municipal water supply and wastewater services. Therefore, there will be no impact on the water balance and local groundwater or surface water quantity and quality conditions related to any on-site groundwater supply pumping or disposal of septic effluent.

7.5 Post-Development with No LID Measures

In order to assess the potential development impact on infiltration volumes, the post-development infiltration volumes have been calculated for the Subject Lands in Table E-3 (Appendix E). The calculations provided in Table E-3 assume no low impact development (LID) measures to promote infiltration are in place.

The total areas for the proposed land uses have been estimated based on the proposed development concept. The total calculated post-development infiltration volume (without mitigation) is about 2,200 m^3/year.

Comparison of the pre-development and post-development infiltration volumes from the water balance calculations shows that development has the potential to reduce the natural infiltration on the Subject Lands by about 45%. Again, it is noted that with the assumptive nature of the input values and the wide margins of error associated with this type of analysis, the estimated infiltration deficit volume is simply considered as a reasonable estimate and may not reflect the actual volume of water that may infiltrate on the Subject Lands.

7.6 Water Balance Mitigation Strategies

The basic premise for low impact development is to try to manage stormwater to minimize the runoff of rainfall and increase the potential for infiltration. As outlined in the SWMP Design Manual (2003) and Low Impact Development Stormwater Management Planning and Design Guide (2010), there are a wide variety of mitigation techniques that can be used to try to reduce the increases in direct runoff that occur with land development and increase the potential for post-development infiltration.

Techniques to maximize the water availability in pervious areas such as designing grades to direct roof runoff towards lawns, side and rear yard swales, and other pervious areas throughout the development where possible can considerably increase the volume of infiltration in developed areas. These types of surface LID techniques promote natural infiltration simply by providing additional water volumes in the pervious areas (i.e., these areas would receive precipitation as well as extra water from roof runoff). This may be particularly effective in the summer months, when natural infiltration would not generally occur because the additional water overcomes the natural soil moisture deficit.

Other mitigation techniques that can be considered to mitigate increases in runoff and reductions in infiltration include such measures as: permeable pavements, rain gardens, rain barrels, bioswales, subsurface infiltration trenches, galleries and pervious pipe systems. Subsurface methods should only be considered in areas where there is sufficient depth to water table to accommodate the systems within the unsaturated zone and sufficient soil hydraulic conductivity to function effectively. The 2003 SWM manual recommends that subsurface galleries or trenches should generally be about 1 m above the seasonally high water table.

As presented in the FSR prepared by RAND (February 2021), the proposed SWM strategy includes the following LID measures:

- Increased topsoil depth across all lots. The intention with increased topsoil depth is to aid retention of runoff through increased soil storage and promote more infiltration in these areas. Typically, topsoil is increased to about 300 mm.

- Rear roof areas from all detached dwellings will be discharged to pre-cast splash pads and directed to rear/side pervious areas. The TRCA and CVC Stormwater Management Criteria (2010) indicates that a conservative estimate for the reduction in runoff due to roof leader disconnection is 25% for silt to clayey soils.

As discussed in Section 5.3 herein, the surficial soils have a low hydraulic conductivity and limit the volume of runoff that can be infiltrated. At the time or report preparation, the limited groundwater data available does not provide suitable data to evaluate whether additional LIDs such as subsurface infiltration can be implemented at this time. As additional groundwater data is gathered, it will be further evaluated to determine if subsurface infiltration can be implemented as part of the SWM strategy.

7.7 Post-Development with LID Measures in Place

Quantification of these surficial LID techniques is challenging and there are no widely accepted quantification standards. To assess the potential effectiveness of the recommended LID measures for groundwater infiltration and runoff reduction for the Subject Lands, the water balance component values were recalculated. It has been assumed in the calculations that 25% of the roof runoff directed to pervious areas (rear/side yards) will infiltrate, as per the estimation provided in the Low Impact Development Stormwater Management Planning and Design Guide (CVC and TRCA, 2010).

Recalculation of the water balance for the Subject Lands with these LID measures in place demonstrates that infiltration volumes would be about 86% of pre-development volumes (Table E-5, Appendix E). This shows the significant benefit of the proposed LID strategy in increasing recharge volumes in the developed area.

8.0 Construction Considerations

8.1 Construction Below Water Table

The construction of buried services below the water table has the potential to capture and redirect shallow groundwater flow through more permeable fill materials typically placed in the base of excavated trenches. Over the long-term, these impacts can lower the groundwater table across the development area. Use of appropriate best management practices for servicing and construction across the Subject Lands is recommended where necessary to prevent long-term water table lowering. This will involve the use of cut-off collars or clay plugs to provide barriers to flow to prevent groundwater flow along granular bedding and erosion of the backfill materials.

8.2 Dewatering/Depressurization Requirements

Dewatering and/or depressurization requirements and anticipated water flow volumes will be confirmed by geotechnical and hydrogeological investigations completed in support of detailed servicing design. The removal of subsurface water (dewatering) to facilitate construction is regulated by the MECP. Water taking in excess of 50,000 L/day but less than 400,000 L/day is regulated via an Environmental Sector Activity Registry (EASR) process. For takings in excess of 400,000 L/d, a Permit to Take Water (PTTW) will be required in accordance with the provincial regulations prior to dewatering activities. A detailed groundwater management and monitoring plan will be required in support of an EASR or PTTW application at the engineering design review stage.

8.3 Groundwater Quality

Depending on land use, runoff from urban developments may contain a variety of dilute contaminants such as suspended solids, chloride from road salt, oil and grease, metals, pesticide residues, bacteria and viruses. For the surface water, the stormwater management strategy must be designed to meet Enhanced Level quality controls. The use of best management practices for road salt usage is also recommended throughout the development area.

For groundwater, generally, with the exception of the dissolved constituents such as nitrogen and salt, most contaminants are attenuated by filtration during groundwater transport through the soils. The potential for effects on groundwater quality from infiltration in the proposed development area is expected to be limited.

8.4 Private Services

The proposed development of the Subject Lands will be serviced by municipal water supply and wastewater services. Therefore, there will be no on-site development of water supply wells and no on-site disposal of sewage effluent, and as such, no associated impacts on the local groundwater or surface water quantity and quality conditions.

8.5 Private Water Wells

As outlined in Section 6.1, there are no existing private wells within about 450 m of the Subject Lands other than the dug well located adjacent to the existing dwelling on the Subject Lands. It is not anticipated that development construction activities will adversely affect local groundwater supplies.

8.6 Well Decommissioning

Prior to construction, it will be necessary to ensure that all inactive water supply wells within the development footprint have been located and properly decommissioned by a licensed water well contractor according to Ontario Regulation 903. In addition, all groundwater monitoring wells installed for study purposes must be decommissioned in accordance with provincial regulations prior to or during the site development, unless they are maintained throughout the construction period for monitoring purposes.

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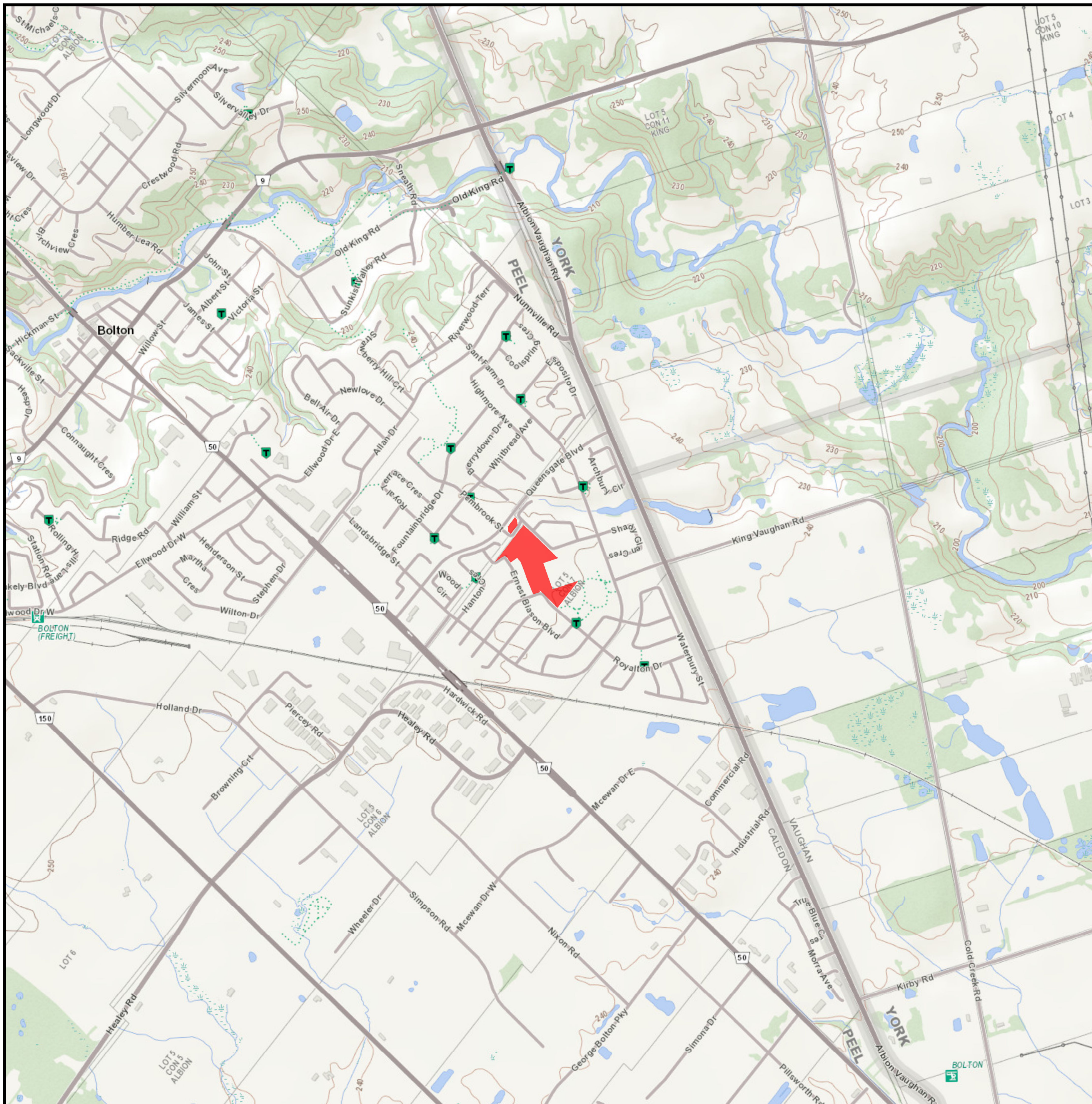
Figures



LEGEND

SUBJECT LANDS

0 500 1,000 1,500 2,000

Metres

N

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CARANTANIA INVESTMENTS (BT) INC.
BOLTON, ONTARIO

HYDROGEOLOGICAL ASSESSMENT AND WATER BALANCE

Figure Title:

SITE LOCATION

Drawn	Checked	Date	Figure No.
SK	JD	February 2021	1
Scale		Project No.	
1:25,000		300052444	

File Path: Nigel/Shared Work Areas/052444arantanis/06_GIS/052444 Site Location.mxd

LEGEND

- SUBJECT LANDS
- WATERCOURSE
- CONTOUR (1m intervals - masl)
- ROADWAY
- BUILT-UP AREA: IMPERVIOUS
- BUILT-UP AREA: PERVIOUS
- OPEN WATER

0 50 100 150 200 250 300

Metres

N

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BOLTON, ONTARIO

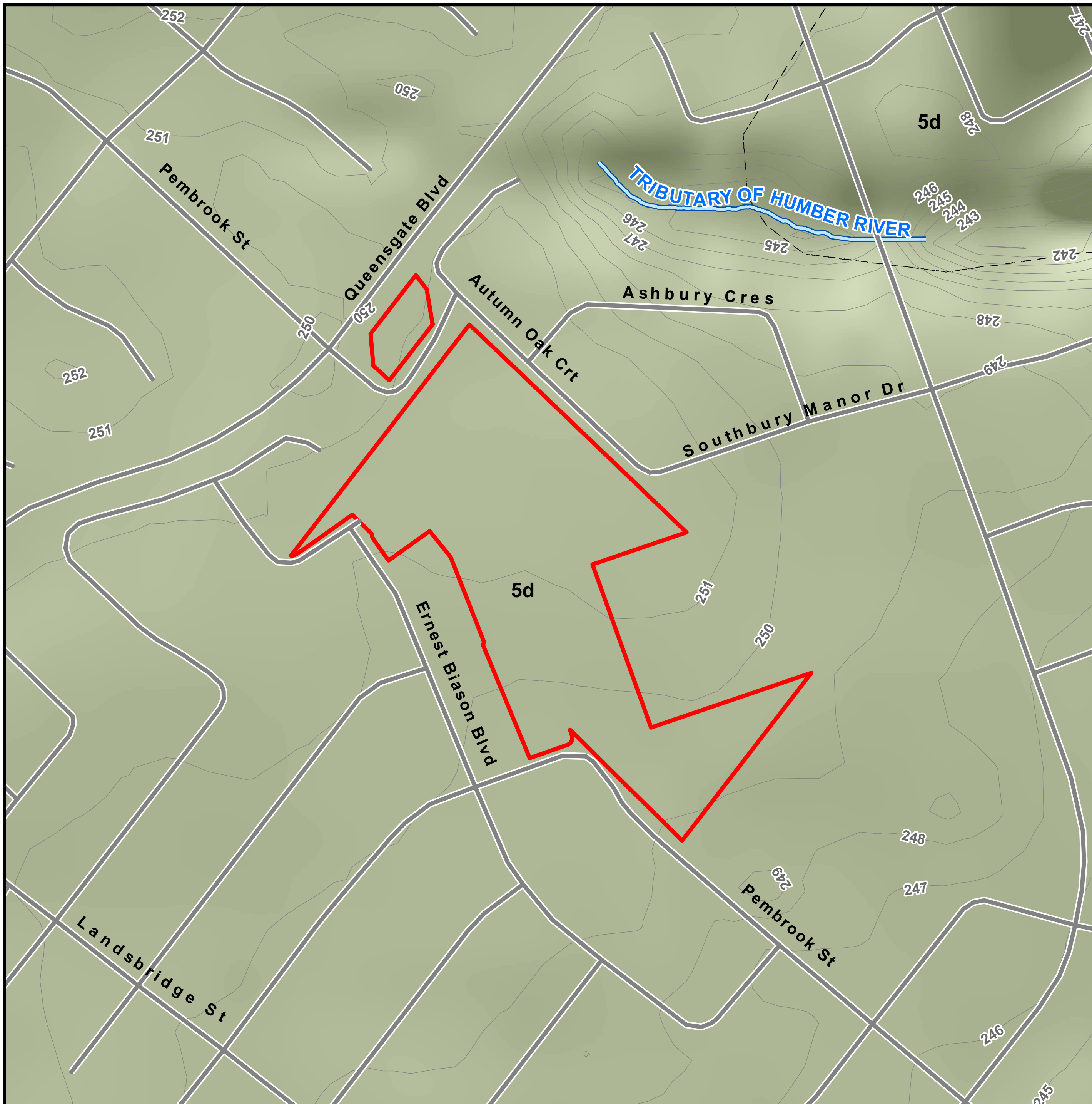
HYDROGEOLOGICAL ASSESSMENT AND WATER BALANCE

Figure Title:

TOPOGRAPHY AND DRAINAGE

Drawn	Checked	Date	Figure No.
SK	JD	February 2021	2
Scale		Project No.	
1:4,000		300052444	

File Path: Nigel/Shared Work Areas/052444arantanis/06_GIS/052444 Topogrphy & Drainage.mxd



LEGEND

- SUBJECT LANDS
- ROADWAY
- WATERCOURSE
- CONTOUR (1m intervals - masl)
- 5d: Till: Glaciolacustrine-derived silty to clayey till

Sources:

1. Ministry of Natural Resources, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.
3. Ontario Geological Survey 2017. Surficial Geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 128 - Revision 1.

0 50 100 150 200 250 300
Metres

N

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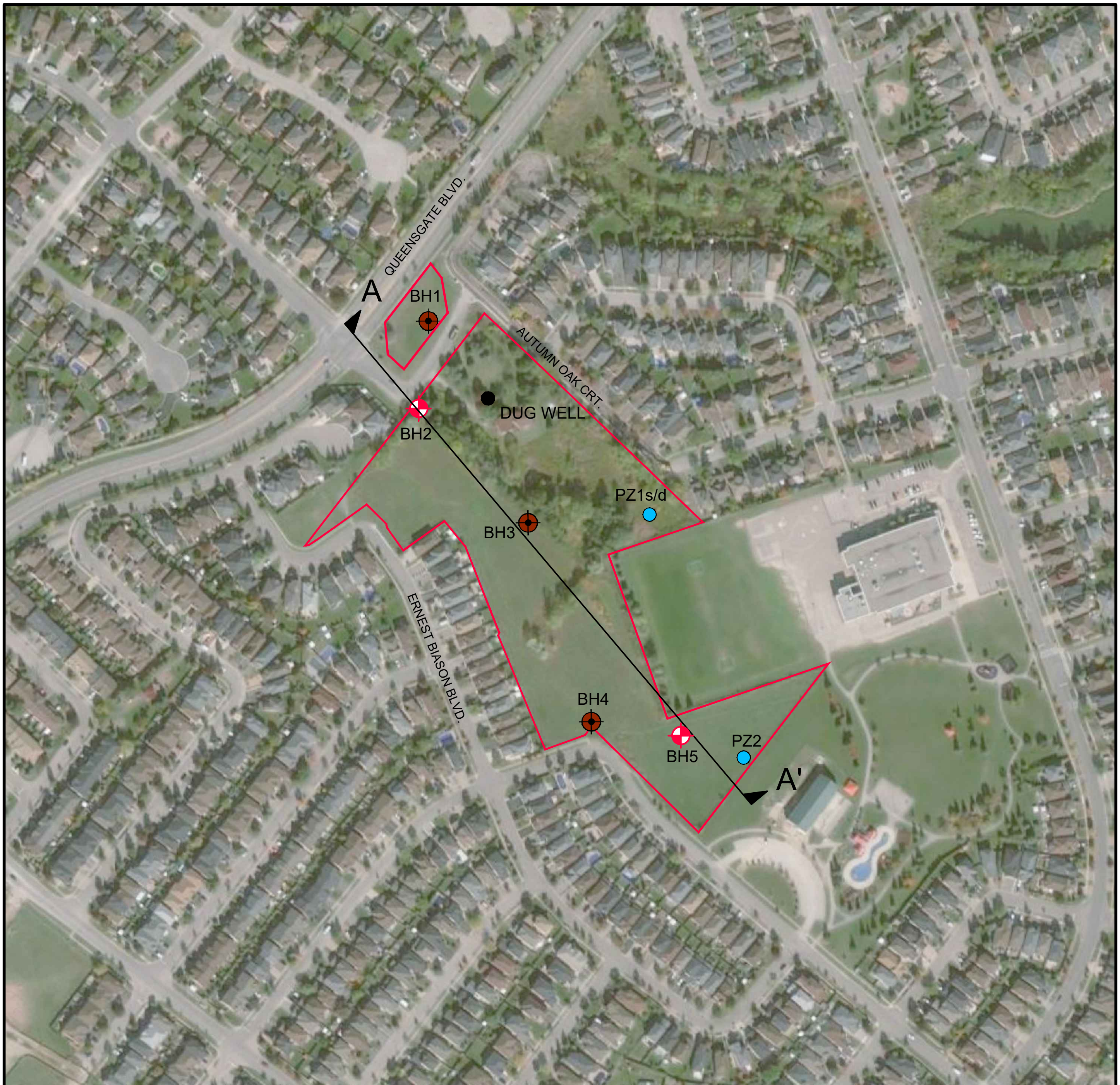
CARANTANIA INVESTMENTS (BT) INC.
BOLTON, ONTARIO
HYDROGEOLOGICAL ASSESSMENT AND WATER BALANCE

Figure Title:

SURFICIAL GEOLOGY

Drawn	Checked	Date	Figure No.
SK	JD	February 2021	3
Scale		Project No.	
1:4,000		300052444	

File Path: Nigel/Shared Work Areas/052444arantanis/06_GIS/052444 Surficial Geology.mxd



LEGEND

SUBJECT LANDS

MONITORING WELL (EXP, 2020)

BOREHOLE (EXP, 2020)

DRIVE POINT PIEZOMETER (RJB, 2020)

A A'

CROSS-SECTION LOCATION KEY

0 50 100 150 200 250 300

Metres

N

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CARANTANIA INVESTMENTS (BT) INC.
BOLTON, ONTARIO

HYDROGEOLOGICAL ASSESSMENT AND WATER BALANCE

Figure Title

MONITORING WELL, BOREHOLE AND CROSS-SECTION LOCATIONS

Drawn	Checked	Date	Figure No.
SK	JD	February 2021	4
Scale		Project No.	
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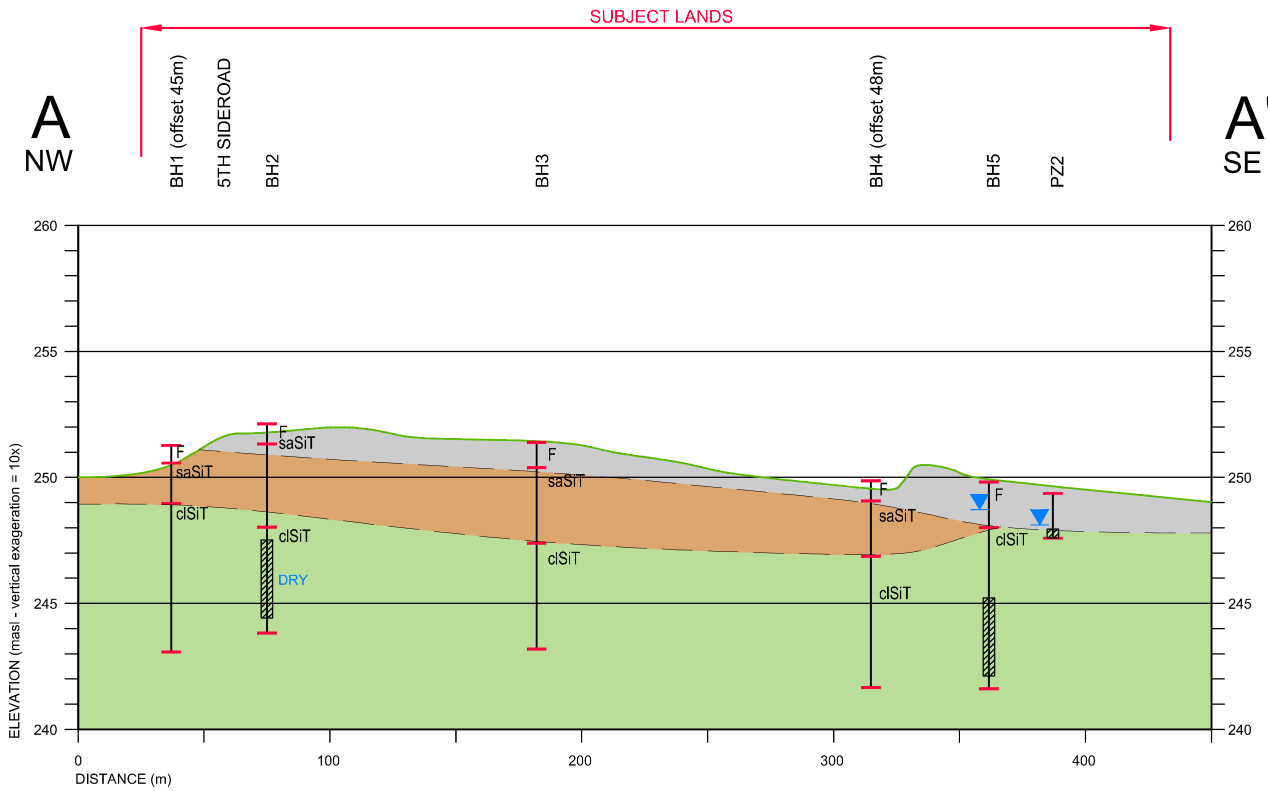
File Name:Nigel/Shared Work Areas/042081 2100 Brant/ 052444 HG Assessment Drawing Set.dwg Date Plotted: February 18, 2021 - 11:39 AM



LEGEND

BH1 WELL NUMBER / ID

EXISTING GROUND PROFILE

GEOLOGICAL CONTACT

MEASURED WATER LEVEL (January 21, 2021)

WELL SCREEN

si	SILTY
sa	SANDY
cl	CLAYEY
GR	GRAVEL
SA	SAND
Si	SILT
CL	CLAY
ST	STONES
LSMN	LIMESTONE

INTERPRETED STRATIGRAPHY

FILL

SANDY SILT TILL

SILT CLAY TILL

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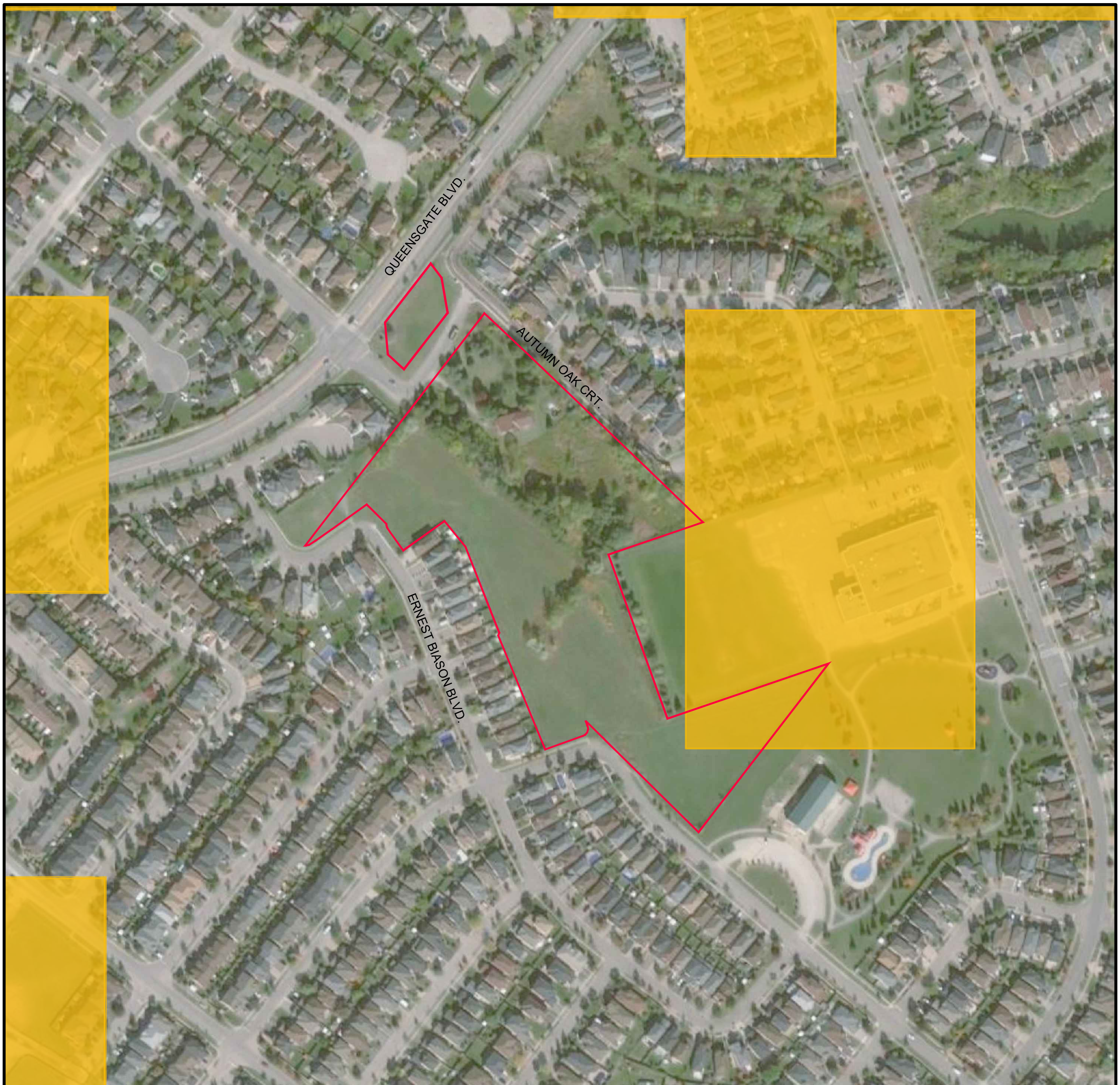
CARANTANIA INVESTMENTS (BT) INC.
BOLTON, ONTARIO

HYDROGEOLOGICAL ASSESSMENT AND WATER BALANCE

Figure Title

INTERPRETED GEOLOGICAL CROSS-SECTION A-A'

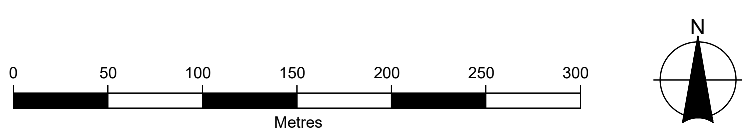
Drawn	Checked	Date	Figure No.
SK	JD	February 2021	5
Scale		Project No.	
1:3,000		300052444	



LEGEND

SUBJECT LANDS

HIGHLY VULNERABLE AQUIFER AREA



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CARANTANIA INVESTMENTS (BT) INC.
BOLTON, ONTARIO

HYDROGEOLOGICAL ASSESSMENT AND WATER BALANCE

Figure Title

HIGHLY VULNERABLE AQUIFER AREAS

Drawn	Checked	Date	Figure No.
SK	JD	February 2021	6
Scale		Project No.	
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File Name:Nigel/Shared Work Areas/042081 2100 Brant/ 052444 HG Assessment Drawing Set.dwg Date Plotted: February 18, 2021 - 12:51 PM

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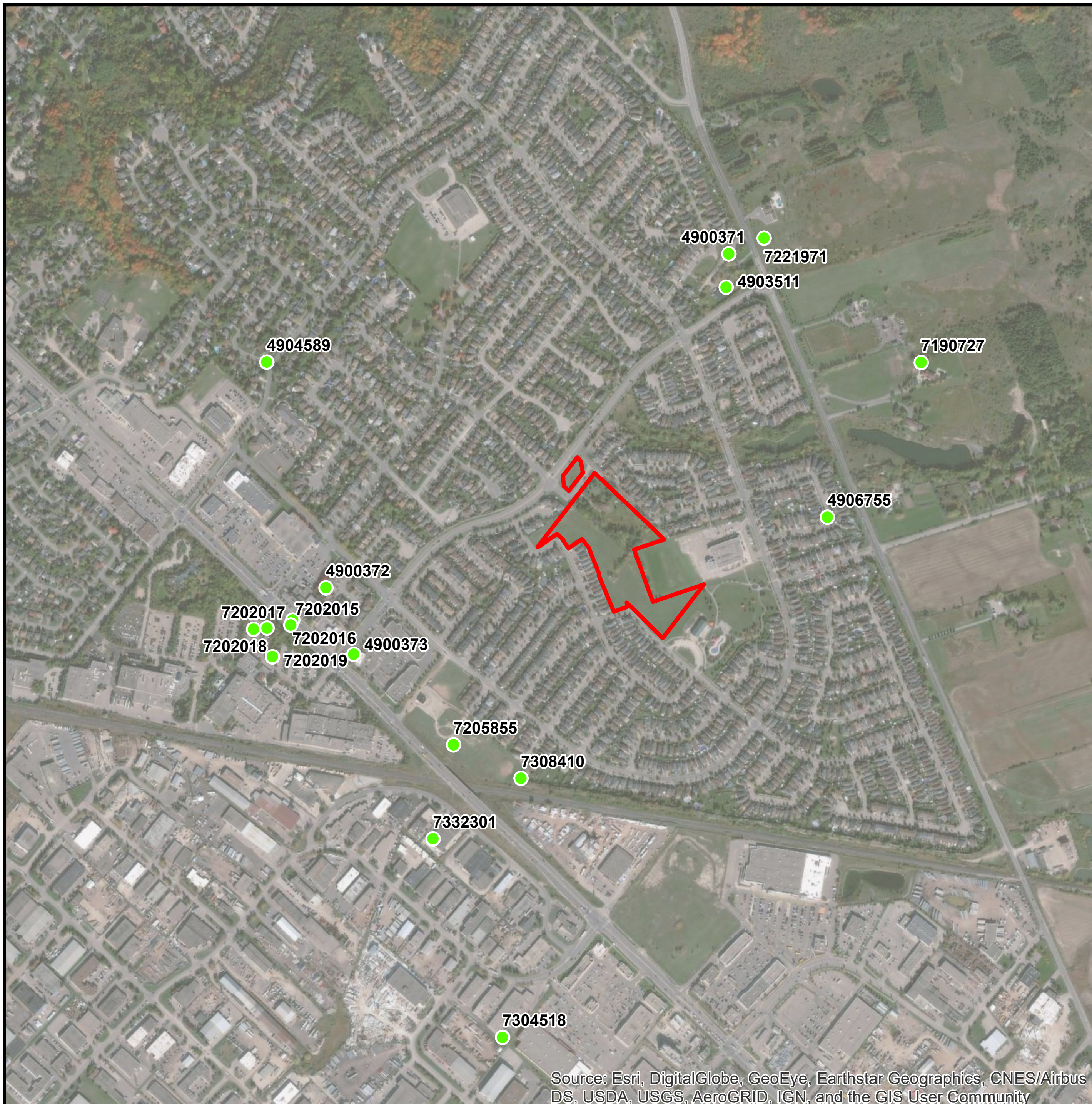
Appendix A

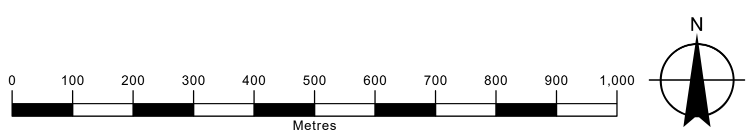
MECP Well Records



LEGEND

SUBJECT LANDS

MECP WELL RECORD LOCATION



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CARANTANIA INVESTMENTS (BT) INC.
BOLTON, ONTARIO

HYDROGEOLOGICAL ASSESSMENT AND WATER BALANCE

Figure Title:

MECP WELL RECORD LOCATION

Drawn	Checked	Date	Figure No.
SK	JD	February 2021	A1
Scale		Project No.	
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File Path: Nigel/Shared Work Areas/052444arantanis/06_GIS/052444 Site Location.mxd

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
CALEDON TOWN (ALBION	17 602399 4858188 W	2013/04 7241						7202017 (Z133266) A	0017
CALEDON TOWN (ALBION	17 602483 4858208 W	2013/04 7241						7202016 (Z163157) A	0017
CALEDON TOWN (ALBION	17 602479 4858197 W	2013/04 7241						7202015 (Z163161) A	0014
CALEDON TOWN (ALBION	17 602428 4858191 W	2013/04 7241	2			MT	0007 10	7202018 (Z163160) A119380	BLCK SOFT 0000 BRWN FSND GRVL SOFT 0002 BRWN SILT FSND SOFT 0014 GREY SILT FSND SOFT 0017
CALEDON TOWN (ALBION	17 602440 4858129 W	2013/04 7241	2.04			MT	0004 10	7202019 (Z163159) A119379	BLCK SOFT 0000 BRWN FSND GRVL SOFT 0003 BRWN SILT FSND SOFT 0011 GREY SILT FSND SOFT 0014
CALEDON TOWN (ALBION CON 07 005	17 602829 4857940 W	2013/07 7147						7205855 (C22658) P	
CALEDON TOWN (ALBION CON 07 005	17 603455 4858926 W	2017/10 7230						7308431 (C40166) A229380 P	
CALEDON TOWN (ALBION CON 07 005	17 603421 4858994 W	1967/08 1307	30	FR 0075	75//0/:	DO		4900371 ()	BRWN LOAM CLAY 0015 GREY CLAY 0075 MSND 0076 GREY CLAY 0095
CALEDON TOWN (ALBION CON 07 005	17 603415 4858923 W	1970/11 5206	5	FR 0220	130/180/15/4:0	DO	0242 4	4903511 ()	PRDG 0090 SILT 0110 BLUE CLAY 0220 FSND 0246
CALEDON TOWN (ALBION CON 07 005	17 603730 4858316 W	1987/09 1633	6 6	FR 0140	122/165/2/1:0	CO		4906760 (09135)	BRWN CLAY 0014 BLUE CLAY 0044 BLUE CLAY GRVL 0052 GREY SAND MSND FSND 0055 BLUE CLAY SILT GRVL 0078 BLUE CLAY 0110 GREY SAND SILT FSND 0121 BLUE CLAY 0130 BLUE GRVL CLAY 0140 GREY SHLE 0170
CALEDON TOWN (ALBION CON 07 005	17 603632 4858429 W	1987/07 1663	6 6	SA 0300				4906755 (NA) A	BLCK LOAM 0001 BRWN CLAY 0009 GREY CLAY 0016 BLUE CLAY 0044 BLUE CLAY GRVL 0057 GREY FSND SILT 0059 BLUE CLAY GRVL SAND 0071 BLUE CLAY 0143 GREY GRVL CLAY 0145 GREY GRVL SAND CLAY 0157 BLUE CLAY GRVL 0170 GREY SHLE HARD 0305
CALEDON TOWN (ALBION CON 07 006	17 602555 4858277 W	1955/10 3512	5 5	SA 0300	142///:	CO		4900372 ()	LOAM 0001 BLUE CLAY 0194 MSND 0198 BLUE CLAY 0210 BLUE CLAY SHLE 0342
CALEDON TOWN (ALBION CON 07 006	17 602615 4858134 W	1957/06 4813	6 6	SA 0240	102/120/10/25:0	CO		4900373 ()	BRWN CLAY 0008 BLUE HPAN 0160 BLUE CLAY 0194 MSND 0200 BLUE SHLE 0241
CALEDON TOWN (ALBION CON 07 007	17 602428 4858762 W	1974/11 3612	30 30	UK 0017 UK 0028	17/28/4/2:30	DO		4904589 ()	BLCK LOAM 0002 BRWN CLAY 0017 GREY SAND 0028 GREY GRVL SAND 0032 BLUE CLAY 0033
CALEDON TOWN (BOLTON	17 602974 4857868 W	2017/12 7230						7308410 (C41568) A229958 P	

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
CALEDON TOWN (BOLTON	17 602785 4857738 W	6946						7332301 (C45599) A262901 P	
KING TOWNSHIP 11 002	17 603705 4858989 W	2006/06 7143	6	0223	112//12/3:	DO	0218 12	6930407 (Z42508) A038081	BRWN CLAY 0017 GREY CLAY 0070 GREY GRVL CLAY 0080 GREY GRVL CSND 0090 GREY CLAY STNS 0224 GREY MSND 0230
KING TOWNSHIP CON 11 002	17 603496 4859028 W	2014/05 7154	6.25 5.5	FR 0248	110/137/20/1:0	DO	0248 8	7221971 (Z181429) A133100	BRWN CLAY 0069 GREY CLAY SILT 0245 GREY FSND 0256
VAUGHAN TOWN (KING) CON 11 001	17 603765 4858673 W	1979/05 3742	36 21	FR 0052	50/62/3/4:0	DO		6915455 ()	BRWN CLAY 0014 BLUE CLAY 0042 SAND 0055 BLUE CLAY 0069
VAUGHAN TOWN (KING) CON 11 001	17 603834 4858761 W	2012/04 1663	6 5	UT	106/144/9/1:5	DO	0163 2	7190727 (Z146284) A116175	BRWN FILL 0008 BRWN CLAY GRVL SAND 0021 GREY CLAY SAND GRVL 0048 GREY CLAY GRVL 0073 GREY CLAY 0137 GREY SILT CLAY 0154 GREY FSND 0168 GREY SILT CLAY 0178

Notes:
UTM: UTM in Zone, Easting, Northing and Datum is NAD83; L: UTM estimated from Centroid of Lot; W: UTM not from Lot Centroid
DATE CNTR: Date Work Completedand Well Contractor Licence Number
CASING DIA: .Casing diameter in inches
WATER: Unit of Depth in Fee. See Table 4 for Meaning of Code

PUMP TEST: Static Water Level in Feet / Water Level After Pumping in Feet / Pump Test Rate in GPM / Pump Test Duration in Hour : Minutes
WELL USE: See Table 3 for Meaning of Code
SCREEN: Screen Depth and Length in feet
WELL: WEL (AUDIT #) Well Tag . A: Abandonment; P: Partial Data Entry Only
FORMATION: See Table 1 and 2 for Meaning of Code

1. Core Material and Descriptive terms

Code Description	Code Description	Code Description	Code Description	Code Description
BLDR BOULDERS	FCRD FRACTURED	IRFM IRON FORMATION	PORS POROUS	SOFT SOFT
BSLT BASALT	FGRD FINE-GRAINED	LIMY LIMY	PRDG PREVIOUSLY DUG	SPST SOAPSTONE
CGRD COARSE-GRAINED	FGVL FINE GRAVEL	LMSN LIMESTONE	PRDR PREV. DRILLED	STKY STICKY
CGVL COARSE GRAVEL	FILL FILL	LOAM TOPSOIL	QRTZ QUARTZITE	STNS STONES
CHRT CHERT	FLDS FELDSPAR	LOOS LOOSE	QSND QUICKSAND	STNY STONEY
CLAY CLAY	FLNT FLINT	LTCL LIGHT-COLOURED	QTZ QUARTZ	THIK THICK
CLN CLEAN	FOSS FOSILIFEROUS	LYRD LAYERED	ROCK ROCK	THIN THIN
CLYY CLAYEY	FSND FINE SAND	MARL MARL	SAND SAND	TILL TILL
CMTD CEMENTED	GNIS GNEISS	MGRD MEDIUM-GRAINED	SHLE SHALE	UNKN UNKNOWN TYPE
CONG CONGLOMERATE	GRNT GRANITE	MGVL MEDIUM GRAVEL	SHLY SHALY	VERY VERY
CRYS CRYSTALLINE	GRSN GREENSTONE	MRBL MARBLE	SHRP SHARP	WBRG WATER-BEARING
CSND COARSE SAND	GRVL GRAVEL	MSND MEDIUM SAND	SHST SCHIST	WDFR WOOD FRAGMENTS
DKCL DARK-COLOURED	GRWK GREYWACKE	MUCK MUCK	SILT SILT	WTHD WEATHERED
DLMT DOLOMITE	GVLY GRAVELLY	OBDN OVERBURDEN	SLTE SLATE	
DNSE DENSE	GYPS GYPSUM	PCKD PACKED	SLTY SILTY	
DRTY DIRTY	HARD HARD	PEAT PEAT	SNDS SANDSTONE	
DRY DRY	HPAN HARDPAN	PGVL PEA GRAVEL	SNDY SANDYOAPSTONE	

2. Core Color

Code	Description
WHIT	WHITE
GREY	GREY
BLUE	BLUE
GREN	GREEN
YLLW	YELLOW
BRWN	BROWN
RED	RED
BLCK	BLACK
BLGY	BLUE-GREY

3. Well Use

Code Description	Code Description
DO Domestic	OT Other
ST Livestock	TH Test Hole
IR Irrigation	DE Dewatering
IN Industrial	MO Monitoring
CO Commercial	MT Monitoring TestHole
MN Municipal	
PS Public	
AC Cooling And A/C	
NU Not Used	

4. Water Detail

Code Description	Code Description
FR Fresh	GS Gas
SA Salty	IR Iron
SU Sulphur	
MN Mineral	
UK Unknown	

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Appendix B

Borehole Logs

Log of Borehole BH 1

Project No. BRM-00603811-B0 — Drawing No. 2

Project: Geotechnical Investigation — Sheet No. 1 of 1

Location: 9229 5th Sideroad, Caledon, Ontario

Bolton, Ontario

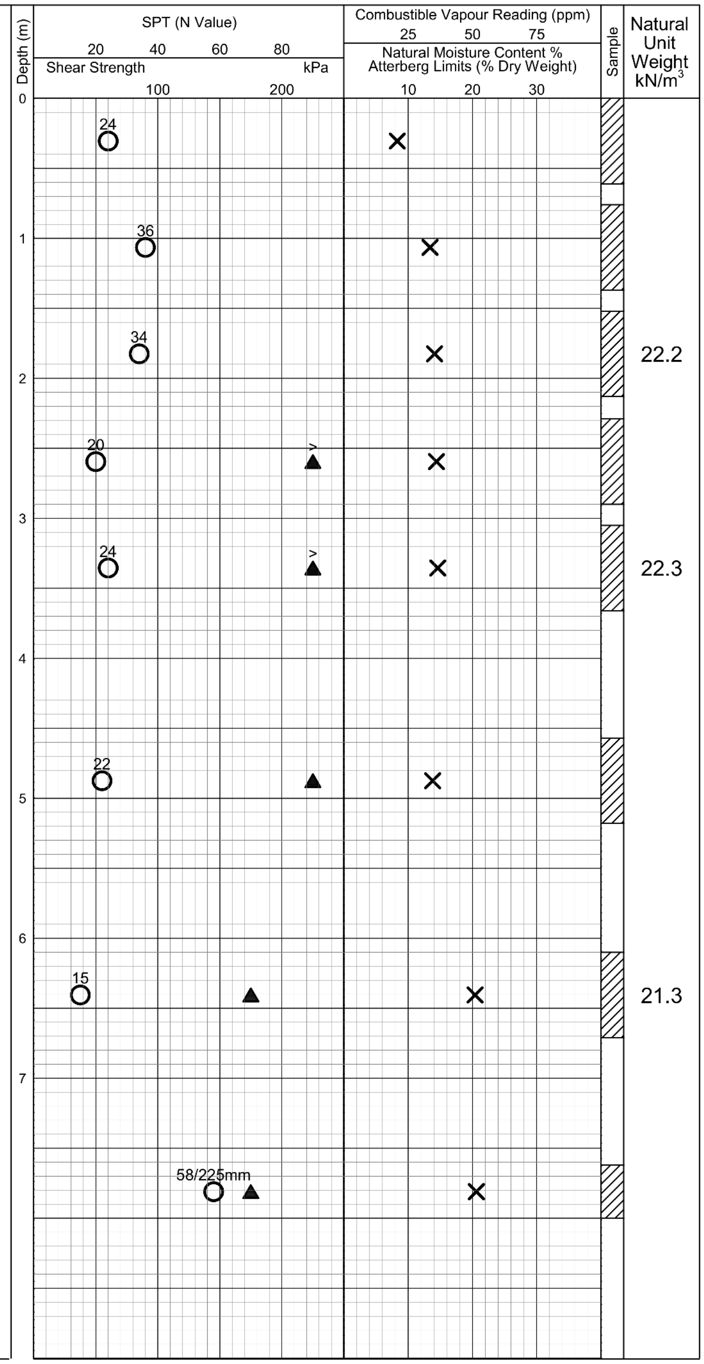
Date Drilled: September 25, 2020

Drill Type: Hollow Stem Auger - CME 75

Datum: Geodetic

Auger Sample	⊠	Combustible Vapour Reading	□
SPT (N) Value	○ ▨	Natural Moisture	×
Dynamic Cone Test	—	Plastic and Liquid Limit	├──○
Shelby Tube	■	Undrained Triaxial at % Strain at Failure	⊕
Field Vane Test	S	Penetrometer	▲

Soil Description	ELEV. m
	251.27
~100 mm **TOPSOIL** over **FILL:** Reworked sandy silt, some silty sand layer, trace rootlets in the upper portion, brown, moist	~250.6
SANDY SILT TILL: some clay, trace gravel, oxidized zones, brown, moist, dense	~249.0
CLAYEY SILT TILL: trace sand, trace garvel, brown, moist, very stiff -becoming grey -becoming stiff - probable boulder	~245.8 ~243.0
END OF BOREHOLE	



Date	Water Level (m)	Hole Open to (m)
On Completion	Dry	

exp.

Log of Borehole BH 2

Project No. BRM-00603811-B0 | Drawing No. 3

Project: Geotechnical Investigation | Sheet No. 1 of 1

Location: 9229 5th Sideroad, Caledon, Ontario

Bolton, Ontario

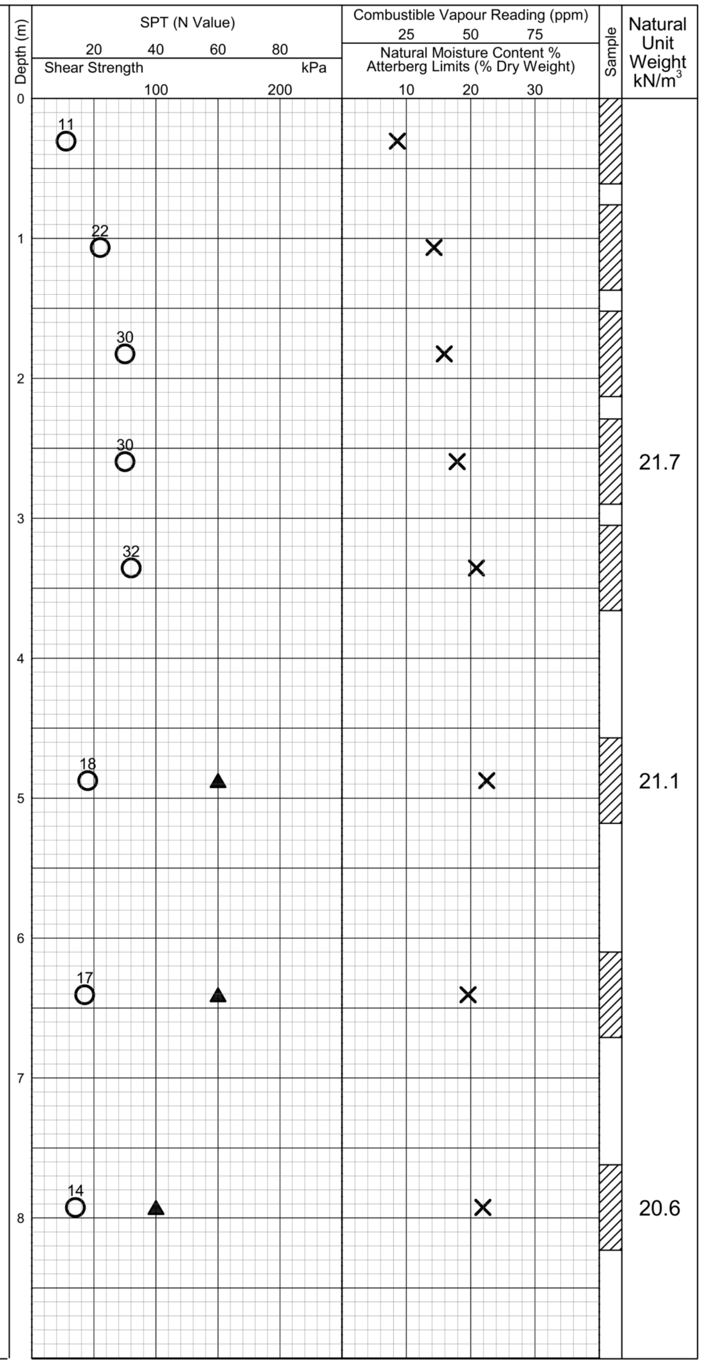
Date Drilled: September 25, 2020

Drill Type: Hollow Stem Auger - CME 75

Datum: Geodetic

Auger Sample	⊠
SPT (N) Value	○ ▨
Dynamic Cone Test	——
Shelby Tube	■
Field Vane Test	S
Combustible Vapour Reading	□
Natural Moisture	×
Plastic and Liquid Limit	├──○
Undrained Triaxial at % Strain at Failure	⊕
Penetrometer	▲

Groundwater	Soil/Rock Symbol	Soil Description	ELEV. m
			252.08
		~100 mm **TOPSOIL** over **FILL:** Reworked sandy silt, some rootlets in the upper portion, brown, moist	~251.3
		SANDY SILT TILL: some clay, trace gravel, oxidized zones, brown, moist, compact to dense	~248.0
		CLAYEY SILT TILL: trace sand, trace garvel, grey , moist, very stiff to stiff	~243.9
		END OF BOREHOLE	



EXPLOGBRAMPTON 9229 5TH SIDEROAD - BOREHOLE LOGS.GPJ NEW.GDT 10/7/20

Date	Water Level (m)	Hole Open to (m)
On Completion	Dry	
September 28, 2020	Dry	

exp.

Log of Borehole BH 3

Project No. BRM-00603811-B0 | Drawing No. 4

Project: Geotechnical Investigation | Sheet No. 1 of 1

Location: 9229 5th Sideroad, Caledon, Ontario

Bolton, Ontario

Date Drilled: September 25, 2020

Drill Type: Hollow Stem Auger - CME 75

Datum: Geodetic

Auger Sample	⊠	Combustible Vapour Reading	□
SPT (N) Value	○ ▨	Natural Moisture	✕
Dynamic Cone Test	——	Plastic and Liquid Limit	├──○
Shelby Tube	■	Undrained Triaxial at % Strain at Failure	⊕
Field Vane Test	✚ S	Penetrometer	▲

Soil Description	ELEV. m	Depth (m)	SPT (N Value)	Shear Strength / Penetrometer (kPa)	Natural Moisture Content %	Natural Unit Weight kN/m³
~125 mm **TOPSOIL** over **FILL:** Reworked sandy silt, some rootlets in the upper portion, brown, moist	251.38	0	7		✕	
SANDY SILT TILL: some clay, trace gravel, oxidized zones, brown, moist, compact	~250.4	1	31		✕	
			32		✕	
			28		✕	
			29		✕	21.6
CLAYEY SILT TILL: trace sand, trace garvel, grey, moist, very stiff	~247.4	4				
			20	▲ >	✕	
-becoming stiff	~245.9					
			14	▲	✕	21.0
			14	▲	✕	
END OF BOREHOLE	~243.2					

Date	Water Level (m)	Hole Open to (m)
On Completion	Dry	

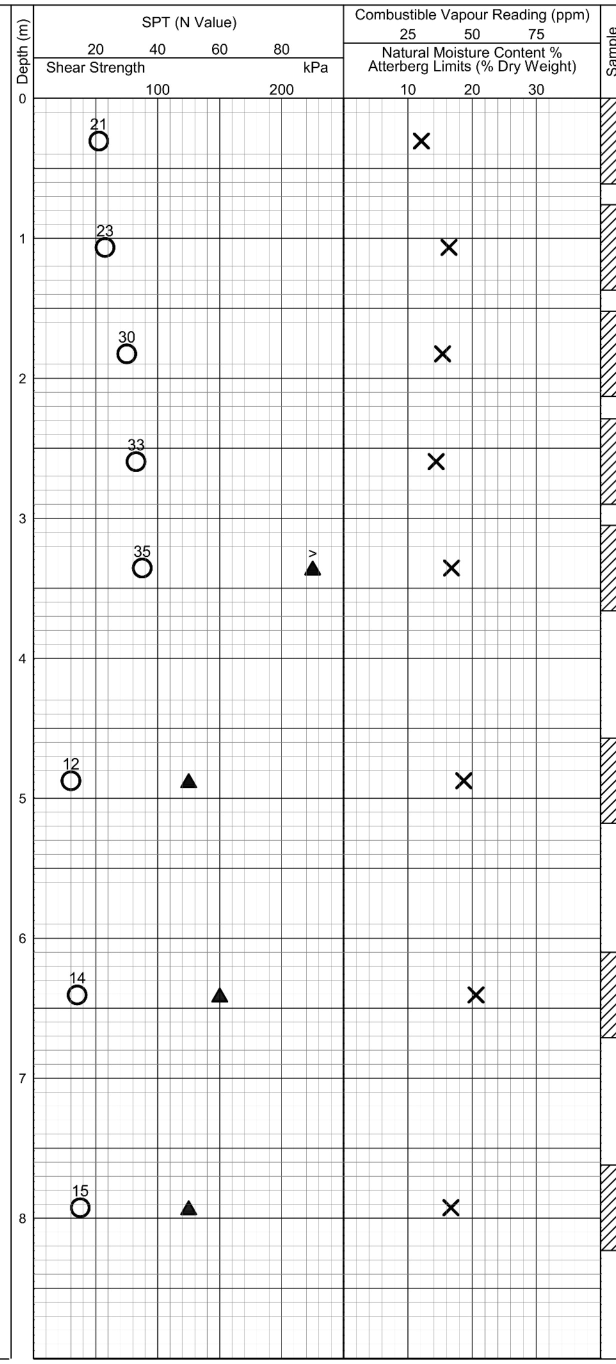
exp.

Log of Borehole BH 4

Project No.	BRM-00603811-B0	Drawing No.	5
Project:	Geotechnical Investigation	Sheet No.	1 of 1
Location:	9229 5th Sideroad, Caledon, Ontario		
	Bolton, Ontario		
Date Drilled:	September 25, 2020		
Drill Type:	Hollow Stem Auger - CME 75		
Datum:	Geodetic		

Auger Sample	⊠	Combustible Vapour Reading	□
SPT (N) Value	○ ▨	Natural Moisture	×
Dynamic Cone Test	—	Plastic and Liquid Limit	├──○
Shelby Tube	■	Undrained Triaxial at % Strain at Failure	⊕
Field Vane Test	S	Penetrometer	▲

Soil Description	ELEV. m	Depth (m)
	249.93	0
~80 mm **TOPSOIL** over **FILL:** Reworked sandy silt, some silty sand layer, trace rootlets in the upper portion, brown, moist		
SANDY SILT TILL: some clay, trace gravel, oxidized zones, brown, moist, compact to dense	~249.1	
CLAYEY SILT TILL: trace sand, trace gravel, grey, moist, hard	~246.9	
-becoming stiff	~245.7	
END OF BOREHOLE	~241.7	



Natural Unit Weight kN/m³
21.9
21.3

EXPLOGBRAMPTON 9229 5TH SIDEROAD - BOREHOLE LOGS.GPJ NEW.GDT 10/7/20

Date	Water Level (m)	Hole Open to (m)
On Completion	Dry	

exp.

Log of Borehole BH 5

Project No. BRM-00603811-B0

Drawing No. 6

Project: Geotechnical Investigation

Sheet No. 1 of 1

Location: 9229 5th Sideroad, Caledon, Ontario

Bolton, Ontario

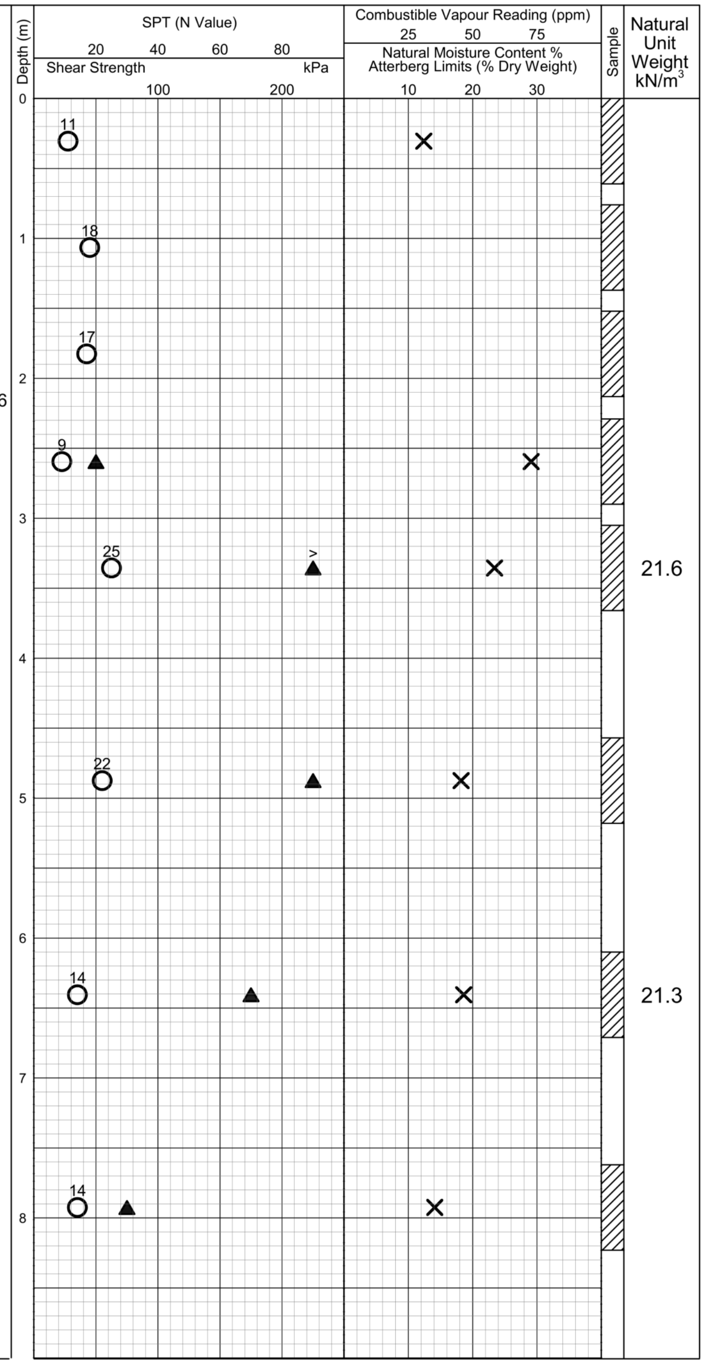
Date Drilled: September 25, 2020

Drill Type: Hollow Stem Auger - CME 75

Datum: Geodetic

Legend	
Auger Sample	⊠
SPT (N) Value	○ ▨
Dynamic Cone Test	—
Shelby Tube	■
Field Vane Test	S
Combustible Vapour Reading	□
Natural Moisture	×
Plastic and Liquid Limit	├──○
Undrained Triaxial at % Strain at Failure	⊕
Penetrometer	▲

Groundwater	Soil/Rock Symbol	Soil Description	ELEV. m
			249.80
		~100 mm **TOPSOIL** over **FILL:** Reworked clayey silt, some sand, trace rootlets in the upper portion, dark brown to brown, moist	
			~248.0
		CLAYEY SILT TILL: trace garvel, brown to grey below 3.0 m, moist, firm to very stiff	~247.6
		-wet seams	
			~244.2
		-becoming stiff	
			~241.6
		END OF BOREHOLE	



Date	Water Level (m)	Hole Open to (m)
On Completion	Dry	
September 28, 2020	2.2	

EXPLOGBRAMPTON 9229 5TH SIDEROAD - BOREHOLE LOGS.GPJ NEW.GDT 10/7/20

exp.

LOG OF DRILLING OPERATIONS

PZ1

BURNSIDE
R.J. Burnside & Associates Limited
292 Speedvale Avenue West, Unit 20, Guelph, Ontario, N1H 1C4
telephone (519) 823-4995 fax (519) 836-5447

Client: **Carantania Investments (BT) Inc.**	Project Name: **Proposed Residential Dev.**	Logged by: **J. Donkersgoed**
Project No.: **300052444**	Location: **Bolton, Ontario**	Ground (m amsl): **251.0**
Drilling Co.: **R.J. Burnside**	Date Started: **11/27/2020**	Static Water Level Depth (m):
Drilling Method: **Hand Auger**	Date Completed: **11/27/2020**	Sand Pack Depth (m) : **NA**

Surface Elevation (m): **251.00**

Depth (m)	Stratigraphic Description	Elev. (m)	Depth (m)	Sample Type
0.00–0.50	Peat and Organics, layered	250.50	0.50	CS
0.50–1.80	SANDY SILT TILL, trace clay, moist, oxidization, brown	249.20	1.80	CS
1.80–2.00	SAND, some silt, some gravel, reddish brown, damp	249.00	2.00	CS
2.00–2.38	CLAYEY SILT TILL, trace gravel, moist, grey-brown	248.62	2.38	CS
	End of Borehole			

Well: steel casing; stainless steel screen; 3.00

Depth Scale (ft) (m): 1.0, 5.0, 2.0, 3.0

Prepared By: **J.D.** Checked By: **T.M.** Date Prepared: **11/30/2020**

This borehole log was prepared for hydrogeological and/or environmental purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by R. J. Burnside & Associates Limited personnel before use by others.

LEGEND
- ▼ Water found @ time of drilling
- ▽ Static Water Level -

MONITORING WELL DATA
- Pipe: **32 mm dia. Steel**
- Screen: **32 mm dia. s.s. #10 slot**

SAMPLE TYPE
- AC Auger Cutting
- CS Continuous
- RC Rock Core
- SS Split Spoon
- AR Air Rotary
- WC Wash Cuttings

LOG OF DRILLING OPERATIONS

PZ2

BURNSIDE
R.J. Burnside & Associates Limited
292 Speedvale Avenue West, Unit 20, Guelph, Ontario, N1H 1C4
telephone (519) 823-4995 fax (519) 836-5447

Client: **Carantania Investments (BT) Inc.**	Project Name: **Proposed Residential Dev.**	Logged by: **J. Donkersgoed**
Project No.: **300052444**	Location: **Bolton, Ontario**	Ground (m amsl): **249.4**
Drilling Co.: **R.J. Burnside**	Date Started: **11/27/2020**	Static Water Level Depth (m):
Drilling Method: **Hand Auger**	Date Completed: **11/27/2020**	Sand Pack Depth (m) : **NA**

Surface Elevation (m): **249.40**

Depth Scale (ft)	Depth Scale (m)	Stratigraphic Description	Elev. (m)	Depth (m)	Well	Sample Num.	Sample Type	Sample Int.
		Topsoil, dark brown, moist	249.15	0.25	steel casing			
		Silty Sand FILL, some gravel, trace organics, dark brown, moist	248.70	0.70	steel casing		CS	
		SILTY SAND, some gravel, reddish brown, damp	248.60	0.80	steel casing			
	1.0	SANDY SILT TILL, trace clay, trace gravel, moist, grey-brown	248.00	1.40	steel casing			
5.0		Auger Refusal on Gravel		1.61	stainless steel screen			

Prepared By: **J.D.** Checked By: **T.M.** Date Prepared: **11/30/2020**

This borehole log was prepared for hydrogeological and/or environmental purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by R. J. Burnside & Associates Limited personnel before use by others.

LEGEND	MONITORING WELL DATA	SAMPLE TYPE
Water found @ time of drilling	Pipe: **32 mm dia. Steel**	AC Auger Cutting; SS Split Spoon
Static Water Level -	Screen: **32 mm dia. s.s. #10 slot**	CS Continuous; AR Air Rotary
		RC Rock Core; WC Wash Cuttings

2019_BHLOG_COLOUR C:\USERS\JDONKERSGOED\ONEDRIVE - RJB_TRAVIS\BOLTON 300052444\052444_BOLTON 5 SIDE ROAD.GPJ 2019_1.GDT 11/30/20

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Appendix C

Grainsize Analysis

Appendix C

exp Services Inc.
1595 Clark Boulevard, Brampton
Ontario, Canada, L6T 4V1
Telephone: (905) 793-9800
Fax: (905) 793-0641

Grain Size Analysis & Hydrometer Test Report

ST08

Sample Test No.: 361386-1 **Report No.:** 1 **Date Reported:** 10-Feb-21

Project No.: brm-00603811-b0
Project Name: 9229 5th Sideroad, Bolton, ON - Geotechnical Investigation

Grain Size Proportion (%)

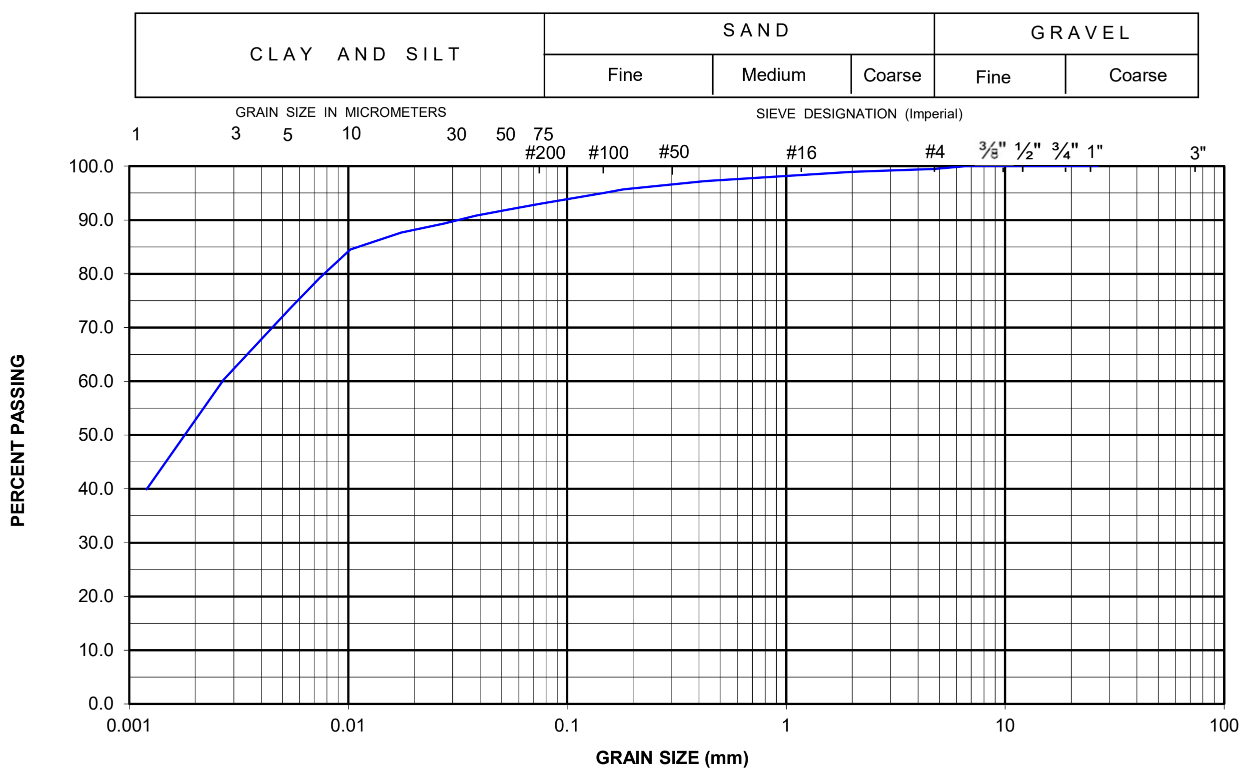
Gravel (> 4.75mm):	**0.5**
Sand (> 75µm, < 4.75mm):	**6.5**
Silt (> 2µm), < 75µm):	**42.2**
Clay (< 2µm):	**50.8**
Total:	**100.0**

Sample Information

Location:	BH 2
Sample Method:	SS
Sample No.:	7
Depth:	6.1 - 6.7 m
Sample Description:	Clay and Silt, trace Sand and Gravel; Grey
Sampled By:	exp Brampton
Sampling Date:	9/25/2020
Date Received:	2/1/2021
Client Sample ID:	
Comments:	

Grain Size (mm)	% Passing	Grain Size (mm)	% Passing
26.5	100.0	**0.0383**	90.8
22.4	100.0	**0.0273**	89.3
19	100.0	**0.0174**	87.7
16	100.0	**0.0102**	84.5
13.2	100.0	**0.0074**	79.2
12.5	100.0	**0.0054**	73.5
9.5	100.0	**0.0027**	60.3
6.7	100.0	**0.0012**	39.9
4.75	99.5		
2	98.9		
0.85	98.0		
0.425	97.2		
0.25	96.3		
0.18	95.7		
0.15	95.1		
0.075	93.0		
0.053	91.9		

UNIFIED SOIL CLASSIFICATION SYSTEM



Project Manager: Aamna Arora **Approved By:** *Original Signed By* **Date Approved:** 10-Feb-21

Willie Rodych, Lab Supervisor

exp Services Inc.
1595 Clark Boulevard, Brampton
Ontario, Canada, L6T 4V1
Telephone: (905) 793-9800
Fax: (905) 793-0641

Grain Size Analysis & Hydrometer Test Report

ST08

Sample Test No.: 361387-1 **Report No.:** 2 **Date Reported:** 10-Feb-21

Project No.: brm-00603811-b0
Project Name: 9229 5th Sideroad, Bolton, ON - Geotechnical Investigation

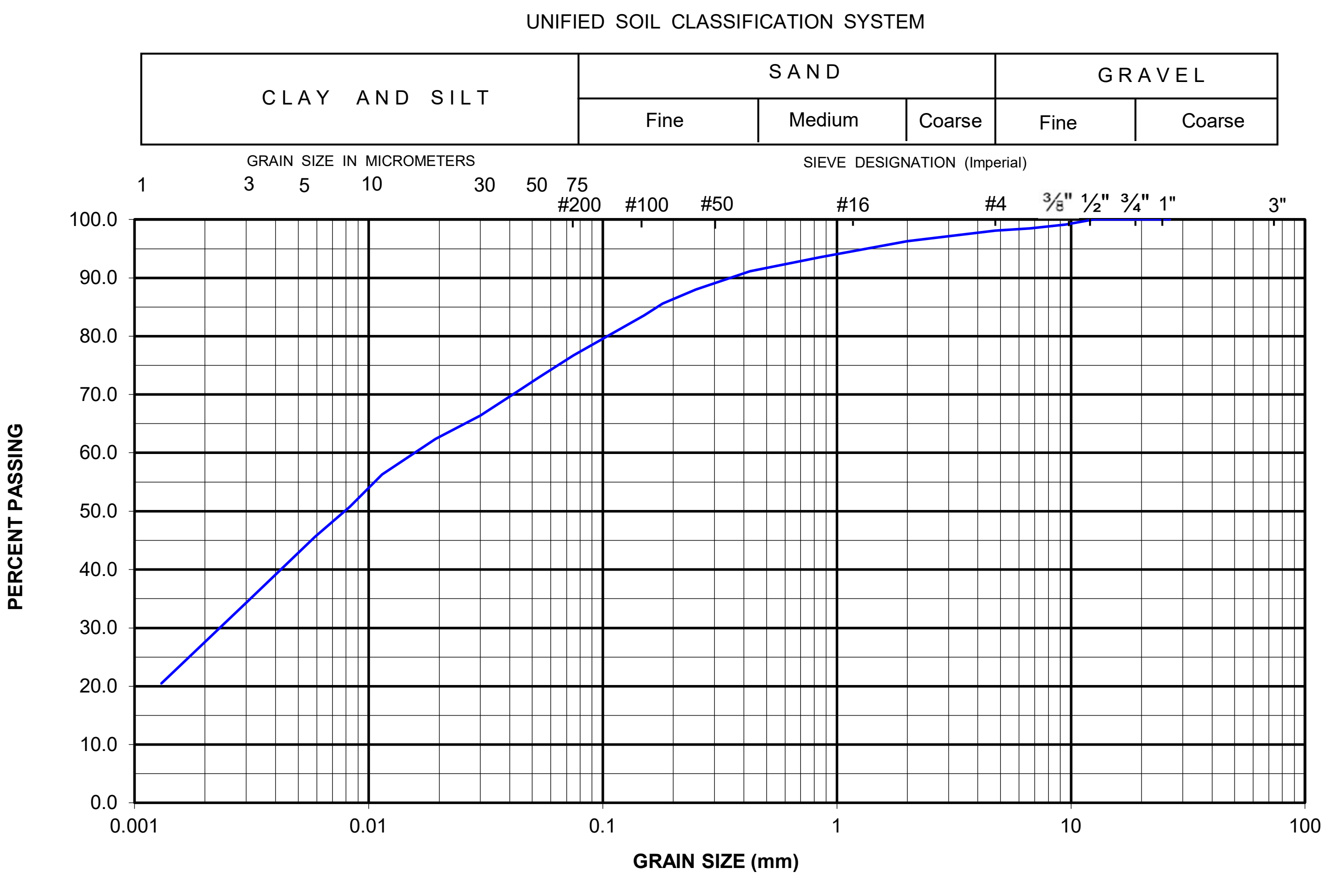
Grain Size Proportion (%)

Gravel (> 4.75mm):	**1.9**
Sand (> 75μm, < 4.75mm):	**21.4**
Silt (> 2μm), < 75μm):	**50.5**
Clay (< 2μm):	**26.2**
Total:	**100.0**

Sample Information

Location: BH 3
Sample Method: SS
Sample No.: 2
Depth: 0.8 - 1.4 m
Sample Description: Sandy, Clayey Silt; trace Gravel; Brown
Sampled By: exp Brampton
Sampling Date: 9/25/2020
Date Received: 2/1/2021
Client Sample ID:
Comments:

Grain Size (mm)	% Passing	Grain Size (mm)	% Passing
26.5	100.0	**0.0418**	70.1
22.4	100.0	**0.0300**	66.4
19	100.0	**0.0193**	62.4
16	100.0	**0.0114**	56.3
13.2	100.0	**0.0083**	50.8
12.5	100.0	**0.0059**	45.6
9.5	99.1	**0.0030**	34.3
6.7	98.5	**0.0013**	20.5
4.75	98.1		
2	96.3		
0.85	93.5		
0.425	91.1		
0.25	88.0		
0.18	85.6		
0.15	83.6		
0.075	76.7		
0.053	72.8		



Project Manager: Aamna Arora **Approved By:** *Original Signed By* Willie Rodych, Lab Supervisor **Date Approved:** 10-Feb-21

exp Services Inc.
1595 Clark Boulevard, Brampton
Ontario, Canada, L6T 4V1
Telephone: (905) 793-9800
Fax: (905) 793-0641

Grain Size Analysis & Hydrometer Test Report

ST08

Sample Test No.: 361388-1 **Report No.:** 3 **Date Reported:** 10-Feb-21

Project No.: brm-00603811-b0
Project Name: 9229 5th Sideroad, Bolton, ON - Geotechnical Investigation

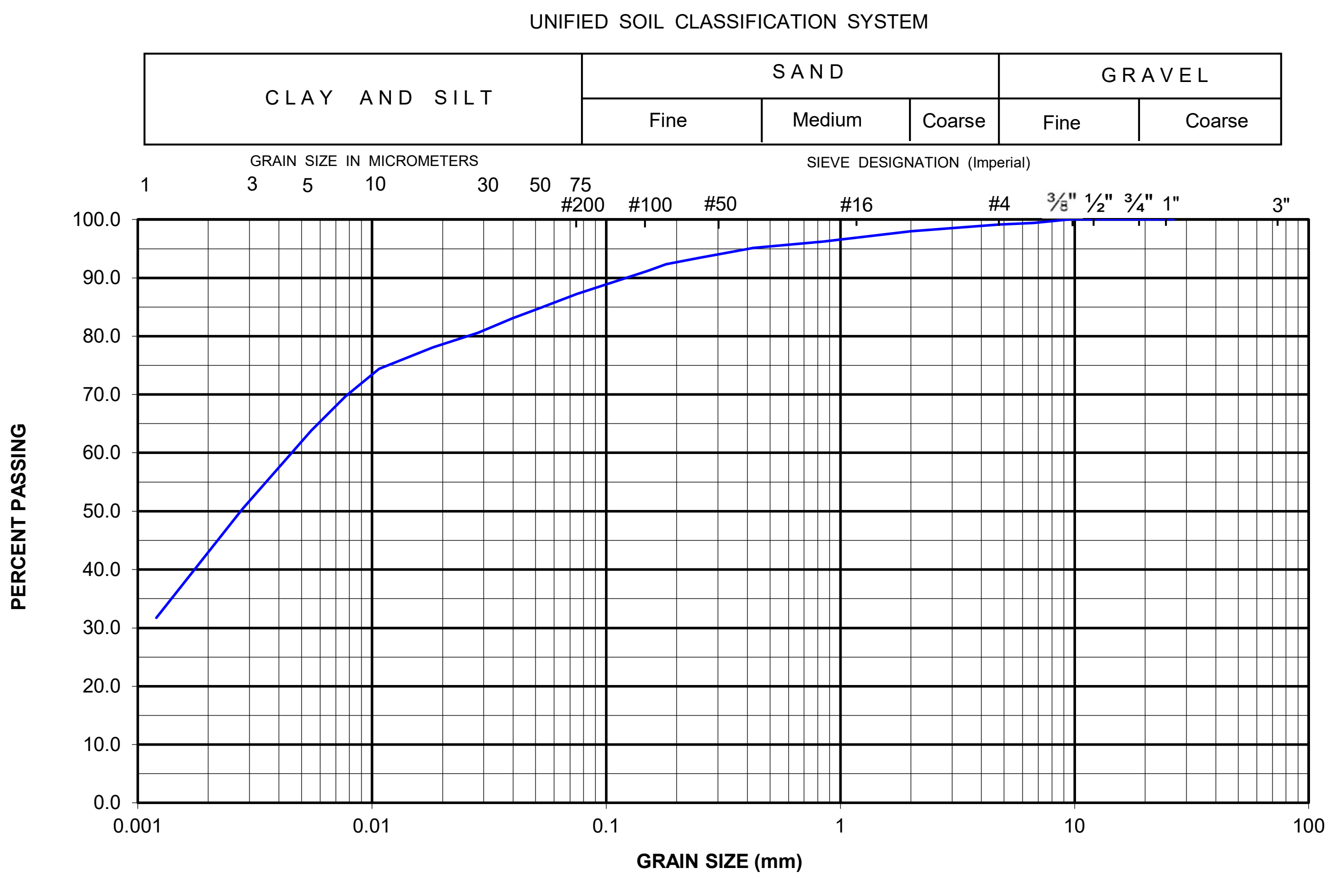
Grain Size Proportion (%)

Gravel (> 4.75mm):	**0.9**
Sand (> 75μm, < 4.75mm):	**11.9**
Silt (> 2μm), < 75μm):	**46.1**
Clay (< 2μm):	**41.1**
Total:	**100.0**

Sample Information

Location: BH 4
Sample Method: SS
Sample No.: 3
Depth: 1.5 - 2.1 m
Sample Description: Silt and Clay, some Sand; trace Gravel; Brown
Sampled By: exp Brampton
Sampling Date: 9/25/2020
Date Received: 2/1/2021
Client Sample ID:
Comments:

Grain Size (mm)	% Passing	Grain Size (mm)	% Passing
26.5	100.0	**0.0397**	83.1
22.4	100.0	**0.0284**	80.6
19	100.0	**0.0182**	78.1
16	100.0	**0.0107**	74.4
13.2	100.0	**0.0077**	69.7
12.5	100.0	**0.0055**	63.8
9.5	100.0	**0.0028**	50.4
6.7	99.5	**0.0012**	31.7
4.75	99.1		
2	98.0		
0.85	96.3		
0.425	95.2		
0.25	93.5		
0.18	92.3		
0.15	91.2		
0.075	87.2		
0.053	85.0		



Project Manager: Aamna Arora **Approved By:** *Original Signed By* Willie Rodych, Lab Supervisor **Date Approved:** 10-Feb-21

exp Services Inc.
1595 Clark Boulevard, Brampton
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Telephone: (905) 793-9800
Fax: (905) 793-0641

Grain Size Analysis & Hydrometer Test Report

ST08

Sample Test No.: 361389-1 **Report No.:** 4 **Date Reported:** 10-Feb-21

Project No.: brm-00603811-b0
Project Name: 9229 5th Sideroad, Bolton, ON - Geotechnical Investigation

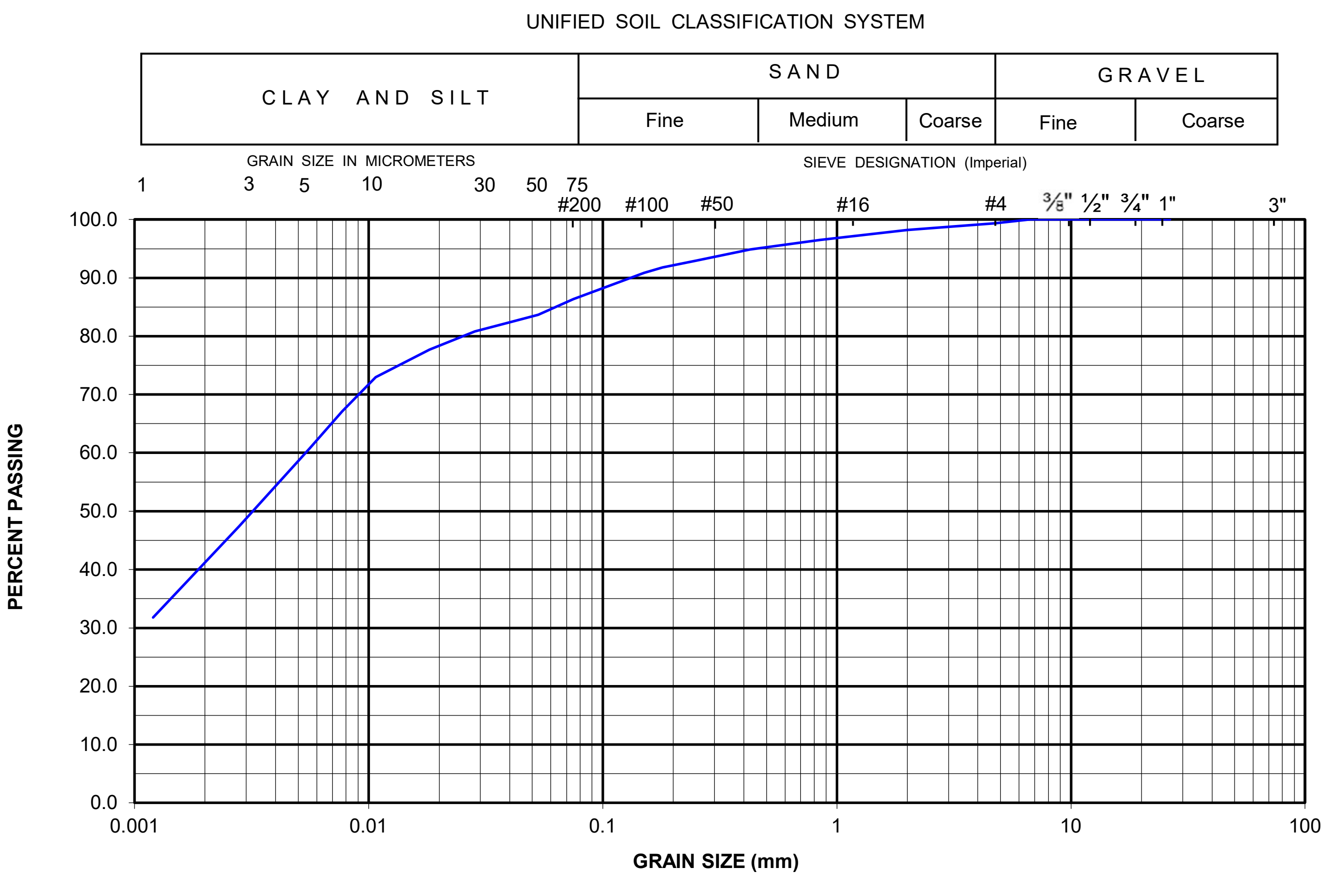
Grain Size Proportion (%)

Gravel (> 4.75mm):	**0.6**
Sand (> 75µm, < 4.75mm):	**13.1**
Silt (> 2µm), < 75µm):	**46.7**
Clay (< 2µm):	**39.6**
Total:	**100.0**

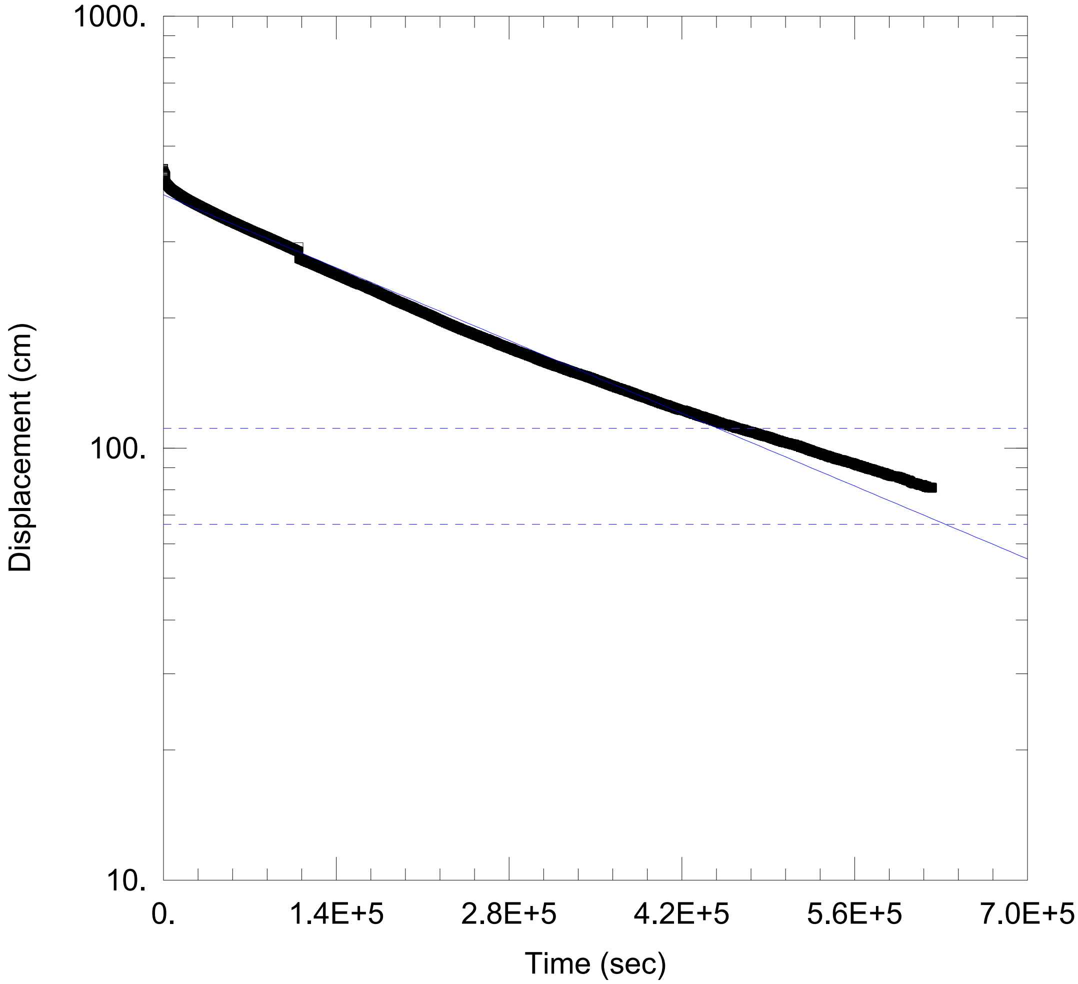
Sample Information

Location: BH 5
Sample Method: SS
Sample No.: 7
Depth: 6.1 - 6.7 m
Sample Description: Silt and Clay, some Sand; trace Gravel; Grey
Sampled By: exp Brampton
Sampling Date: 9/25/2020
Date Received: 2/1/2021
Client Sample ID:
Comments:

Grain Size (mm)	% Passing	Grain Size (mm)	% Passing
26.5	100.0	**0.0398**	82.4
22.4	100.0	**0.0284**	80.8
19	100.0	**0.0182**	77.7
16	100.0	**0.0107**	73.0
13.2	100.0	**0.0077**	67.1
12.5	100.0	**0.0056**	60.8
9.5	100.0	**0.0028**	47.4
6.7	100.0	**0.0012**	31.8
4.75	99.4		
2	98.2		
0.85	96.5		
0.425	94.8		
0.25	92.9		
0.18	91.8		
0.15	90.9		
0.075	86.3		
0.053	83.7		



Project Manager: Aamna Arora **Approved By:** *Original Signed By* Willie Rodych, Lab Supervisor **Date Approved:** 10-Feb-21



HYDRAULIC CONDUCTIVITY TEST AT BH5 - SCREENED IN CLAYEY SILT TILL

PROJECT INFORMATION

Company: R.J Burnside & Associates Ltd.
Project: 300052444
Location: 5 Sideroad, Bolton
Test Well: BH5
Test Date: February 2, 2020

AQUIFER DATA

Saturated Thickness: 653. cm

Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (BH5)

Initial Displacement: 444. cm
Total Well Penetration Depth: 653. cm
Casing Radius: 2.54 cm

Static Water Column Height: 653. cm
Screen Length: 304. cm
Well Radius: 7.62 cm
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 5.531E-7 cm/sec

y0 = 385.5 cm

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Appendix D

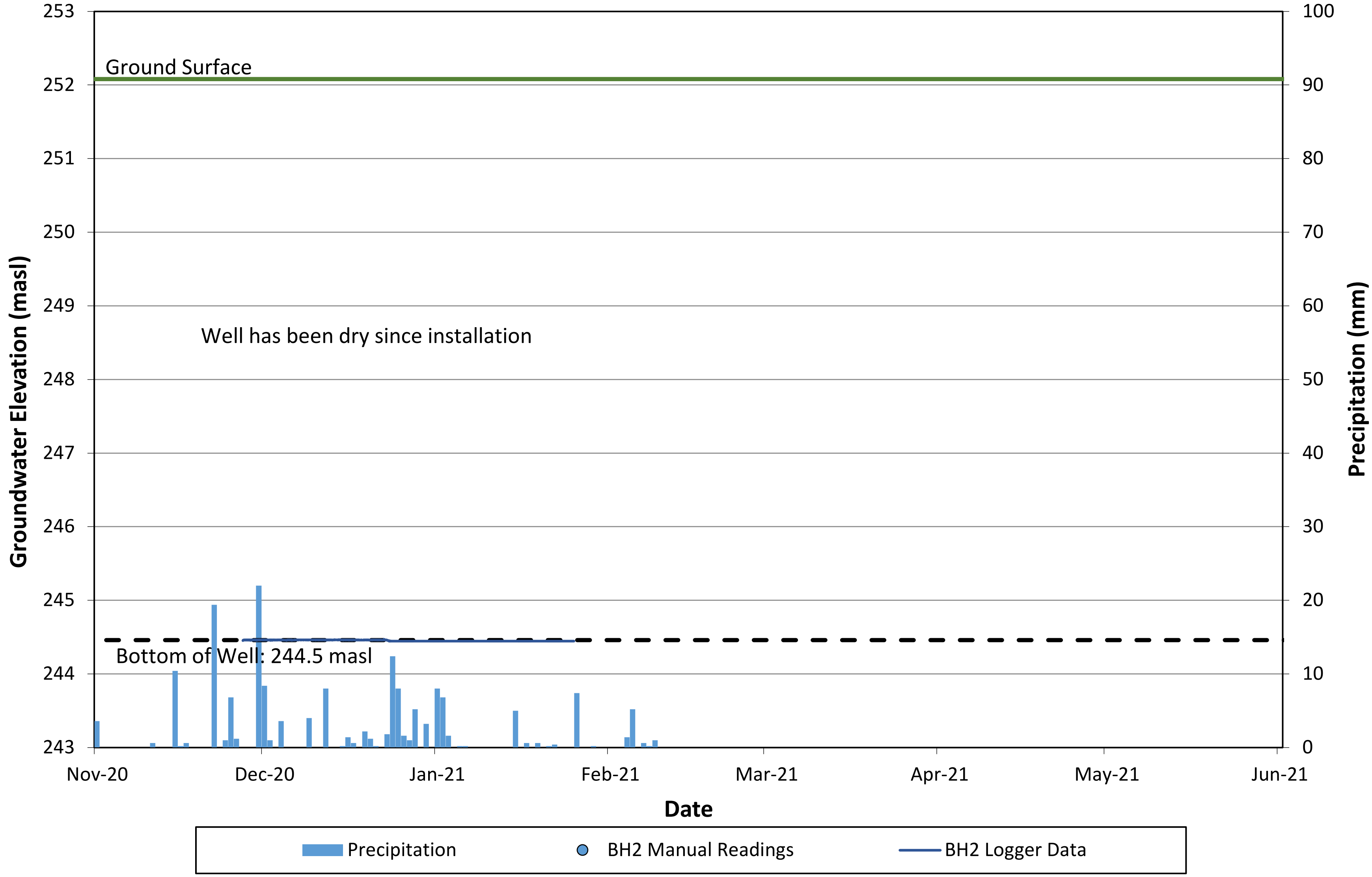
Groundwater Monitoring

Table D-1: Groundwater Elevations

Well	Well Depth (mbgs)	Ground Elevation (masl)	27-Nov-20		22-Dec-20		21-Jan-21	
			Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)
BH2	7.62	252.08	Dry	Dry	Dry	Dry	Dry	Dry
BH5	7.68	249.83	2.40	247.43	3.31	246.52	2.01	247.82
Dug Well	29.60	**252.00**	26.36	225.64	-	-	-	-
PZ1s	1.25	**251.00**	Dry	Dry	0.20	250.80	0.76	250.24
PZ1d	3.00	**251.00**	Dry	Dry	0.91	250.09	0.64	250.36
PZ2	1.61	**249.40**	Dry	Dry	Dry	Dry	1.27	248.13

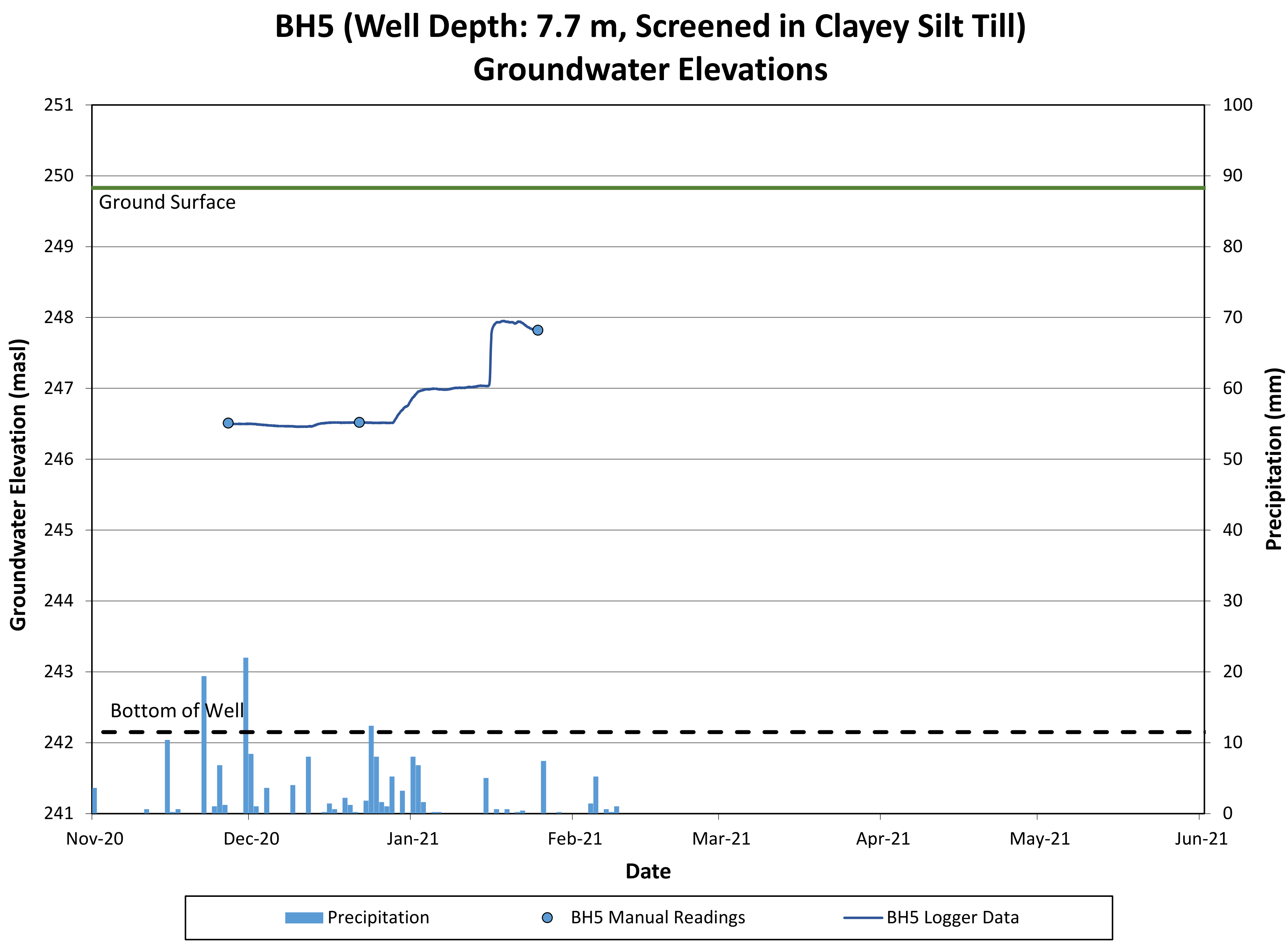
Notes:
"-" denotes data not available
mbgs - metres below ground level
masl - metres above sea level
Bolded Ground Elevations are estimated from topographic contours

BH2 (Well Depth: 7.6 m, Screened in Clayey Silt Till)
Groundwater Elevations



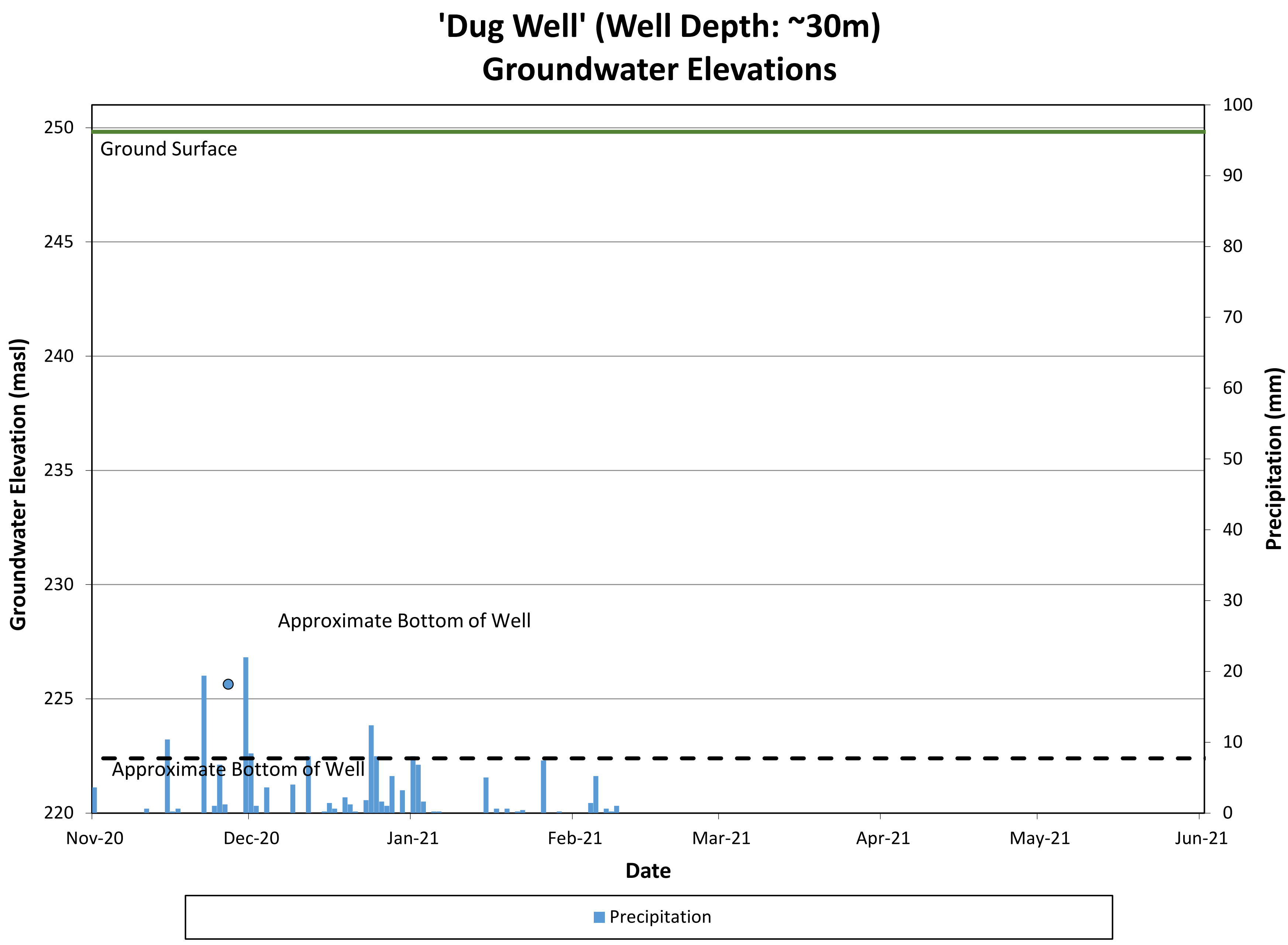
R.J. Burnside & Associates Limited
300052444

Figure D-1



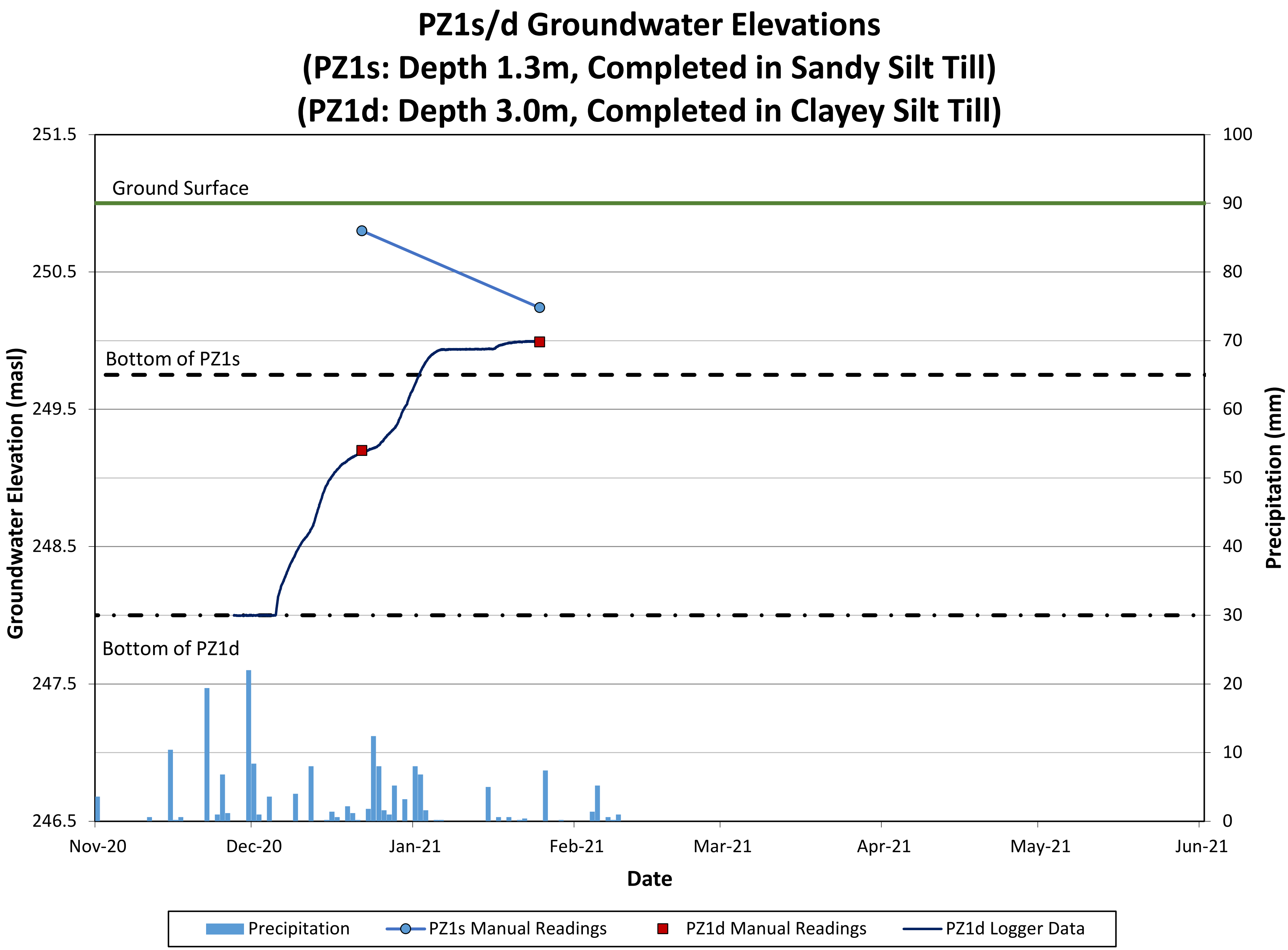
R.J. Burnside & Associates Limited
300052444

Figure D-2



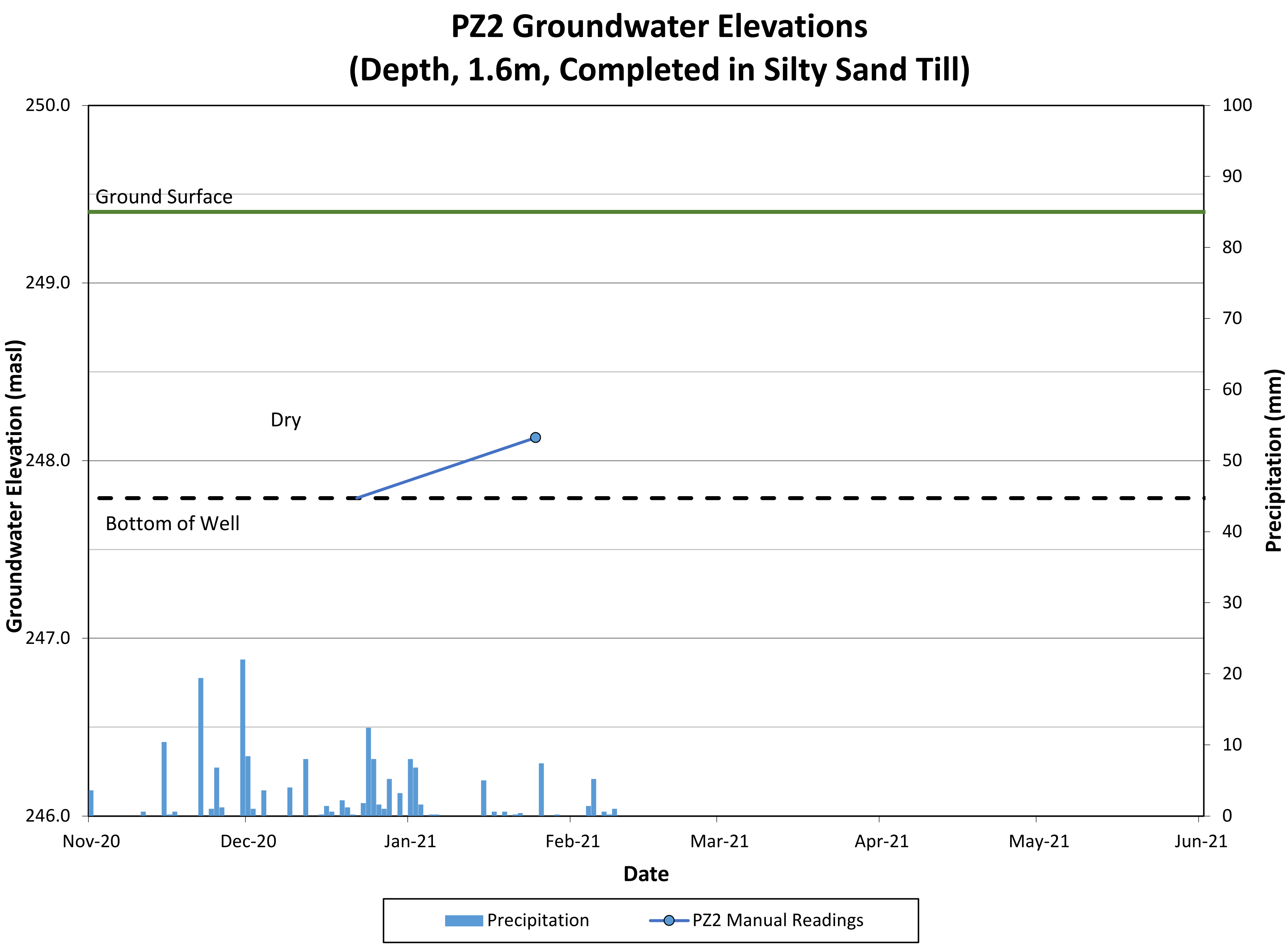
R.J. Burnside & Associates Limited
300052444

Figure D-3



R.J. Burnside & Associates Limited
300052444

Figure D-4



R.J. Burnside & Associates Limited
300052444

Figure D-5

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Appendix E

Water Balance

WATER BALANCE CALCULATIONS
Carantania Investments (BT) Inc.

PROJECT No.300052444.0000

TABLE E-1

Pre- Development Monthly Water Balance Components

Based on Thornthwaite's Soil Moisture Balance Approach with a Soil Moisture Retention of 250 mm (pasture and shrubs in silt and clay till soils)

Precipitation data from Toronto Lester B. Pearson International Airport Climate Station (1981 - 2010)

Potential Evapotranspiration Calculation	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Average Temperature (Degree C)	-5.5	-4.5	0.1	7.1	13.1	18.6	21.5	20.6	16.2	9.5	3.7	-2.2	**8.2**
Heat index: $i = (t/5)^{1.514}$	0.00	0.00	0.00	1.70	4.30	7.31	9.10	8.53	5.93	2.64	0.63	0.00	**40.1**
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	0.25	30.43	60.72	90.16	106.17	101.17	77.16	42.26	14.59	0.00	**523**
Adjusting Factor for U (Latitude 43^{o} 40' N)	0.81	0.82	1.02	1.12	1.26	1.28	1.29	1.2	1.04	0.95	0.81	0.77	
Adjusted Potential Evapotranspiration PET (mm)	0	0	0	34	77	115	137	121	80	40	12	0	**617**
COMPONENTS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Precipitation (P)	52	48	50	69	74	72	76	78	75	61	75	58	**786**
Potential Evapotranspiration (PET)	0	0	0	34	77	115	137	121	80	40	12	0	**617**
P - PET	52	48	50	34	-2	-44	-61	-43	-6	21	63	58	**169**
Change in Soil Moisture Storage	14	0	0	0	-2	-44	-61	-43	-6	21	63	58	**0**
Soil Moisture Storage max 250 mm	250	250	250	250	248	204	143	99	94	115	178	236	
Actual Evapotranspiration (AET)	0	0	0	34	77	115	137	121	80	40	12	0	**617**
Soil Moisture Deficit max 250 mm	0	0	0	0	2	46	107	151	156	135	72	14	
Water Surplus - available for infiltration or runoff	38	48	50	34	0	0	0	0	0	0	0	0	**169**
Potential Infiltration (based on MOE metholodogy*; independent of temperature)	23	29	30	21	0	0	0	0	0	0	0	0	**102**
Potential Direct Surface Water Runoff (independent of temperature)	15	19	20	14	0	0	0	0	0	0	0	0	**68**
IMPERVIOUS AREA WATER SURPLUS													
Precipitation (P)	786	mm/year											
Potential Evaporation (PE) from impervious areas (assume 15%)	118	mm/year											
P-PE (surplus available for runoff from impervious areas)	668	mm/year											

Assume January storage is 100% of Soil Moisture Storage		
Soil Moisture Storage	250 mm	<-- See "Water Holding Capacity" values in Table 3.1, MOE SWMPDM, 2003
*MOE SWM infiltration calculations		
topography - flat	0.3	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
soils - sandy silt till	0.2	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
cover - shrubs and pasture (Open Space)	0.1	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
Infiltration factor	**0.6**	
Latitude of site (or climate station)	43 ^{O} N.	

WATER BALANCE CALCULATIONS
Carantania Investments (BT) Inc.

PROJECT No.300052444.0000

TABLE E-2

Post-Development Monthly Water Balance Components

Based on Thornthwaite's Soil Moisture Balance Approach with a Soil Moisture Retention of 125 mm (shallow rooted vegetation/urban lawns in sandy silt till soils)

Precipitation data from Toronto Lester B. Pearson International Airport Climate Station (1981 - 2010)

Potential Evapotranspiration Calculation	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Average Temperature (Degree C)	-5.50	-4.50	0.10	7.10	13.10	18.60	21.50	20.60	16.20	9.50	3.70	-2.20	**8.2**
Heat index: $i = (t/5)^{1.514}$	0.00	0.00	0.00	1.70	4.30	7.31	9.10	8.53	5.93	2.64	0.63	0.00	**40.1**
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	0.25	30.43	60.72	90.16	106.17	101.17	77.16	42.26	14.59	0.00	**523**
Adjusting Factor for U (Latitude 43° 40' N)	0.81	0.82	1.02	1.12	1.26	1.28	1.29	1.2	1.04	0.95	0.81	0.77	
Adjusted Potential Evapotranspiration PET (mm)	0	0	0	34	77	115	137	121	80	40	12	0	**617**
COMPONENTS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Precipitation (P)	52	48	50	69	74	72	76	78	75	61	75	58	**786**
Potential Evapotranspiration (PET)	0	0	0	34	77	115	137	121	80	40	12	0	**617**
P - PET	52	48	50	34	-2	-44	-61	-43	-6	21	63	58	**169**
Change in Soil Moisture Storage	0	0	0	0	-2	-44	-61	-18	0	21	63	41	**0**
Soil Moisture Storage max 125 mm	125	125	125	125	123	79	18	0	0	21	84	125	
Actual Evapotranspiration (AET)	0	0	0	34	77	115	137	96	75	40	12	0	**585**
Soil Moisture Deficit max 125 mm	0	0	0	0	2	46	107	125	125	104	41	0	
Water Surplus - available for infiltration or runoff	52	48	50	34	0	0	0	0	0	0	0	17	**201**
Potential Infiltration (based on MOE metholodogy*; independent of temperature)	31	29	30	21	0	0	0	0	0	0	0	10	**120**
Potential Direct Surface Water Runoff (independent of temperature)	21	19	20	14	0	0	0	0	0	0	0	7	**80**
IMPERVIOUS AREA WATER SURPLUS													
Precipitation (P)	786	mm/year											
Potential Evaporation (PE) from impervious areas (assume 15%)	118	mm/year											
P-PE (surplus available for runoff from impervious areas)	668	mm/year											

Assume January storage is 100% of Soil Moisture Storage
Soil Moisture Storage 125 mm <-- See "Water Holding Capacity" values in Table 3.1, MOE SWMPDM, 2003

*MOE SWM infiltration calculations

topography - flat/graded land	0.3	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
soils - silty and clayey till	0.2	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
cover - urban lawns	0.1	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
Infiltration factor	**0.6**	

Latitude of site (or climate station) 43 ° N.

WATER BALANCE CALCULATIONS
Carantania Investments (BT) Inc.

PROJECT No.300052444.0000

TABLE E-3

Water Balance - Existing Conditions and Post-Development with No Mitigation

Land Use	Approx. Land Area (m^2)	Estimated Impervious Fraction for Land Use	Estimated Impervious Area (m^2)	Runoff from Impervious Area* (m/a)	Runoff Volume from Impervious Area (m^3/a)	Estimated Pervious Area (m^2)	Runoff from Pervious Area* (m/a)	Runoff Volume from Pervious Area (m^3/a)	Infiltration from Pervious Area* (m/a)	Infiltration Volume from Pervious Area (m^3/a)	Total Runoff Volume (m^3/a)	Total Infiltration Volume (m^3/a)
Existing Land Use												
Existing Residential Lands + Open Space	44,900	0.12	5,388	0.668	3,600	39,512	0.068	2,674	0.102	4,011	6,273	4,011
TOTAL PRE-DEVELOPMENT	**44,900**		**5,388**		**3,600**	**39,512**		**2,674**		**4,011**	**6,273**	**4,011**
Post-Development Land Use												
Residential - Detached Dwellings	33,650	0.57	19,181	0.668	12,814	14,470	0.080	1,161	0.120	1,741	13,975	1,741
Streets	7,250	1.00	7,250	0.668	4,844	0	0.080	0	0.120	0	4,844	0
Park	4,000	0.00	0	0.668	0	4,000	0.080	321	0.120	481	321	481
TOTAL POST-DEVELOPMENT	**44,900**		**26,431**		**17,658**	**18,470**		**1,482**		**2,223**	**19,140**	**2,223**
% Change from Pre to Post											305	45
Effect of development (with no mitigation)											3.1 times increase	45% reduction in infiltration

* figures from Tables E-1 and E-2

To balance pre- to post-,
the infiltration target (m^3/a)= **1,788** **m^3/a**

WATER BALANCE CALCULATIONS
Carantania Investments (BT) Inc.

PROJECT No.300052444.0000

TABLE E-4

Post-Development Monthly Water Balance Components

Based on Thornthwaite's Soil Moisture Balance Approach with a Soil Moisture Retention of 125 mm (urban lawns in sandy silt till soils) + additional topsoil

Precipitation data from Toronto Lester B. Pearson International Airport Climate Station (1981 - 2010)

Potential Evapotranspiration Calculation	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Average Temperature (Degree C)	-5.50	-4.50	0.10	7.10	13.10	18.60	21.50	20.60	16.20	9.50	3.70	-2.20	**8.2**
Heat index: $i = (t/5)^{1.514}$	0.00	0.00	0.00	1.70	4.30	7.31	9.10	8.53	5.93	2.64	0.63	0.00	**40.1**
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	0.25	30.43	60.72	90.16	106.17	101.17	77.16	42.26	14.59	0.00	**523**
Adjusting Factor for U (Latitude 43^{o} 40' N)	0.81	0.82	1.02	1.12	1.26	1.28	1.29	1.2	1.04	0.95	0.81	0.77	
Adjusted Potential Evapotranspiration PET (mm)	0	0	0	34	77	115	137	121	80	40	12	0	**617**
COMPONENTS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Precipitation (P)	52	48	50	69	74	72	76	78	75	61	75	58	**786**
Potential Evapotranspiration (PET)	0	0	0	34	77	115	137	121	80	40	12	0	**617**
P - PET	52	48	50	34	-2	-44	-61	-43	-6	21	63	58	**169**
Change in Soil Moisture Storage	0	0	0	0	-2	-44	-61	-18	0	21	63	41	**0**
Soil Moisture Storage max 125 mm	125	125	125	125	123	79	18	0	0	21	84	125	
Actual Evapotranspiration (AET)	0	0	0	34	77	115	137	96	75	40	12	0	**585**
Soil Moisture Deficit max 125 mm	0	0	0	0	2	46	107	125	125	104	41	0	
Water Surplus - available for infiltration or runoff	52	48	50	34	0	0	0	0	0	0	0	17	**201**
Potential Infiltration (based on MOE metholodogy*; independent of temperature)	34	31	32	22	0	0	0	0	0	0	0	11	**130**
Potential Direct Surface Water Runoff (independent of temperature)	18	17	17	12	0	0	0	0	0	0	0	6	**70**
IMPERVIOUS AREA WATER SURPLUS													
Precipitation (P)	786	mm/year											
Potential Evaporation (PE) from impervious areas (assume 15%)	118	mm/year											
P-PE (surplus available for runoff from impervious areas)	668	mm/year											

Assume January storage is 100% of Soil Moisture Storage
Soil Moisture Storage 125 mm <-- See "Water Holding Capacity" values in Table 3.1, MOE SWMPDM, 2003

*MOE SWM infiltration calculations

topography - graded land	0.3	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
soils - sandy silt till + additional topsoil	0.25	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
cover - urban lawns	0.1	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
Infiltration factor	**0.65**	

Latitude of site (or climate station) 43 ^{O} N.

WATER BALANCE CALCULATIONS
Carantania Investments (BT) Inc.

PROJECT No.300052444.0000

TABLE E-5

Water Balance - Existing Conditions and Post-Development with Mitigation (with LIDs)

Land Use	Approx. Land Area (m^2)	Estimated Impervious Fraction for Land Use	Estimated Impervious Area (m^2)	Runoff from Impervious Area* (m/a)	Runoff Volume from Impervious Area (m^3/a)	Estimated Pervious Area (m^2)	Runoff from Pervious Area* (m/a)	Runoff Volume from Pervious Area (m^3/a)	Infiltration from Pervious Area* (m/a)	Infiltration Volume from Pervious Area (m^3/a)	Total Runoff Volume (m^3/a)	Total Infiltration Volume (m^3/a)
Existing Land Use												
Existing Residential Lands + Open Space	44,900	0.12	5,388	0.668	3,600	39,512	0.068	2,674	0.102	4,011	6,273	4,011
TOTAL PRE-DEVELOPMENT	**44,900**		**5,388**		**3,600**	**39,512**		**2,674**		**4,011**	**6,273**	**4,011**
Post-Development Land Use												
Residential - Detached Dwellings (less rear roofs)	27,350	0.47	12,881	0.668	8,606	14,469	0.070	1,016	0.130	1,887	9,622	1,887
Roof Areas - roof to grass with additional topsoil (assume 25% of runoff volume infiltrates)[a]	6,300	1.00	6,300	0.668	4,209	0	0.070	0	0.130	0	3,157	1,052
Streets	7,250	1.00	7,250	0.668	4,844	0	0.070	0	0.130	0	4,844	0
Park	4,000	0.00	0	0.668	0	4,000	0.070	281	0.130	522	281	522
TOTAL POST-DEVELOPMENT	**44,900**		**26,431**		**17,659**	**18,469**		**1,297**		**2,408**	**17,903**	**3,460**
% Change from Pre to Post											285	14
Effect of development (with mitigation)											2.9 times increase	14% reduction in infiltration

* figures from Tables E-1 and E-5

[a] based on estimation in the LID SWM Planning and Design Guide (CVC & TRCA, 2010) for hydrologic groups C & D

To balance pre- to post-,
the infiltration target (m^3/a)= **550** **m^3/a**

R.J. Burnside & Associates Limited