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Hydrogeological Assessment, Hewitt's Gate South Subdivision

Hansen Group Inc.
Barrie, Ontario

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1.0 Introduction

R.J. Burnside & Associates Limited (Burnside) has been retained by Hansen Group Inc. to complete a hydrogeological assessment for lands known as Hewitt’s Gate South and herein referred to as the subject lands. The subject lands are located east of Yonge Street and north of Lockhart Road in the City of Barrie, Ontario (Figure 1). Hewitt’s Creek transects the subject lands with a small 1.8 ha parcel located west of the creek, and a larger 15.6 ha parcel located east of the creek.

The lands are located within the Barrie Annexed Lands and the OPA 39 Hewitt’s Secondary Plan Area (SPA) located on the southern boundary of the City of Barrie. In 2016, a Subwatershed Impact Study (SIS) for the Hewitt’s SPA was completed for the Hewitt’s Creek Landowners Group that included an assessment of regional hydrogeology (Burnside, 2016). The Terms of Reference for the SIS included recommendations for additional studies to be done in support of draft plan approvals for the individual parcels within the Hewitt’s SPA. Burnside first completed a hydrogeological assessment for the subject lands in 2023. The current assessment is an update to the previous Burnside report that is being adjusted for the development plan and to better characterize the water balance contributions to areas west and east of the creek.

1.1 Scope of Work

The scope of work completed for the hydrogeological assessment was developed to build upon the more regional work completed for the Hewitt’s SPA (Burnside, 2016) and to address requirements for hydrogeological studies in support of draft plan approval. The scope of work for the hydrogeological assessment included the completion of the following site-specific tasks:

1. Review of published geological and hydrogeological information: A review of background material for the area, including topography, surficial geology and bedrock geology mapping, Source Water Protection mapping and existing geotechnical and hydrogeological reports was completed to assess the regional and local hydrogeological setting.

2. Review of the Ministry of the Environment, Conservation and Parks (MECP) water 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 plotted on Figure 5. 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 in the field. These well data were compiled and mapped to characterize the local

groundwater resources and assess potential impacts to the local private wells from development of the subject lands.

3. Groundwater monitoring network: A network of monitoring wells was installed for previous studies and the data from that network was used to gain information on groundwater distribution and fluctuations. The locations of the monitoring wells used for the current study are shown on Figure 2 and monitoring well construction details are provided on the borehole logs in Appendix B.

4. Hydraulic conductivity testing: Burnside conducted single well response tests at three monitoring wells (MW104, MW107 and MW111) on the subject lands to determine the hydraulic conductivity of selected layers within the subsurface. Historical hydraulic conductivity test results completed as part of the SIS (MW15d and CD-18) have also been included in the following study. The hydraulic conductivity field testing results are provided in Appendix C.

5. Monitoring of groundwater levels: Monitoring has been completed to measure the depth to the water table and assess the horizontal and vertical groundwater flow conditions. Groundwater level monitoring data is available from 2017 to 2023. Burnside completed groundwater level monitoring from January 2018 to December 2020 and one round in October 2023. Monitoring data collected by Peto MacCallum Ltd. (Peto) between January to December 2022 has been included herein. The groundwater monitoring data and hydrographs are provided in Appendix D.

6. Review of surface water conditions: Surface water monitoring was completed as part of the SIS at two monitoring locations on and adjacent to the subject lands (SW1-CD and SW2-CD, Figure 2). The stations were inspected for water depth and flow on site visits between 2018 and 2020. The surface water monitoring data are summarized in Appendix E.

7. Water quality review and testing: Water quality data was collected from two on-site monitoring wells, MW104 and MW107 to typify the water quality in the vicinity of the subject lands. The water samples were submitted to an accredited laboratory for analyses of general water quality indicators (e.g., pH, hardness, and conductivity), basic ions (including chloride and nitrate) and selected metals to characterize the background water quality at the property. The laboratory water quality data are provided in Appendix F.

8. Water balance calculations: Pre- and post-development water balance calculations have been completed to assess the groundwater infiltration volumes for the subject

lands on a west and east creek catchment basis. The local climate data and detailed water balance calculations are provided in Appendix G.

9. Reporting: All the data compiled as part of the assessment were reviewed in order to develop an understanding of site-specific hydrogeological conditions. The data were used to construct maps and figures and geological cross-sections in support of the interpreted geological conditions. The development concept was used to determine the potential impacts of the proposed development on the hydrogeological regime and mitigation techniques were examined in the context of applicability to the subject lands. The results of the assessment are presented in the current report.

2.0 Topography and Drainage

The subject lands are located within the Hewitt’s Creek subwatershed within the larger Lake Simcoe watershed (Figure 3). The topography of the subject lands is generally flat to gently rolling. Elevations on the west side of Hewitt’s Creek range from 258 meters above sea level (masl) along Lockhart Road to 253 masl at the northeast corner near the wetland. Elevations on the east side of Hewitt’s Creek range from a high of 265 masl near the southeast corner at Lockhart Road to a low of 253 masl at northwest corner near the wetland.

Hewitt’s Creek is the main drainage system within the subject lands and is associated with St. Paul’s Swamp (a Provincially Significant Wetland) located northwest of the subject lands. The main branch of Hewitt’s Creek transects the subject lands and flows south to north from south of Lockhart Road towards the St. Paul’s Swamp (Figure 3). A swale drainage feature is located north of the subject lands which flows east to west draining into a dug pond that outlets to the wetland.

3.0 Geology

The subject lands are located in the physiographic region known as the Peterborough Drumlin Field. The region is characterized as a rolling drumlinized till plain. The drumlins through the region are comprised of highly calcareous till (Chapman & Putnam, 1984).

The overburden in the vicinity of the subject lands was deposited as a series of advances and retreats of the Simcoe glacial ice lobe. This has resulted in the geology of the area being comprised of drumlinized sheets of glacial till (Newmarket till), stratified glaciolacustrine deposits of sand and gravel, littoral-foreshore deposits and massive-well laminated deposits of sand and gravel (OGS, 2003). A review of the quaternary geology mapping for the area (OGS, 2003) indicates that the overburden sediments of the subject lands consist primarily of silty to sandy glacial till with some coarse textured glacio-lacustrine deposits (Figure 4). The subject lands are mapped exclusively as sandy silt to silty sand till in the area west of Hewitt’s Creek while the area east of the creek is mapped as sandy silt to silty sand till with coarser grained sand and gravel mapped on the southeast portion. Organic deposits are also mapped in association with wetlands northwest of the subject lands.

The bedrock underlying the subject lands is mapped as the Lindsay Formation of the Simcoe Group, which consists of limestone and shale (OGS, 2007). The overburden has been estimated to be over 140 m thick in the vicinity of the subject lands (ORMGP, 2018).

4.0 Hydrogeology

4.1 Regional Hydrostratigraphy

The regional hydrogeology of an area describes the major aquifers and aquitards and the interactions between these types of hydrogeological units. Local conditions may vary from the regional interpretations based on site-specific conditions, however major groundwater flow systems are assumed to be regional in nature.

The overburden deposits underlying the subject lands have been interpreted by regional studies such as the Tier 3 Water Balance (AquaResource, 2011) and Source Water Protection Assessment Report (LSRCA, 2012) to consist of alternating sequences of coarser-grained permeable layers (aquifers) and finer-grained less permeable layers (aquitards) of varying thicknesses. This sequence of layers was also supported by the SIS (Burnside, 2016). The basic hydrostratigraphic sequence that was interpreted for the area of the subject lands includes four main aquifer layers (A1 to A4) and four main aquitards (C1 to C4) with a confining layer (UC) overlying the uppermost aquifer (A1).

A description of the interpreted regional hydrostratigraphic framework is provided below based on the Source Water Protection Assessment Report (LSRCA, 2012):

- Surficial Geology Layer – This layer represents coarse grained sediments in stream beds and at surface surficial geology areas that overly the UC. The thickness ranges from 0.1 m to 3 m.
- UC – Upper Confining Layer – Represents smaller areas of less permeable surficial material. Regional studies such as the AquaResource (2011) report indicate that the confining layer (UC) is patchy in the Barrie area and may also be patchy in the area of the subject lands.

- A1 – Represents the uppermost aquifer – Occasionally exists as a surficial unconfined aquifer and is stratigraphically equivalent to the Oak Ridges Moraine. It is generally associated with coarse grained glacial and interglacial sediments mapped as ice contact stratified drift. The majority of the local domestic wells in the Barrie area are completed within this aquifer.

- C1 – Upper aquitard – Described as varved clay and silt (LRSCA, 2012).
- A2 – Intermediate aquifer which is stratigraphically equivalent to areas within the Northern Till. The aquifer is generally described as being composed of sand with some clast rich portions (LRSCA, 2012). This area is used for the Innisfil Heights water supply.
- C2 – Intermediate aquitard.
- A3 – This area constitutes the main Barrie municipal aquifer and is the source of the Stroud water supply; it is stratigraphically equivalent to the Thorncliffe deposits in the Upland regions.
- C3 – Lower aquitard.
- A4 – Lower aquifer, thin and sometimes combined with A3 where C3 is thin or absent.
- C4 – Lower aquitard but may also represent weathered bedrock.

4.2 Local Stratigraphy

Boreholes were drilled across the subject lands as part of a geotechnical investigation by Peto in 2022. The locations of the boreholes are shown on Figure 5 and the borehole logs are provided in Appendix B. The boreholes indicated that the overburden is generally composed of layers of sandy silt to silty sand till overlying silty sand and sand. The till deposits also had varying amounts of clay and gravel. Localized units of silty clay were also encountered. The lithology encountered by the boreholes is generally consistent with the lithology shown on the geological maps.

To illustrate the shallow stratigraphy of the subject lands, schematic geologic cross-sections have been prepared by Burnside (Figure 6 and Figure 7) using the soils information collected during drilling of boreholes and monitoring wells (Appendix B) and MECP well records (Appendix A). The locations of the cross-sections are illustrated on Figure 5 along with the locations of water wells and boreholes used in the construction of the cross-sections. The cross-sections (Figure 6 and Figure 7) show that the subject lands are underlain by an intermittent sand layer at surface up to about 5 m thick. Where sand is not present at surface, there is a till layer with a thickness of about 12 m. The till layer confines a deeper sand layer found at elevations of 234 masl to 25 masl. The monitoring wells on the subject lands are generally completed in the surficial till with the exception of MW107 completed in the surficial sand layer above the till and MW110 completed in the confined sand layer below the till (Figure 6).

4.3 Soil Hydraulic Conductivity

Hydraulic Conductivity is a measure of a soil's ability to transmit groundwater. There are various methods that can be used to assess soil hydraulic conductivity depending on the available instrumentation. Grainsize data and soil characteristics collected during a geotechnical investigation can be used to provide a general estimate of hydraulic conductivity. Single well response tests such as in situ bail-down or slug-testing methods are used in groundwater monitoring wells to assess in situ hydraulic conductivity of the soils represented across the screened interval of the well. Single well response tests were completed to estimate the hydraulic conductivity of the soils encountered in the boreholes across the subject lands as discussed below.

4.3.1 Single Well Response Tests

To assess the in situ hydraulic conductivity of the sediments, single well response tests were completed at MW104, MW107, MW111, MW15d and CD18 (Figure 2). The results from the tests were plotted (Appendix C) and analyzed to calculate hydraulic conductivity of the sediments screened. A summary of the calculated hydraulic conductivities is provided below in Table 1.

Table 1: Single Well Response Testing Results

Monitoring Well	Screen Interval (mbgs)*	Formation Screened	Hydraulic Conductivity (cm/s)
MW104	3.0 – 4.5	Sandy Silt Till	4.8×10^{-5}
MW107	4.6 – 6.1	Sand	3.9×10^{-3}
MW111	4.6 – 6.1	Silty Sand Till	6.5×10^{-5}
MW15d	12.5 – 14.0	Silty Clay/Silty Sand	1.8×10^{-4}
CD-18	5.2 – 7.3	Silty Clay/Clayey Silt	1.1×10^{-4}

* metres below ground surface

4.3.2 Hydraulic Conductivity Discussion

Grainsize analyses from Peto (2022, Appendix C) indicate that the sediments within the overburden range in composition from clay and silt (85% fines) to silty sand till (40% fines). The greater amounts of fines within a deposit impacts the ability of the material to transmit water and generally lowers the overall hydraulic conductivity. Groundwater flow is generally limited by fine grained sediments with lower hydraulic conductivity.

The single well response test analyses resulted in hydraulic conductivities ranging from 10^{-3} cm/s to 10^{-5} cm/s. MW107 was screened in the surficial sand layer which forms the local surficial aquifer. The remaining tests at MW104, MW111, MW15d and CD-18 were screened in the overburden that acts as an aquitard, within fine grained till and silts and clays imbedded with sand. Overall, the hydraulic conductivity of the overburden sediments on the subject lands consisting of sand and silty sand till is interpreted to range from 10^{-3} cm/s (moderate) to 10^{-5} cm/s (low).

4.4 Local Groundwater Use

The City of Barrie obtains its water supply from a combination of groundwater and surface water-based sources. Municipal servicing is assumed to be available for lands within the municipal city boundary which includes lands north of Mapleview Drive (Figure 2). It is our understanding that while private servicing existed south of Mapleview Drive in the past, municipal servicing is being extended into the area as part of the development of the Hewitt’s Secondary Plan Area. Areas that were previously privately serviced are assumed to still have individual private water supply wells. A review of the MECP water well records for an area within 500 m of the subject lands indicates that there are 12 supply wells (livestock and domestic) located within this area. It is expected that as development proceeds the remaining residences will be included in the development process and that municipal services will be provided to all homes within the jurisdiction of the City of Barrie that are within 500 m of the subject lands. Lands within the Town of Innisfil, south of Lockhart Road may remain serviced by private supply wells, however as outlined in Section 8.2, no impact to surrounding wells is anticipated.

There are no municipal water supply wells located in the vicinity of the subject lands. The closest municipal supply wells are located on the west and northern sides of the city and more than 5 kilometers from the subject lands. The subject lands do not fall within any wellhead protection areas or intake protection zones associated with the City of Barrie water supply systems (LSRCA, 2012). The City of Barrie groundwater supply wells are located in deep aquifers (A3 and A4 in the regional hydrostratigraphy). These aquifers are interpreted to be found at elevations of 150 masl to 195 masl and 115 masl to 160 masl respectively and are therefore significantly below (approximately 70 to 100 m below the surficial layer found on the subject lands) and separated from any potential impact due to the proposed development (AquaResource et al., 2011).

4.5 Water Level Monitoring Results

Groundwater levels were monitored at monitoring wells across the subject lands in order to gain information on groundwater distribution and fluctuations. Groundwater levels were monitored at the on-site monitoring wells at various frequencies between 2017 and 2023. Burnside completed groundwater level monitoring from January 2018 to December 2020 and one round in October 2023. Additionally, Peto completed groundwater level monitoring from January to December 2022 and the data has been included herein. Groundwater elevations are plotted on hydrographs (Figures D-1 to D-13, Appendix D) with daily precipitation data obtained from a nearby climate station – Barrie-Oro (Climate Station ID# 6117700) which is the closest station with daily precipitation values for 2017 to 2023.

The groundwater monitoring data show the following (refer to Figure 2 for the monitoring locations and the data tables and hydrographs in Appendix D):

- Shallow wells in southern Ontario typically show a pattern of groundwater fluctuations that is related to seasonal variations in precipitation and infiltration. This pattern shows the highest groundwater levels occurring in the spring, levels declining throughout the summer and early fall and then rising again in the late fall/early winter. This pattern is apparent in the wells located on the subject lands (Figures D-1 to D-13, in Appendix D). The seasonal variation in water levels shows a range from 0.3 m at MW101 (Figure D-4) to 2.8 m at MW107 (Figure D-10). Seasonal variations at drive-point piezometers PZ4s/d (Figure D-14) were generally less than 0.8 m.

- Continuous water level data obtained from a datalogger installed at CD-18 was plotted against precipitation to determine whether there is a correlation between precipitation events (recharge events) and changes in water level (Figure D-1). At CD-18, there are minor changes in water levels in response to precipitation events.

- Groundwater potentiometric levels at the monitoring wells ranged from above grade in particular areas to 5.2 meters below ground surface for wells completed in the shallow subsurface. Groundwater potentiometric levels at CD-18, MW101, MW102 and MW110 show water levels above grade (Figures D-1, D-4, D-5 and D-12, respectively, Appendix D). These wells are screened within and/or below a sandy silt till layer in the subsurface. The sand and silt layer in which these wells are screened is interpreted to be confined/semi-confined beneath the sandy silt till resulting in artesian pressures with potentiometric surfaces that are at or above existing grade. The areas where wells exhibit these pressures are interpreted to extend locally into the overlying sand and silt till.

- Groundwater levels at MW107 located along Lockhart Road on has water levels ranging from 2.4 mbgs to 5.2 mbgs (Figure D-10, Appendix D) and the aquifer in this area is interpreted to exist under unconfined (water table) conditions.

4.6 Interpreted Groundwater Flow Pattern

Groundwater flow within the shallow overburden (water table) is interpreted to be influenced by the surface topography with groundwater flow from the topographically higher areas towards topographically lower areas and surface water features. Groundwater elevation data from the month of April obtained from the monitoring wells are shown on Figure 8, along with the interpreted groundwater elevation contours for the area and interpreted direction of the groundwater movement. Groundwater level data for

Peto monitoring wells (MW101 to MW111) are from April 2023, and Burnside monitoring wells CD-18 and CD-19 are from April 2019 and MW15s/d are from April 2018.

On Figure 8, groundwater flow generally follows the topography with some convergence towards the main channel of Hewitt's Creek. East of Hewitt's Creek groundwater is interpreted to flow north and west towards St. Paul's Swamp while due to the convergence, the flow in the area west of Hewitt's Creek is north and east towards Hewitt's Creek and St. Paul's Swamp.

4.7 Recharge and Discharge Conditions

Areas where water from precipitation infiltrates into the ground and moves downward (i.e., areas of downward hydraulic gradients) are known as recharge areas. Recharge areas are generally located where there is relatively higher topographic elevation. Areas where groundwater moves upward (i.e., areas of upward hydraulic gradients) are discharge areas and these generally occur in areas of relatively lower topographic elevation, such as into wetlands and along watercourses.

4.7.1 Groundwater Surface Water Interactions

To assess shallow groundwater conditions and gradients near the watercourse (tributary of Hewitt's Creek), a drive-point piezometer nest (PZ-C3s/d) was installed and water level recordings were observed. PZ-C3s/d is located near a drainage feature that drains to a tributary to Hewitt's Creek at the northwestern edge of the subject lands and close to the St. Paul's Swamp (Figure 2). The hydrograph for this location shows water levels in the shallow piezometer responding to seasonal variations (Figure D-14, Appendix D). The water levels in the deep piezometer however do not respond and show a gradual increase in levels over time suggesting that it may still be recovering from installation. The deep piezometer was damaged in September 2019 before a gradient could be discerned. Based on our interpretation of groundwater flow in the area, it is assumed that groundwater discharge is possible in this area due to its proximity to the swamp.

4.7.2 Significant Groundwater Recharge Areas and Ecologically Significant Groundwater Recharge Areas

Significant Groundwater Recharge Areas (SGRAs) can be described as areas that can effectively move water from the surface through the unsaturated soil zone to replenish available groundwater resources (LSRCA, 2012). SGRAs were mapped by the Source Water Protection Assessment Report (LSRCA, 2012) as a requirement of the Clean Water Act, 2006 and based on guidance provided by the MECP. The delineation of these areas was completed using numerical models and analyses at a regional scale that included the evaluations of numerous factors including precipitation, temperature and other climate data along with land use, soil type, topography and vegetation to predict groundwater recharge, runoff and evapotranspiration. Within the jurisdiction of the LSRCA, SGRAs represent areas where the annual recharge rate is greater than 115% of the average recharge of 164 mm/year across the Lake Simcoe watershed (or greater than the threshold recharge rate of 189 mm/year) (LSRCA, 2012). SGRA was mapped in the southeastern corner of the subject lands along Lockhart Road (Figure 9). The coarse outlines of the SGRAs reflect the regional nature of the data used to generate these areas.

Ecologically Significant Groundwater Recharge Areas (ESGRAs) were delineated for the Barrie Creek, Lovers Creek and Hewitt’s Creek subwatersheds by Earthfx (2012) using the groundwater model developed by AquaResources for the Source Protection studies. ESGRAs were defined as areas of land that are assumed to support groundwater systems or environmentally sensitive features like lakes, cold water streams and wetlands (Earthfx, 2012). ESGRAs were delineated in the groundwater model by identifying pathways in which recharge, if it occurred, would reach an ecologically significant feature. Ecologically significant features used for the delineation of the ESRGAs included headwater streams, cold water fisheries, wetlands, and brook trout and sculpin capture sites. As with the SGRAs, ESGRAs were developed using regional data within the groundwater model and the nature of the areas delineated is interpreted as representing the model resolution.

ESGRAs and SGRAs are not mutually exclusive. ESGRAs are determined based on the linkage between a recharge area and an ecologically sensitive area while SGRAs are located where high volumes of recharge are assumed to occur. ESGRAs are mapped across the parcel of land west of the creek and in the northern portion of the subject lands east of the creek (Figure 9). It is interpreted that the ESGRA delineated is associated with Hewitt’s Creek and St. Paul’s Swamp.

4.8 Aquifer Vulnerability

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 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.

The aquifer vulnerability for the subject lands was mapped in the Lakes Simcoe and Couchiching-Black River SPA Part 1 Approved Assessment Report, Lake Simcoe Region Conservation Authority, 2012. The approach used by the LSRCA to create a regional vulnerability map was the aquifer vulnerability index (AVI) method. Using water well records for the area to determine the soil types and depths to aquifer an AVI was calculated for each delineated aquifer to produce a map of regional groundwater vulnerability.

The high aquifer vulnerability mapping for the subject lands is provided in Figure 10. The area of high aquifer vulnerability is shown on the western half of the subject lands on both sides of Hewitt’s Creek. The coarse grid nature of the mapped HVAs reflect the regional nature of the data used to generate these areas. Site-specific data indicates that these lands are underlain by till deposits. As shown on cross-section A-A’ (Figure 6), the water supply aquifer is confined by a low permeability layer. Based on the fact that the local aquifer is separated from the zone in which construction will take place, the proposed development is interpreted as not posing a high risk to the aquifer.

5.0 Surface Water Monitoring

The main branch of Hewitt’s Creek transects the subject lands, flowing south to north. A tributary to Hewitt’s Creek flows east to west along the northern boundary of the subject lands. To characterize the flow conditions on and vicinity of the subject lands, monitoring locations were established at each of these tributaries (Figure 2). Monitoring was completed between 2018 and 2020 and the data is provided in Appendix E and summarized below.

- SW1-CD is located at Hewitt’s Creek where it passes under Lockhart Road. The surface water flow data for this location show that flow ranges from 10 L/s up to 132 L/s (Table E-1, Appendix E) and is generally always present except for during the winter months when conditions are recorded as partially frozen. Perennial flow suggests that groundwater discharge supports baseflow in this watercourse during low flow conditions.

- SW2-CD is located along a swale that drains into a dug pond that outlets to a tributary to Hewitt’s Creek. The channel is approximately 1.5 m wide, well defined with vegetation along its banks. Observations of flow in this channel indicate flows are intermittent and that that channel conveys water in association with precipitation events and snow melt.

6.0 Water Quality

6.1 Groundwater Quality

Water quality data was collected to typify the groundwater quality across the subject lands. Groundwater sampling was completed on November 1, 2023 at MW104 and MW107 and submitted to an accredited laboratory for analyses of general water quality indicators (e.g., pH, hardness, and conductivity), basic ions (including chloride and nitrate) and selected metals to characterize the background water quality. The groundwater testing results from the analytical laboratory are provided in Table F-1, Appendix F and discussed below in relation to the Provincial Water Quality Objectives (PWQO) to assess the water quality in the event of construction dewatering.

The samples exceeded the PWQO for Total Phosphorus (0.03 mg/L) with values of 11.6 mg/L and 0.7 mg/L at MW104 and MW107, respectively. Total phosphorus is a measure of all forms of phosphorus (dissolved or particulate) that are found in the water sample. There was very little dissolved phosphorus (phosphate as P) reported in the groundwater samples suggesting the reported concentrations are particulate in the groundwater sample. With the use of sediment control measures, the total phosphorus can be reduced.

7.0 Water Balance

In order to assess potential land development impacts on the local groundwater conditions, a detailed water balance analysis has been completed to determine the pre-development recharge volumes (based on existing land use conditions) and the post-development recharge volumes that would be expected based on the proposed land use plan. The detailed water balance calculations are provided in Appendix G.

The water balance computed as part of the current study was completed using a similar approach as that completed for the SIS (Burnside, 2016). It was noted at the SIS level that subsequent studies should complete individual water balance assessments at a site-specific level in order to determine the potential impacts of development on local features and to evaluate the need for Low Impact Development (LID) measures.

7.1 Water Balance Components

A water balance is a planning tool that provides an accounting of the water resources within a given area. The water balance uses regional and site-specific information to estimate the resulting parameters. It is important to understand that the water balance is a diagnostic tool that provides an order of magnitude understanding of water resources. Based on the assumptions and simplification required to undertake these assessments, it should be noted that predictions from a water balance provide more of an understanding of the nature of an impact rather than a precise measure of the impact.

As a concept, the water balance is relatively simple and may be estimated from the following equation:

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

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 an area. The information collected as part of the current study including 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. These input parameters have been estimated for the subject lands and are discussed below:

Precipitation (P)

Precipitation represents the main input to the water balance calculation. Precipitation for the subject lands was estimated based on the climate normal (the long-term average annual precipitation for the 30-year period 1981 to 2010). The normal precipitation for the area of the subject lands was determined to be 933 mm based on data from the Environment Canada Barrie WPCC (Station 6110557, 44°22'33.012" N, 79°41'23.010" W, elevation 221.0 masl). The climate station is located 5 km northeast of the subject lands. The normal monthly records of precipitation and temperature from this station have been used for the water balance calculations in this study (Appendix G). It is noted that the actual precipitation of the subject lands may vary from the documented normal.

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 for the purposes of the water balance calculation. This does not impact the evaluation as the water balance is considered at the annual scale where annual losses and annual gains are expected to balance out.

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 assessment, the PET has been calculated using a climate variable approach and corrections for latitude and heat index. The AET is 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 the groundwater table (referred to as 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 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, however both interflow and direct runoff together form the total surface water runoff component.

7.2 Water Balance 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 150 mm was selected as a representative value for the existing vegetation and soil conditions which consists of predominantly short to moderate-rooted vegetation in the fields and agricultural areas (Table G-1, Appendix G).

A soil moisture storage capacity of 75 mm was used to represent the post-development vegetation which will be dominantly urban lawn (Table G-2, Appendix G). Tables G-1 and G-2 in Appendix G 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 MECP 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 calculated water balance components from this table are then used to assess the pre-development and post development volumes for runoff and infiltration.

The water balance assessment has been completed based on catchments east and west of Hewitt’s Creek. The assessment only includes the development areas, leaving out the areas designated as environmental protection. These areas were omitted as they will either remain unchanged in post-development conditions or be enhanced with additional vegetation. In either case, the omission of these areas is not anticipated to affect the overall results of the analyses. The water balance for the east development area is shown as Table G-3 and the west development area as Table G-4.

7.3 Water Balance Component Values

The detailed monthly calculations of the water balance components are provided in Tables G-1 and G-2 in Appendix G. The infiltration and runoff components have been calculated using the infiltration factor methodology from Table 3.1 of MECP SWM Planning and Design Manual (2003). The methodology accounts for topography, soil type and land cover assigning a factor between 0.1 and 0.4 to each component. The infiltration factors used in this analysis are provided in Tables G-1 and G-2, Appendix G.

The calculations show that a water surplus is generally available from November to May and the period of surplus is illustrated in Figure G-1 in Appendix G. The monthly water balance calculations illustrate how infiltration occurs during periods when there is sufficient water available to overcome the soil moisture storage requirements. The monthly calculations are summed to provide estimates of the annual water balance component values (Tables G-1and G-2, Appendix G). A summary of these values is provided in Table 1.

Table 2: Water Balance Component Values

Water Balance Component	Agricultural Land Use	Post-Development (Urban Lawn)
Average Precipitation	933 mm/year	933 mm/year
Actual Evapotranspiration	593 mm/year	555 mm/year
Water Surplus	340 mm/year	378 mm/year
Infiltration	204 mm/year	246 mm/year
Runoff	136 mm/year	132 mm/year

7.4 Pre-Development Water Balance (Existing Conditions)

Based on the water balance component values calculated in Tables G-1 and G-2, Appendix G, an estimate of the total pre-development groundwater infiltration volume for each development catchment area was calculated (Tables G-3 and G-4, Appendix G). The percent impervious for pre-development was based on existing buildings and driveways determined by satellite images. The existing impervious areas are shown on Figure G-2. The pre-development groundwater infiltration is estimated to be 30,800 m^3/year for the east catchment and 3,500 m^3/year for the west catchment

7.5 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. Evaporation from impervious surfaces remains under post-development conditions and evaporation from impervious surfaces is relatively minor (estimated to be 10% to 20% of precipitation) compared to the evapotranspiration component that occurs with vegetation in this area (about 64% 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. The natural infiltration components (interflow and deep recharge) are reduced.

A water balance calculation of the potential water surplus for impervious areas is shown at the bottom of Table G-1 in Appendix G. For the purposes of the calculations in this study, the evaporation 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 is a potential water surplus from impervious areas of 793 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.

7.6 Post-Development Water Balance with No Mitigation

To assess potential development impacts on infiltration, the post-development infiltration volumes have been calculated for the east and west development catchments based on the proposed post-development land use (Tables G-3 and G-4, Appendix G). These calculations assume no low impact development (LID) measures for stormwater management are in place. The infiltration and runoff components for the post-development land uses have been calculated using the MECP SWM Planning and Design Manual (2003) methodology based on topography, soil type and land cover as shown on Tables G-2 in Appendix G.

The total calculated post-development infiltration volumes (without LID measures) are provided below in Table 3. The water balance calculations suggest that, without mitigation, the east catchment would receive about 52% of the current amount of average annual groundwater infiltration after development and the west catchment would receive about 34% of the current annual infiltration.

Table 3: Pre- and Post-Development Infiltration

	East Catchment	**West Catchment**
Pre-Development Infiltration (m^3/year)	30,800	3,500
Post-Development Infiltration (m^3/year)	16,100	1,200
Infiltration Deficit (m^3/year)	14,700	2,300
% Change	-48%	-66%

7.7 Mitigation Strategies for Infiltration

The water balance calculations suggest that, without mitigation, the catchments would receive about 34% to 52% of the current amount of average annual groundwater infiltration after development. As per the SIS recommendations, the use of Low Impact Development (LID) measures for stormwater management is recommended to ensure the post-development groundwater infiltration volume is maintained as close to the pre-development infiltration volume as possible. It is our understanding that four centralized LID infiltration galleries are proposed with the east catchment. Mitigation measures for the west catchment will be addressed at Site Plan approval. The details of proposed LIDs are provided in the stormwater management report by Jones Consulting Group Ltd.

8.0 Development Considerations

8.1 Construction Below the Water Table

Groundwater level data collected as part of this study indicates that shallow groundwater conditions are present on the subject lands. Should excavations completed during construction of servicing extend below the water table the local soils may need to be dewatered. The volume of water required for dewatering is dependent on the hydrogeological properties of the sediments and the depth of the excavation. Hydraulic conductivity testing of the soils estimated the hydraulic conductivity to range between 10^{-5} cm/s to 10^{-3} cm/s.

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/day, a Permit to Take Water (PTTW) will be required in accordance with provincial regulations prior to dewatering activities. Detailed groundwater impact assessment and monitoring plans are required to support EASR and PTTW applications. These studies should be completed once servicing depths are available.

The construction of buried services below the water table has the potential to capture and redirect groundwater flow through more permeable fill materials typically placed in the base of excavations. Groundwater may also infiltrate into joints in storm sewers and manholes. Over the long-term, these impacts can lower the groundwater table across the development area. To mitigate this effect, services to be installed below the water table should be constructed to prevent redirection of groundwater flow. This will involve the use of anti-seepage collars or clay plugs surrounding the pipes to provide barriers to flow and prevent groundwater flow along granular bedding material and erosion of the backfill materials.

8.2 Local Groundwater Supply Wells

The area surrounding the subject lands is not currently serviced and residences are supplied by private wells. A water well survey study was completed on behalf of the Hewitt’s SPA Landowner’s Group for residences within 300 m of the Hewitt’s SPA lands to assess the potential for impacts to private supply wells (Burnside, 2018). The report, which included the subject lands identified potentially vulnerable wells in the vicinity of the subject lands and outlined a monitoring and mitigation plan. This report was submitted to the Town of Barrie and a domestic well monitoring program was initiated in 2019. Annual reports on trends observed are expected to be produced from the wells that are monitored. It is expected that the monitoring will continue for 5 years within the Phase 1 lands and potentially for 10 years within Phase 2. During this period, the interference protocol outlined in the report will be implemented should any episode of interference occur.

8.3 Well Decommissioning

Prior to or during construction, it is necessary to ensure that all inactive wells within the development footprint have been located and properly decommissioned by a licensed water well contractor according to Ontario Regulation 903. This regulation applies to private domestic wells and to the groundwater observation wells installed for this study unless they are maintained throughout the construction for monitoring purposes.

9.0 References

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Peto MacCallum, 2017b. Supplemental Geotechnical Investigation Proposed Crisdawn Subdivision, Barrie, Ontario. Peto MacCallum Ltd., April 18, 2017.

Peto MacCallum, 2017c. Geotechnical Investigation Proposed Crisdawn Subdivision – Part 2, Mapleview Drive, Barrie, Ontario. Peto MacCallum Ltd., June 2017.

Peto MacCallum, 2017d. Supplemental Geotechnical Investigation Proposed Crisdawn Subdivision, Barrie, Ontario. Peto MacCallum Ltd., July 20, 2017.

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Peto MacCallum, 2022. Preliminary Geotechnical Investigation Proposed Hewitt’s Gate East Residential Subdivision – Part 3, Barrie, Ontario. Peto MacCallum Ltd., July 2022.

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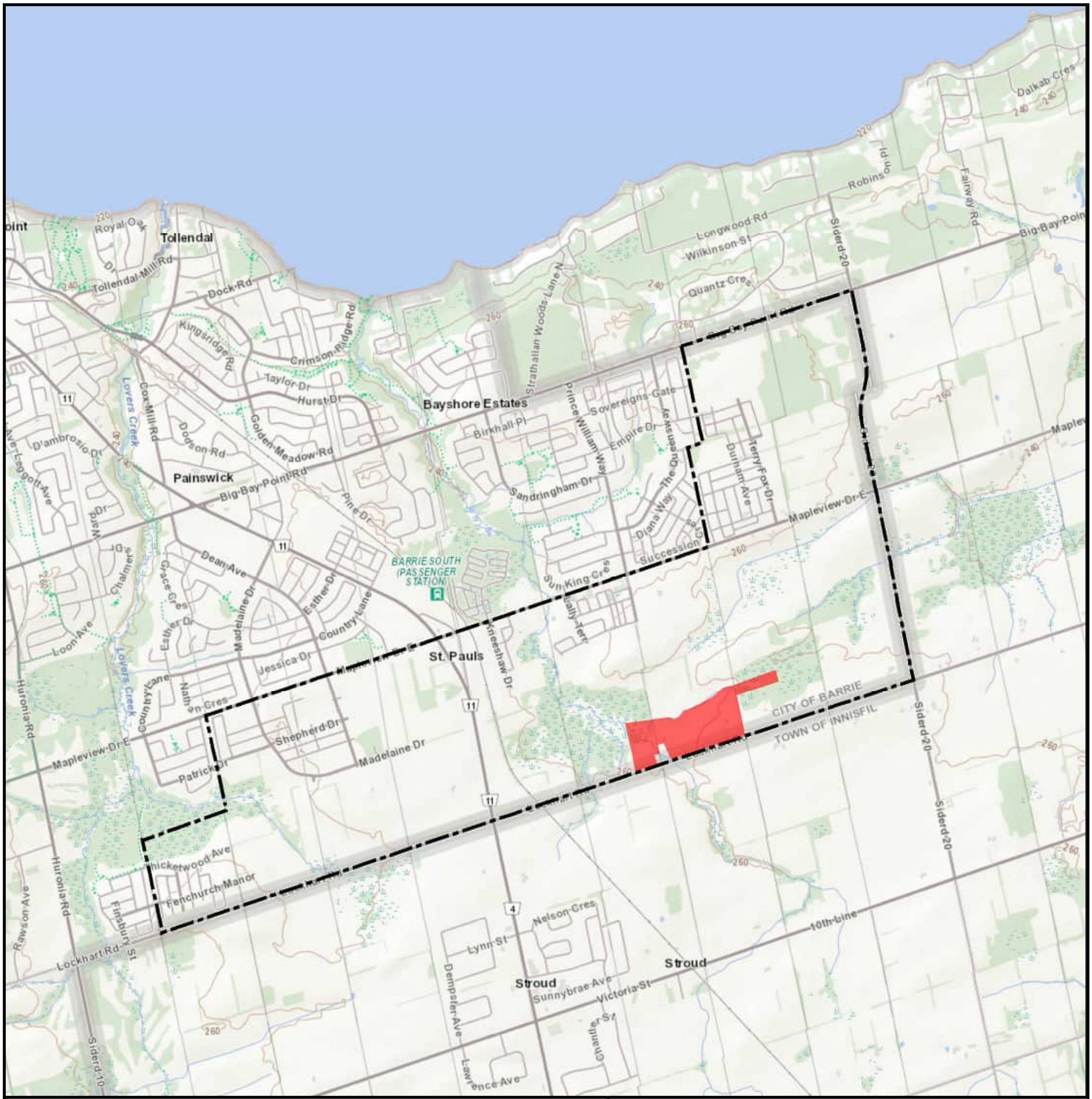
Figures



LEGEND

🟥 SUBJECT LANDS

▭ HEWITT'S SECONDARY PLAN AREA

0 250 500 1,000 1,500 2,000 2,500 3,000

Metres

N

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HANSEN GROUP INC.
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HEWITT'S GATE SOUTH
HYDROGEOLOGICAL ASSESSMENT

Figure Title:

SITE LOCATION

Drawn SK

Checked SC

Date November 2024

Scale 1:40,000

Project No. 300041559.0005

Figure No. 1

File Path: Nigel/Shared Work Areas/Nigel/Shared Work Areas/041559 Hewitt's Gate/Hewitt's Gate South/06_GIS/041559 Hewitt's Gate South Site Location.mxd

LEGEND

▭	SUBJECT LANDS
═	WATERCOURSE (AZIMUTH, DECEMBER 2023)
- -	DRAINAGE FEATURE
▭	DUG POND
⊕	MONITORING WELL (PML, 2022)
⊕	MONITORING WELL (RJB, 2018)
●	DRIVE POINT PIEZOMETER
▲	SURFACE WATER MONITORING LOCATION

Sources:

1. Ministry of Natural Resources and Forestry, © King's Printer for Ontario
2. Natural Resources Canada © His Majesty the King in Right of Canada.
3. Satellite imagery - Maxar 2023

N

0 50 100 150 200 250 300

Metres

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Figure Title

MONITORING NETWORK

Drawn	Checked	Date	Figure No.
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Scale		Project No.	
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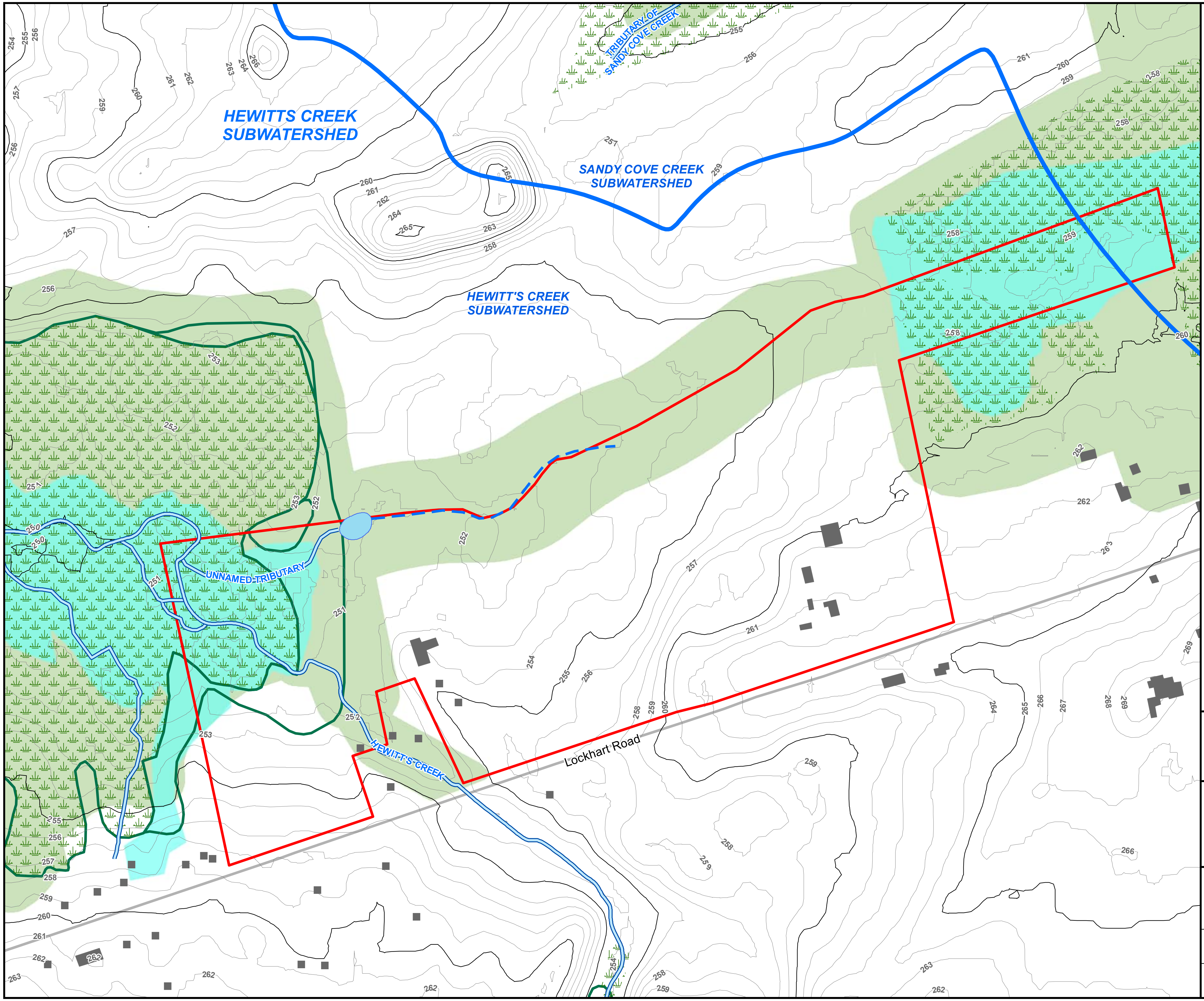

LEGEND

- 🟥 SUBJECT LANDS
- ━ SUBWATERSHED BOUNDARY (LSRCA, 2016)
- ╍ DRAINAGE FEATURE
- ═ WATERCOURSE (AZIMUTH, DECEMBER 2023)
- 🟦 DUG POND
- ■ BUILDING
- ─ CONTOUR (5m intervals - masl)
- ─ CONTOUR (1m intervals - masl)
- ─ ROADWAY
- 🟩 NHS CORE AND BUFFER
- ▨ WETLAND (MNR, 2010)
- ☐ PROVINCIALLY SIGNIFICANT WETLAND
- 🟦 WETLAND (AZIMUTH, 2014)

Sources:

1. Ministry of Natural Resources and Forestry, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.
3. Contours derived from Ontario Ministry of Natural Resources and Forestry, Ontario Digital Terrain Model, 2023

N

0 50 100 150 200 250 300

Metres

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Figure Title

TOPOGRAPHY AND DRAINAGE

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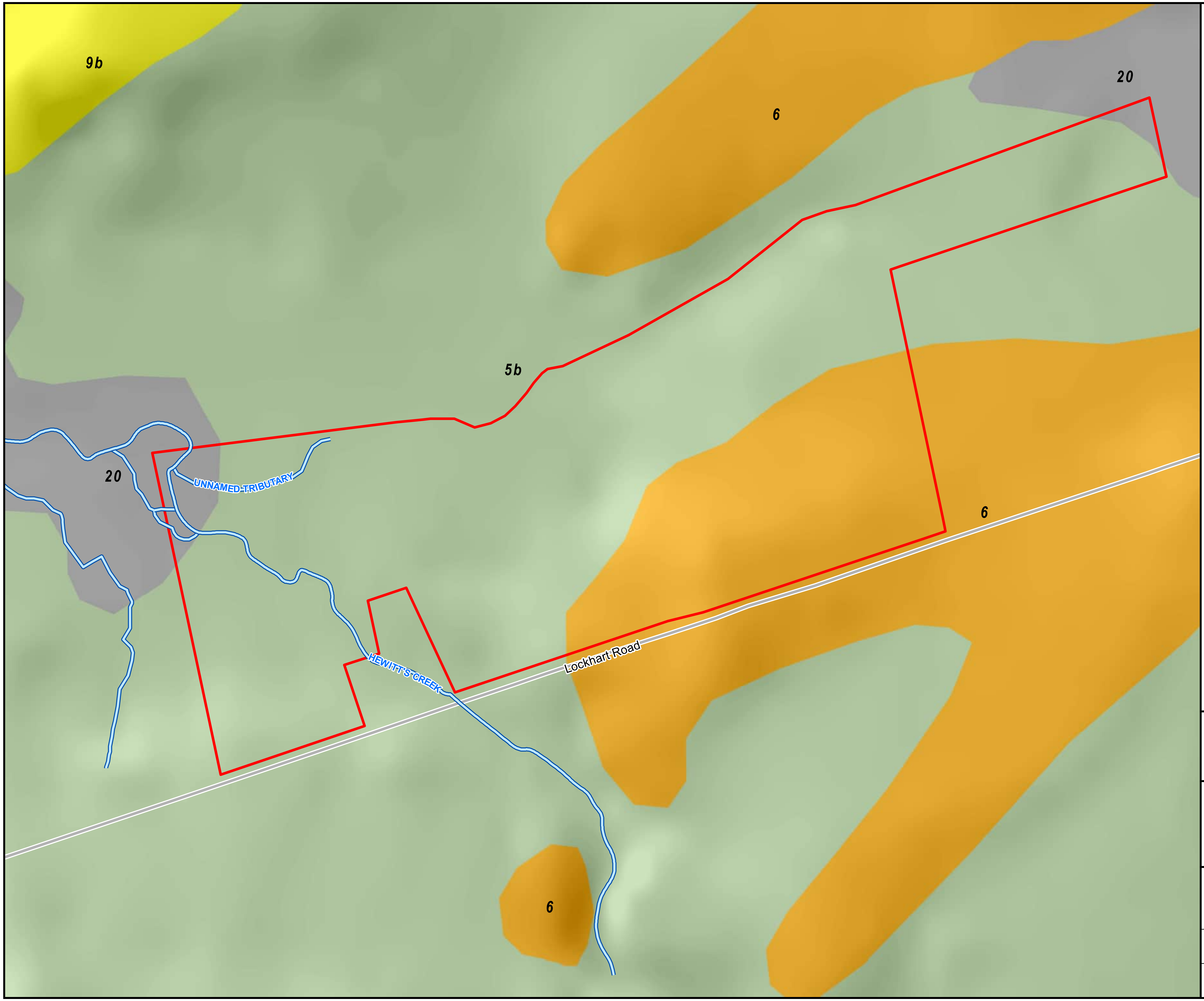

LEGEND

🟥 SUBJECT LANDS
— ROADWAY
═ WATERCOURSE (AZIMUTH, DECEMBER 2023)
🟩 5b: sandy silt to silty sand-textured till
🟧 6: sand and gravel, minor silt, clay and till
🟨 9b: Coarse-textured glaciolacustrine deposits: Littoral-foreshore deposits
⬜ 20: organic deposits

Sources:

1. Ministry of Natural Resources and Forestry, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.
3. Ontario Geological Survey 2010. Surficial Geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 128 - Revised.

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HEWITT'S GATE SOUTH
HYDROGEOLOGICAL ASSESSMENT

Figure Title

SURFICIAL GEOLOGY

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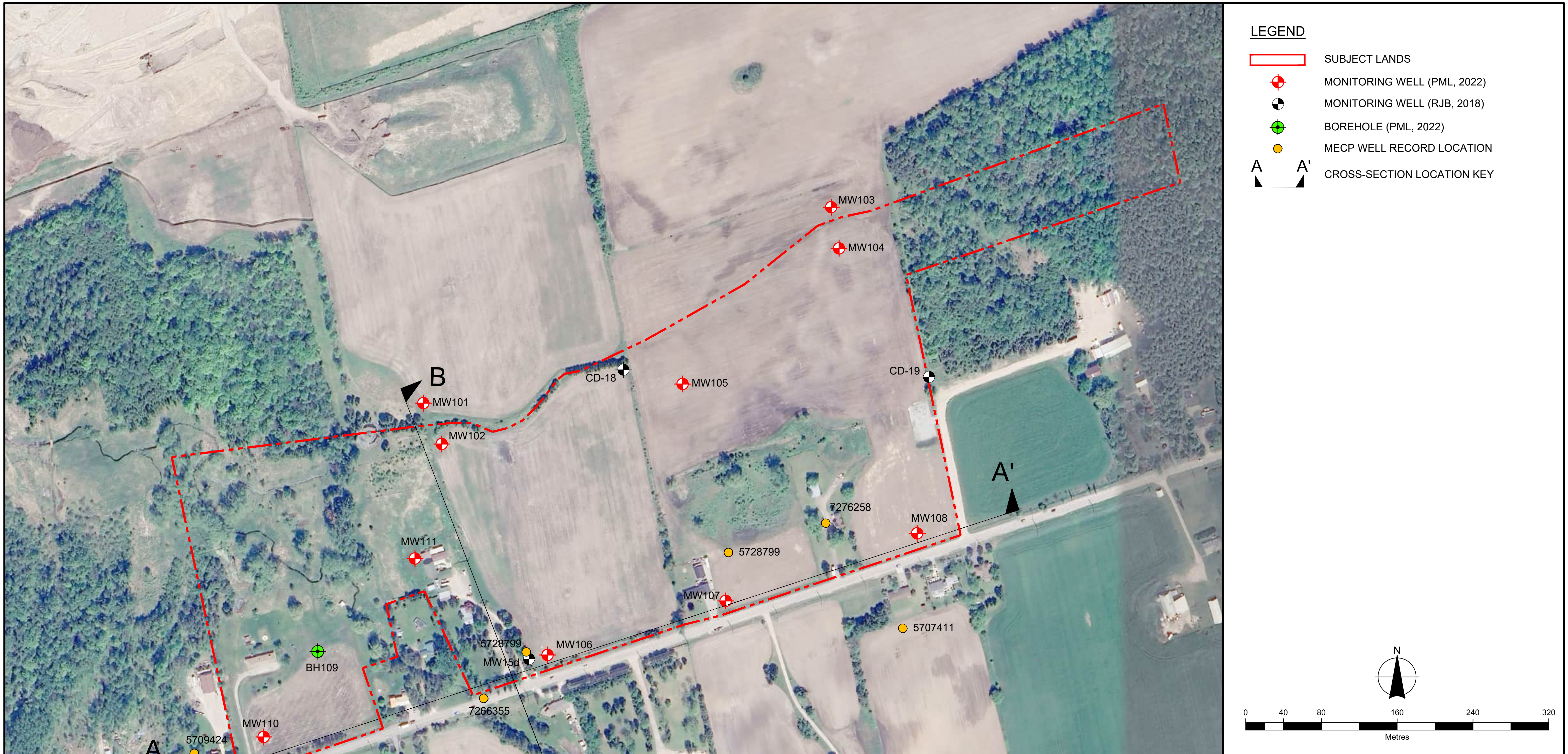

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HYDROGEOLOGICAL ASSESSMENT

Figure Title

BOREHOLE, WELL AND CROSS-SECTION LOCATIONS

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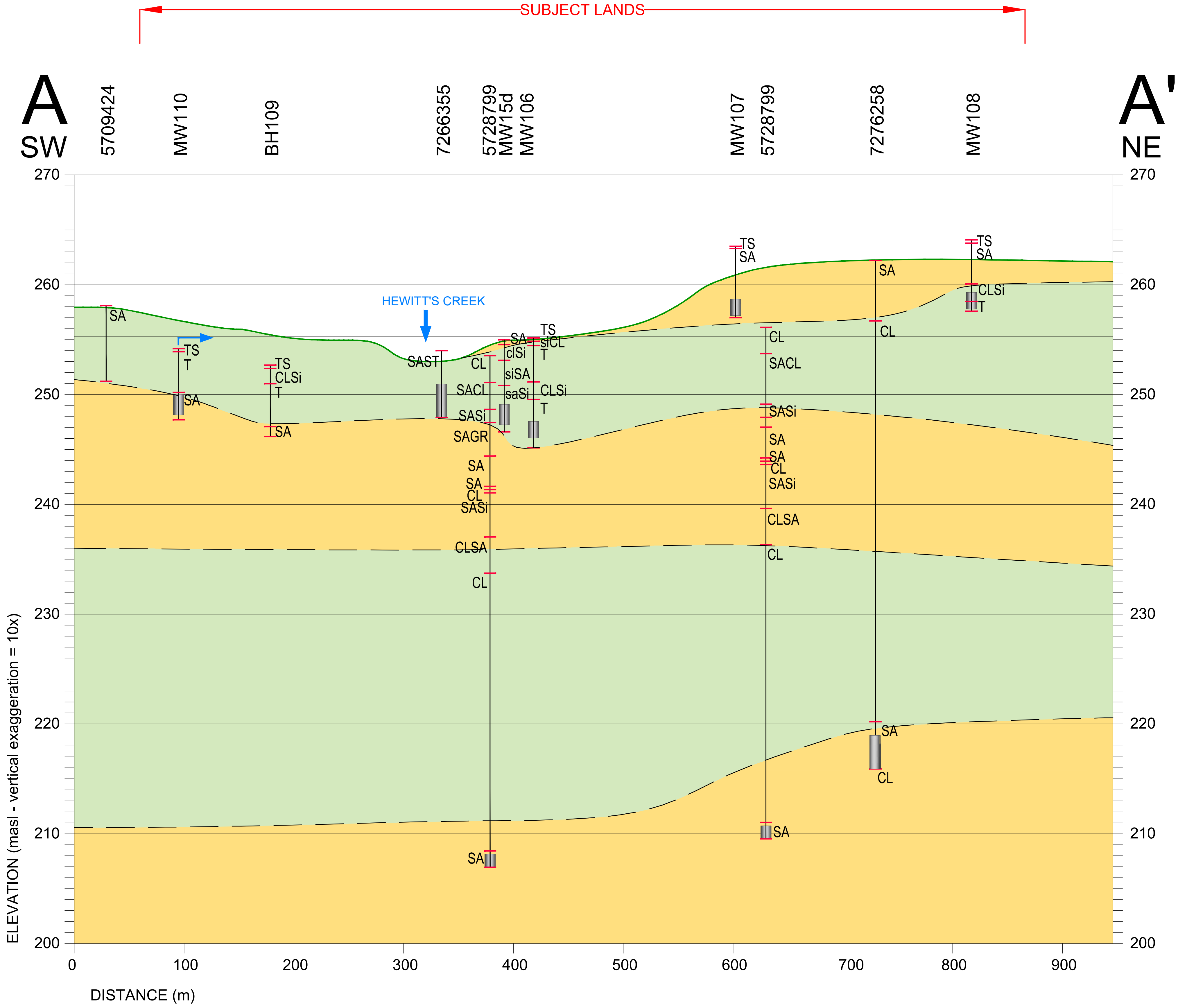

LEGEND

4901807 WELL / BOREHOLE ID

GEOLOGICAL STRATIGRAPHY

▽ STATIC WATER LEVEL (REPORTED ON MECP WELL RECORD)

▼ MEASURED WATER LEVEL (PML, APRIL 2023)

WELL SCREEN

si	SILTY
cl	CLAYEY
sa	SANDY
F	FILL
TS	TOPSOIL
T	TILL
SA	SAND
Si	SILT
GR	GRAVEL
CL	CLAY
ST	STONES

→ INDICATES FLOWING WELL

↓ WATERCOURSE CROSSING

– – – INTERPRETED GEOLOGICAL CONTACT

🟩 CLAY / SILT / TILL

🟨 SAND / GRAVEL

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HEWITT'S GATE SOUTH
HYDROGEOLOGICAL ASSESSMENT

Figure Title

INTERPRETED GEOLOGICAL
CROSS-SECTION A-A'

Drawn	Checked	Date	Figure No.
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Scale		Project No.	
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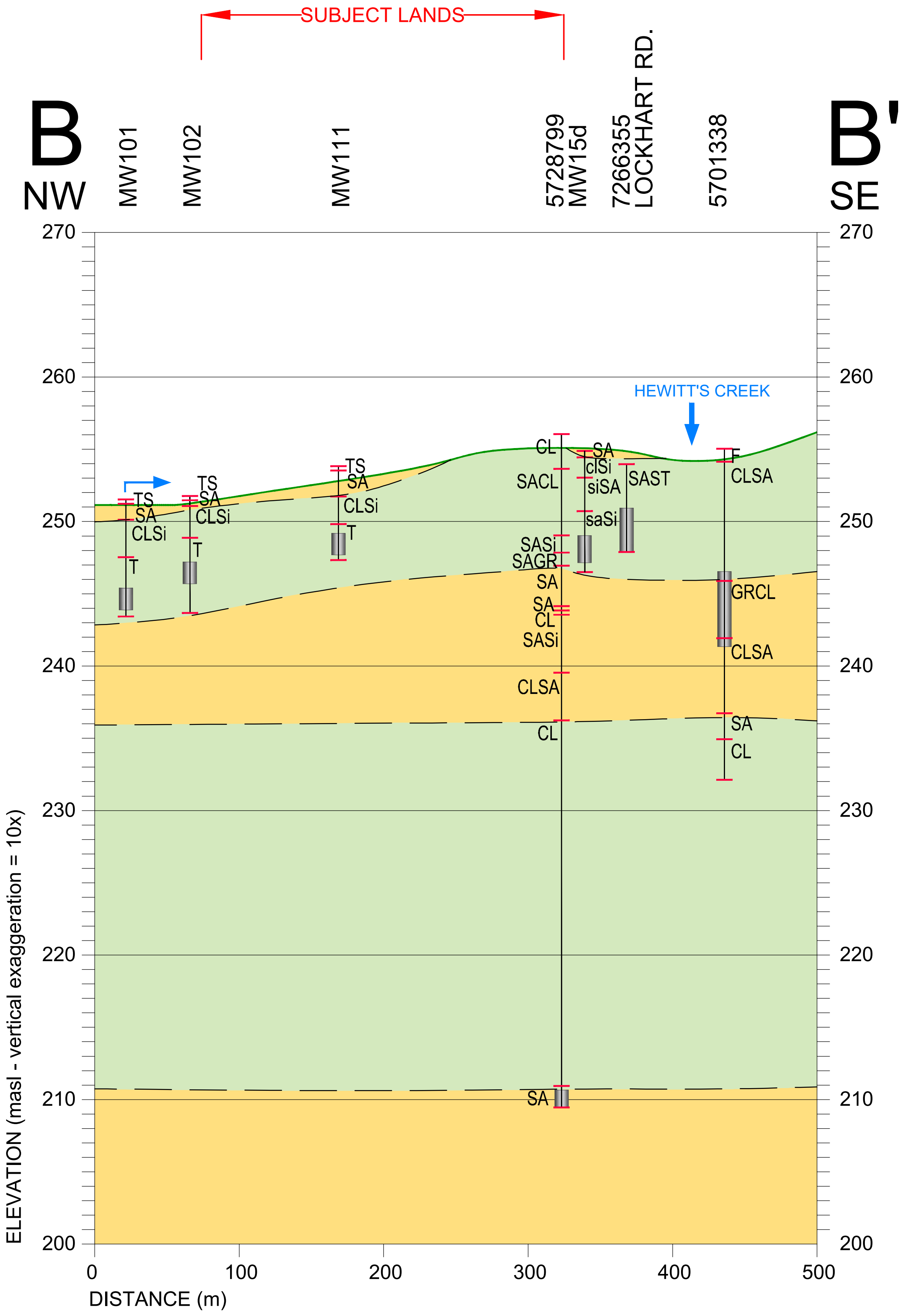

LEGEND

4901807 WELL / BOREHOLE ID

GEOLOGICAL STRATIGRAPHY

▽ STATIC WATER LEVEL
(REPORTED ON MECP WELL RECORD)

▼ MEASURED WATER LEVEL
(PML, APRIL 2023)

WELL SCREEN

si	SILTY
cl	CLAYEY
sa	SANDY
F	FILL
TS	TOPSOIL
T	TILL
SA	SAND
Si	SILT
GR	GRAVEL
CL	CLAY
ST	STONES

↓ WATERCOURSE CROSSING

– – – INTERPRETED GEOLOGICAL CONTACT

🟩 CLAY / SILT / TILL

🟨 SAND / GRAVEL

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HEWITT'S GATE SOUTH
HYDROGEOLOGICAL ASSESSMENT

Figure Title

INTERPRETED GEOLOGICAL CROSS-SECTION B-B'

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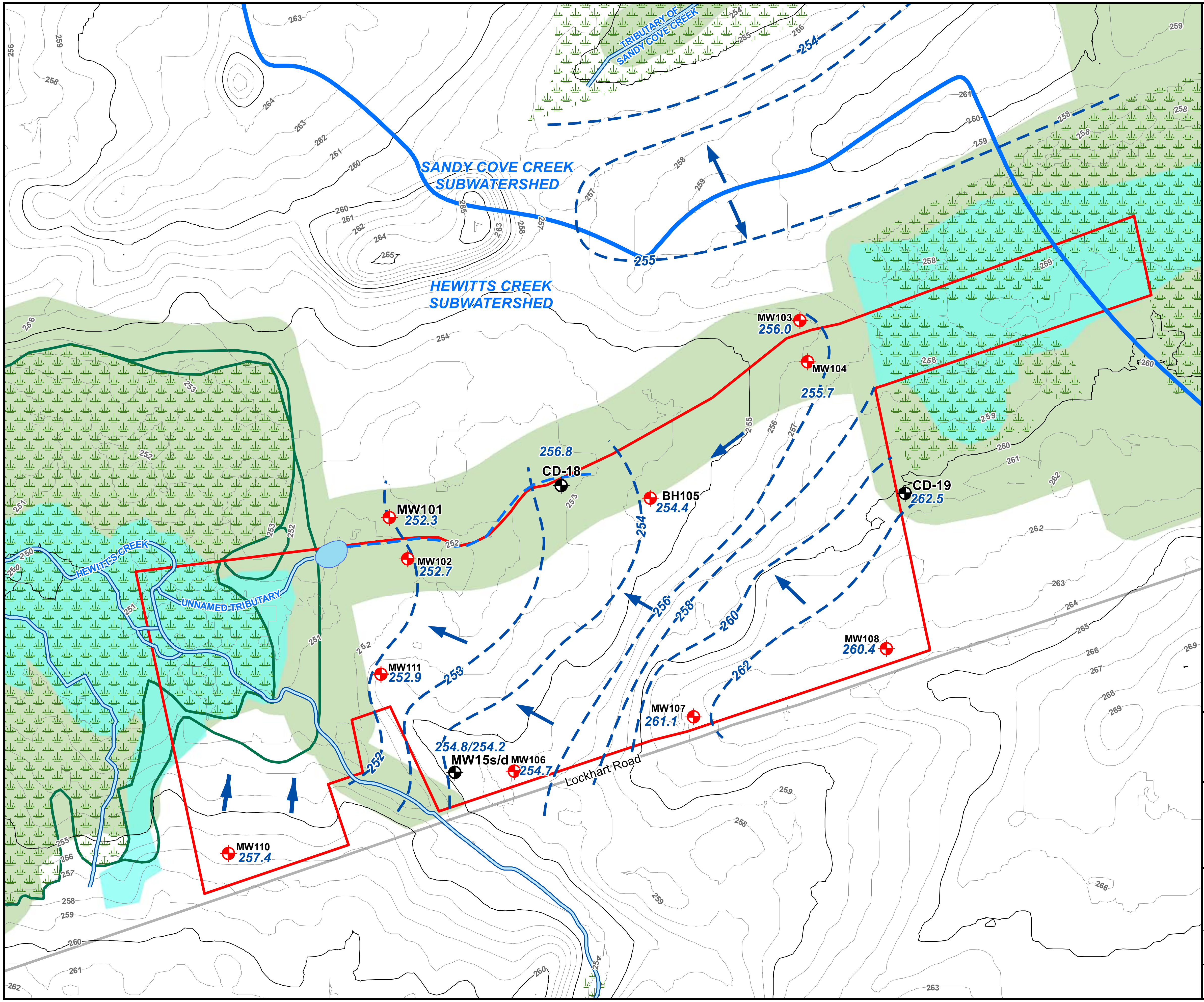

LEGEND

- 🟥 SUBJECT LANDS
- — CONTOUR (5m intevals - masl)
- — CONTOUR (1m intervals - masl)
- — ROADWAY
- - - DRAINAGE FEATURE
- — WATERCOURSE (aZIMUTH, DECEMBER 2023)
- 🟦 DUG POND
- 🟩 NHS CORE AND BUFFER
- WETLAND (MNR, 2010)
- 🟩 PROVINCIALLY SIGNIFICANT WETLAND
- 🟦 WETLAND (AZIMUTH, 2014)
- ⊕ MONITORING WELL (PML, 2022)
- ⊕ MONITORING WELL (RJB, 2018)
- - - INTERPRETED GROUNDWATER CONTOUR (masl)
- ← INTERPRETED GROUNDWATER FLOW DIRECTION
- 253.35 MEASURED WATER LEVEL - masl (PML, April, 2023)

NOTE:
MEASURED WATER LEVELS FOR CD-18 & CD-19
FROM RJB, APRIL 2019
MW15s/d FROM RJB APRIL 2018

Sources:

1. Ministry of Natural Resources and Forestry, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.
3. Contours derived from Ontario Ministry of Natural Resources and Forestry, Ontario Digital Terrain Model, 2023

N

0 50 100 150 200 250 300
Metres

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HYDROGEOLOGICAL ASSESSMENT

Figure Title

INTERPRETED GROUNDWATER FLOW

Drawn	Checked	Date	Figure No.
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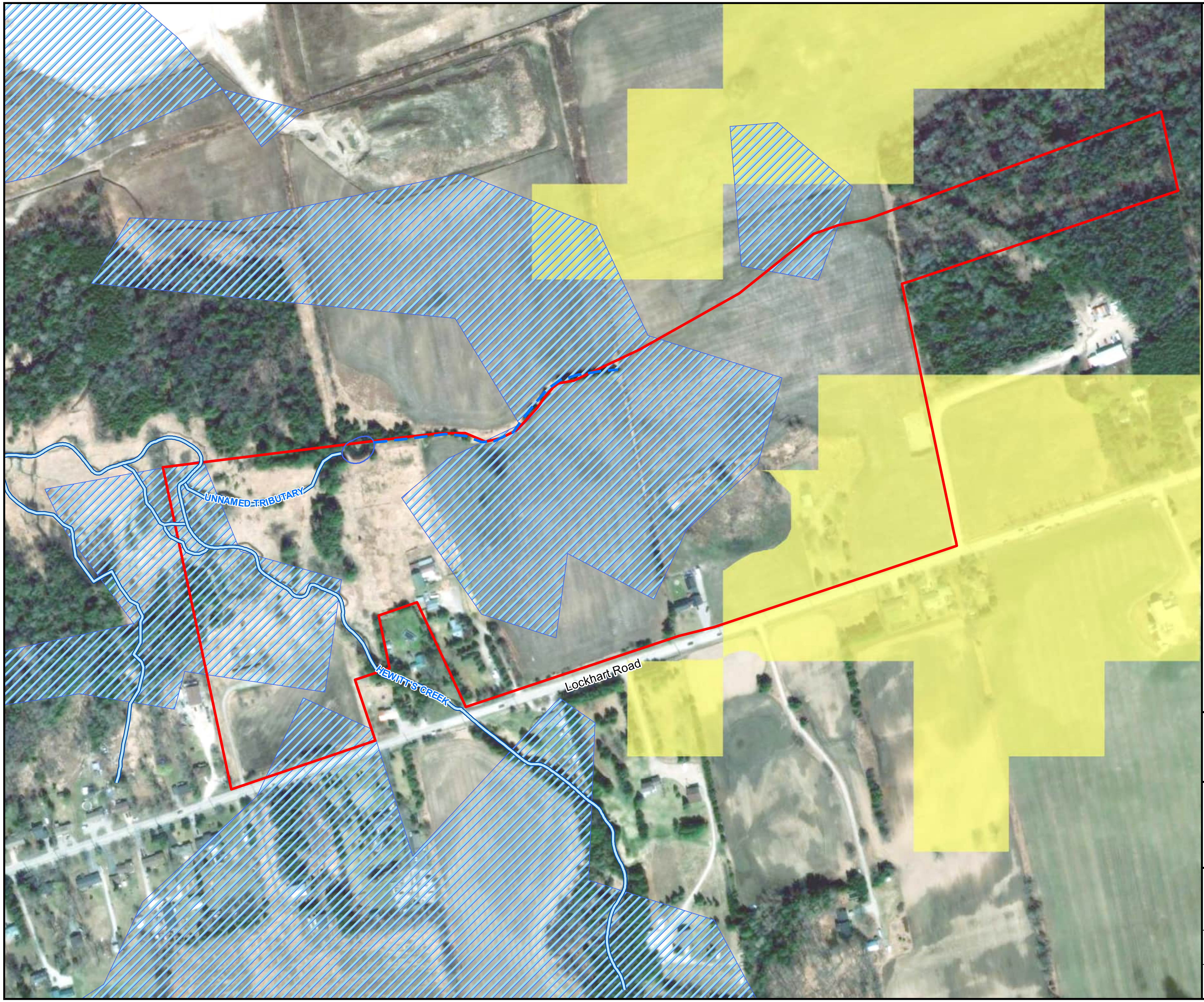
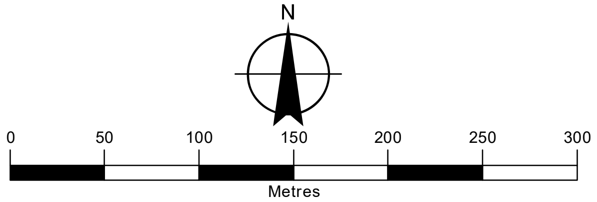


LEGEND

- 🟥 SUBJECT LANDS
- ═ WATERCOURSE (AZIMUTH, DECEMBER 2023)
- – – DRAINAGE FEATURE
- ☐ DUG POND
- 🟨 SIGNIFICANT GROUNDWATER RECHARGE AREAS (SGRA, LSRCA)
- ▨ ECOLOGICALLY SIGNIFICANT GROUNDWATER RECHARGE AREAS (ESGRA, LSRCA)

Sources:

1. Ministry of Natural Resources and Forestry, © King's Printer for Ontario
2. Natural Resources Canada © His Majesty the King in Right of Canada.
3. ESGRA and SGRA mapping provided by Lake Simcoe Regional Conservation Authority, 2018.
4. Satellite imagery - Maxar 2023



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HEWITT'S GATE SOUTH
HYDROGEOLOGICAL ASSESSMENT

Figure Title

RECHARGE AREAS

Drawn	Checked	Date	Figure No.
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Scale		Project No.	
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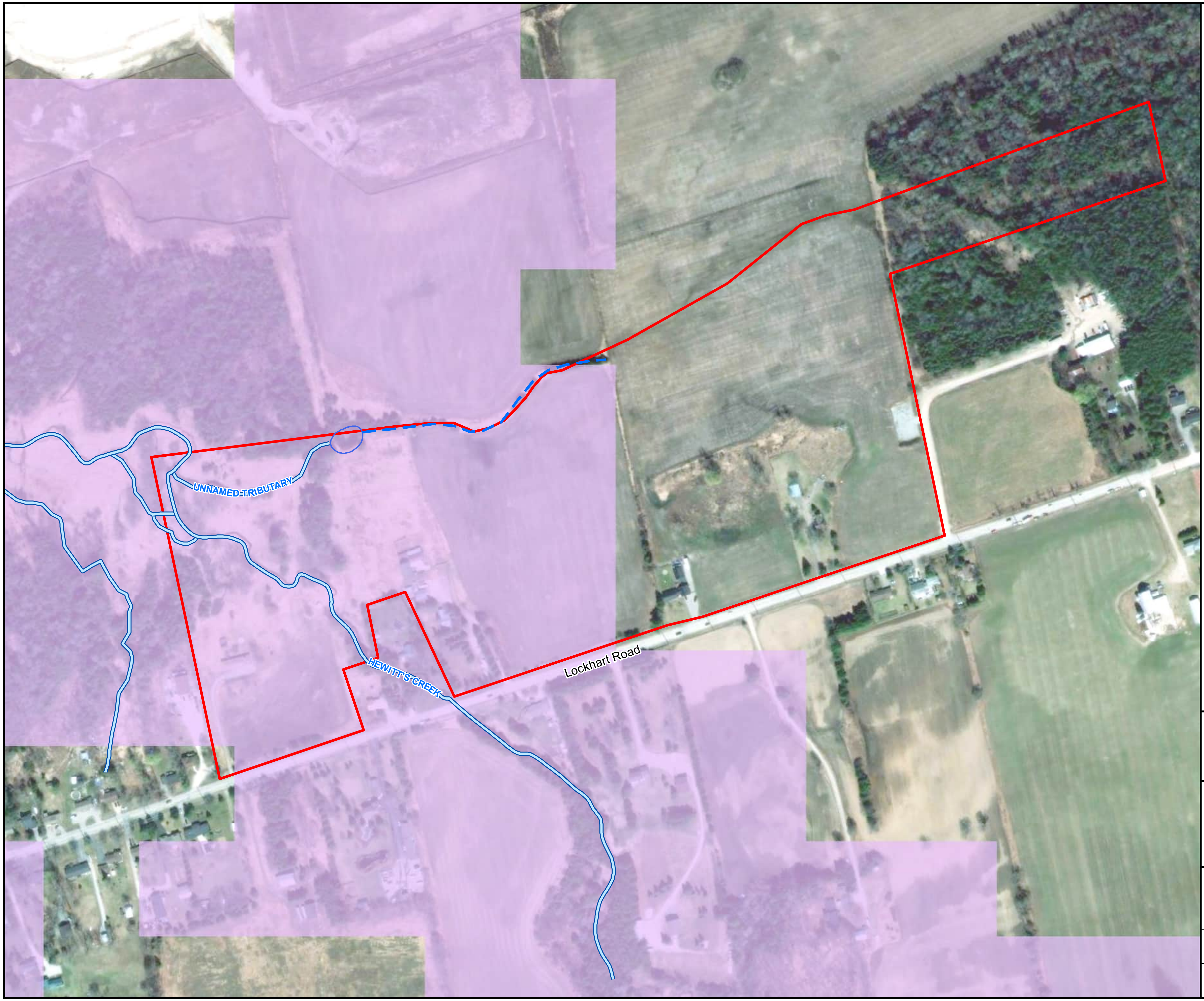

LEGEND

🟥 SUBJECT LANDS

═ WATERCOURSE (AZIMUTH, DECEMBER 2023)

- - DRAINAGE FEATURE

☐ DUG POND

🟪 HIGH AQUIFER VULNERABILITY ZONE

Sources:

1. Ministry of Natural Resources and Forestry, © King's Printer for Ontario
2. Natural Resources Canada © His Majesty the King in Right of Canada.
3.ESGRA and SGRA mapping provided by Lake Simcoe Regional Conservation Authority, 2018.
4. Satellite imagery - Maxar 2023

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HEWITT'S GATE SOUTH
HYDROGEOLOGICAL ASSESSMENT

Figure Title

AQUIFER VULNERABILITY

Drawn	Checked	Date	Figure No.
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Appendix A

MECP Water Well Records

Water Well Records

Thursday, November 02, 2023

11:57:09 AM

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
INNISFIL TOWNSHIP	17 611087 4910698 W	2018/02 7626						7310643 (C39455) A235188 P	
INNISFIL TOWNSHIP	17 611042 4910649 W	2016/06 6946	2			MO	0010 10	7266355 (Z232473) A203375	BRWN SAND STNS WBRG 0020
INNISFIL TOWNSHIP	17 610469 4910446 W	2016/06 6946	2			MO	0010 10	7266354 (Z232470) A203374	BRWN SAND STNS WBRG 0020
INNISFIL TOWNSHIP CON 10 017	17 610599 4910458 W	1967/07 2514	6					5701335 () A	LOAM 0001 MSND 0030 GREY FSND SILT 0045 BLUE CLAY 0048 GREY FSND CLAY 0090 BLUE CLAY 0135
INNISFIL TOWNSHIP CON 10 017	17 610725 4910471 W	1965/10 2514	6					5701334 () A	PRDG 0016 BRWN CLAY MSND 0025 GREY FSND 0050 BLUE CLAY MSND STNS 0070 BLUE CLAY 0076
INNISFIL TOWNSHIP CON 10 018	17 611065 4910572 W	1965/08 2514	6	FR 0033	10/40/4/72:0	DO	0028 17	5701338 ()	FILL 0003 BRWN CLAY MSND BLDR 0030 GRVL CLAY MSND 0043 BLUE CLAY MSND 0060 FSND CLAY 0066 BLUE CLAY 0075
INNISFIL TOWNSHIP CON 10 018	17 611484 4910723 W	1970/08 3203	5	FR 0112	25/60/4/2:30	ST DO	0150 5	5707411 ()	BRWN LOAM 0001 BRWN GRVL MSND 0010 GREY CLAY GRVL 0045 GREY CLAY STNS 0053 GREY CLAY MSND 0070 GREY MSND 0072 GREY CLAY GRVL 0074 GREY MSND GRVL 0084 GREY CLAY MSND GRVL 0125 GREY SILT 0138 GREY CLAY 0142 GREY FSND 0155
INNISFIL TOWNSHIP CON 10 019	17 611791 4910642 W	1963/12 4102	6					5701341 () A	BLUE CLAY 0045
INNISFIL TOWNSHIP CON 10 019	17 611640 4910741 W	1963/12 2514	6 5	FR 0061	44/67/3/2:0	ST DO	0061 3 0064 3	5701342 ()	LOAM 0001 GRVL 0015 MSND GRVL 0045 CSND 0055 YLLW FSND 0067 BLUE CLAY FSND 0084
INNISFIL TOWNSHIP CON 11 017	17 610514 4910523 W	1985/11 4816	6		10/20/5/2:0	DO	0040 4	5720335 ()	SAND 0004 GRVL 0006 BRWN SAND 0045 GREY CLAY 0045
INNISFIL TOWNSHIP CON 11 017	17 610736 4910591 W	1972/09 4608	30	FR 0010	8/11/3/0:30	DO		5709424 ()	GREY SAND 0018
INNISFIL TOWNSHIP CON 11 017	17 610550 4911182 L	1989/08 1467	5	SU 0142	37/98/5/2:30	DO	0158 7	5725449 (65157)	BRWN SAND 0006 BRWN CLAY SAND 0014 GREY CLAY SAND 0037 GREY SILT 0049 GREY CLAY 0142 GREY SAND CLAY LYRD 0165 GREY CLAY 0165
INNISFIL TOWNSHIP CON 11 017	17 611300 4910803 W	1991/12 1456	5	FR 0023 FR 0148	35/100/4/2:0	DO	0149 4	5728799 (103676)	BRWN CLAY 0008 BRWN SAND CLAY 0023 GREY SAND SILT 0027 GREY CSND GRVL 0030 GREY CSND 0039 GREY FSND 0040 GREY CLAY 0041 GREY CSND SILT LYRD 0054 GREY CLAY SAND 0065 GREY CLAY DNSE 0148 GREY SAND PORS 0153
INNISFIL TOWNSHIP CON 11 018	17 611403 4910834 W	2016/04 7222	2.41 2.01	FR 0453	9//7/1:0	DO	0046 45	7276258 (Z187237) _NO_TAG	BRWN SAND STNS LOOS 0059 GREY CLAY SAND DNSE 0453 BRWN SAND LOOS 0499 GREY CLAY DNSE

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
INNISFIL TOWNSHIP CON 11 018	17 611126 4911376 L	1986/06 1467	5	FR 0031	11/33/5/3:0	DO	0037 4	5720922 (NA)	BRWN SAND 0031 GREY FSND 0041
INNISFIL TOWNSHIP CON 11 019	17 611726 4911003 W	2018/12 4645	6.25	FR 0105	23/55/8/1:	DO	0101 4	7324767 (Z298450) A257711	BLCK LOAM SOFT 0001 BRWN SAND LOOS 0013 BRWN CLAY SILT SOFT 0026 BRWN SILT DRTY 0030 GREY CLAY HARD 0082 GREY SAND DRTY 0088 GREY CLAY HARD 0092 GREY SAND CLN 0105
INNISFIL TOWNSHIP CON 11 019	17 611910 4910919 W	1964/10 4608	30	FR 0031	6//1/:	ST DO		5701422 ()	RED CLAY 0009 MSND 0038
INNISFIL TOWNSHIP CON 11 019	17 611705 4911568 L	1987/11 3203	5	FR 0044	21/32/5/:	DO	0040 4	5723059 (NA)	LOAM 0001 BRWN CLAY SAND 0027 BRWN SAND WBRG 0044 BRWN SAND CLAY 0051

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		

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix B

Borehole Logs

LOG OF DRILLING OPERATIONS

BURNSIDE

R.J. Burnside & Associates Limited
292 Speedvale Avenue West, Guelph, Ontario N1H 1C4
telephone (519) 823-4995 fax (519) 836-5477

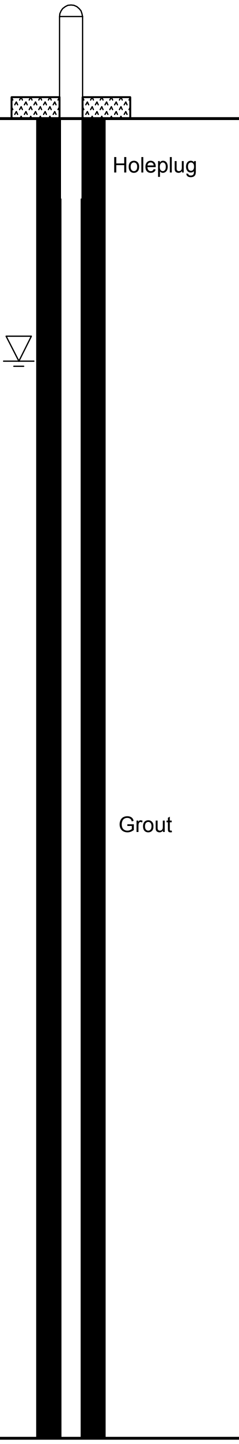
MW15d

Page 1 of 2

Client: **Crisdawn Construction Limited**	Project Name: **Crisdawn FBWB Study**	Logged by: **B.Ward**
Project No.: **300041559**	Location: **Barrie, ON**	Ground (m amsl): **255.00**
Drilling Co.: **Lantech Drilling Services Inc.**	Date Started: **2/20/2018**	Static Water Level Depth (m): **1.84**
Drilling Method: **Hollow Stem Auger**	Date Completed: **2/21/2018**	Sand Pack Depth (m) : **12.50 - 13.98**

Surface Elevation (m): **255.00**

Stratigraphic Description	Depth (m)
TOPSOIL Dark brown loam	0.20
SAND Brown, fine to medium, loose, wet, well graded, trace silt	0.35
CLAY Silty Till like, trace sand, trace fine gravel, brown, firm, moist, weakly plastic.	1.48
SAND Silty Brown, fine to medium, compact, wet, well graded, some clay, trace gravel subrounded (<2 cm diam.) at 2.5 m - medium to coarse, loose, saturated	3.33
SILT Sandy Brown, firm, wet, weakly plastic, trace to some clay, trace gravel becomes grey, saturated and soft at 4.5 m; occasional cobbles	6.10
SAND Grey, trace clay, saturated, very stiff to hard.	6.30
Clayey SILT/ Silty CLAY Grey, trace sand, damp to wet, hard, occasional gravel. at 6.91m 5cm sand seam	9.07
SAND Grey, well graded, saturated, friable, very stiff at 9.20m and 9.31m 8cm seams of SILT	9.83



Num.	Type	Int.	N.Val.
1	SS	☒	3
2	SS	☒	37
3	SS	☒	11
4	SS	☒	21
5	SS	☒	44
6	NR	○	>100
7	SS	☒	89/18"
8	SS	☒	82/12"
9	SS	☒	70
10	SS	☒	>100
11	SS	☒	>50
12	SS	☒	44

Prepared By: **B.Ward** Checked By: **D. Smikle** Date Prepared: **3/7/2018**

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 - 2/21/2018

MONITORING WELL DATA
Pipe: **51 mm dia. PVC**
Screen: **51 mm dia. PVC #10 slot**

SAMPLE TYPE					
AC	◧	Auger Cutting	SS	☒	Split Spoon
CS	▯	Continuous	AR	▨	Air Rotary
RC	▭	Rock Core	WC	▭	Wash Cuttings

LOG OF DRILLING OPERATIONS

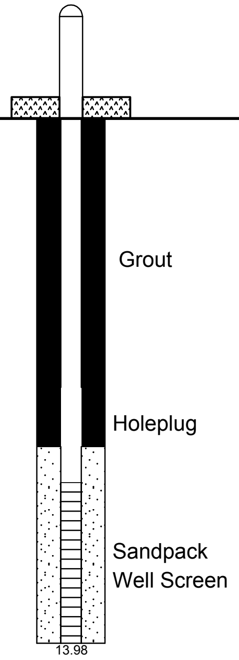
MW15d

BURNSIDE
R.J. Burnside & Associates Limited
292 Speedvale Avenue West, Guelph, Ontario N1H 1C4
telephone (519) 823-4995 fax (519) 836-5477

Client: **Crisdawn Construction Limited**	Project Name: **Crisdawn FBWB Study**	Logged by: **B.Ward**
Project No.: **300041559**	Location: **Barrie, ON**	Ground (m amsl): **255.00**
Drilling Co.: **Lantech Drilling Services Inc.**	Date Started: **2/20/2018**	Static Water Level Depth (m): **1.84**
Drilling Method: **Hollow Stem Auger**	Date Completed: **2/21/2018**	Sand Pack Depth (m) : **12.50 - 13.98**

Surface Elevation (m): **255.00**

Depth Scale (ft)	Depth Scale (m)	Stratigraphic Description	Depth (m)	SAMPLE Num.	SAMPLE Type	SAMPLE Int.	SAMPLE N.Val.
		Clayey/ CLAY Silty		13	SS	☒	>50
35.0		Clayey SILT Clayey/ Silty CLAY Grey, trace sand, trace gravel, damp, hard.					
	11.0	at 10.9 m increasing sand content		14	SS	☒	>50
				15	SS	☒	>50
	12.0						
40.0				16	SS	☒	>50
	13.0						
		SAND Silty Grey, trace clay, wet, hard	13.11				
45.0		SAND Grey, trace gravel, saturated, hard.	13.72				
	14.0			17	SS	☒	>114
			14.33				



Prepared By: **B.Ward** Checked By: **D. Smikle** Date Prepared: **3/7/2018**

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: **51 mm dia. PVC**	AC	Auger Cutting	SS ☒	Split Spoon
▽ Static Water Level - 2/21/2018	Screen: **51 mm dia. PVC #10 slot**	CS	Continuous	AR ▨	Air Rotary
		RC	Rock Core	WC	Wash Cuttings

LOG OF DRILLING OPERATIONS

CD-18

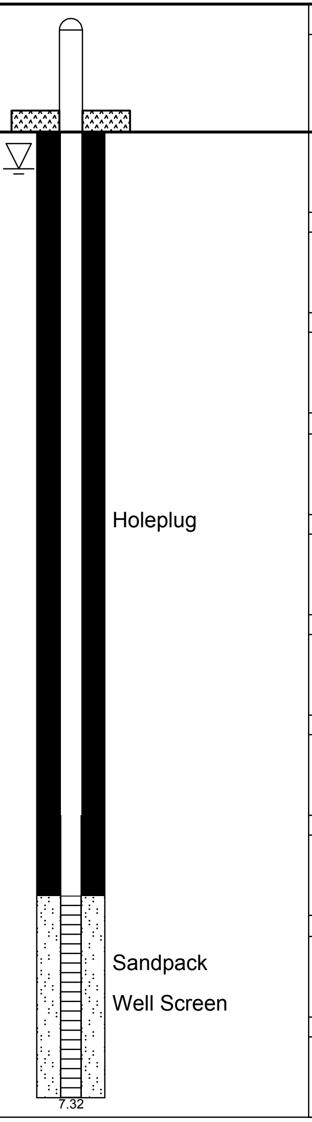
BURNSIDE
R.J. Burnside & Associates Limited
292 Speedvale Avenue West, Guelph, Ontario N1H 1C4
telephone (519) 823-4995 fax (519) 836-5477

Page 1 of 1

Client: **Crisdawn Construction Limited**	Project Name: **Crisdawn FBWB Study**	Logged by: **B.Ward**
Project No.: **300041559**	Location: **Barrie, ON**	Ground (m amsl):
Drilling Co.: **Lantech Drilling Services Inc.**	Date Started: **2/21/2018**	Static Water Level Depth (m): **0.28**
Drilling Method: **Hollow Stem Auger**	Date Completed: **2/21/2018**	Sand Pack Depth (m) : **5.18 - 7.32**

Depth Scale (ft) (m): 5.0, 10.0, 15.0, 20.0 (ft); 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0 (m)

Stratigraphic Description	Depth (m)
TOPSOIL Brown, trace sand, wet, rootlets throughout	0.40
CLAY Light brown, damp to wet, highly plastic, medium hardness with depth increasing silt and sand content at 1.52m occasional gravel and mottling at 3.05m grey	3.73
CLAY Silty/ SILT Clayey Grey, trace sand, trace gravel, wet to saturated, medium plasticity, stiff. at 6.22m and 6.42m small sand seams	7.47



SAMPLE Num.	Type	Int.	N.Val.
1	SS	☒	10
2	SS	☒	14
3	SS	☒	17
4	SS	☒	15
5	SS	☒	26
6	SS	☒	21
7	SS	☒	26
8	SS	☒	35
9	SS	☒	40
10	SS	☒	>91

Prepared By: **B.Ward** Checked By: **D. Smikle** Date Prepared: **3/7/2018**

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: **51 mm dia. PVC**	AC ◧ Auger Cutting	CS ◫ Continuous	RC ⛰ Rock Core
▽ Static Water Level - 2/22/2018	Screen: **51 mm dia. PVC #10 slot**	SS ☒ Split Spoon	AR ▨ Air Rotary	WC 〜 Wash Cuttings

LOG OF DRILLING OPERATIONS

CD-19

BURNSIDE

R.J. Burnside & Associates Limited
292 Speedvale Avenue West, Guelph, Ontario N1H 1C4
telephone (519) 823-4995 fax (519) 836-5477

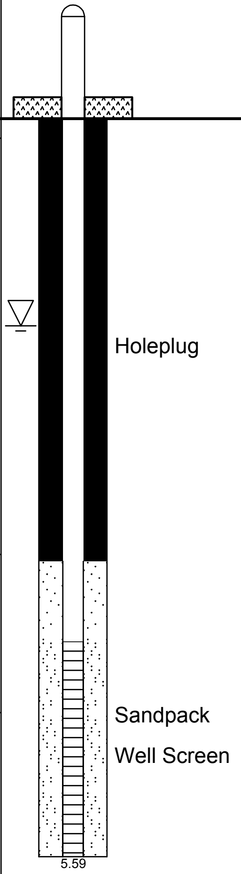
Page 1 of 1

Client: **Crisdawn Construction Limited**	Project Name: **Crisdawn FBWB Study**	Logged by: **B.Ward**
Project No.: **300041559**	Location: **Barrie, ON**	Ground (m amsl):
Drilling Co.: **Lantech Drilling Services Inc.**	Date Started: **2/22/2018**	Static Water Level Depth (m): **1.57**
Drilling Method: **Hollow Stem Auger**	Date Completed: **2/22/2018**	Sand Pack Depth (m) : **3.35 - 5.59**

Stratigraphic Description	Depth (m)
TOPSOIL Brown, sand and silt, damp, friable, rootlets throughout	0.15
SAND Red to brown, uniform, damp, medium hardness. at 0.76m saturated at 1.52m light brown	3.30
Sandy SILT/ Silty SAND Brown, uniform, saturated, very stiff. at 3.35m 5cm sand seam	4.50
SILT Brown, trace sand, saturated, stiff at 5.33m 10cm sand seam	5.90
CLAY Grey, uniform, trace silt, damp, very stiff, occasional gravel.	6.71

Depth Scale (ft) (m)

(ft)	(m)
	1.0
5.0	
	2.0
	3.0
10.0	
	4.0
15.0	
	5.0
	6.0
20.0	



SAMPLE Num.	Type	Int.	N.Val.
1	SS	☒	12
2	SS	☒	34
3	SS	☒	34
4	SS	☒	33
5	SS	☒	33
6	SS	☒	25
7	SS	☒	28
8	SS	☒	17
9	SS	☒	28

Prepared By: **B.Ward** Checked By: **D. Smikle** Date Prepared: **3/7/2018**

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.

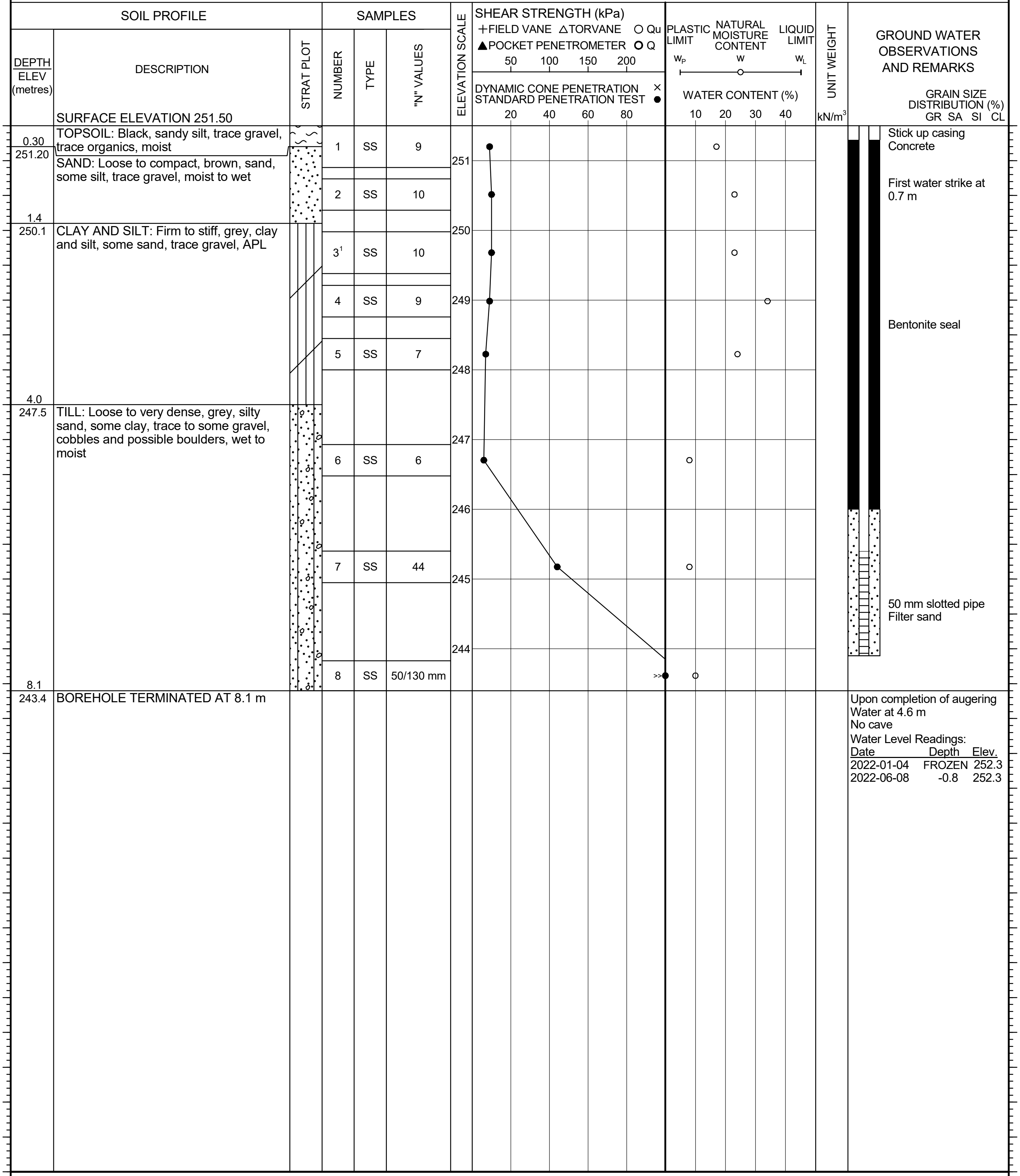
LEGEND	MONITORING WELL DATA	SAMPLE TYPE			
▼ Water found @ time of drilling	Pipe: **51 mm dia. PVC**	AC ◧	Auger Cutting	SS ☒	Split Spoon
▽ Static Water Level - 2/22/2018	Screen: **51 mm dia. PVC #10 slot**	CS ▯	Continuous	AR ▨	Air Rotary
		RC ▦	Rock Core	WC ▭	Wash Cuttings

LOG OF BOREHOLE/MONITORING WELL NO. 101

1 of 1

17T 610974E 4910966N

PROJECT Proposed Hewitt's Gate East Residential Development - Phase 3
PML REF. 21BF052
LOCATION Barrie, Ontario
BORING DATE December 13, 2022
ENGINEER FM
BORING METHOD Continuous Flight Hollow Stem Augers
TECHNICIAN FF



SURFACE ELEVATION 251.50

DEPTH / ELEV (metres)	DESCRIPTION
0.30 251.20	TOPSOIL: Black, sandy silt, trace gravel, trace organics, moist
1.4 250.1	SAND: Loose to compact, brown, sand, some silt, trace gravel, moist to wet
4.0 247.5	CLAY AND SILT: Firm to stiff, grey, clay and silt, some sand, trace gravel, APL
8.1 243.4	TILL: Loose to very dense, grey, silty sand, some clay, trace to some gravel, cobbles and possible boulders, wet to moist
	BOREHOLE TERMINATED AT 8.1 m

NUMBER	TYPE	"N" VALUES
1	SS	9
2	SS	10
3^1	SS	10
4	SS	9
5	SS	7
6	SS	6
7	SS	44
8	SS	50/130 mm

GROUND WATER OBSERVATIONS AND REMARKS

Stick up casing
Concrete

First water strike at 0.7 m

Bentonite seal

50 mm slotted pipe
Filter sand

Upon completion of augering
Water at 4.6 m
No cave
Water Level Readings:

Date	Depth	Elev.
2022-01-04	FROZEN	252.3
2022-06-08	-0.8	252.3

NOTES 1. Sample submitted for chemical testing

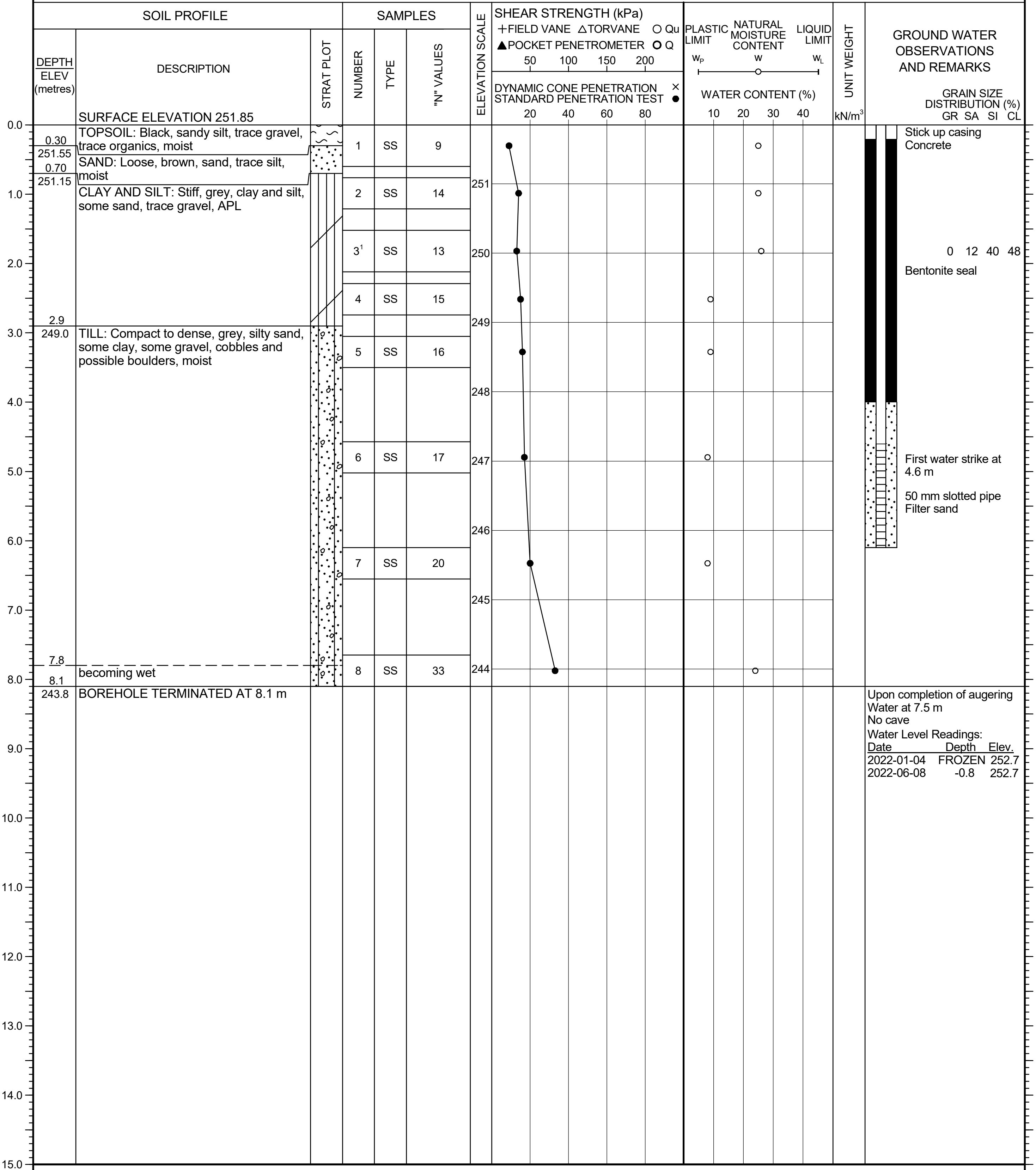
Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE/MONITORING WELL NO. 102

1 of 1

17T 611000E 4910907N

PROJECT Proposed Hewitt's Gate East Residential Development - Phase 3
PML REF. 21BF052
LOCATION Barrie, Ontario
BORING DATE December 13, 2022
ENGINEER FM
BORING METHOD Continuous Flight Hollow Stem Augers
TECHNICIAN FF



SOIL PROFILE

DEPTH ELEV (metres)	DESCRIPTION
	SURFACE ELEVATION 251.85
0.30 251.55	TOPSOIL: Black, sandy silt, trace gravel, trace organics, moist
0.70 251.15	SAND: Loose, brown, sand, trace silt, moist
	CLAY AND SILT: Stiff, grey, clay and silt, some sand, trace gravel, APL
2.9 249.0	TILL: Compact to dense, grey, silty sand, some clay, some gravel, cobbles and possible boulders, moist
7.8	becoming wet
8.1 243.8	BOREHOLE TERMINATED AT 8.1 m

SAMPLES

NUMBER	TYPE	"N" VALUES
1	SS	9
2	SS	14
3[1]	SS	13
4	SS	15
5	SS	16
6	SS	17
7	SS	20
8	SS	33

GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
0	12	40	48

GROUND WATER OBSERVATIONS AND REMARKS

Stick up casing
Concrete

Bentonite seal

First water strike at 4.6 m

50 mm slotted pipe
Filter sand

Upon completion of augering
Water at 7.5 m
No cave
Water Level Readings:

Date	Depth	Elev.
2022-01-04	FROZEN	252.7
2022-06-08	-0.8	252.7

NOTES 1. Sample submitted for chemical testing

LOG OF BOREHOLE/MONITORING WELL NO. 103

1 of 1

17T 611406E 4911170N

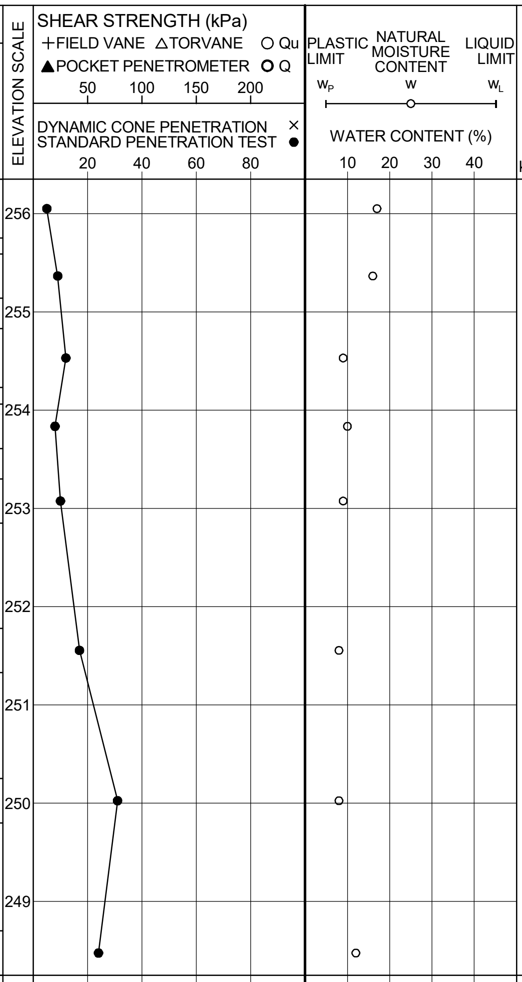
PROJECT Proposed Hewitt's Gate East Residential Development - Phase 3
PML REF. 21BF052
LOCATION Barrie, Ontario
BORING DATE December 14, 2022
ENGINEER FM
BORING METHOD Continuous Flight Hollow Stem Augers
TECHNICIAN FF

SOIL PROFILE

DEPTH ELEV (metres)	DESCRIPTION
0.0	SURFACE ELEVATION 256.35
	TOPSOIL: Black, sandy silt, trace gravel, trace organics, moist
0.20 256.15	SAND: Loose, brown, sand, trace silt, trace gravel, moist
0.70 255.65	CLAY AND SILT: Stiff, brown, clay and silt, trace sand, trace gravel, APL
1.4 255.0	TILL: Loose to dense, grey, silty sand, some clay, some gravel, cobbles and possible boulders, moist
7.1 249.3	SAND: Compact, grey, sand, trace gravel, wet
8.1 248.3	BOREHOLE TERMINATED AT 8.1 m

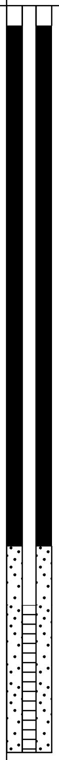
SAMPLES

NUMBER	TYPE	"N" VALUES
1	SS	5
2	SS	9
3[1]	SS	12
4	SS	8
5	SS	10
6	SS	17
7	SS	31
8	SS	24



GROUND WATER OBSERVATIONS AND REMARKS

GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL



Stick up casing
Concrete

Bentonite seal

First water strike at 6.7 m
50 mm slotted pipe
Filter sand

Upon completion of augering
Water at 2.4 m
No cave
Water Level Readings:

Date	Depth	Elev.
2022-01-04	0.9	255.5
2022-06-08	0.3	256.1

NOTES 1. Sample submitted for chemical testing

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE/MONITORING WELL NO. 104

17T 611415E 4911123N

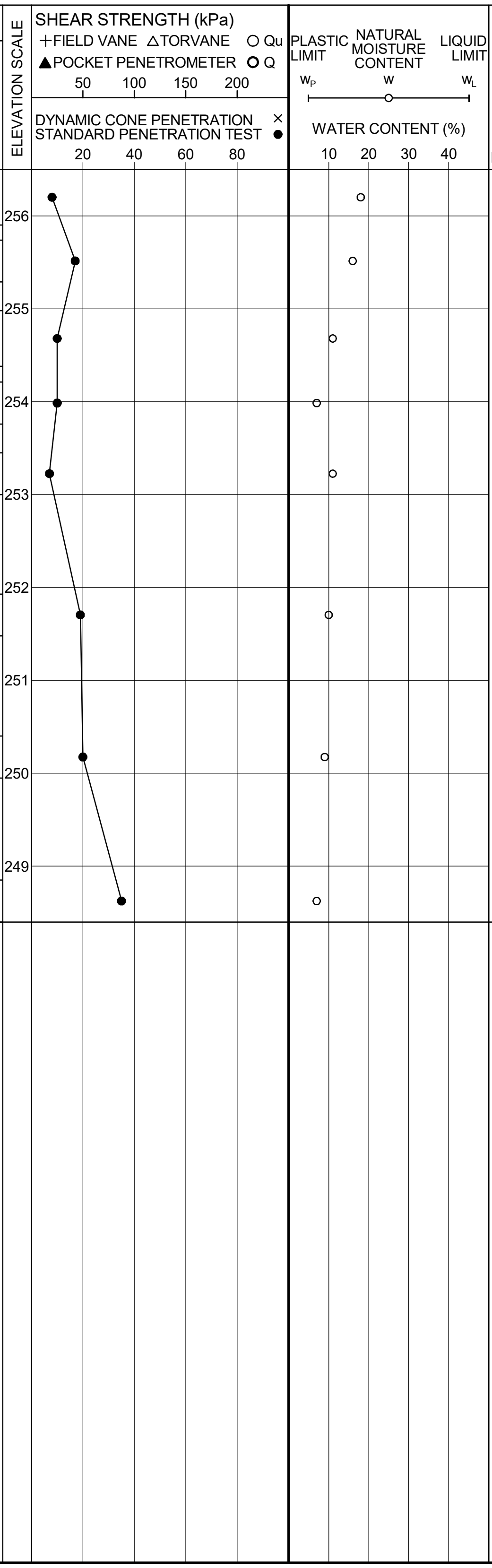
1 of 1

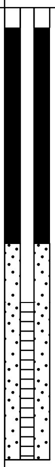
PROJECT Proposed Hewitt's Gate East Residential Development - Phase 3
PML REF. 21BF052
LOCATION Barrie, Ontario
BORING DATE December 14, 2022
ENGINEER FM
BORING METHOD Continuous Flight Hollow Stem Augers
TECHNICIAN FF

DEPTH / ELEV (metres)	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GROUND WATER OBSERVATIONS AND REMARKS
0.0	SURFACE ELEVATION 256.50				
	TOPSOIL: Black, sandy silt, trace gravel, trace organics, moist	1	SS	8	Stick up casing Concrete
0.30 256.20	SAND: Compact, brown, sand, trace silt, very moist	2	SS	17	
1.4 255.1	TILL: Loose to compact, grey, sandy silt, some clay to clayey, some gravel, cobbles and possible boulders, moist to very moist	3[1]	SS	10	Bentonite seal
		4	SS	10	
		5	SS	7	
4.0 252.5	becoming dense, silty sand, some clay, trace to some gravel				50 mm slotted pipe Filter sand First water strike at 4.0 m
		6	SS	19	GRAIN SIZE DISTRIBUTION (%) GR 15, SA 39, SI 34, CL 12
		7	SS	20	
		8	SS	35	
8.1 248.4	BOREHOLE TERMINATED AT 8.1 m				Upon completion of augering Water at 3.9 m No cave

Water Level Readings:

Date	Depth	Elev.
2022-01-04	1.1	255.4
2022-06-08	0.8	255.7





NOTES 1. Sample submitted for chemical testing

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE/MONITORING WELL NO. 105

1 of 1

17T 611249E 4910979N

PROJECT Proposed Hewitt's Gate East Residential Development - Phase 3 **PML REF.** 21BF052

LOCATION Barrie, Ontario **BORING DATE** December 13, 2022 **ENGINEER** FM

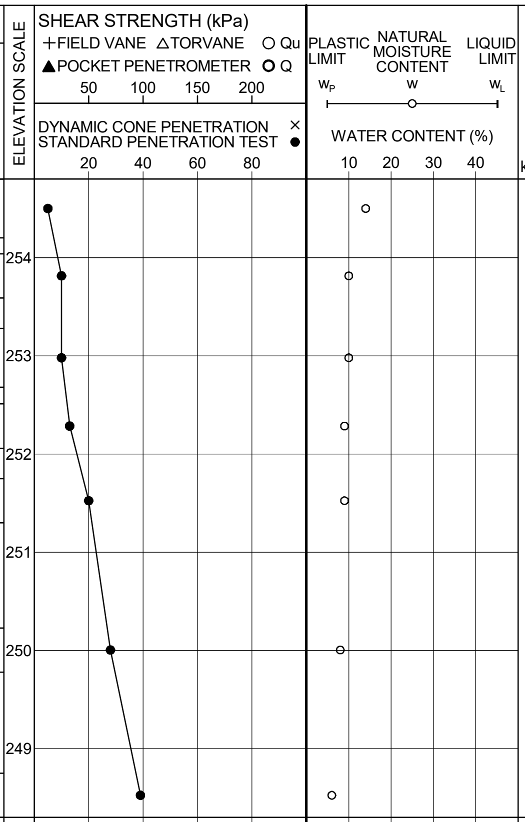
BORING METHOD Continuous Flight Hollow Stem Augers **TECHNICIAN** FF

SOIL PROFILE

DEPTH ELEV (metres)	DESCRIPTION
0.0	SURFACE ELEVATION 254.80
0.30 254.50	TOPSOIL: Black, silty sand, trace gravel, trace organics, moist
	SAND: Compact, brown, sand, some silt, trace gravel, moist
1.4 253.4	TILL: Compact to dense, grey, silty sand, some clay, some gravel, cobbles and possible boulders, moist
6.5 248.3	BOREHOLE TERMINATED AT 6.5 m

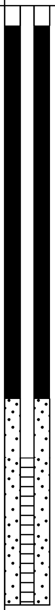
SAMPLES

NUMBER	TYPE	"N" VALUES
1	SS	5
2	SS	10
3^1	SS	10
4	SS	13
5	SS	20
6	SS	28
7	SS	39



GROUND WATER OBSERVATIONS AND REMARKS

GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL



Upon completion of augering
Water at 6.0 m
No cave

Water Level Readings:

Date	Depth	Elev.
2022-01-04	0.5	254.3
2022-06-08	0.6	254.2

NOTES 1. Sample submitted for chemical testing

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE/MONITORING WELL NO. 106

1 of 1

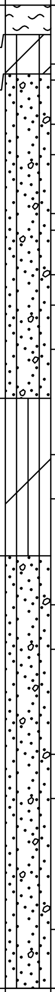
17T 611104E 4910699N

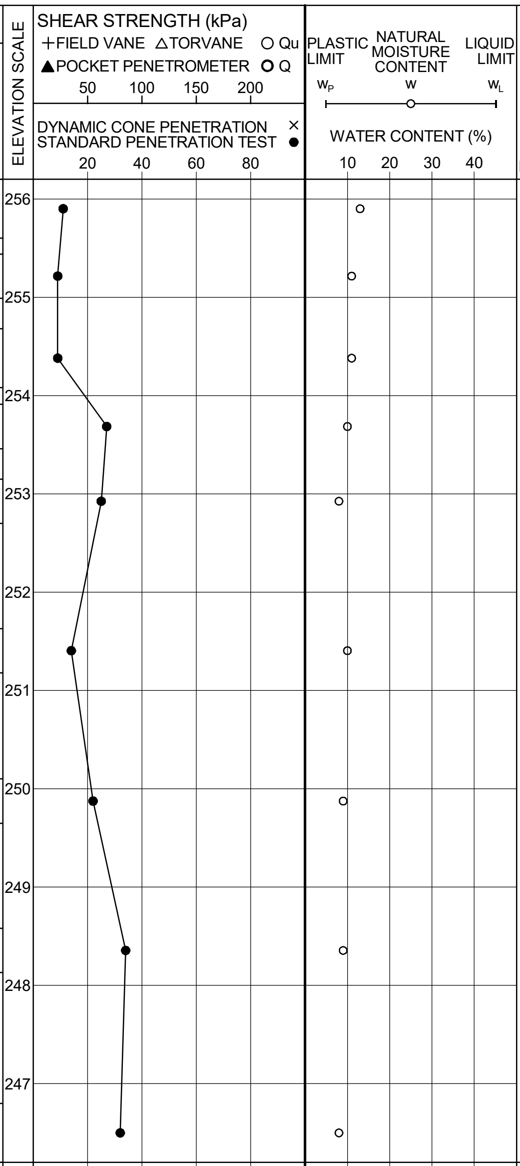
PROJECT Proposed Hewitt's Gate East Residential Development - Phase 3
PML REF. 21BF052
LOCATION Barrie, Ontario
BORING DATE December 13, 2022
ENGINEER FM
BORING METHOD Continuous Flight Hollow Stem Augers
TECHNICIAN FF

SURFACE ELEVATION 256.20

DEPTH / ELEV (metres)	DESCRIPTION
0.30 255.90	TOPSOIL: Black, silty sand, trace organics, moist
0.70 255.50	SILTY CLAY: Stiff, brown to grey, silty clay, trace sand, moist
4.0 252.2	TILL: Loose to compact, brown to grey, silty sand, some clay, trace gravel, moist
5.6 250.6	CLAY AND SILT: Stiff, grey, clay and silt, some sand, APL
10.0 246.2	TILL: Compact to dense, grey, silty sand, some clay, some gravel, cobbles and possible boulders, very moist to wet
	BOREHOLE TERMINATED AT 10.0 m

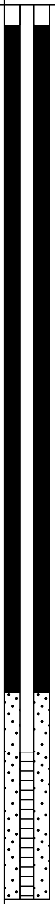
NUMBER	TYPE	"N" VALUES	GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1	SS	11	
2	SS	9	
3[1]	SS	9	9 45 34 12
4	SS	27	
5	SS	25	
6	SS	14	
7	SS	22	
8	SS	34	
9	SS	32	





UNIT WEIGHT kN/m³

GROUND WATER OBSERVATIONS AND REMARKS



Stick up casing
Concrete

Bentonite seal

First water strike at 4.6 m

50 mm slotted pipe
Filter sand

Upon completion of augering
Water at 4.6 m
No cave
Water Level Readings:

Date	Depth	Elev.
2022-01-04	1.5	254.7
2022-06-08	1.6	254.6

NOTES 1. Sample submitted for chemical testing

Peto MacCallum Ltd.
CONSULTING ENGINEERS

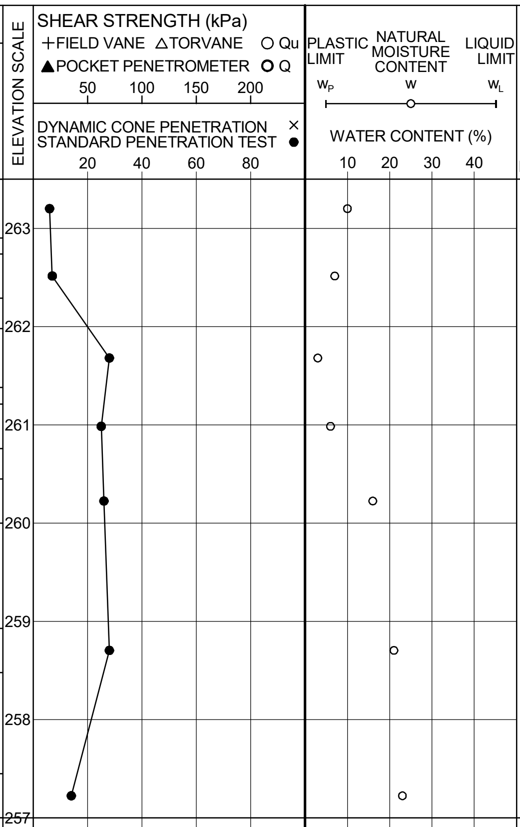
LOG OF BOREHOLE/MONITORING WELL NO. 107

1 of 1

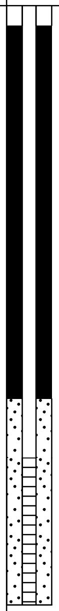
17T 611311E 4910770N

PROJECT Proposed Hewitt's Gate East Residential Development - Phase 3
PML REF. 21BF052
LOCATION Barrie, Ontario
BORING DATE December 14, 2022
ENGINEER FM
BORING METHOD Continuous Flight Hollow Stem Augers
TECHNICIAN FF

DEPTH / ELEV (metres)	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	"N" VALUES
	SURFACE ELEVATION 263.50			
0.20 263.30	TOPSOIL: Black, silty sand, trace gravel, trace organics, moist	1	SS	6
	SAND: Loose to compact, brown, sand, trace to some silt, trace gravel, moist	2	SS	7
1.5 262.0	Becoming till-like with cobbles and possible boulders	3^1	SS	28
		4	SS	25
		5	SS	26
4.6 258.9	Becoming grey, wet	6	SS	28
		7	SS	14
6.5 257.0	BOREHOLE TERMINATED AT 6.5 m			



GROUND WATER OBSERVATIONS AND REMARKS
GRAIN SIZE DISTRIBUTION (%) GR SA SI CL



Upon completion of augering
Water at 4.6 m
No cave
Water Level Readings:

Date	Depth	Elev.
2022-01-04	2.4	261.1
2022-06-08	4.4	259.1

NOTES 1. Sample submitted for chemical testing

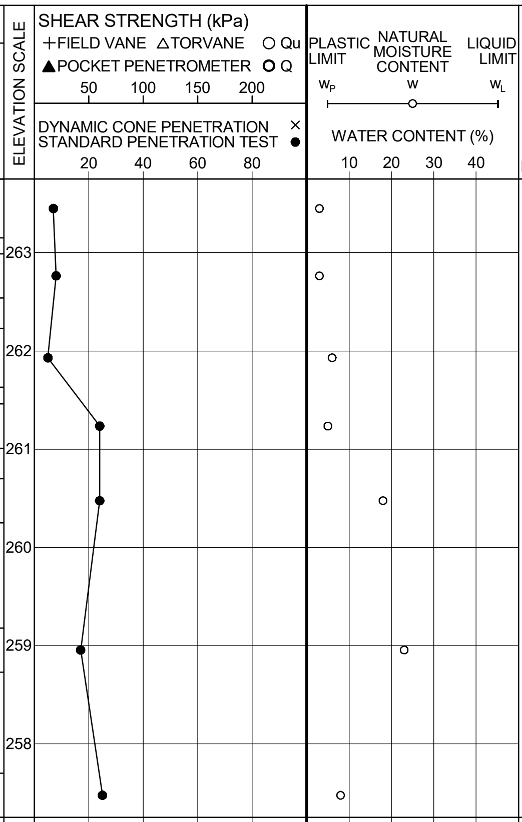
LOG OF BOREHOLE/MONITORING WELL NO. 108

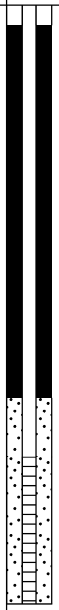
17T 611496E 4910822N

1 of 1

PROJECT Proposed Hewitt's Gate East Residential Development - Phase 3
PML REF. 21BF052
LOCATION Barrie, Ontario
BORING DATE December 14, 2022
ENGINEER FM
BORING METHOD Continuous Flight Hollow Stem Augers
TECHNICIAN FF

DEPTH / ELEV (metres)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER OBSERVATIONS AND REMARKS
0.0	SURFACE ELEVATION 263.75					Stick up casing Concrete
0.30 263.45	TOPSOIL: Black, sand, trace gravel, trace organics, moist		1	SS	7	
	SAND: Loose to compact, brown, sand, trace gravel, moist to very moist		2	SS	8	
1.5 262.3	becoming gravelly and till-like		3[1]	SS	5	Bentonite seal
			4	SS	24	
			5	SS	24	
4.0 259.8	CLAY AND SILT: Very stiff, grey, clay and silt, some sand, trace gravel, APL		6	SS	17	First water strike at 4.6 m 50 mm slotted pipe Filter sand
5.6 258.2	TILL: Compact, grey, silty sand, some clay, some gravel, cobbles and possible boulders, moist		7	SS	25	
6.5 257.3	BOREHOLE TERMINATED AT 6.5 m					Upon completion of augering Water at 4.6 m No Cave





Water Level Readings:

Date	Depth	Elev.
2022-01-04	3.3	260.5
2022-06-08	3.8	260.0

Depth scale: 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0

NOTES 1. Sample submitted for chemical testing

Peto MacCallum Ltd.
CONSULTING ENGINEERS

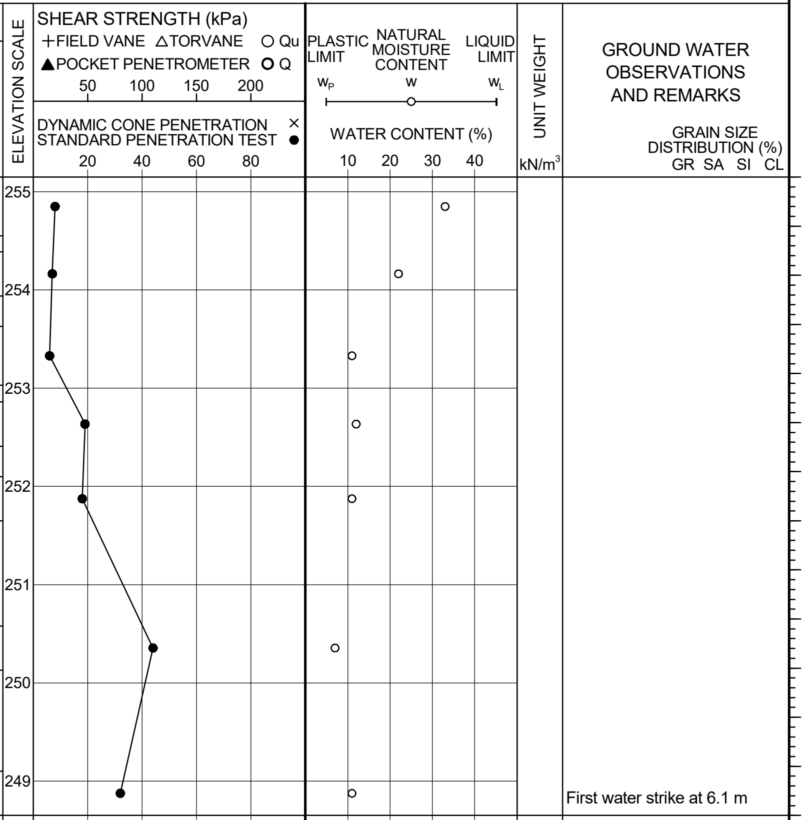
LOG OF BOREHOLE/MONITORING WELL NO. 109

1 of 1

17T 610867E 4910652N

PROJECT Proposed Hewitt's Gate East Residential Development - Phase 3
PML REF. 21BF052
LOCATION Barrie, Ontario
BORING DATE December 15, 2022
ENGINEER FM
BORING METHOD Continuous Flight Hollow Stem Augers
TECHNICIAN FF

DEPTH ELEV (metres)	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER OBSERVATIONS AND REMARKS
0.0	SURFACE ELEVATION 255.15				
	TOPSOIL: Black, sandy silt, trace gravel, trace organics, moist	1	SS	8	
0.30 254.85	CLAY AND SILT: Firm, brown, clay and silt, some sand, APL	2	SS	7	
1.7 253.5	TILL: Compact to dense, grey, silty sand, some clay, trace to some gravel, cobbles and possible boulders, moist	3[1]	SS	6	
		4	SS	19	
		5	SS	18	
		6	SS	44	
5.6 249.6	SAND: Dense, grey, sand, some silt, trace to some gravel, wet	7	SS	32	First water strike at 6.1 m
6.5 248.7	BOREHOLE TERMINATED AT 6.5 m ARTESIAN CONDITIONS HIT				Upon completion of augering Artesian conditions encountered



NOTES 1. Sample submitted for chemical testing

Peto MacCallum Ltd.
CONSULTING ENGINEERS

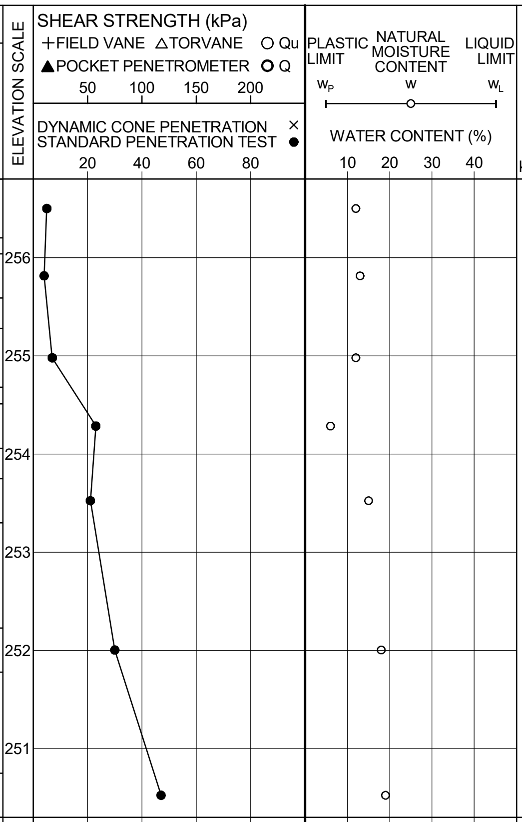
LOG OF BOREHOLE/MONITORING WELL NO. 110

1 of 1

17T 610819E 4910610N

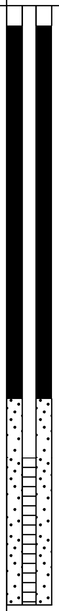
PROJECT Proposed Hewitt's Gate East Residential Development - Phase 3
PML REF. 21BF052
LOCATION Barrie, Ontario
BORING DATE December 15, 2022
ENGINEER FM
BORING METHOD Continuous Flight Hollow Stem Augers
TECHNICIAN FF

SOIL PROFILE		SAMPLES		
DEPTH ELEV (metres)	DESCRIPTION	NUMBER	TYPE	"N" VALUES
	SURFACE ELEVATION 256.80			
0.30 256.50	TOPSOIL: Black, sandy silt, trace gravel, trace organics, moist	1	SS	5
	TILL: Loose, brown, sandy silt, some clay to clayey, trace gravel, very moist	2	SS	4
		3[1]	SS	7
2.1 254.7	becoming compact, grey, silty sand, some clay, some gravel, cobbles and possible boulders	4	SS	23
		5	SS	21
4.0 252.8	SAND: Dense, brown, sand, trace to some silt, trace gravel, wet	6	SS	30
		7	SS	47
6.5 250.3	BOREHOLE TERMINATED AT 6.5 m			



GROUND WATER OBSERVATIONS AND REMARKS

GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL



Stick up casing
Concrete

Bentonite seal

First water strike at 3.1 m

50 mm slotted pipe
Filter sand

Upon completion of augering
Water at 3.0 m
No cave
Water Level Readings:

Date	Depth	Elev.
2022-01-04	1.0	255.8
2022-06-08	-0.6	257.4

NOTES 1. Sample submitted for chemical testing

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE/MONITORING WELL NO. 111

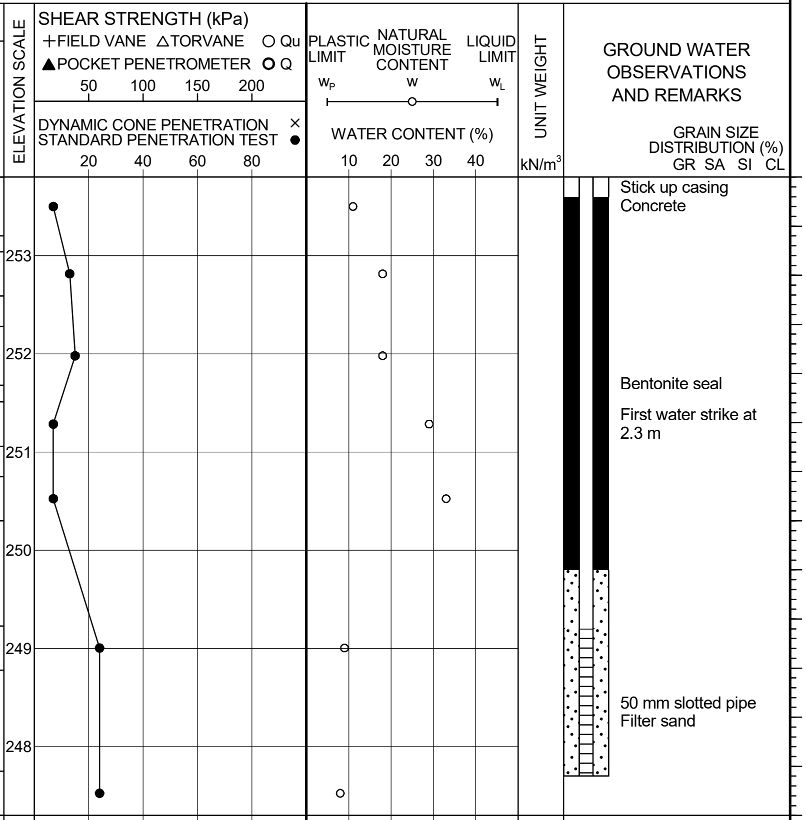
1 of 1

17T 610968E 4910803N

PROJECT Proposed Hewitt's Gate East Residential Development - Phase 3
PML REF. 21BF052
LOCATION Barrie, Ontario
BORING DATE December 15, 2022
ENGINEER FM
BORING METHOD Continuous Flight Hollow Stem Augers
TECHNICIAN FF

SURFACE ELEVATION 253.80

DEPTH (metres)	ELEV (metres)	DESCRIPTION	NUMBER	TYPE	"N" VALUES
0.30	253.50	TOPSOIL: Black, sandy silt, trace gravel, trace organics, moist	1	SS	7
		SAND: Loose to compact, brown, sand, trace to some gravel, trace silt, moist to wet	2	SS	13
1.5	252.3	Becoming gravelly	3[1]	SS	15
2.1	251.7	CLAY AND SILT: Firm, grey, clay and silt, trace sand, APL	4	SS	7
			5	SS	7
4.0	249.8	TILL: Compact, grey, silty sand, some clay, some gravel, cobbles and possible boulders, moist	6	SS	24
			7	SS	24
6.5	247.3	BOREHOLE TERMINATED AT 6.5 m			



Stick up casing
Concrete

Bentonite seal

First water strike at 2.3 m

50 mm slotted pipe
Filter sand

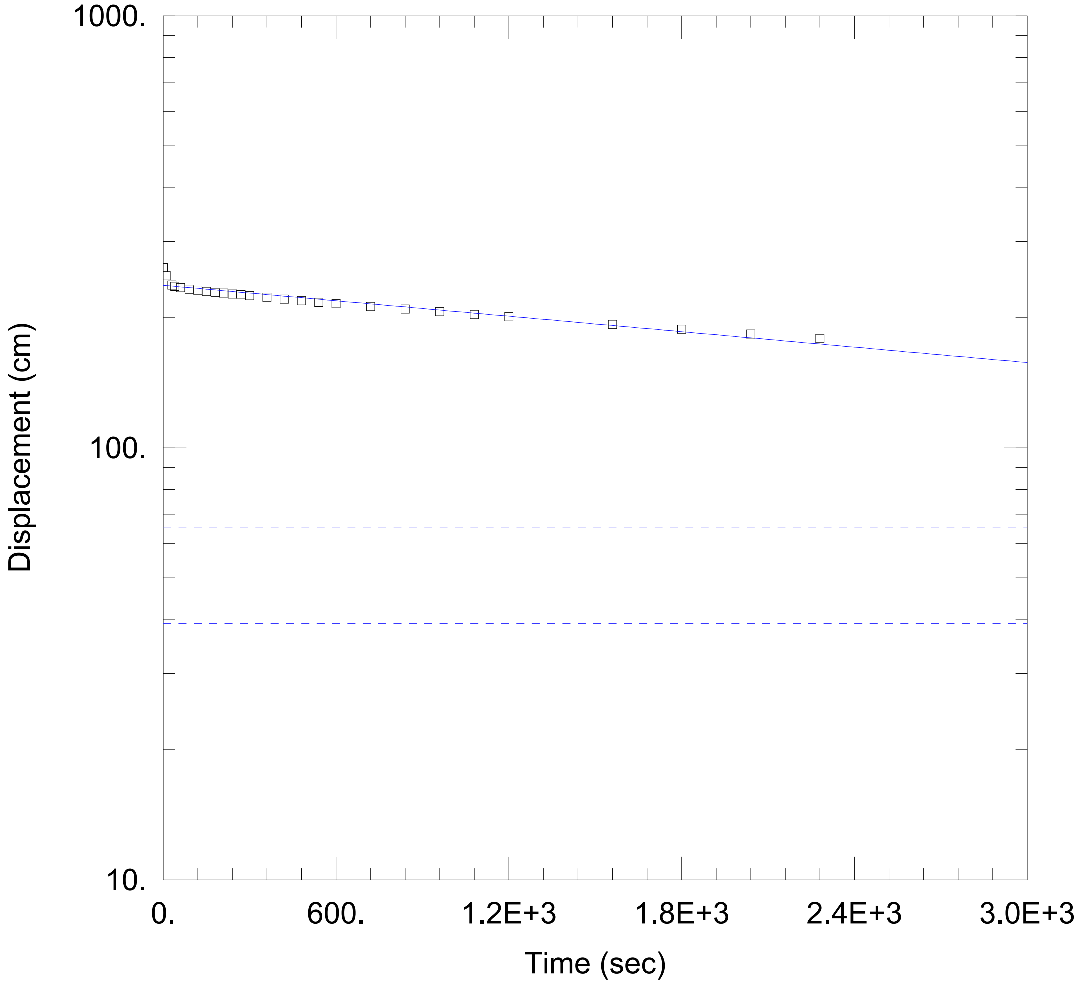
Upon completion of augering
Water at 2.2 m
No cave
Water Level Readings:

Date	Depth	Elev.
2022-01-04	1.2	252.6
2022-06-08	0.9	252.9

NOTES 1. Sample submitted for chemical testing

Appendix C

Hydraulic Conductivity Data



HYDRAULIC CONDUCTIVITY TEST AT BH104 - SCREENED IN SANDY SILT TILL

PROJECT INFORMATION

Company: R.J. Burnside & Associates
Project: 300041559.0005
Location: Barrie, ON
Test Well: BH104
Test Date: October 24, 2023

AQUIFER DATA

Saturated Thickness: 386. cm
Anisotropy Ratio (Kz/Kr): 0.1

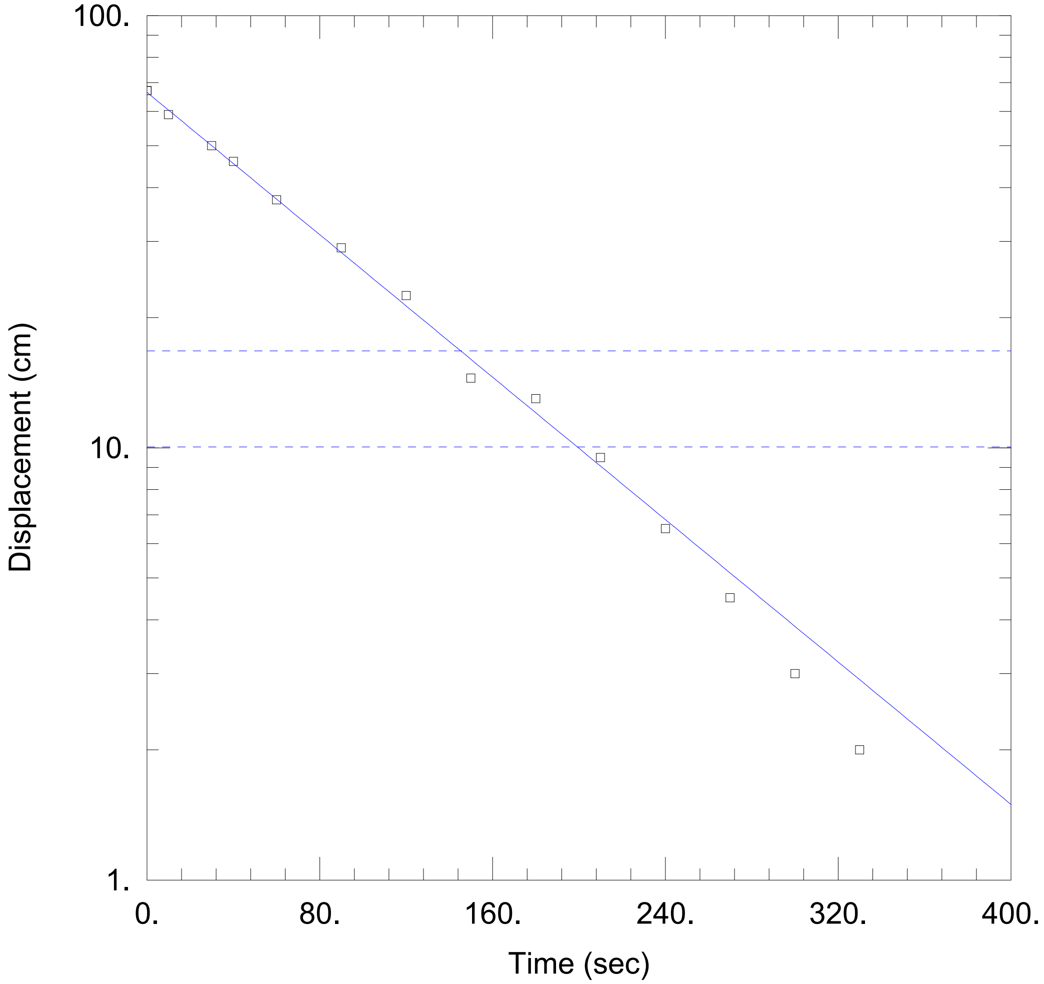
WELL DATA (BH104)

Initial Displacement: 261. cm
Total Well Penetration Depth: 386. cm
Casing Radius: 2.54 cm
Static Water Column Height: 386. cm
Screen Length: 152. cm
Well Radius: 7.62 cm
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev

K = 4.793E-5 cm/sec
y0 = 237.7 cm



HYDRAULIC CONDUCTIVITY TEST AT BH107 - SCREENED IN SAND

PROJECT INFORMATION

Company: R.J. Burnside & Associates
Project: 300041559.0005
Location: Barrie, ON
Test Well: BH107
Test Date: October 24, 2023

AQUIFER DATA

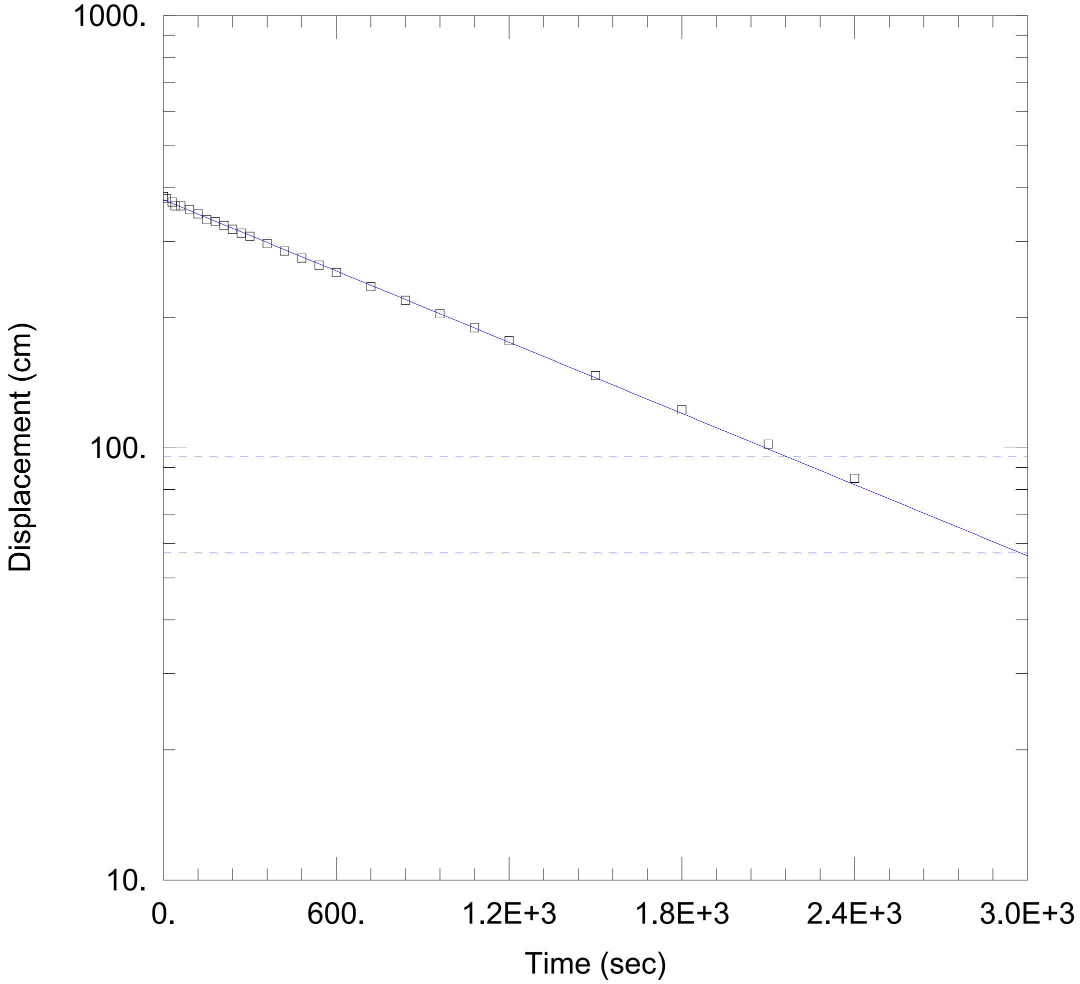
Saturated Thickness: 142. cm
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (BH107)

Initial Displacement: 67. cm
Total Well Penetration Depth: 152. cm
Casing Radius: 2.54 cm
Static Water Column Height: 142. cm
Screen Length: 152. cm
Well Radius: 7.62 cm
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.003881 cm/sec
y0 = 66.42 cm



HYDRAULIC CONDUCTIVITY AT BH111 - SCREENED IN SILTY SAND TILL

PROJECT INFORMATION

Company: R.J. Burnside & Associates
Project: 300041559.0005
Location: Barrie, ON
Test Well: BH111
Test Date: October 24, 2023

AQUIFER DATA

Saturated Thickness: 512. cm
Anisotropy Ratio (Kz/Kr): 0.1

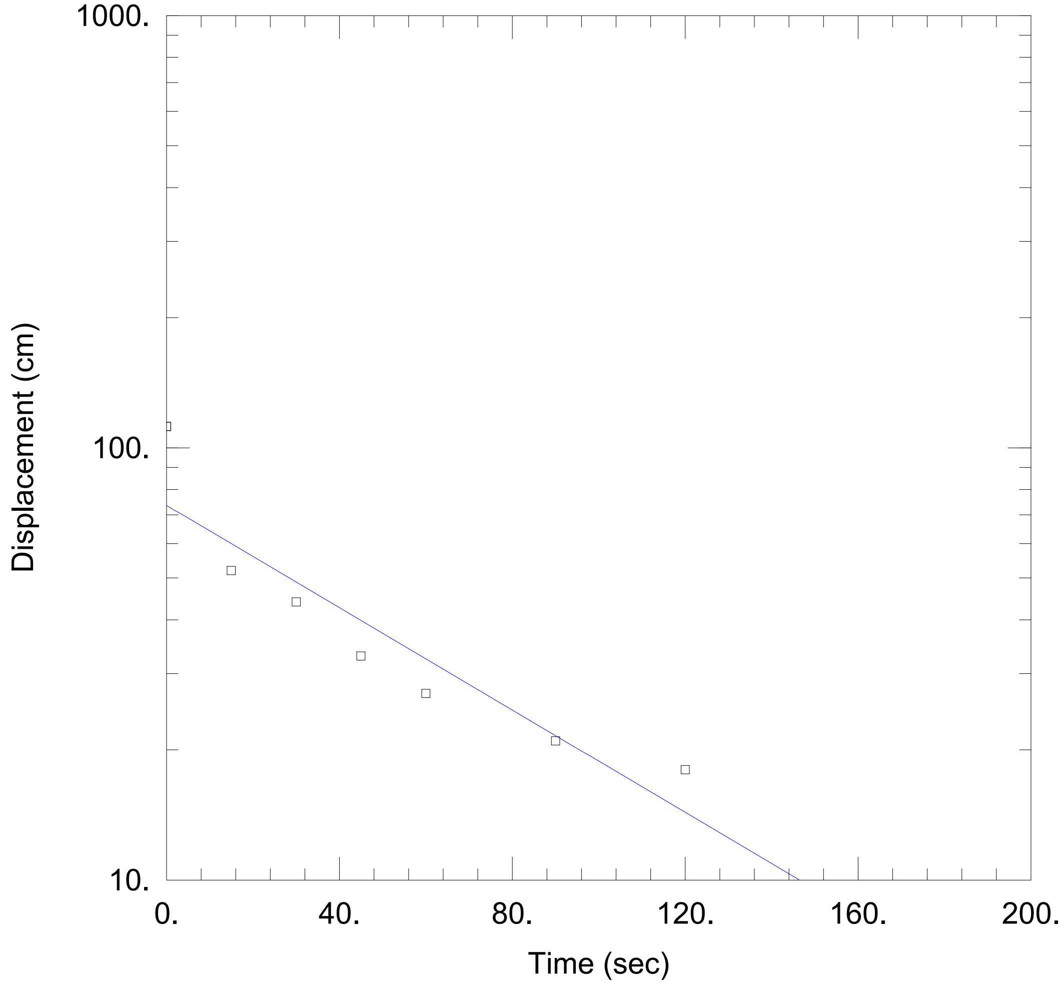
WELL DATA (BH111)

Initial Displacement: 381. cm
Total Well Penetration Depth: 512. cm
Casing Radius: 2.54 cm
Static Water Column Height: 512. cm
Screen Length: 152. cm
Well Radius: 7.62 cm

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev

K = 6.492E-5 cm/sec
y0 = 374.7 cm



HYDRAULIC CONDUCTIVITY TEST AT CD-18 (SCREENED IN SILTY CLAY/CLAYEY SILT)

PROJECT INFORMATION

Company: R.J Burnside
Client: Crisdawn
Project: 300041559
Location: Barrie
Test Well: CD-18
Test Date: May 23, 2018

AQUIFER DATA

Saturated Thickness: 813. cm

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (CD-18)

Initial Displacement: 112. cm
Total Well Penetration Depth: 813. cm
Casing Radius: 2.54 cm

Static Water Column Height: 813. cm
Screen Length: 152. cm
Well Radius: 7.62 cm

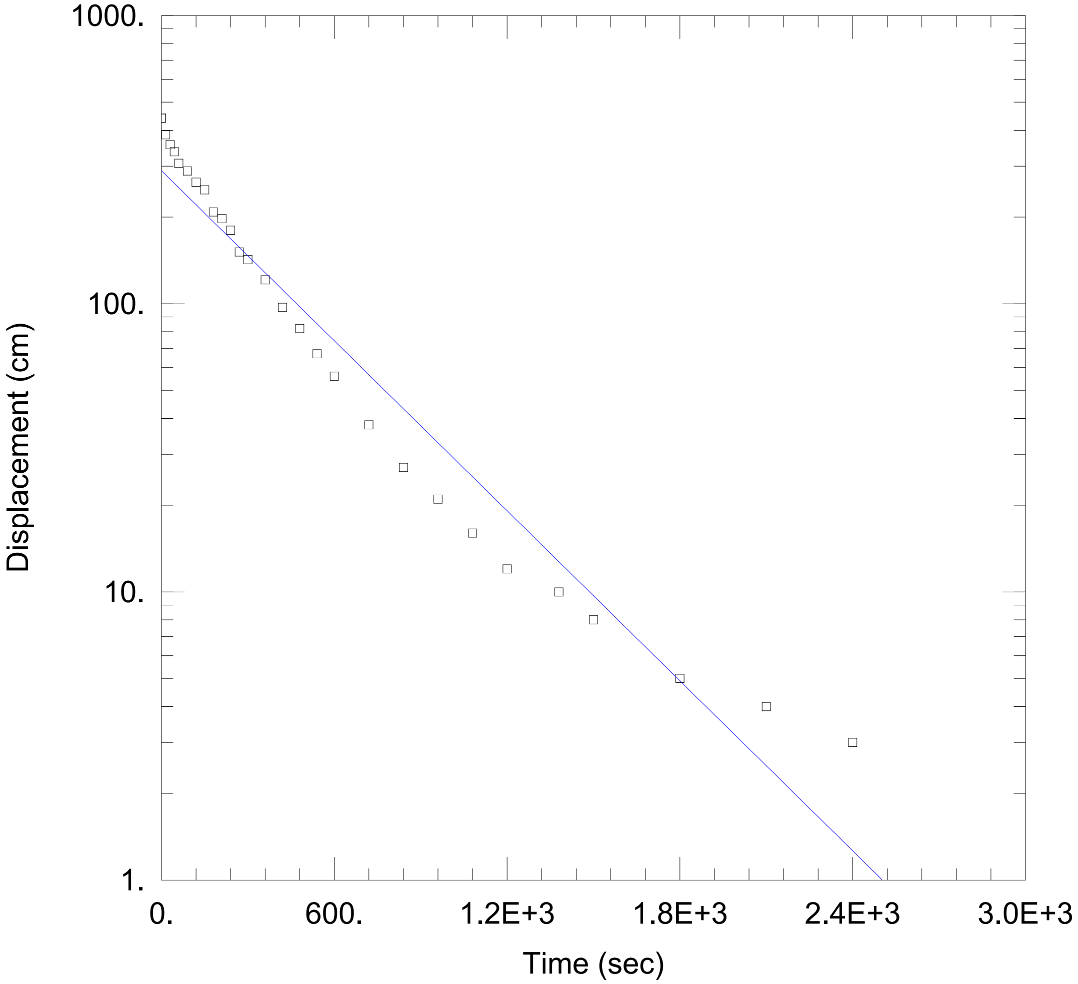
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 0.001066 cm/sec

y0 = 73.56 cm



HYDRAULIC CONDUCTIVITY TEST AT MW15D (SCREENED IN SILTY CLAY/SILTY SAND)

PROJECT INFORMATION

Company: R.J Burnside
Client: Crisdawn
Project: 300041559
Location: Barrie
Test Well: MW15d
Test Date: May 23, 2018

AQUIFER DATA

Saturated Thickness: 1286. cm

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW15d)

Initial Displacement: 441. cm
Total Well Penetration Depth: 1286. cm
Casing Radius: 2.54 cm

Static Water Column Height: 1286. cm
Screen Length: 152. cm
Well Radius: 7.62 cm

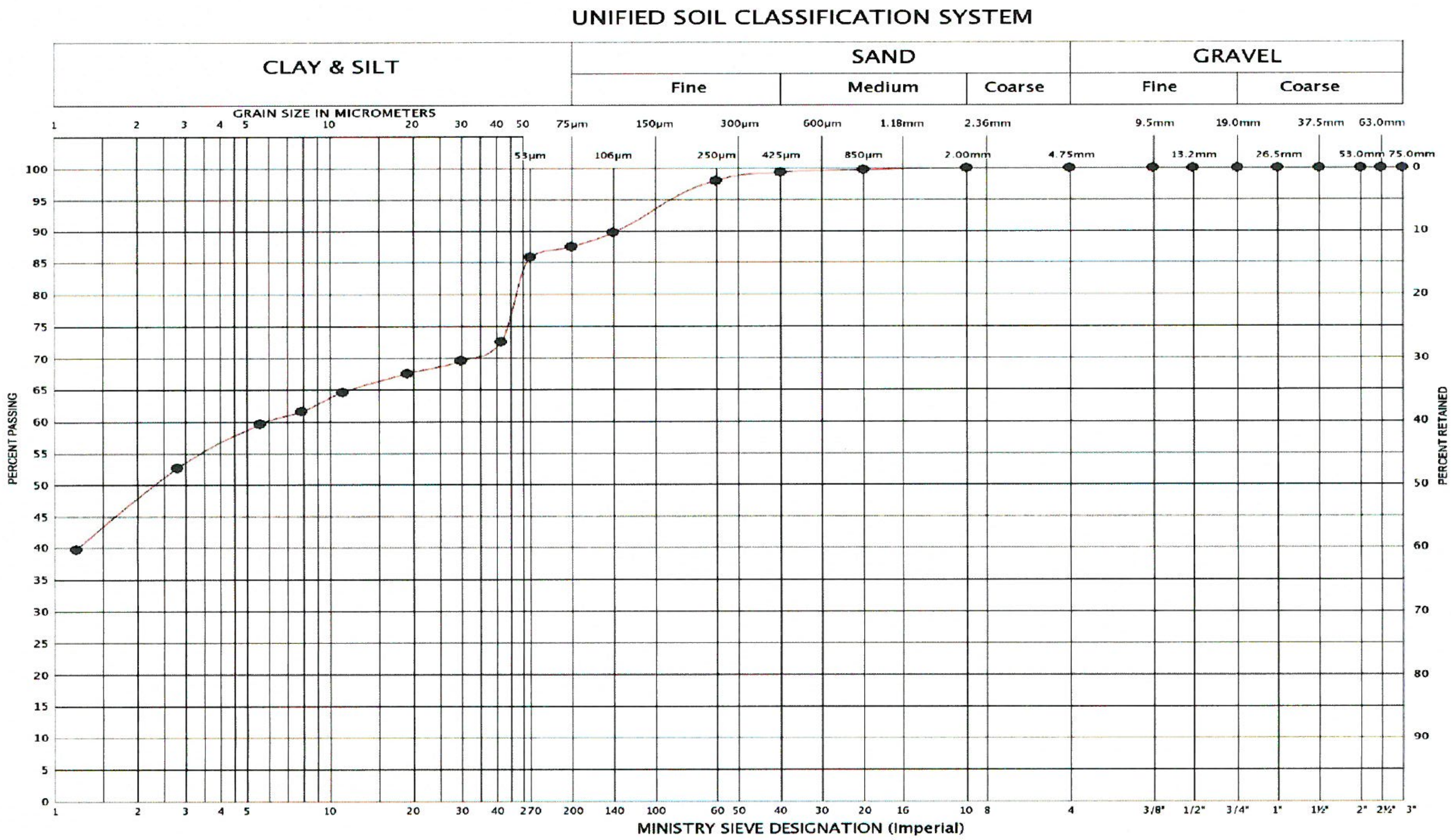
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 0.0001772 cm/sec

y0 = 289.3 cm



LEGEND	BH	102
	SAMPLE	3
	SYMBOL	●

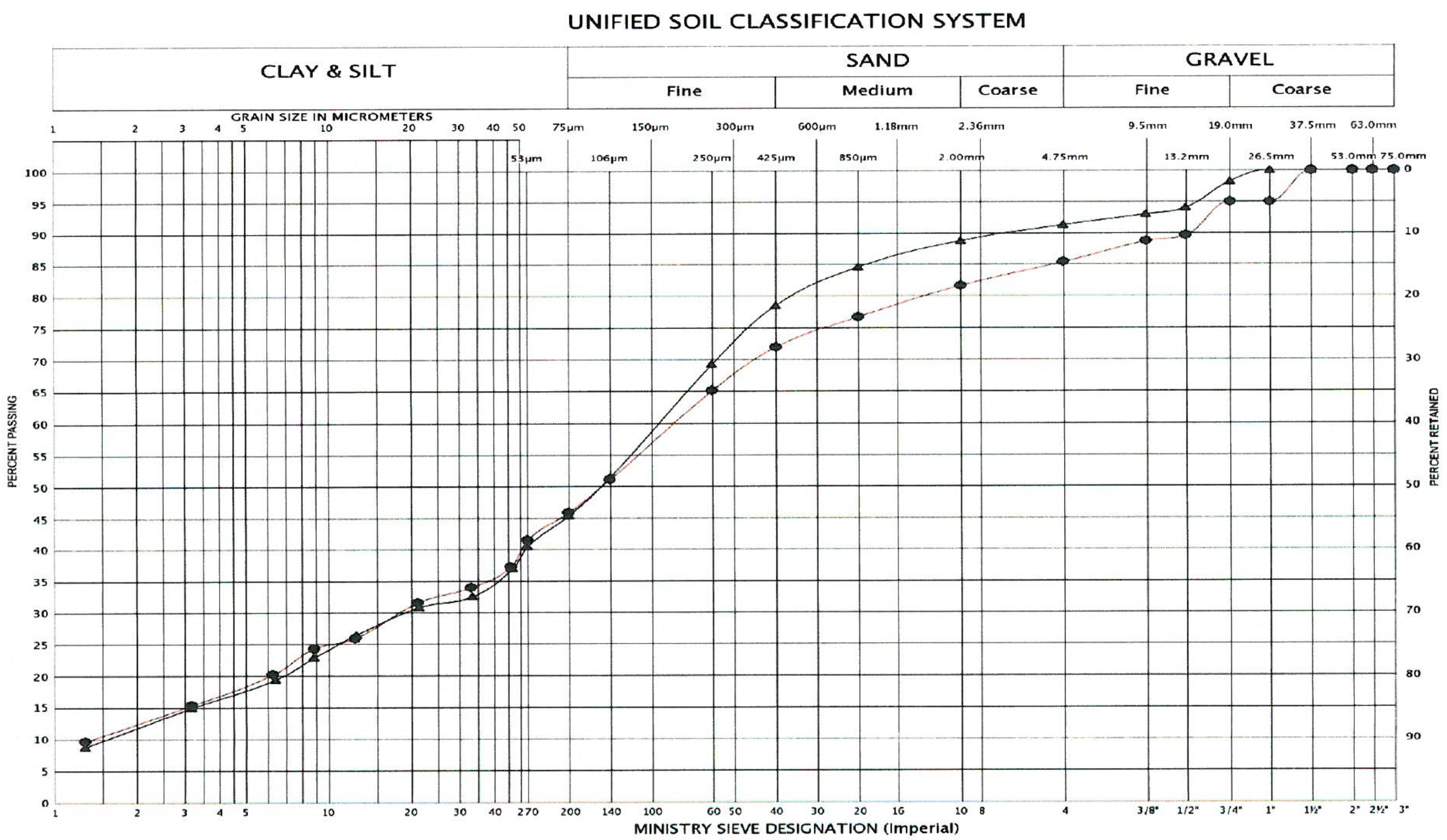
PML Peto MacCallum Ltd.
CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

CLAY AND SILT, Some Sand

FIG No.: 2-1

Project No.: 21BF052



LEGEND	**BH**	104	106
	SAMPLE	6	3
	SYMBOL	●	▲

Peto MacCallum Ltd.
CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

TILL: Silty Sand, Some Clay, Trace To Some Gravel

FIG No.: 2-3

Project No.: 21BF052

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix D

Groundwater Elevation Data

Table D-1
Groundwater Elevations

Monitoring Well	Well Depth (mbgl)	Ground Surface Elevation (masl)	25-Jan-2018		22-Feb-2018		23-Mar-2018		20-Apr-2018		29-May-2018	
			Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)
CD-18	7.27	256.00	-	-	-0.62	256.62	Frozen	Frozen	Flowing	Flowing	Flowing	Flowing
CD-19	5.59	263.00	-	-	0.69	262.31	1.00	262.00	0.57	262.43	0.59	262.41
MW15s	6.19	255.00	1.20	253.81	1.10	253.91	1.36	253.65	0.92	254.09	1.26	253.75
MW15d	13.98	255.00	-	-	0.98	254.02	1.18	253.82	0.76	254.24	1.07	253.93
MW101	7.50	251.50	-	-	-	-	-	-	-	-	-	-
MW102	6.10	251.85	-	-	-	-	-	-	-	-	-	-
MW103	7.60	256.35	-	-	-	-	-	-	-	-	-	-
MW104	4.50	256.50	-	-	-	-	-	-	-	-	-	-
MW105	6.10	254.80	-	-	-	-	-	-	-	-	-	-
MW106	9.10	256.10	-	-	-	-	-	-	-	-	-	-
MW107	6.10	263.50	-	-	-	-	-	-	-	-	-	-
MW108	6.00	263.75	-	-	-	-	-	-	-	-	-	-
MW109	6.00	255.15	-	-	-	-	-	-	-	-	-	-
MW110	6.00	256.80	-	-	-	-	-	-	-	-	-	-
MW111	6.00	253.80	-	-	-	-	-	-	-	-	-	-

mbgs - metres below ground surface

masl - metres above sea level

'-' - unavailable data

note - 2022 data collected by Peto

Table D-1
Groundwater Elevations

Monitoring Well	Well Depth (mbgl)	Ground Surface Elevation (masl)	28-Jun-2018		2-Aug-2018		24-Aug-2018		28-Sep-2018		24-Oct-2018	
			Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)
CD-18	7.27	256.00	-0.44	256.44	-0.15	256.15	-0.37	256.37	-0.01	256.01	-0.25	256.25
CD-19	5.59	263.00	0.97	262.03	1.21	261.79	1.06	261.94	1.43	261.57	1.42	261.58
MW15s	6.19	255.00	1.61	253.40	1.79	253.22	1.55	253.46	1.90	253.11	1.70	253.31
MW15d	13.98	255.00	1.38	253.62	1.55	253.45	1.33	253.67	1.64	253.36	1.46	253.54
MW101	7.50	251.50	-	-	-	-	-	-	-	-	-	-
MW102	6.10	251.85	-	-	-	-	-	-	-	-	-	-
MW103	7.60	256.35	-	-	-	-	-	-	-	-	-	-
MW104	4.50	256.50	-	-	-	-	-	-	-	-	-	-
MW105	6.10	254.80	-	-	-	-	-	-	-	-	-	-
MW106	9.10	256.10	-	-	-	-	-	-	-	-	-	-
MW107	6.10	263.50	-	-	-	-	-	-	-	-	-	-
MW108	6.00	263.75	-	-	-	-	-	-	-	-	-	-
MW109	6.00	255.15	-	-	-	-	-	-	-	-	-	-
MW110	6.00	256.80	-	-	-	-	-	-	-	-	-	-
MW111	6.00	253.80	-	-	-	-	-	-	-	-	-	-

mbgs - metres below ground surface
masl - metres above sea level
'-' - unavailable data
note - 2022 data collected by Peto

Table D-1
Groundwater Elevations

Monitoring Well	Well Depth (mbgl)	Ground Surface Elevation (masl)	29-Nov-2018		17-Dec-2018		1-Mar-2019		25-Apr-2019		24-Jun-2019	
			Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)
CD-18	7.27	256.00	-0.61	256.61	Flowing	Flowing	Frozen	Frozen	-0.81	256.81	-0.65	256.65
CD-19	5.59	263.00	1.00	262.00	1.00	262.00	1.14	261.86	0.51	262.49	0.77	262.23
MW15s	6.19	255.00	1.22	253.79	1.30	253.71	1.51	253.50	1.08	253.93	1.36	253.65
MW15d	13.98	255.00	1.09	253.91	1.11	253.89	1.30	253.70	-	-	1.17	253.83
MW101	7.50	251.50	-	-	-	-	-	-	-	-	-	-
MW102	6.10	251.85	-	-	-	-	-	-	-	-	-	-
MW103	7.60	256.35	-	-	-	-	-	-	-	-	-	-
MW104	4.50	256.50	-	-	-	-	-	-	-	-	-	-
MW105	6.10	254.80	-	-	-	-	-	-	-	-	-	-
MW106	9.10	256.10	-	-	-	-	-	-	-	-	-	-
MW107	6.10	263.50	-	-	-	-	-	-	-	-	-	-
MW108	6.00	263.75	-	-	-	-	-	-	-	-	-	-
MW109	6.00	255.15	-	-	-	-	-	-	-	-	-	-
MW110	6.00	256.80	-	-	-	-	-	-	-	-	-	-
MW111	6.00	253.80	-	-	-	-	-	-	-	-	-	-

mbgs - metres below ground surface

masl - metres above sea level

'-' - unavailable data

note - 2022 data collected by Peto

Table D-1
Groundwater Elevations

Monitoring Well	Well Depth (mbgl)	Ground Surface Elevation (masl)	26-Aug-2019		23-Oct-2019		16-Dec-2019		26-Mar-2020		24-Jun-2020	
			Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)
CD-18	7.27	256.00	0.28	255.72	0.32	255.68	Frozen	Frozen	Frozen	Frozen	Flowing	Flowing
CD-19	5.59	263.00	1.50	261.50	1.67	261.33	1.24	261.76	0.50	262.50	0.93	262.07
MW15s	6.19	255.00	-	-	-	-	-	-	1.09	253.92	1.95	253.06
MW15d	13.98	255.00	1.85	253.15	2.83	252.17	1.22	253.78	0.95	254.05	1.78	253.22
MW101	7.50	251.50	-	-	-	-	-	-	-	-	-	-
MW102	6.10	251.85	-	-	-	-	-	-	-	-	-	-
MW103	7.60	256.35	-	-	-	-	-	-	-	-	-	-
MW104	4.50	256.50	-	-	-	-	-	-	-	-	-	-
MW105	6.10	254.80	-	-	-	-	-	-	-	-	-	-
MW106	9.10	256.10	-	-	-	-	-	-	-	-	-	-
MW107	6.10	263.50	-	-	-	-	-	-	-	-	-	-
MW108	6.00	263.75	-	-	-	-	-	-	-	-	-	-
MW109	6.00	255.15	-	-	-	-	-	-	-	-	-	-
MW110	6.00	256.80	-	-	-	-	-	-	-	-	-	-
MW111	6.00	253.80	-	-	-	-	-	-	-	-	-	-

mbgs - metres below ground surface
masl - metres above sea level
'-' - unavailable data
note - 2022 data collected by Peto

Table D-1
Groundwater Elevations

Monitoring Well	Well Depth (mbgl)	Ground Surface Elevation (masl)	21-Sep-2020		16-Dec-2020		4-Jan-2022		7-Feb-2022		3-Mar-2022	
			Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)
CD-18	7.27	256.00	-0.32	256.32	Frozen	Frozen	-	-	-	-	-	-
CD-19	5.59	263.00	1.12	261.88	0.92	262.08	-	-	-	-	-	-
MW15s	6.19	255.00	1.54	253.47	1.28	253.73	-	-	-	-	-	-
MW15d	13.98	255.00	1.35	253.65	1.08	253.92	-	-	-	-	-	-
MW101	7.50	251.50	-	-	-	-	-0.83	252.33	-0.83	252.33	-0.83	252.33
MW102	6.10	251.85	-	-	-	-	-0.81	252.66	-0.81	252.66	-0.81	252.66
MW103	7.60	256.35	-	-	-	-	0.88	255.47	0.57	255.78	0.54	255.81
MW104	4.50	256.50	-	-	-	-	1.13	255.37	0.97	255.53	0.93	255.57
MW105	6.10	254.80	-	-	-	-	0.53	254.27	0.78	254.02	0.80	254.00
MW106	9.10	256.10	-	-	-	-	1.47	254.63	1.78	254.32	1.67	254.43
MW107	6.10	263.50	-	-	-	-	2.42	261.08	2.78	260.72	4.37	259.13
MW108	6.00	263.75	-	-	-	-	3.32	260.43	3.19	260.56	3.76	259.99
MW109	6.00	255.15	-	-	-	-	-	-	-	-	-	-
MW110	6.00	256.80	-	-	-	-	0.98	255.82	0.77	256.03	0.74	256.06
MW111	6.00	253.80	-	-	-	-	1.22	252.58	Frozen	Frozen	0.94	252.86

mbgs - metres below ground surface
masl - metres above sea level
'-' - unavailable data
note - 2022 data collected by Peto

Table D-1
Groundwater Elevations

Monitoring Well	Well Depth (mbgl)	Ground Surface Elevation (masl)	4-Apr-2022		10-May-2022		8-Jun-2022		5-Jul-2022		6-Aug-2022	
			Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)
CD-18	7.27	256.00	-	-	-	-	-	-	-	-	-	-
CD-19	5.59	263.00	-	-	-	-	-	-	-	-	-	-
MW15s	6.19	255.00	-	-	-	-	-	-	-	-	-	-
MW15d	13.98	255.00	-	-	-	-	-	-	-	-	-	-
MW101	7.50	251.50	-0.83	252.33	-0.83	252.33	-0.83	252.33	-0.80	252.30	-0.80	252.30
MW102	6.10	251.85	-0.81	252.66	-0.81	252.66	-0.81	252.66	-0.21	252.06	-0.21	252.06
MW103	7.60	256.35	0.32	256.03	0.08	256.27	0.27	256.08	0.42	255.93	0.93	255.42
MW104	4.50	256.50	0.73	255.77	0.75	255.75	0.77	255.73	0.81	255.69	0.91	255.59
MW105	6.10	254.80	0.37	254.43	0.53	254.27	0.57	254.23	0.63	254.17	0.84	253.96
MW106	9.10	256.10	1.39	254.71	1.52	254.58	1.55	254.55	1.79	254.31	1.97	254.13
MW107	6.10	263.50	3.98	259.52	4.06	259.44	4.36	259.14	4.41	259.09	4.48	259.02
MW108	6.00	263.75	3.36	260.39	3.32	260.43	3.80	259.95	3.84	259.91	3.97	259.78
MW109	6.00	255.15	-	-	-	-	-	-	-	-	-	-
MW110	6.00	256.80	-0.61	257.41	-0.61	257.41	-0.51	257.31	-0.51	257.31	-0.51	257.31
MW111	6.00	253.80	0.90	252.90	0.80	253.00	0.89	252.91	0.90	252.90	1.00	252.80

mbgs - metres below ground surface

masl - metres above sea level

'-' - unavailable data

note - 2022 data collected by Peto

Table D-1
Groundwater Elevations

Monitoring Well	Well Depth (mbgl)	Ground Surface Elevation (masl)	6-Sep-2022		24-Oct-2022		30-Nov-2022		21-Dec-2022		24-Oct-2023	
			Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)
CD-18	7.27	256.00	-	-	-	-	-	-	-	-	-	-
CD-19	5.59	263.00	-	-	-	-	-	-	-	-	1.45	261.55
MW15s	6.19	255.00	-	-	-	-	-	-	-	-	1.69	253.31
MW15d	13.98	255.00	-	-	-	-	-	-	-	-	1.59	253.41
MW101	7.50	251.50	-0.80	252.30	-0.80	252.30	-0.80	252.30	-0.50	252.00	damaged	damaged
MW102	6.10	251.85	-0.21	252.06	-0.20	252.05	-0.20	252.05	-0.20	252.05	damaged	damaged
MW103	7.60	256.35	1.33	255.02	1.57	254.78	1.59	254.76	1.36	254.99	1.25	255.10
MW104	4.50	256.50	0.96	255.54	1.11	255.39	1.32	255.18	1.02	255.48	0.80	255.70
MW105	6.10	254.80	1.54	253.26	1.31	253.49	1.52	253.28	1.07	253.73	-	-
MW106	9.10	256.10	2.22	253.88	2.09	254.01	2.09	254.01	1.92	254.18	1.84	254.26
MW107	6.10	263.50	4.73	258.77	5.15	258.35	5.20	258.30	5.15	258.35	4.84	258.66
MW108	6.00	263.75	4.05	259.70	4.32	259.43	4.23	259.52	4.40	259.35	3.43	260.32
MW109	6.00	255.15	-	-	-	-	-	-	-	-	-	-
MW110	6.00	256.80	-0.51	257.31	-0.51	257.31	-0.51	257.31	-0.51	257.31	-	-
MW111	6.00	253.80	1.03	252.77	1.37	252.43	1.39	252.41	1.13	252.67	1.07	252.73

mbgs - metres below ground surface
masl - metres above sea level
'-' - unavailable data
note - 2022 data collected by Peto

Table D-2

Piezometer Groundwater Elevations

Piezometer	Depth (mbgl)	Ground Surface Elevation (masl)	20-Apr-2018		29-May-2018		28-Jun-2018		2-Aug-2018		24-Aug-2018	
			Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)
PZ-C3s	1.26	254.0	1.01	252.99	0.25	253.76	0.90	253.10	0.92	253.08	0.22	253.78
PZ-C3d	1.89	254.0	1.35	252.65	0.83	253.17	0.69	253.31	0.78	253.22	0.75	253.25
PZ-C4s	1.20	260.0	0.28	259.72	0.19	259.81	0.55	259.45	0.53	259.48	0.22	259.78
PZ-C4d	1.92	260.0	0.94	259.06	0.40	259.60	0.44	259.56	0.59	259.41	0.47	259.53

mbgs - metres below ground surface

masl - metres above sea level

'-' - unavailable data

Table D-2

Piezometer Groundwater Elevations

Piezometer	Depth (mbgl)	Ground Surface Elevation (masl)	28-Sep-2018		24-Oct-2018		29-Nov-2018		17-Dec-2018		1-Mar-2019	
			Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)
PZ-C3s	1.26	254.0	0.96	253.04	0.45	253.55	0.16	253.84	0.18	253.82	Frozen	Frozen
PZ-C3d	1.89	254.0	0.70	253.30	0.64	253.36	0.45	253.55	0.37	253.63	0.25	253.75
PZ-C4s	1.20	260.0	0.55	259.45	0.19	259.81	0.16	259.84	0.17	259.83	0.24	259.76
PZ-C4d	1.92	260.0	0.49	259.51	0.36	259.64	0.22	259.78	0.20	259.80	0.22	259.78

mbgs - metres below ground surface
masl - metres above sea level
'-' - unavailable data

Table D-2

Piezometer Groundwater Elevations

Piezometer	Depth (mbgl)	Ground Surface Elevation (masl)	25-Apr-2019		24-Jun-2019		26-Aug-2019		23-Oct-2019		16-Dec-2019	
			Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)
PZ-C3s	1.26	254.0	0.16	253.84	0.42	253.58	-	-	Dry	Dry	0.18	253.82
PZ-C3d	1.89	254.0	0.11	253.89	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged
PZ-C4s	1.20	260.0	0.12	259.88	0.23	259.77	0.99	259.01	0.30	259.70	0.15	259.85
PZ-C4d	1.92	260.0	0.13	259.87	0.21	259.79	0.76	259.24	0.65	259.35	0.28	259.72

mbgs - metres below ground surface

masl - metres above sea level

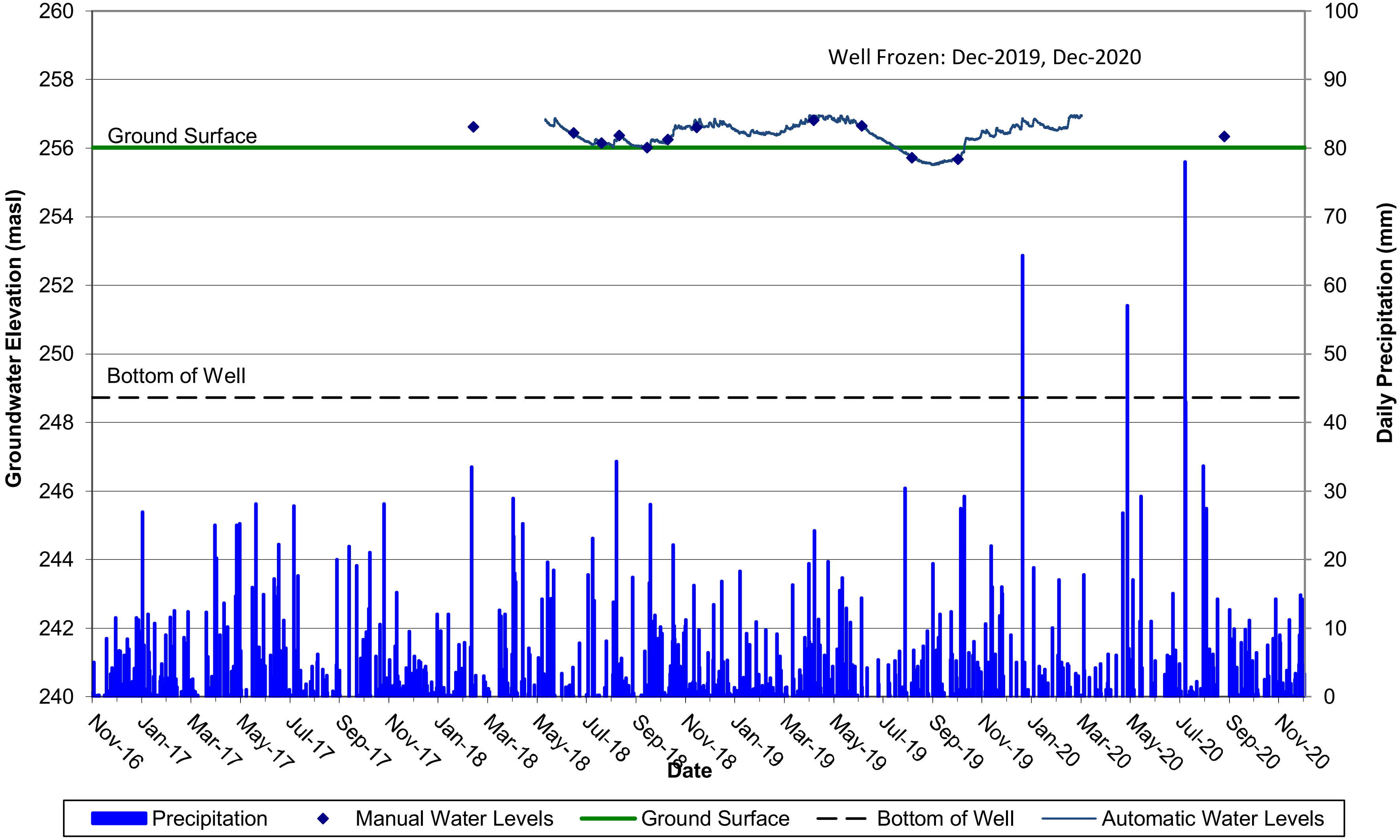
'-' - unavailable data

Table D-2
Piezometer Groundwater Elevations

Piezometer	Depth (mbgl)	Ground Surface Elevation (masl)	26-Mar-2020		24-Jun-2020		21-Sep-2020		16-Dec-2020		24-Oct-2023	
			Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)
PZ-C3s	1.26	254.0	0.17	253.83	0.44	253.56	0.49	253.51	Frozen	Frozen	-	-
PZ-C3d	1.89	254.0	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	Damaged	-	-
PZ-C4s	1.20	260.0	0.12	259.88	0.13	259.87	0.44	259.56	0.08	259.92	0.23	259.77
PZ-C4d	1.92	260.0	0.16	259.84	0.29	259.71	0.37	259.63	0.18	259.82	0.49	259.51

mbgs - metres below ground surface
masl - metres above sea level
'-' - unavailable data

CD-18 (Well Depth: 7.3 m, Screened in Silty Clay/Clayey Silt)
Groundwater Elevations



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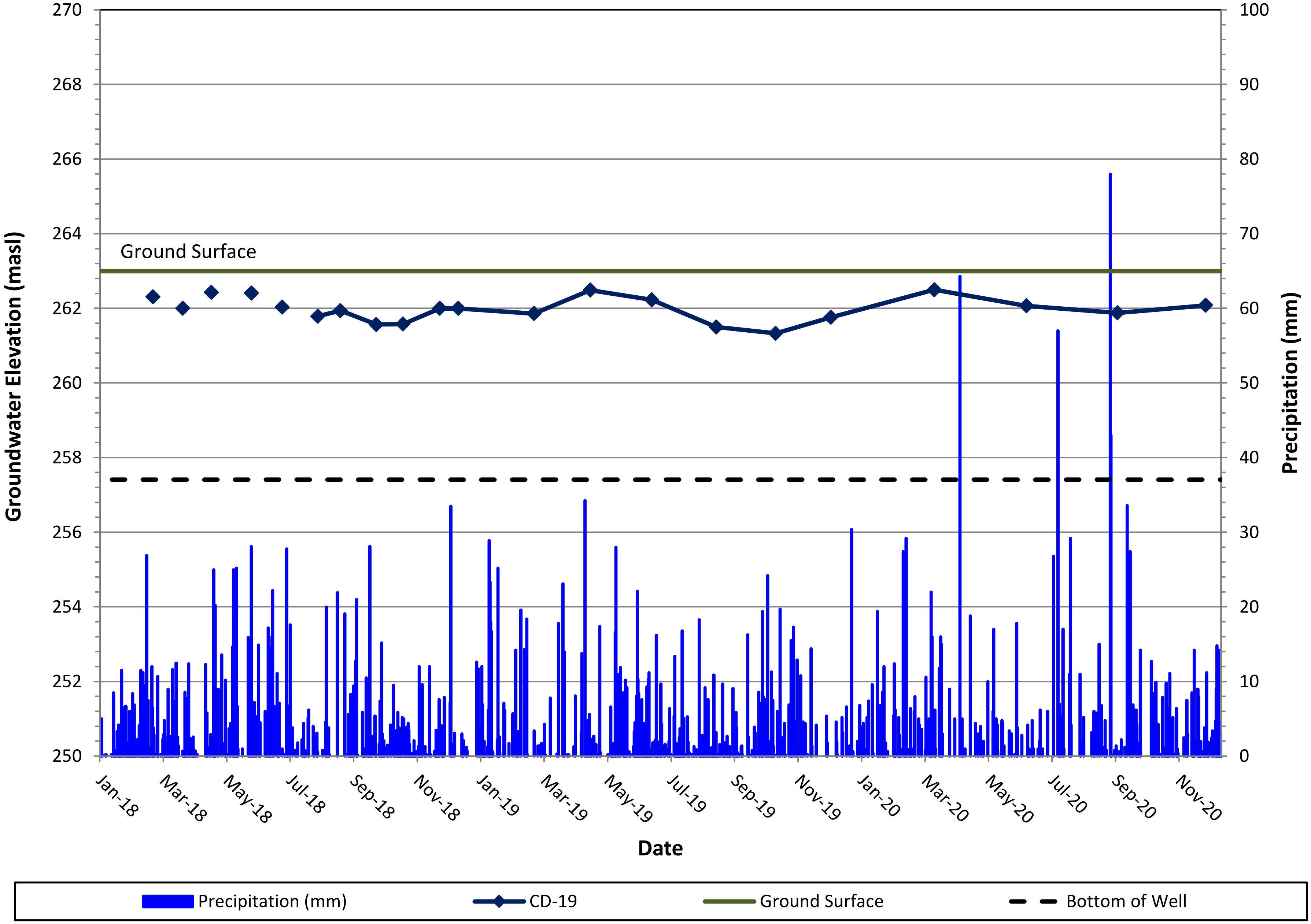
300041559.0005

Figure D-1

CD-19 (Well Depth: 5.6 m, Screened in Sandy Silt/ Silty Sand)
Groundwater Elevations



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300041559.0005

Figure D-2

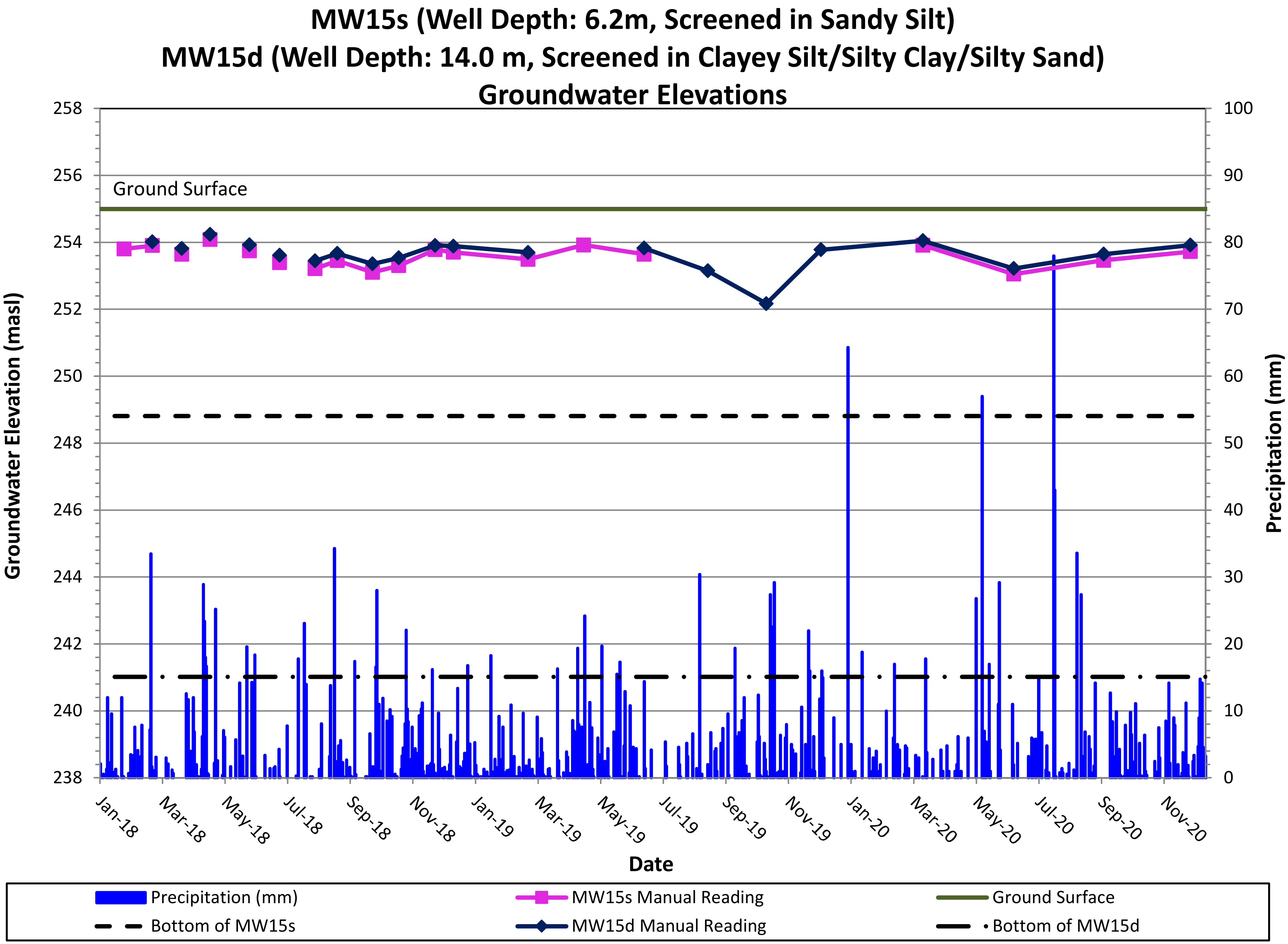

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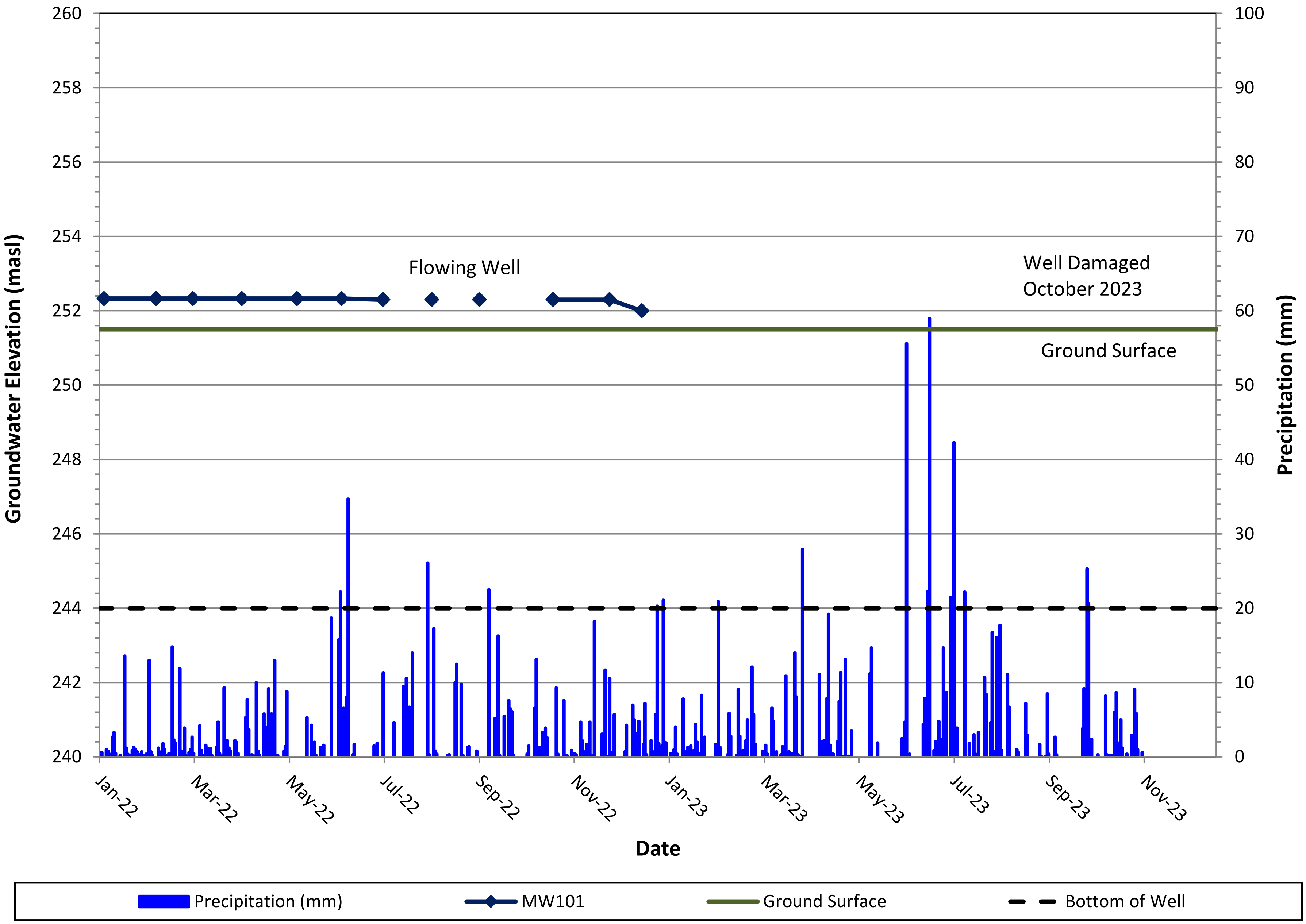
Figure D-3

MW101 (Well Depth: 7.5 m, Screened in Silty Sand)
Groundwater Elevations



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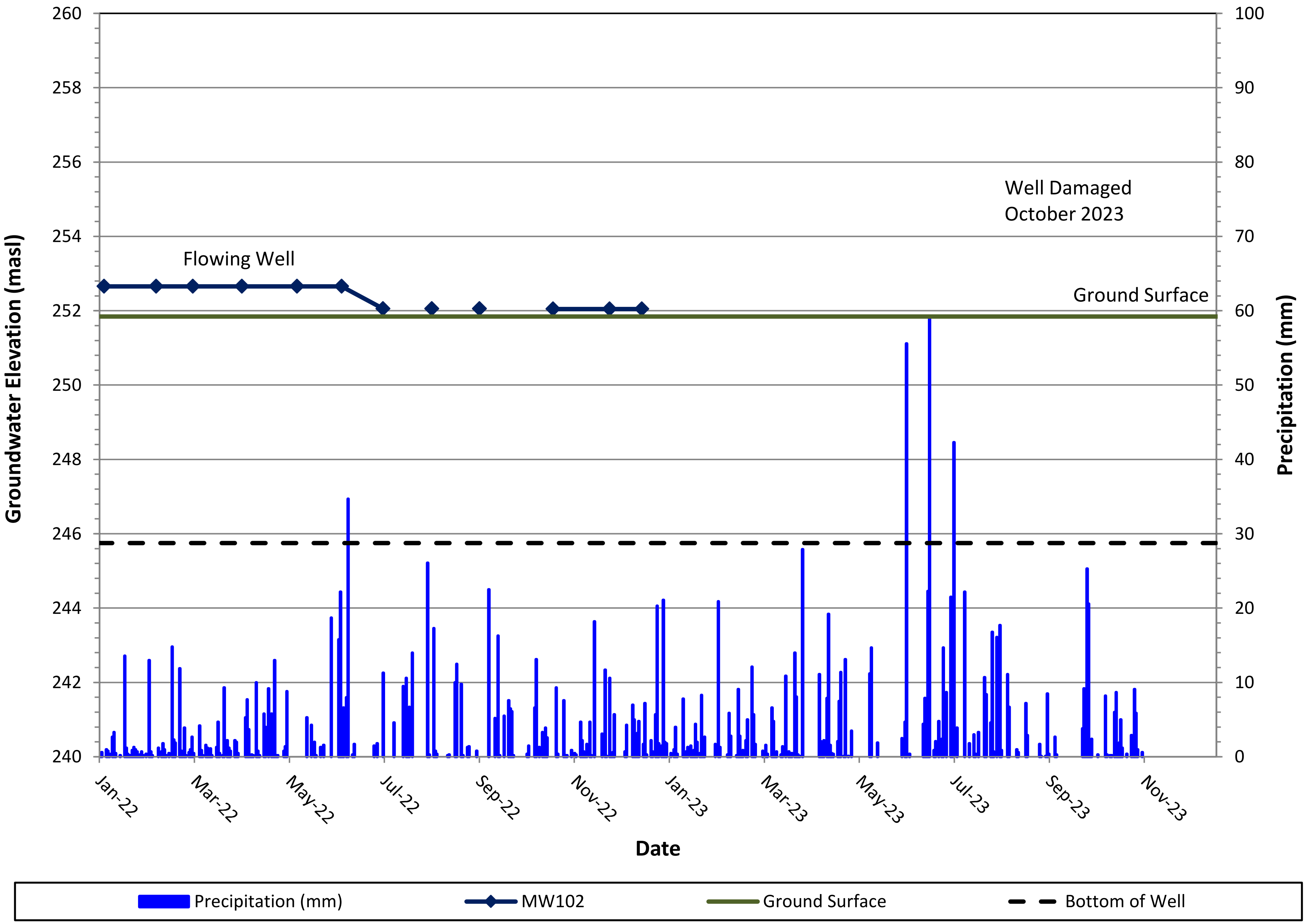
300041559.0005

Figure D-4

MW102 (Well Depth: 6.1 m, Screened in Silty Sand)
Groundwater Elevations



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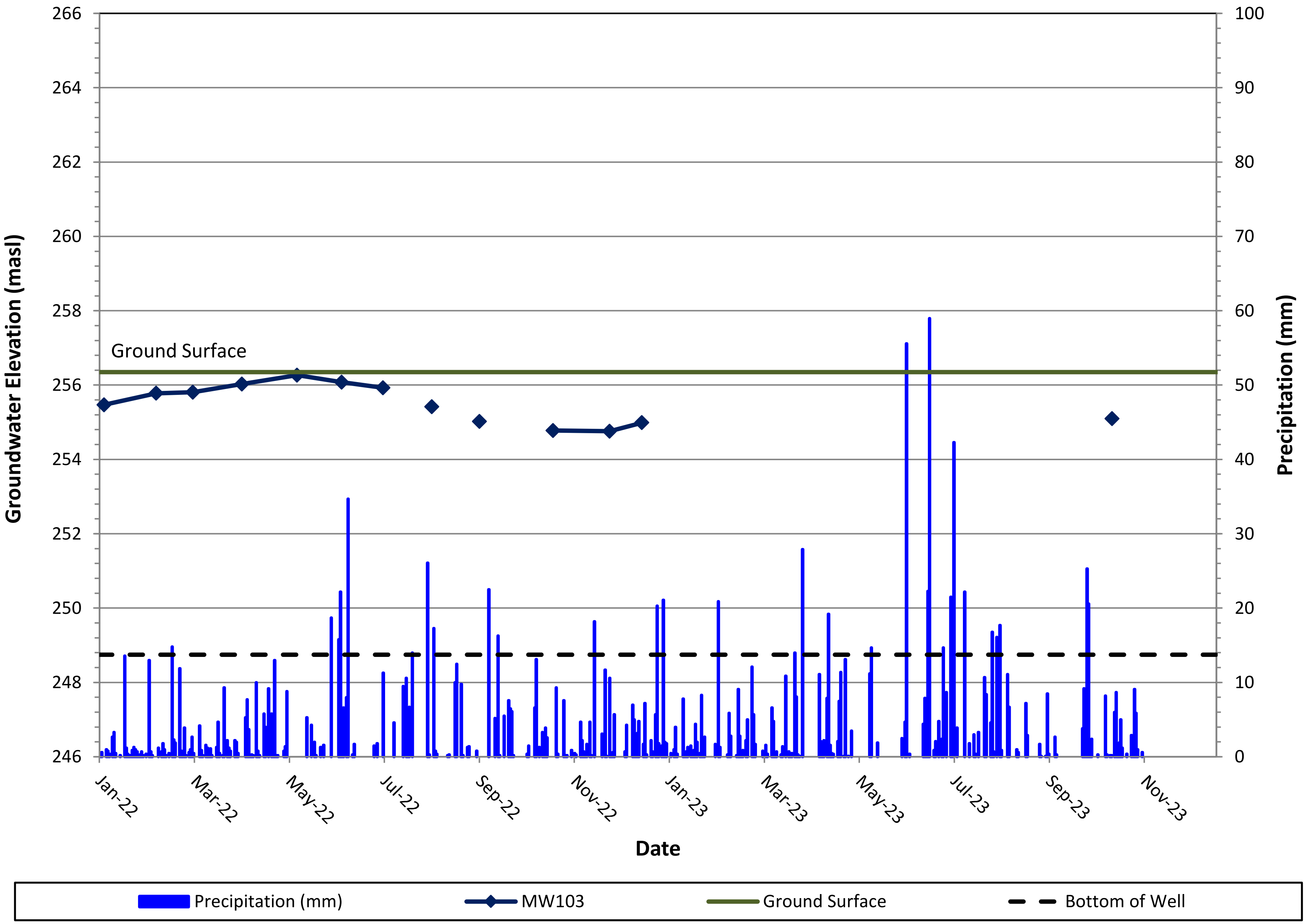
300041559.0005

Figure D-5

MW103 (Well Depth: 7.6 m, Screened in Sand/Silty Sand)
Groundwater Elevations



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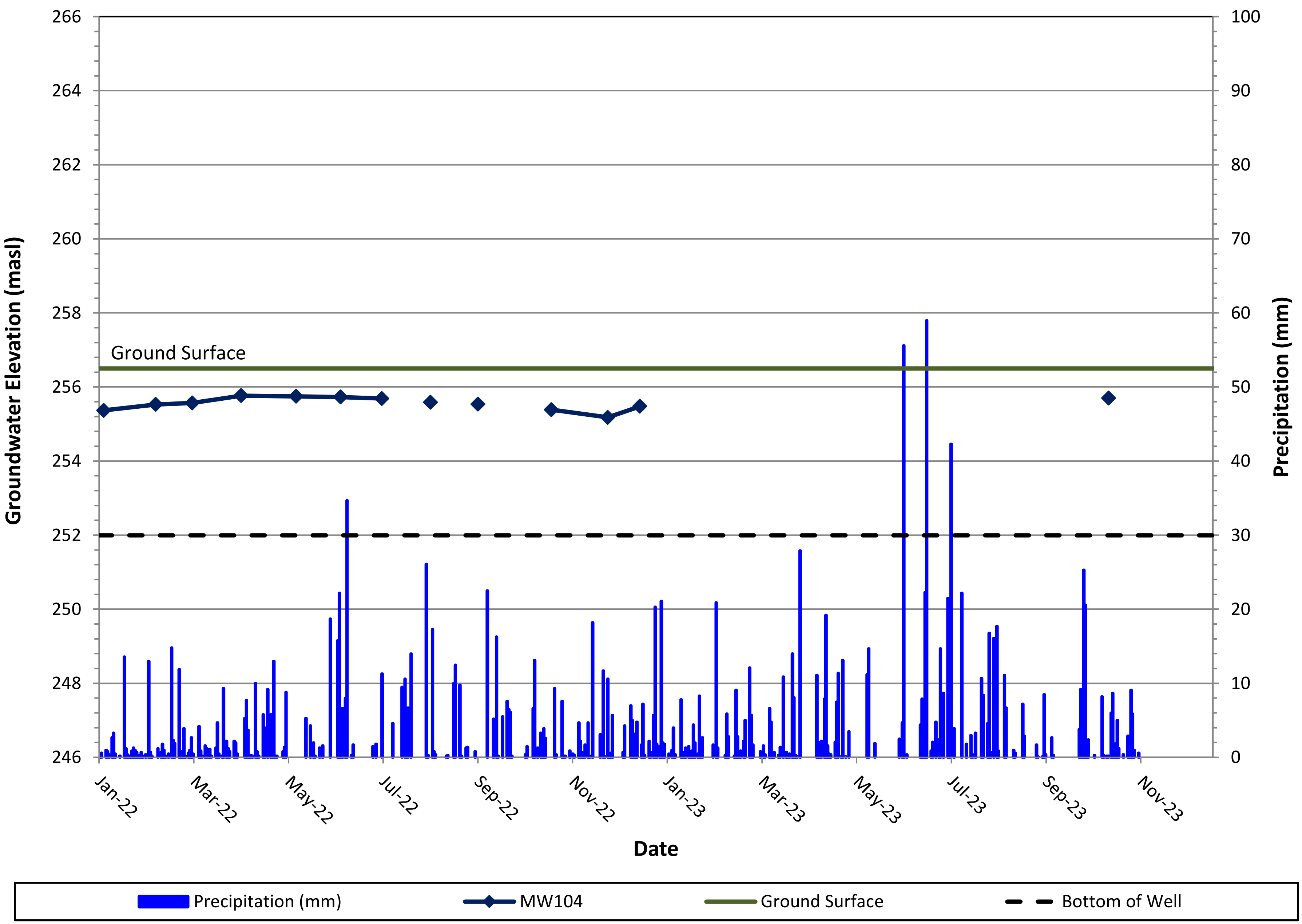
300041559.0005

Figure D-6

MW104 (Well Depth: 4.5 m, Screened in Sand Silt/Silty Sand)
Groundwater Elevations



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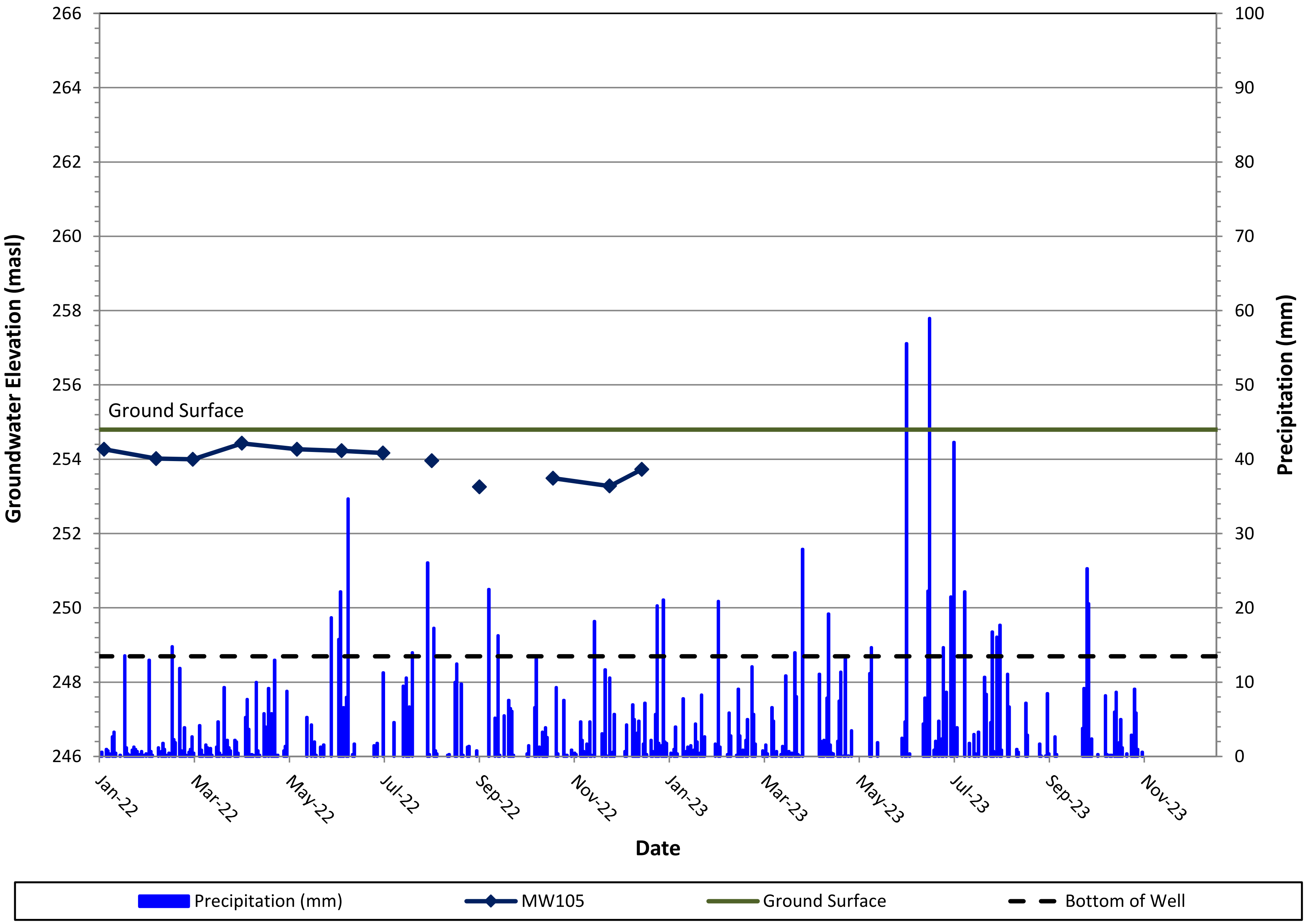
300041559.0005

MW105 (Well Depth: 6.1 m, Screened in Silty Sand)
Groundwater Elevations



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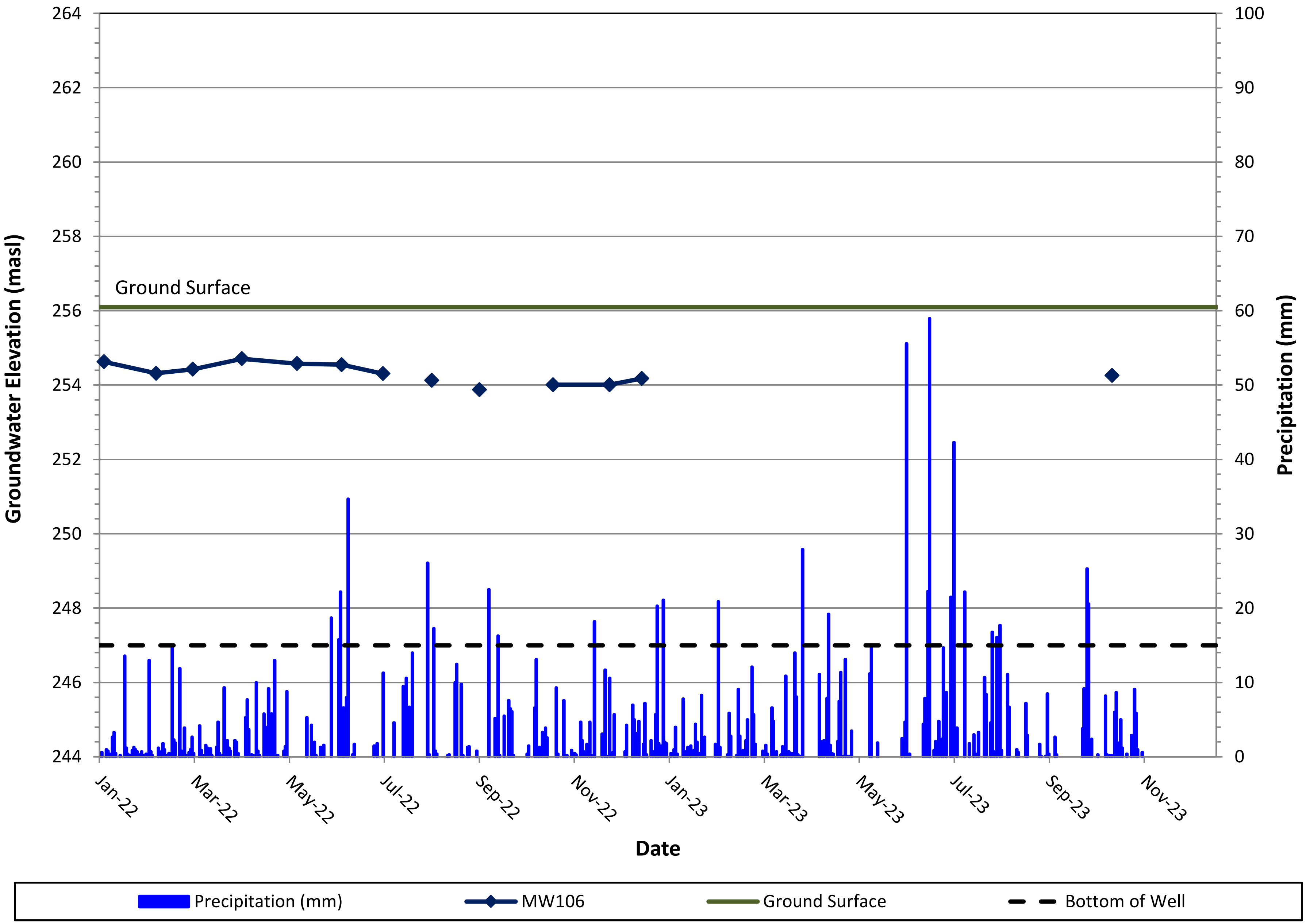
300041559.0005

Figure D-8

MW106 (Well Depth: 9.1 m, Screened in Silty Sand)
Groundwater Elevations



MW107 (Well Depth: 6.1 m, Screened in Sand)
Groundwater Elevations

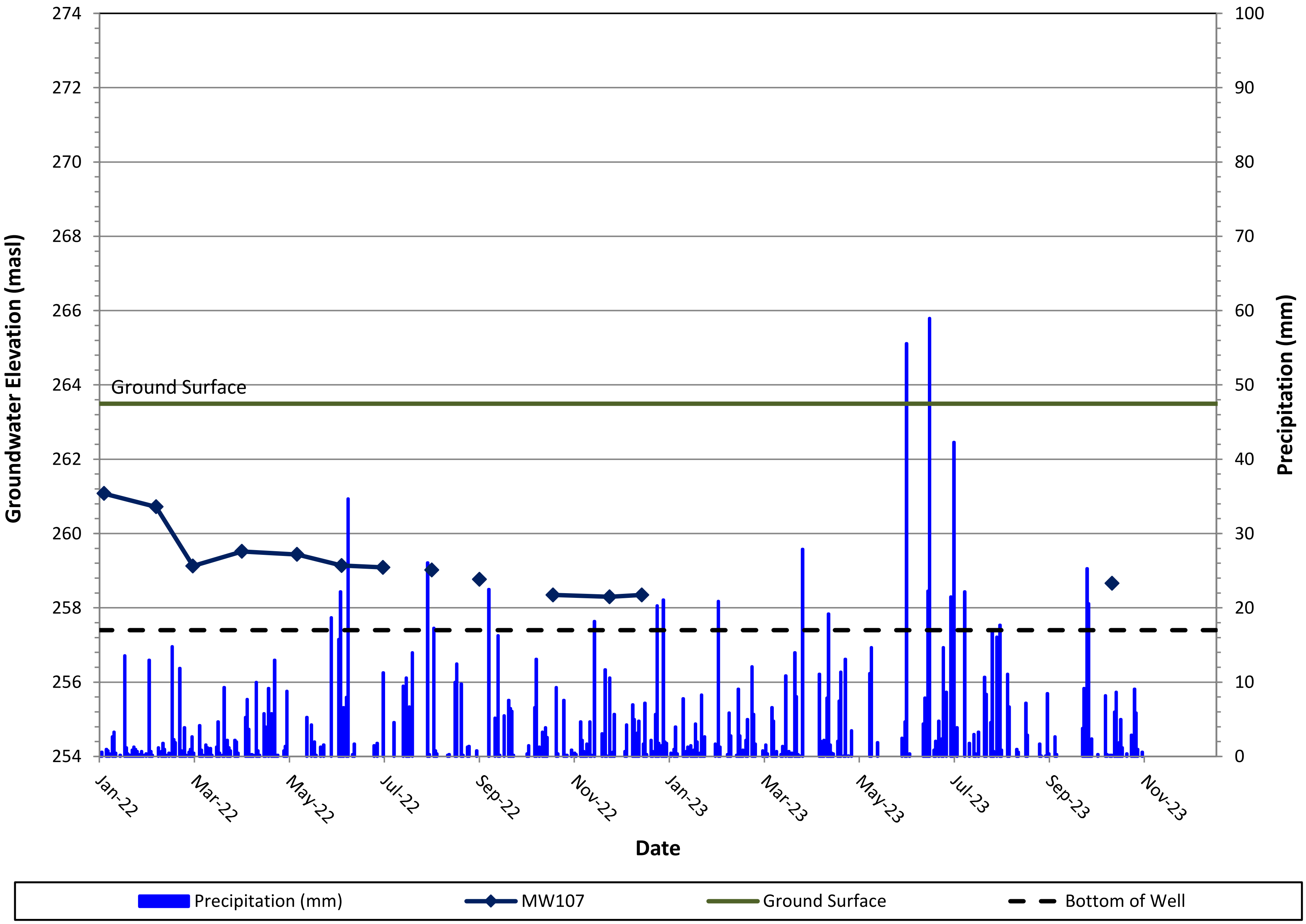


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Figure D-10

MW108 (Well Depth: 6.0 m, Screened in Silty Sand)
Groundwater Elevations

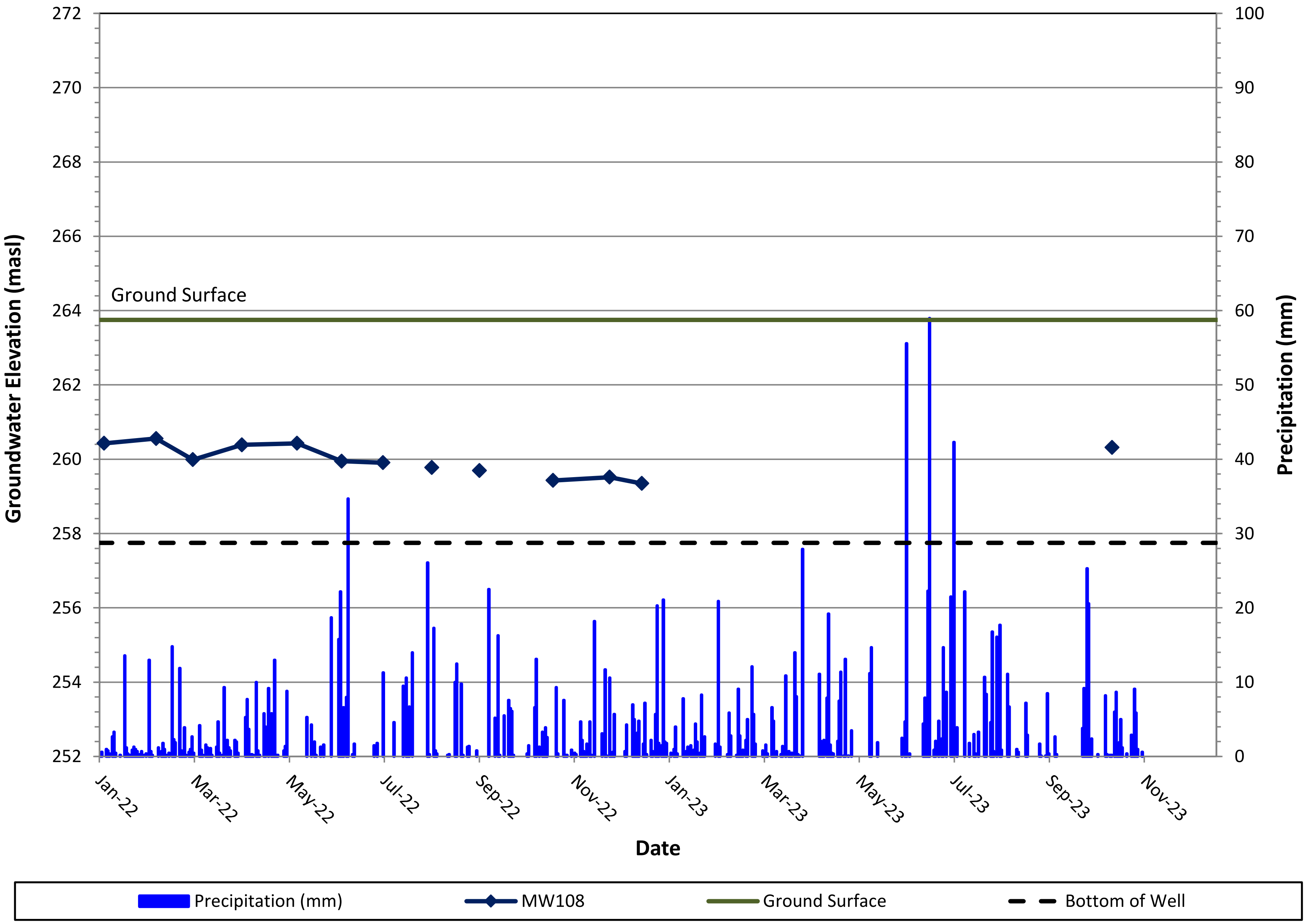

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Figure D-11

MW110 (Well Depth: 6.0 m, Screened in Sand)
Groundwater Elevations

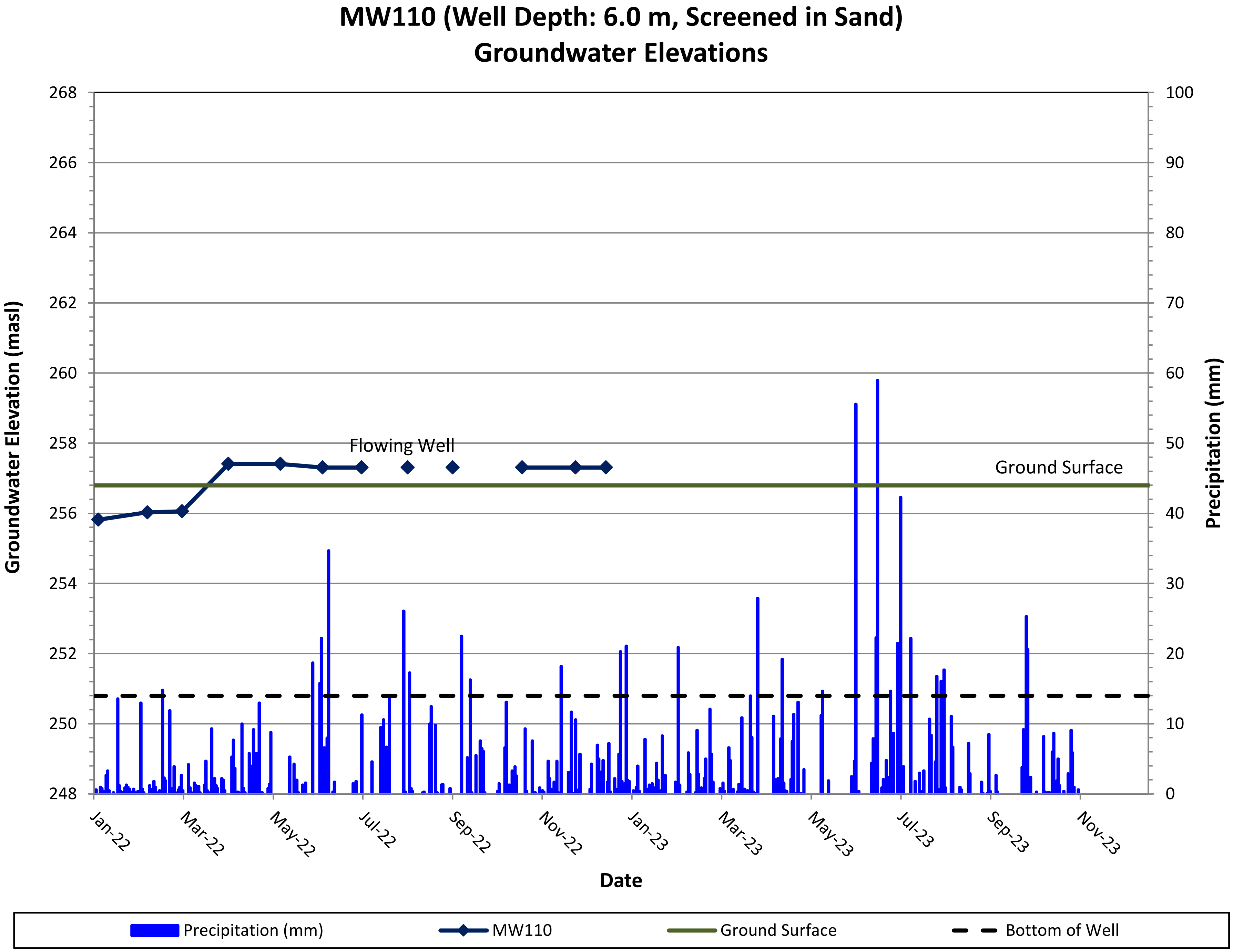

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Figure D-12

MW111 (Well Depth: 6.0 m, Screened in Silty Sand)
Groundwater Elevations

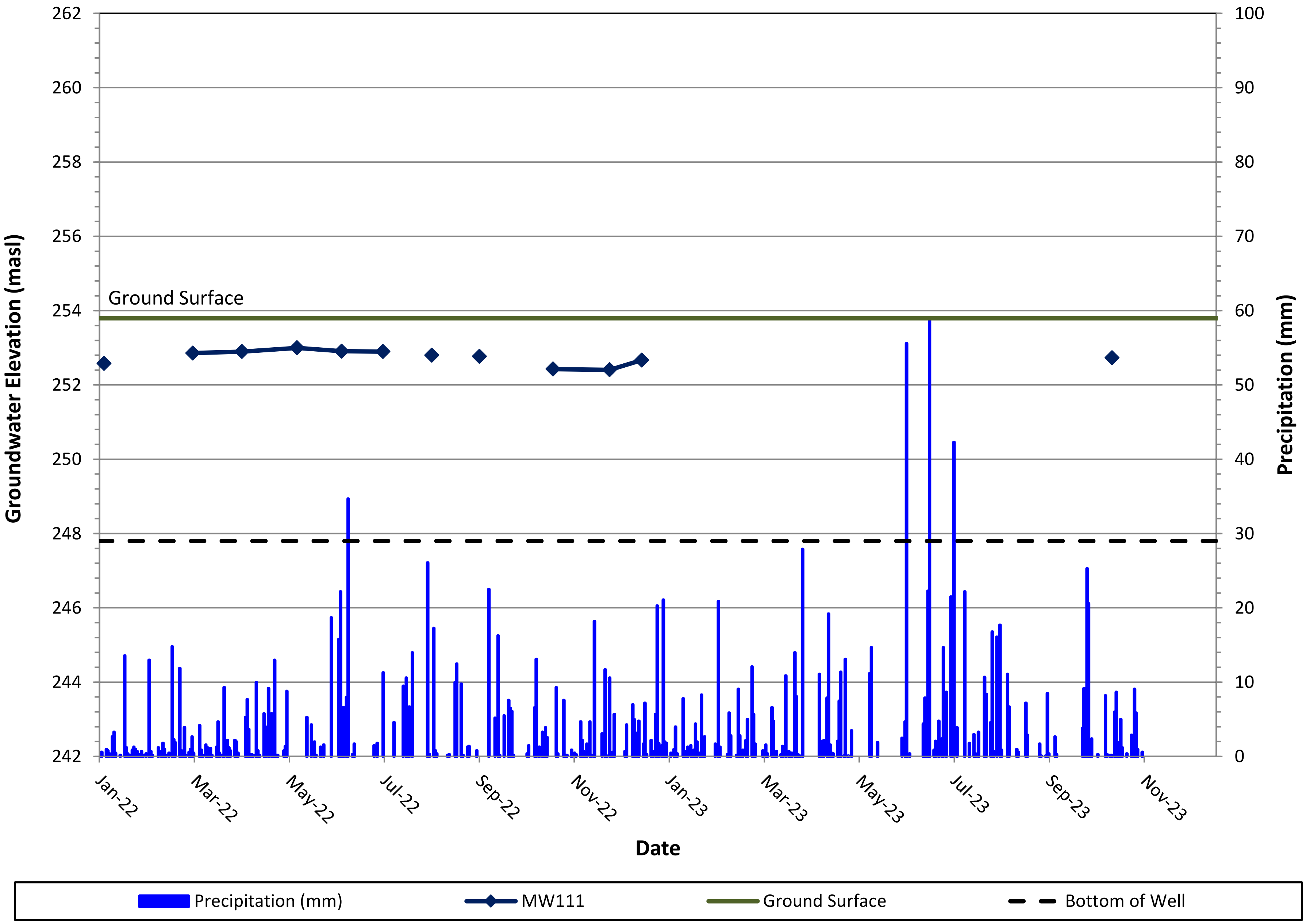

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Figure D-13

PZ-C3 s/d
Groundwater Elevations

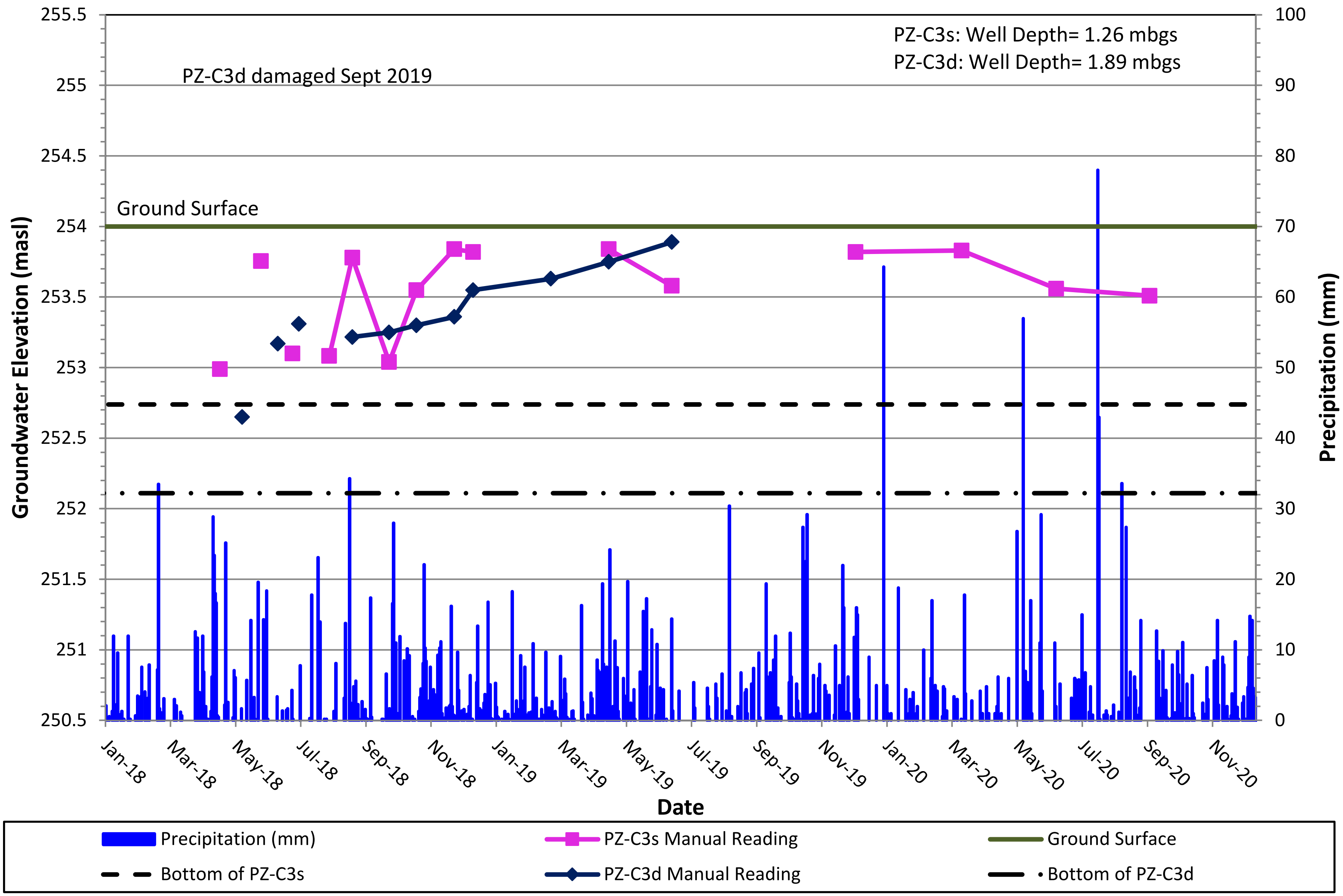

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Figure D-14

PZ-C4 s/d
Groundwater Elevations

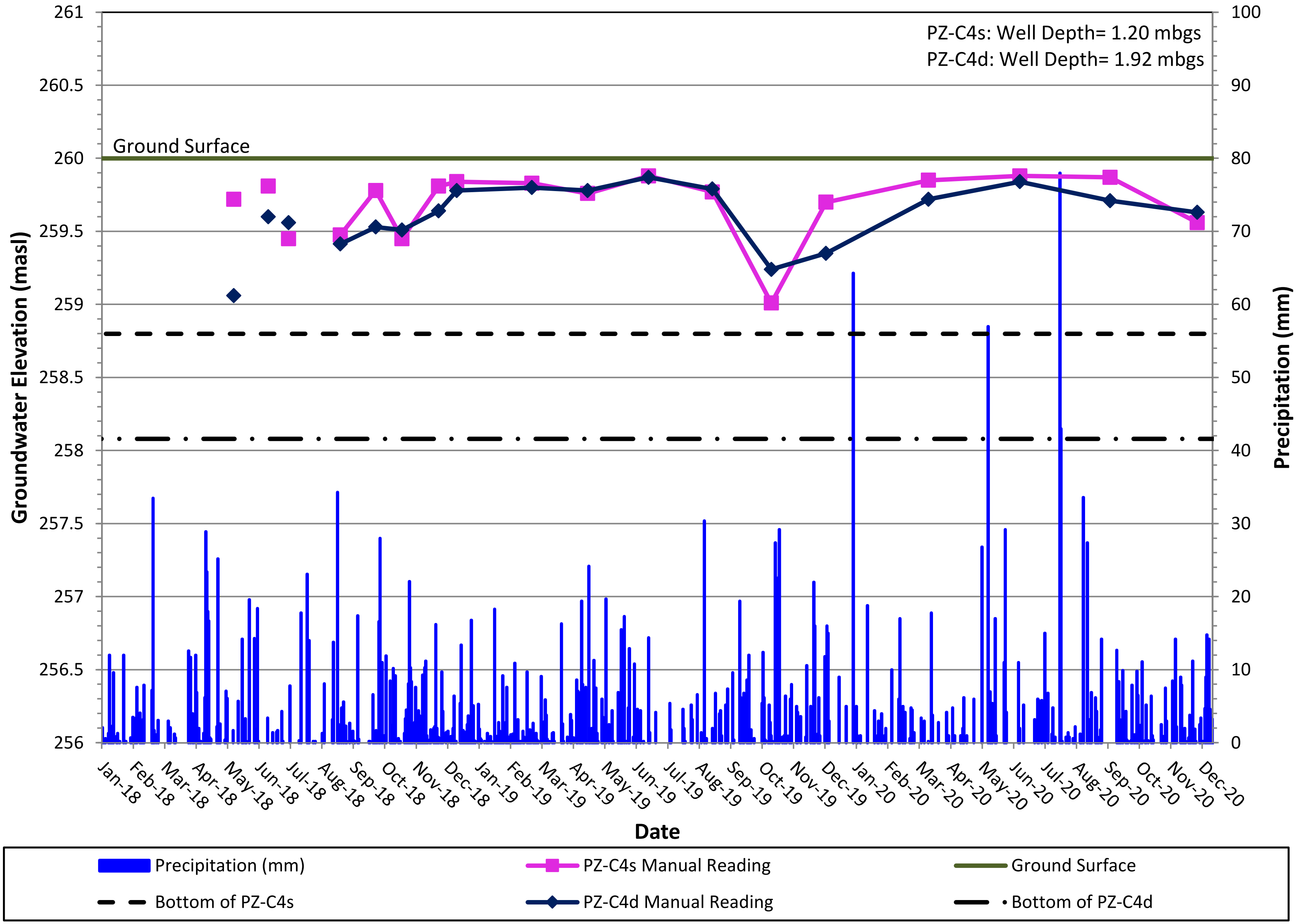

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Figure D-15

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Appendix E

Surface Water Monitoring

Table E-1
Surface Water Flow

Date	Days since rain:	Flow Rate (L/s)	
		SW1-CD	SW2-CD
25-Jan-18	1	Partially Frozen	Partially Frozen
22-Feb-18	1	Flow too high to measure	Flow too high to measure
23-Mar-18	9	Partially Frozen	Partially Frozen
20-Apr-18	2	Partially Frozen	Partially Frozen
29-May-18	3	21	Dry
26-Jun-18	3	16	Dry
2-Aug-18	3	11	Dry
6-Sep-18	0	18	Dry
28-Sep-18	0	10	Dry
24-Oct-18	1	37	Dry
29-Nov-18	0	Partially Frozen/ Snow Covered	Partially Frozen/ Snow Covered
17-Dec-18	1	Partially Frozen	Partially Frozen
1-Mar-19	0	Frozen and Snow Covered	Frozen and Snow Covered
25-Apr-19	1	132	<0.5
24-Jun-19	-	21	Dry
19-Aug-19	1	14	Dry
23-Oct-19	0	18	Dry
16-Dec-19	1	Partially Frozen	Frozen and Snow Covered
26-Mar-20	0	100	<0.5
24-Jun-20	0	67	Dry
21-Sep-20	0	17	Dry

Notes:
<0.5 L/s - denotes minimal flow, not measurable with equipment

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Appendix F

Water Quality

Table F-1
Groundwater Quality

		Sample Description	**BH104**	**BH107**
		Date Sampled	**11/01/2023**	**11/01/2023**
Parameter	**Unit**	**PWQO**		
Electrical Conductivity	µS/cm	--	462	666
pH	pH Units	6.5-8.5	7.68	7.69
Hardness (as CaCO3) (Calculated)	mg/L	--	182	345
Total Dissolved Solids	mg/L	--	306	514
Alkalinity (as CaCO3)	mg/L	--	185	226
Bicarbonate (as CaCO3)	mg/L	--	185	226
Carbonate (as CaCO3)	mg/L	--	<5	<5
Fluoride	mg/L	--	<0.05	<0.05
Chloride	mg/L	--	16.8	22.5
Nitrate as N	mg/L	--	1.64	23.9
Nitrite as N	mg/L	--	<0.05	<0.05
Sulphate	mg/L	--	49.5	13.0
Phosphate as P	mg/L	--	<0.10	<0.10
Ammonia as N	mg/L	--	<0.02	<0.02
Dissolved Organic Carbon	mg/L	--	2.6	2.9
Total Phosphorus	mg/L	0.03	**11.6**	**0.70**
Total Organic Carbon	mg/L	--	1.81	4.4
True Colour	TCU	--	<2.50	<2.50
Turbidity	NTU	--	6780	5390
Dissolved Calcium	mg/L	--	49.3	131
Dissolved Magnesium	mg/L	--	14.2	4.38
Dissolved Potassium	mg/L	--	1.66	1.07
Dissolved Sodium	mg/L	--	33.0	43.1
Aluminum-dissolved	mg/L	0.075	<0.004	<0.004
Dissolved Antimony	mg/L	0.020	<0.001	<0.001
Dissolved Arsenic	mg/L	0.1	0.004	<0.001
Dissolved Barium	mg/L	--	0.075	0.027
Dissolved Beryllium	mg/L	1.1	<0.0005	<0.0005
Dissolved Boron	mg/L	0.2	0.026	0.018
Dissolved Cadmium	mg/L	0.0002	<0.0001	<0.0001
Dissolved Chromium	mg/L	--	<0.002	<0.002
Dissolved Cobalt	mg/L	0.0009	<0.0005	<0.0005
Dissolved Copper	mg/L	0.005	0.001	0.002
Dissolved Iron	mg/L	0.3	<0.010	<0.010
Dissolved Lead	mg/L	0.025	<0.0005	<0.0005
Dissolved Manganese	mg/L	--	0.033	<0.002
Dissolved Mercury	mg/L	0.0002	<0.0001	<0.0001
Dissolved Molybdenum	mg/L	0.040	0.008	<0.002
Dissolved Nickel	mg/L	0.025	0.001	<0.001
Dissolved Selenium	mg/L	0.1	<0.001	<0.001
Dissolved Silver	mg/L	0.0001	<0.0001	<0.0001
Dissolved Uranium	mg/L	0.005	0.0021	<0.0005
Dissolved Vanadium	mg/L	0.006	<0.002	<0.002
Dissolved Zinc	mg/L	0.030	<0.005	<0.005
Dissolved Zirconium	mg/L	0.004	<0.004	<0.004

PWQO - Provincial Water Quality Objectives
BOLD - Exceeds PWQO

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Appendix G

Water Balance

WATER BALANCE CALCULATIONS
Hansen Group Inc.
Hewitt's Gate South
Barrie, ON
PROJECT No.300041559.0005

TABLE G-1

Water Balance Components

Based on Thornthwaite's Soil Moisture Balance Approach with a Soil Moisture Retention of 150 mm (moderately-rooted vegetation in sandy loam soils)

Precipitation data from Barrie WPCC Climate Station (1981 - 2010)

Potential Evapotranspiration Calculation	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Average Temperature (Degree C)	-7.7	-6.6	-2.1	5.6	12.3	17.9	20.8	19.7	15.3	8.7	2.7	-3.5	**6.9**
Heat index: $i = (t/5)^{1.514}$	0.00	0.00	0.00	1.19	3.91	6.90	8.66	7.97	5.44	2.31	0.39	0.00	**36.8**
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	0.00	25.18	58.76	88.02	103.48	97.59	74.33	40.47	11.47	0.00	**499**
Adjusting Factor for U (Latitude 44^{o} 20' N)	0.81	0.82	1.02	1.13	1.27	1.29	1.3	1.2	1.04	0.95	0.8	0.76	
Adjusted Potential Evapotranspiration PET (mm)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
WATER BALANCE COMPONENTS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Precipitation (P)	83	62	58	62	82	85	77	90	94	78	89	74	**933**
Potential Evapotranspiration (PET)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
P - PET	83	62	58	34	8	-29	-57	-27	17	39	80	74	**340**
Change in Soil Moisture Storage	0	0	0	0	0	-29	-57	-27	17	39	58	0	**0**
Soil Moisture Storage max 150 mm	150	150	150	150	150	121	64	37	53	92	150	150	
Actual Evapotranspiration (AET)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
Soil Moisture Deficit max 150 mm	0	0	0	0	0	29	86	113	97	58	0	0	
Water Surplus - available for infiltration or runoff	83	62	58	34	8	0	0	0	0	0	22	74	**340**
Potential Infiltration (based on MOE metholodogy*; independent of temperature)	50	37	35	20	5	0	0	0	0	0	13	44	**204**
Potential Direct Surface Water Runoff (independent of temperature)	33	25	23	13	3	0	0	0	0	0	9	29	**136**
IMPERVIOUS AREA WATER SURPLUS													
Precipitation (P)	933	mm/year											
Potential Evaporation (PE) from impervious areas (assume 15%)	140	mm/year											
P-PE (surplus available for runoff from impervious areas)	793	mm/year											

Assume January storage is 100% of Soil Moisture Storage

Soil Moisture Storage	150 mm	<-- See "Water Holding Capacity" values in Table 3.1, MOE SWMPDM, 2003

*MOE SWM infiltration calculations

topography - hilly land (avg slope ~ 2%)	0.1	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
soils - sandy loam	0.4	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
cover - predominantly cultivated land	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
Hansen Group Inc.
Hewitt's Gate South
Barrie, ON
PROJECT No.300041559

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TABLE G-2

Post-Development Water Balance Components

Based on Thornthwaite's Soil Moisture Balance Approach with a Soil Moisture Retention of 75 mm (urban lawn in sandy loam soils)

Precipitation data from Barrie WPCC Climate Station (1981 - 2010)

Potential Evapotranspiration Calculation	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Average Temperature (Degree C)	-7.7	-6.6	-2.1	5.6	12.3	17.9	20.8	19.7	15.3	8.7	2.7	-3.5	**6.9**
Heat index: $i = (t/5)^{1.514}$	0.00	0.00	0.00	1.19	3.91	6.90	8.66	7.97	5.44	2.31	0.39	0.00	**36.8**
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	0.00	25.18	58.76	88.02	103.48	97.59	74.33	40.47	11.47	0.00	**499**
Adjusting Factor for U (Latitude 44° 20' N)	0.81	0.82	1.02	1.13	1.27	1.29	1.3	1.2	1.04	0.95	0.8	0.76	
Adjusted Potential Evapotranspiration PET (mm)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
WATER BALANCE COMPONENTS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Precipitation (P)	83	62	58	62	82	85	77	90	94	78	89	74	**933**
Potential Evapotranspiration (PET)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
P - PET	83	62	58	34	8	-29	-57	-27	17	39	80	74	**340**
Change in Soil Moisture Storage	0	0	0	0	0	-29	-46	0	17	39	19	0	**0**
Soil Moisture Storage max 75 mm	75	75	75	75	75	46	0	0	17	56	75	75	
Actual Evapotranspiration (AET)	0	0	0	28	75	114	123	90	77	38	9	0	**555**
Soil Moisture Deficit max 75 mm	0	0	0	0	0	29	75	75	58	19	0	0	
Water Surplus - available for infiltration or runoff	83	62	58	34	8	0	0	0	0	0	60	74	**378**
Potential Infiltration (based on MOE methodology*; independent of temperature)	54	40	38	22	5	0	0	0	0	0	39	48	**246**
Potential Direct Surface Water Runoff (independent of temperature)	29	22	20	12	3	0	0	0	0	0	21	26	**132**
IMPERVIOUS AREA WATER SURPLUS													
Precipitation (P)	933	mm/year											
Potential Evaporation (PE) from impervious areas (assume 15%)	140	mm/year											
P-PE (surplus available for runoff from impervious areas)	793	mm/year											

Assume January storage is 100% of Soil Moisture Storage

Soil Moisture Storage	75	mm	<-- See "Water Holding Capacity" values in Table 3.1, MOE SWMPDM, 2003

*MOE SWM infiltration calculations

topography - hilly land	0.1	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
soils - sandy loam	0.4	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
cover - urban lawn	0.15	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
Infiltration factor	**0.65**	

Latitude of site (or climate station) 44 ^{O} N.

WATER BALANCE CALCULATIONS
Hansen Group Inc.
Hewitt's Gate South
Barrie, ON
PROJECT No.300041559

TABLE G-3

Water Balance for Pre- and Post-Development Land Use Conditions (with no SWM/LID measures in place) - East Catchment Development Area

Land Use Description	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)
Pre-Development Land Use												
Open Space /Agricultural/Rural Residential	155,819	0.03	4,675	0.793	3,707	151,144	0.136	20,538	0.204	30,808	24,245	30,808
TOTAL PRE-DEVELOPMENT	**155,819**		**4,675**		**3,707**	**151,144**		**20,538**		**30,808**	**24,245**	**30,808**
Post-Development Land Use (with no LID measures in place)												
Single Detached Residential	15,492	0.50	7,746	0.793	6,142	7,746	0.132	1,025	0.246	1,903	7,167	1,903
Townhouse Residential	22,382	0.60	13,429	0.793	10,649	8,953	0.132	1,184	0.246	2,200	11,833	2,200
Medium Density Residential	52,932	0.75	39,699	0.793	31,480	13,233	0.132	1,751	0.246	3,251	33,231	3,251
Roads and Reserves	42,351	0.66	27,952	0.793	22,165	14,399	0.132	1,905	0.246	3,538	24,070	3,538
Stormwater Management Block	16,231	0.00	0	0.793	0	16,231	0.132	2,147	0.246	3,988	2,147	3,988
Open Space	5,019	0.05	251	0.793	199	4,768	0.132	631	0.246	1,171	830	1,171
Commercial	1,412	0.80	1,130	0.793	896	282	0.132	37	0.246	69	933	69
TOTAL POST-DEVELOPMENT	**155,819**		**90,206**		**71,531**	**65,613**		**8,680**		**16,121**	**80,211**	**16,121**
% Change from Pre to Post											331	48
Effect of development (with no mitigation)											3.3 times increase in runoff	48% reduction of infiltration

* data provided by Jones Consulting Nov 2024

** figures from Tables G-1 and G-2

To balance pre- to post-,
the infiltration target (m^3/a)= **14,687**

WATER BALANCE CALCULATIONS
Hansen Group Inc.
Hewitt's Gate South
Barrie, ON
PROJECT No.300041559

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TABLE G-4

Water Balance for Pre- and Post-Development Land Use Conditions (with no SWM/LID measures in place) - West Catchment Development Area

Land Use Description	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)
Pre-Development Land Use												
Open Space /Agricultural/Rural Residential	18,143	0.06	1,089	0.793	863	17,054	0.136	2,317	0.204	3,476	3,181	3,476
TOTAL PRE-DEVELOPMENT	**18,143**		**1,089**		**863**	**17,054**		**2,317**		**3,476**	**3,181**	**3,476**
Post-Development Land Use (with no LID measures in place)												
Medium Density Residential	15,874	0.75	11,906	0.793	9,441	3,969	0.132	525	0.246	975	9,966	975
Roads and Reserves	2,269	0.66	1,498	0.793	1,187	771	0.132	102	0.246	190	1,290	190
TOTAL POST-DEVELOPMENT	**18,143**		**13,403**		**10,628**	**4,740**		**627**		**1,165**	**11,255**	**1,165**
										% Change from Pre to Post	354	66
										Effect of development (with no mitigation)	3.5 times increase in runoff	66% reduction of infiltration

* data provided by Jones Consulting Nov 2024

** figures from Tables G-1 and G-2

To balance pre- to post-,
the infiltration target (m^3/a)= **2,312**

Figure G-1
Pre-Development Monthly Site Water Balance

LEGEND

- SUBJECT LANDS
- CATCHMENT BOUNDARY
- ▨ IMPERVIOUS AREAS

N

0 40 80 160 240 320
Metres

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HANSEN GROUP INC.
BARRIE, ONTARIO
HEWITT'S GATE SOUTH
WATER BALANCE

Figure Title

PRE-DEVELOPMENT LAND USE AREAS

Drawn	Checked	Date	Figure No.
SK	SC	November 2024	G-2
Scale		Project No.	
1:4,000		300041559.0005	

File Name: Nigel/Shared Work Areas/041559 Hewitt's Gate/Hewitt's Gate South/02_Production/041559 HG Figures.dwg

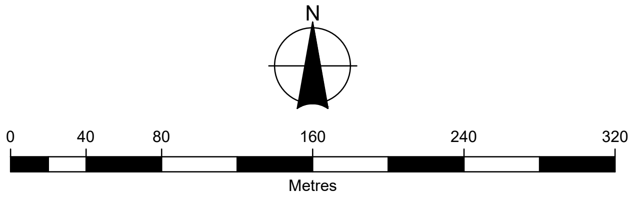
LEGEND

🟥 SUBJECT LANDS

🟪 CATCHMENT BOUNDARY

Landuse Breakdown - Wetland Catchments EAST		
Post-Development Land Use		
(with no LID measures in place)	Imperviousness	Area (ha)
Single Detached	50.0%	1.54
Townhouse Residential	60.0%	2.27
Medium Density Residential	75.0%	5.28
Roads and reserves	80.0%	4.24
Stormwater Management Block	0.0%	1.62
Open Space	5.0%	0.50
Commercial	80.0%	0.14
Total Development catchment		**15.59**

Landuse Breakdown - Wetland Catchments WEST		
Post-Development Land Use		
(with no LID measures in place)	Imperviousness	Area (ha)
Medium Density Residential	75.0%	1.59
Roads and reserves	80.0%	0.23
Total Development catchment		**1.82**
Environmental Protection	0.0%	9.08
Total		26.49



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Client / Report

HANSEN GROUP INC.
BARRIE, ONTARIO
HEWITT'S GATE SOUTH
WATER BALANCE

Figure Title

POST-DEVELOPMENT LAND USE AREAS

Drawn	Checked	Date	Figure No.
SK	SC	November 2024	G-3
Scale		Project No.	
1:4,000		300041559.0005	

File Name: Nigel/Shared Work Areas/041559 Hewitt's Gate/Hewitt's Gate South/02_Production/041559 HG Figures.dwg

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