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# Hydrogeological Assessment - Langen Property

Mattamy (Erin) Limited and
2779181 Ontario Inc.
Erin, Ontario

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## 2779181 Ontario Inc.
## Erin, Ontario

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## Table of Contents

## Tables

## Figures

## Appendices

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# 1.0 Introduction

R.J. Burnside & Associates Limited (Burnside) was retained by Mattamy (Erin) Limited and 2779181 Ontario Inc. to complete a hydrogeological assessment for a proposed residential subdivision located on adjacent parcels of land at 5552 Eighth Line and 5520 Eighth Line in the Town of Erin (herein referred to as the subject lands). The subject lands are located at the southwest corner of Sideroad 17 and Eighth Line (Part Lots 15 and 16, Con. 8) in the Town of Erin, County of Wellington (Figure 1). The hydrogeological assessment has been completed in support of a draft plan of subdivision for each of the parcels, 5552 Eighth Line owned by 2779181 Ontario Inc. and 5520 Eighth Line owned by Mattamy (Erin) Limited. The site location and instrumentation installed as part of the current assessment are shown on Figure 2. An initial study report was provided in June 2022 and based on review agency comments an updated report is being provided in October 2023. The updated report seeks to address agency comments on the initial report.

## 1.1 Scope of Work

The scope of the hydrogeological assessment involved a review of available regional information as well as the completion of site-specific investigations as described below, all field assessments were conducted to characterize the entirety of the subject lands as hydrogeological conditions were determined to be similar across both parcels:

1. Review of published geological and hydrogeological information: A review of background material for the area, including topography, surficial geology and bedrock geology mapping and existing geotechnical and hydrogeological reports was completed to assess the regional 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 6. 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. Install groundwater monitoring network: Groundwater monitoring locations were established to characterize seasonal variations in the water table in both the shallow and deep aquifers. A total of ten boreholes were drilled and completed as monitoring wells (5 cm diameter) to determine the local stratigraphy and site-specific soil and groundwater conditions of the subject lands. Two

monitoring well nests (two wells of different depths at the same location) were installed to assess vertical gradients. An existing monitoring well (referred to as MW4) was included in the monitoring network. A well record or borehole log for MW4 is not available. Two piezometer nests were also installed in wetlands and a single piezometer was installed at a pond to assess vertical hydraulic gradients in the features. The locations of the monitoring wells and piezometers 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 in order to determine hydraulic conductivity. Single well response tests were attempted at five groundwater monitoring wells (MW1s, MW1d, MW2, MW3 and MW9). The hydraulic conductivity field testing results are provided in Appendix C.

5. Monitoring of groundwater levels: Monitoring has been completed in monitoring wells and piezometers to measure the depth to the water table and assess the horizontal and vertical groundwater flow conditions. Groundwater level monitoring began in May 2021 and is ongoing. Automatic water level recorders (dataloggers) were installed in three monitoring wells and three piezometers to document the range of groundwater fluctuations and the response of aquifers to precipitation events (MW1s, MW3, MW8, PZ1d, PZ2d, PZ3). Barometric data from a barologger installed on the subject lands was used for calibration of the datalogger results. The groundwater monitoring data and hydrographs are provided in Appendix D.

6. Surface water monitoring: Surface water monitoring was completed along drainage features that traverses the subject lands (SW1) and at a pond (SG1) in the northern portion of the subject lands (Figure 2). The surface water station SW1 was inspected for water depth and flow and the water level at SG1 was recorded on each site visit. Surface water elevations, when present, were also recorded at each piezometer location. The surface water monitoring data are summarized in Appendix E.

7. Water quality sampling: Water quality data was collected from two monitoring wells (MW1d and MW9) and one surface water location to typify the water quality in the vicinity of the subject lands. The water samples were submitted to a qualified 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 of the subject lands. 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

across the study area. The local climate data and detailed water balance calculations are provided in Appendix G.

9. Data compilation, assessment of site conditions and reporting.

# 2.0 Physical Setting

## 2.1 Topography and Drainage

The subject lands are located in the physiographic region known as the Guelph Drumlin Field which is characterized by drumlins or groups of drumlins, edged with gravel terraces and swampy valleys (Chapman & Putnam, 1984). The topographic high on the subject lands is 459 metres above sea level (masl) which occurs on the ridge of a drumlin (ice-contact slope) running west-east that divides the property (Figure 3). South of the ridge the topography follows a steep drop toward the West Credit River Wetland Complex that outlets to the property to the south at an elevation of 417 masl. North of the drumlin ridge, the property slopes down towards the north, reaching an elevation of 397 masl along the north property lines (Figure 3).

The subject lands are located in the West Credit River subwatershed within the jurisdiction of the Credit Valley Conservation (CVC). Drainage on the north side of the ridge is generally to the northeast towards the Erin Branch of the Credit River just beyond the northeast corner of the property. Discontinuous watercourses/drainage swales are mapped on the subject lands draining north and connecting to wetlands that form part of the West Credit River Wetland Complex.

Drainage in the south portion of the subject lands slopes towards the wetland (also part of the West Credit River Wetland Complex) in the south corner of the subject lands (Figure 3).

### 2.1.1 Surface Water Monitoring

Surface water flow was monitored at SW1 along the drainage feature mapped in the north corner of the subject lands (Figure 3). Flow was observed at SW1 in April 2021 during the site walk and April 2022 but was dry for all monitoring events May 2021 to March 2022 (Table E-1, Appendix E). These observations indicate that the drainage feature is intermittent and carries water associated with the spring melt and runoff. Monitoring subsequent to the above have confirmed the designation as intermittent.

Surface water levels were measured at a pond downstream of SW1 at SG1 from May 2021 to October 2022 (Figure 3). Water levels at SG1 ranged from 0.04 m to 0.75 m above the bottom of pond (Table E-2, Appendix E).

## 2.2 Geology

Surficial geology mapping published by the Ontario Geological Survey (2003) shows that the subject lands are underlain by ice-contact stratified deposits south of the ridge, till consisting of sandy silt to silty sand north of the ridge, and glaciofluvial deposits at the northeast corner (Figure 4). Organic deposits are mapped just north of the subject lands along the course of the Credit River (Erin Branch). The bedrock underlying the subject lands consists of dolostone from the Amabel Formation (Figure 5).

## 2.3 Stratigraphy

A total of 10 boreholes were drilled and completed as monitoring wells in May 2021 to determine the local stratigraphy and site-specific soil and groundwater conditions of the subject lands (logs provided in Appendix B and locations shown on Figure 6). The boreholes indicated that the overburden stratigraphy is generally composed of layers of sand and gravel and silty sand till that are underlain by a finer grained clay with silt and stones. The more prevalent till deposits were generally composed of sandy silt to silty sand with varying amounts of clay and gravel and cobbles. Some layers of clay and silt may have developed in the till and these form localized low permeability layers or lenses. The borehole logs generally agree with the published mapping, although the surficial deposits encountered at MW9 and MW2 are interpreted to be glaciofluvial deposits rather than the sandy silt till that is mapped to this area.

To illustrate the shallow stratigraphy of the subject lands, schematic geologic cross-sections have been prepared (Figures 7, 8 and 9) using the MECP well records (Appendix A) and the soils information collected during drilling of boreholes and monitoring wells (Appendix B). The locations of the cross-sections are illustrated on Figure 6 along with the locations of water wells and boreholes used in the construction of the cross-sections. The cross-sections illustrate that the subject lands are underlain by overburden ranging in thickness from 5 m up to 65 m overlying limestone bedrock (Figures 6, 7 and 8). The overburden consists of layers of sand, gravel, and silty sand glacial till generally overlying a layer of clay with silt and stones. Bedrock is interpreted to be found at elevations from 385 masl to 395 masl.

# 3.0 Hydrogeology

## 3.1 Hydraulic Conductivity

The ability of soil to transmit groundwater is measured as its hydraulic conductivity. Hydraulic conductivity is low in poorly transmissive sediments (aquitards) and higher in more transmissive sediments (aquifers). The determination of hydraulic conductivity rates assists with the determinations of groundwater flow volumes and directions and the relationships between various layers in the subsurface. 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. In situ bail-down or slug-testing methods are used in groundwater monitoring wells to assess site-specific hydraulic conductivity. Both methods have been used to estimate the hydraulic conductivity of the soils encountered in the boreholes completed on the subject lands as discussed below.

### 3.1.1 Grainsize Analysis

Representative soil samples were collected during drilling of boreholes and six samples were submitted for grainsize analysis.

To estimate hydraulic conductivity based on grainsize analysis, an empirical formula method known as the Hazen estimation is used. This method is an approximation of hydraulic conductivity based on grainsize curves for sandy soils. The approximation does not strictly apply to finer grained materials however, it is still considered useful to provide a general indication of the range of the hydraulic conductivity values. Grainsize distribution data were available for seven samples obtained from on-site wells and these data were used to obtain hydraulic conductivity values empirically using the Hazen method. The grainsize distribution graphs are provided in Appendix C-1 and the estimated hydraulic conductivity values are provided in Table 1.

**Table 1: Estimated Hydraulic Conductivity Based on Grainsize Analyses**

| Sample ID | Depth of Sample (mbgs*) | Soil Description | % Fines | Estimated Hydraulic Conductivity (cm/s) |
|---|---|---|---|---|
| MW1-SS5 | 3.0 | Gravelly Sand | 12 | $3.6 \times 10^{-3}$ |
| MW1-SS6 | 4.6 | Sand and Silt | 40 | $2.5 \times 10^{-5}$ |
| MW2-SS4 | 2.3 | Silty Sand | 35 | $2.3 \times 10^{-4}$ |
| MW3-SS6 | 3.8 | Silty Gravelly Sand | 28 | $2.3 \times 10^{-4}$ |
| MW6-SS10 | 12.2 | Silty Sand | 35 | $1.0 \times 10^{-4}$ |
| MW7-SS8 | 7.6 | Sand and Silt | 40 | $1.2 \times 10^{-3}$ |

*metres below ground surface

Grainsize analyses results indicate that the sediments within the overburden range in composition from gravelly sand (12% fines) to sand and silt (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. Grainsize analysis completed indicate that the sediments generally consist of varying amounts of sand, silt and gravel with trace clay. The hydraulic conductivities based on grainsize analyses for the sediments is estimated in the range of $10^{-3}$ to $10^{-4}$ cm/sec.

### 3.1.2 Single Well Response Tests

To assess the in situ hydraulic conductivity of the sediments, single well response tests (bail-down tests and slug tests) were conducted at five monitoring wells. The results from the tests were plotted (Appendix C-2) and analyzed to calculate hydraulic conductivity of the sediments screened. A summary of the calculated hydraulic conductivities is provided below in Table 2.

**Table 2: Single Well Response Testing Results**

| Monitoring Well | Screen Interval (mbgs)* | Formation Screened | Hydraulic Conductivity (cm/sec) |
|---|---|---|---|
| MW1s | 3.1 – 4.6 | Gravelly Sand | 1.3 x $10^{-3}$ |
| MW1d | 7.6 – 9.1 | Silty Sand Till | 2.2 x $10^{-5}$ |
| MW2 | 2.6 – 3.1 | Silty Sand | 3.6 x $10^{-4}$ |
| MW3 | 2.3 – 3.8 | Sand/Silty Sand | 5.3 x $10^{-5}$ |
| MW9 | 3.1 – 4.6 | Sandy Gravel | 2.9 x $10^{-4}$ |

*metres below ground surface

Single well response tests in wells screened in the silty sand till (MW1d, MW3) indicate moderate hydraulic conductivities in the order of $10^{-5}$ cm/sec.

## 3.2 Local Groundwater Use

The Village of Erin is supplied with municipal groundwater however there are still some private water supply wells that are used. A review of the MECP well records for an area of approximately 500 m surrounding the subject lands identified 39 well records. Of the 39, 37 were for water supply wells and the other 2 records were for monitoring wells. All of the 37 water supply wells are completed in the bedrock at depths ranging from 17 m to 68 m. The capacity of the wells reviewed generally ranged between 18 L/min (4 gpm) and 180 L/min (40 gpm). Summaries of the MECP well records are provided in Appendix A and the plotted locations have been included on Figure 6.

A municipal supply well (Town of Erin Well 8) is located on the east side of Eighth Line less than 50 m from the subject lands. The well record is incorrectly plotted in the MECP database further than 500 m east of the site. The well record reports the estimated capacity as 450 L/min (100 gpm). The subject lands are located within Erin Well 8's wellhead protection area for which the implications are discussed in Sections 5.2 and 5.3.

## 3.3 Groundwater Level Monitoring Results

Water levels in 10 monitoring wells and 5 piezometers were collected from May 2021 to September 2023 using a water level meter. Dataloggers (automatic water level recorders) were installed in May 2021 at MW1s, MW6s, MW8, PZ1d and PZ2d and in June 2021 at PZ3 to provide continuous data (hourly readings) of water levels during the monitoring period. The datalogger at MW6s was moved to MW3 in June 2021 as MW6s continued to show dry conditions. A barometric pressure logger was also installed to measure changes in barometric pressure. These data are used to correct the water level data by accounting for changes in atmospheric pressure.

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

- Groundwater elevations across the subject lands range from 396 masl to 436 masl.

- Monitoring wells in the upland areas (MW4, MW5, MW6s/d and MW7) had water levels ranging from 7 m to more than 12 m below ground. MW4 located at 442.4 masl, was constructed to a depth of 19.7 meters and was consistently dry (Figure D-4). MW5 had water levels near the bottom of the screen (~7 mbgs) from July to November then water levels rose to a high of 3.2 mbgs in April 2022 (Figure D-5). The highest groundwater level attained at this monitor was 1.21 mbgs in April 2023. At MW6s/d, water levels were generally dry except for brief periods between March and August in 2022 and May and September in 2023 with a high of 8 mbgs (Figure D-6). Water levels at MW7 were consistently dry indicating the water table is greater than 11.9 mbgs at this location (Figure D-7).

- Monitoring wells located in the lower areas to the north (MW1sd, MW2, MW3, MW8 and MW9) had water levels ranging from 0.1 to 3.5 mbgs. Seasonal variation in these wells ranged from 1.6 m at MW2 to 3.0 m at MW8.

- Typically, shallow wells in southern Ontario show a seasonal pattern in groundwater levels with highest levels occurring in the spring, declining throughout the summer and early fall and then rising again in the late fall/early winter. Water levels observed on the subject lands are consistent with this trend with water levels lowest in the summer months, increasing in the fall and highest in the spring months.

- Hourly automatic water level readings (datalogger readings) collected at monitoring wells MW1s, MW3 and MW8 are plotted against precipitation to determine if there is a correlation between changes in water level and the occurrence of precipitation events. At MW1s there was no direct response to precipitation observed (Figure D-1, Appendix D). At MW3, the water level increased 0.9 m after an 80 mm rain event on September 21/22 and 0.75 m after a 42 mm rain event in February (Figure D-3). At MW8, a response to precipitation event is observed with water levels increasing approximately 0.5 m in response to a large rain event in September 2021 and a 42 mm rain event in February 2022 (Figure D-8).

- Nested monitoring wells MW1s/d and MW6s/d were installed to determine vertical hydraulic gradients and evaluate the recharge or discharge conditions on the subject lands. There was small upward gradient observed at monitoring well nest MW1s/d with water levels in the deep wellbeing slightly higher than the shallow well MW1s, however the difference is too small to be considered significant (Figure D-1, Appendix D). At MW6s/d water levels in the deep well were lower than the shallow well when the wells were not dry indicating recharge conditions (Figure D-6).

## 3.4 Surface Water/Groundwater Interactions

Piezometers were installed at selected wetlands and surface water features on the subject lands to assess the potential for surface water/groundwater interactions and vertical gradients beneath the surface water features. The groundwater levels for the piezometers are provided in Table D-1 and Figures D-10 to D-12, Appendix D. Surface water levels measured at the piezometers are included on the figures and provided in Table E-2, Appendix E.

- PZ1s/d is located in a small, treed wetland channel on the north half of the subject lands. Surface water in the wetland at PZ1s/d was observed at 0.04 m above ground surface in June and July 2021 and was dry the rest of the 2022. In 2023 the surface water level has remained fairly consistent with 2022 observations with only minor seasonal variations being noted (Table E-2, Appendix E). Water levels in the shallow piezometer PZ1s were recorded slightly above ground surface for the duration of the monitoring period (Figure D-10, Appendix D). Water levels measured in the deep piezometer PZ1d show a steady increase from June to December suggesting that water levels were recovering from installation and indicating low hydraulic conductivity in the soils. Static water levels in PZ1d measured after June 2021 were higher than levels in PZ1s indicating an upward gradient and discharge conditions in this area.

- PZ2s/d is located within the West Credit River wetland complex on the east side of the subject lands just north of a woodlot. Water levels at PZ2s were dry from July to October 2021 then ranged from ground surface to 0.54 m below ground between November 2021 and September 2023 (Figure D-11, Appendix D). Water levels at PZ2d ranged from 1.2 mbgs up to 0.01 m above grade. The gradients at PZ2sd appear to change seasonally with a downward gradient during the summer months and upward gradient in the winter and spring. Due to the established elevations compared to regional conditions it is interpreted that perched groundwater conditions exist in this area and support a local groundwater system around the wetland. Surface water was observed at PZ2s/d on only two occasions, April and May 2022. The wetland was dry at PZ2 the rest of the monitoring rounds (Table E-2, Appendix E).

- PZ3 is located at a pond on the south half of the subject lands and was installed on June 30, 2021. Surface water levels at PZ3 ranged from dry during late summer and fall months to 0.55 m in July 2022 and was greater than 0.9 m from April to September in 2023 (Table E-2, Appendix E). The automatic water level meter readings at PZ3 show water levels in the piezometer initially recovering from installation increasing to 0.17 m above ground surface in mid-July then decreasing gradually over the rest of July and August which is typical for summer groundwater levels. Water levels show impacts from large precipitation events in September 2021. In the fall of 2021, water levels start to rise and reach a seasonal high in the summer of 2022 after which the levels fall till November 2022. Based on the observed trends, water level in the piezometer is above grade during the summer months and below grade in the winter months. The observations suggest a discharge gradient at the pond in the summer months and potential recharge during fall/winter.

## 3.5 Interpreted Groundwater Flow

Groundwater elevation data (June 2021) obtained from the monitoring wells and piezometers are shown on Figure 11, along with the interpreted groundwater elevation contours for the area. The groundwater movement in the shallow overburden on the subject lands is interpreted to follow the elevation contours. North of the ridge the shallow groundwater is interpreted to flow northwards towards the low-lying wetlands and the Erin Branch of the Credit River. The groundwater is influenced by the surface topography with groundwater moving from topographic highs towards topographic lows. Arrows perpendicular to the groundwater contours are used to illustrate the groundwater flow directions. It is noted that groundwater flow on north of the ridge is generally towards the north and northwest with slight convergence around watercourses and wetland areas. It is interpreted that groundwater is close to surface in the topographically low areas and also in areas close to wetlands.

## 3.6 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. These areas are generally in areas of 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 along watercourses. Recharge and discharge may occur in local, intermediate and more regional flow systems. Infiltrating water at any given location may follow a shallow flow path and discharge a short distance away from the recharge area along the nearest slopes or in small watercourses, swales, agricultural ditches, wetlands, etc. This is referred to as a local groundwater flow system (i.e., flows that closely follow the existing topography with relatively short flow distances, e.g., up to a few hundred metres).

The coarse-grained soils on the subject lands are ideal for recharge, however high water table conditions in some areas due to the presence of fine grained sediments may impede recharge from occurring. The finer grained soils may also result in horizontal flow through these local flow systems and provide support for wetlands in these areas.

Water level measurements in piezometers and observations in the most northerly wetlands and in the vicinity of PZ1s/d indicate the potential for groundwater discharge to the wetlands and along the surface water features in this area. It is generally interpreted that the upland areas of the subject lands are recharge areas, and that recharge occurs where the groundwater table is at sufficient depth. The wetland feature in the central area of the subject lands is interpreted to be developed on a pocket of finer grained material that sits on top of the coarser grained sands. Surface runoff and local groundwater recharge is ponded in this area by the low permeability soil conditions. As dry conditions persist and as the perched water table drains the groundwater support is gradually reduced and therefore groundwater support to this feature is seasonal.

South of the wetlands are two pond features that are interpreted to exist in similar conditions to the central wetland. The presence of fine-grained sediments in these areas has created the circumstances that allow for perched groundwater conditions to exist and cause local groundwater support to these ponds. The main source of water for these features is however surface water that ponds in the area and gradually infiltrates to the local perched system before percolating a second time to the regional groundwater system or being used by vegetation around the pond.

## 4.0 Water Quality

To establish background water quality on the subject lands groundwater samples were collected on July 12, 2021. Water samples were collected from two groundwater wells (MW1d and MW9) and one surface water location (the watercourse adjacent to PZ1s/d). The samples were sent to AGAT Laboratories for analysis of general water quality indicator parameters and basic ions (e.g., pH, alkalinity, hardness, conductivity, chloride, nitrate, etc.) and selected metals.

### 4.1 Groundwater Quality

The analytical results from the laboratory are provided in Tables F-1, Appendix F and are discussed below. The data reviewed showed the following:

- Both wells exceeded the Ontario Drinking Water Quality Standards (ODWQS) aesthetic objective for total hardness (100 mg/L) with values of 267 and 270 mg/L. Hardness in groundwater is caused by dissolved calcium and magnesium and is typically a result of the geologic material of the aquifer.

- MW1d exceeded the ODWQS aesthetic objective for manganese (0.05 mg/L) with a value of 0.097 mg/L. Manganese naturally occurs in aquifers and at elevated levels causes staining during household use.

- Both wells exceeded the ODWQS aesthetic objective for turbidity due to the sampling techniques and well construction.

- There were no other exceedances of the ODWQS in the groundwater sample results.

- Nitrate in the groundwater ranged from less than 0.05 mg/L to 0.43 mg/L indicating that the groundwater has not been impacted by the surrounding land use activities such as septic systems or agricultural activities.

## 4.2 Surface Water Quality

The analytical results from the laboratory are provided in Tables F-2, Appendix F and are discussed below. The data reviewed showed the following:

- The total phosphorus concentrations were 0.07 mg/L. There is no firm PWQO for phosphorus; however, these concentrations exceed the 0.03 mg/L generally recommended phosphorus concentration for streams. Total phosphorus is a measure of all forms of phosphorus (dissolved or particulate) that are found in the water sample.

- The total concentrations of the cadmium, cobalt, copper, lead and zinc all marginally exceeded the PWQO guidelines for surface water. These may be attributed to sediment in the surface water. The concentration of total iron exceeded the PWQO guideline (0.3 mg/L) with a value of 12.1 mg/L.

- The concentration of nitrate in the surface water was 1.01 mg/L indicating that the groundwater may be impacted by the surrounding land use activities such as septic systems or agricultural activities.

Overall, the water quality data suggest that the surface water and groundwater quality in the Subject Lands area are relatively fair condition compared to the provincial drinking water and surface water quality guidelines. The data suggests that the surface water quality may locally be affected by anthropogenic influences (i.e., agricultural land uses).

# 5.0 Water Balance

A water balance assessment is required in order to assess potential land development impacts on the local groundwater conditions. The water balance completed for this study 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.

## 5.1 Water Balance Components

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

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

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

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

The groundwater balance components for the subject lands are discussed below:

**Precipitation (P)**

The long-term average annual precipitation for the area of the subject lands is 946 mm based on data from the Environment Canada Fergus Shand Dam (Station 6142400, 43°44'05.088" N, 80°19'49.098" W, elevation 417.6 masl) for the period between 1981 and 2010. The climate station is located 19 km west of the subject lands. Average monthly records of precipitation and temperature from this station have been used for the water balance calculations in this study (Appendix G).

**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 and not considered for the calculations.

### Evapotranspiration (ET)

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

### Water Surplus (R + I)

The difference between the mean annual P and the mean annual ET is referred to as the water surplus. Part of the water surplus travels across the surface of the soil as surface or overland runoff (R) and the remainder infiltrates the surficial soil (I). The infiltration is comprised of two end member components: one component that moves vertically downward to 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.

## 5.2 Approach and Methodology

The analytical approach to calculate the water balance utilized for this assessment involves monthly soil-moisture balance calculations to determine the pre-development (based on existing land use) infiltration volumes. For the purposes of this study, the water balance calculations were undertaken using a spreadsheet model. The soil-moisture balance approach utilized 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).

The soil moisture capacity for the soils on the subject lands were estimated based on guidance available in the MECP SWM Planning and Design Manual (2003). A soil moisture storage capacity of 150 mm was used for the areas where the land cover was predominantly short to moderate-rooted vegetation in the fields and agricultural areas (Table G-1, Appendix G). A soil moisture storage capacity of 300 mm was used for the areas where the land cover was woodland (Table G-2, Appendix G). A soil moisture storage capacity of 75 mm was used for areas that were shallow rooted vegetation such as meadow and orchard as well as residential lawn (Table G-3, Appendix G). Tables G-1 to G-3 in Appendix G detail 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 as presented on Table G-4 in Appendix G.

## 5.3 Water Balance Component Values

The detailed monthly calculations of the water balance components are provided in Tables G-1 to G-3 in Appendix G. For these calculations, it has been assumed that sandy loam soils are representative for the subject lands for estimating the soil infiltration factor. The calculations show that a water surplus is generally available from November to May (see Figure G-1). 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-1, G-2 and G-3, Appendix G). A summary of these values is provided in Table 3.

**Table 3: Water Balance Component Values**

| Water Balance Component | Agricultural Lands | Woodland | Open Space/Urban Lawn |
|---|---|---|---|
| Average Precipitation | 946 mm/year | 946 mm/year | 946 mm/year |
| Actual Evapotranspiration | 582 mm/year | 582 mm/year | 571 mm/year |
| Water Surplus | 364 mm/year | 364 mm/year | 375 mm/year |
| Infiltration | 218 mm/year | 255 mm/year | 225 mm/year |
| Runoff | 146 mm/year | 109 mm/year | 150 mm/year |

## 5.4 Pre-Development Water Balance (Existing Conditions)

The water balance component values from Tables G-1, G-2 and G-3 were used to calculate the average annual volume of infiltration across the subject lands. Water balance calculations have been completed for the 5552 Eighth Line property and 5520 Eighth Line property. An area of the subject lands labeled “Lands to be Retained” will not be included in the development and therefore was not included in the water balance calculations (see Figure 14). The pre-development water balance calculations are presented in Table G-4 and Table G-5 in Appendix G and summarized in Table 4 below.

**Table 4: Pre-Development Water Balance**

| Water Balance Component | Runoff ($m^3$/year) | Infiltration ($m^3$/year) |
|---|---|---|
| 5552 Eighth Line | 38,700 | 60,700 |
| 5520 Eighth Line | 44,200 | 87,100 |
| **Total** | **82,900** | **147,800** |

## 5.5 Potential Urban Development Impacts to Water Balance

It is recognized that the urban development of an area affects the natural water balance. The most significant difference is the addition of impervious surfaces as a type of surface cover (i.e., roads, parking lots, driveways, and rooftops). Impervious surfaces prevent infiltration of water into the soils and the removal of the vegetation removes the evapotranspiration component of the natural water balance. The evaporation component from impervious surfaces is relatively minor (estimated to be 10% to 20% of precipitation) compared to the evapotranspiration component that occurs with vegetation in this area (about 62% of precipitation in the area of the subject lands). 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. There is an evaporation component from impervious surfaces and this is typically estimated to be between about 10% and 20% of the total precipitation. 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 804 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.

## 5.6 Post-Development Water Balance with No Mitigation

To assess potential development impacts on infiltration, the post-development infiltration volumes were calculated for the subject lands based on land use areas and the associated percentage imperviousness for the current design layout provided by the design engineers. The proposed land uses areas used in the water balance are mapped on Figure 12. 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-1 to G-3 in Appendix G. The post-development water balance calculations are presented in Table G-4 and Table G-5 in Appendix G and summarized in Table 5 below.

**Table 5: Pre- and Post-Development Infiltration**

| Water Balance Component | Pre-Development Infiltration ($m^3$/year) | Post-Development Infiltration ($m^3$/year) | Reduction in Infiltration ($m^3$/year) |
|---|---|---|---|
| 5552 Eighth Line | 60,700 | 26,800 | 33,900 |
| 5520 Eighth Line | 87,100 | 73,100 | 14,000 |
| **Total** | **147,800** | **99,900** | **47,900** |

Comparing the pre- and post-development infiltration volumes, shows that development has the potential to reduce the average infiltration on the subject lands from 147,800 $m^3$/year to 99,900 $m^3$/year, i.e., a reduction of about 47,900 $m^3$/year or 32%. These calculations assume no low impact development (LID) measures for stormwater management are in place.

## 5.7 Mitigation Strategies for Infiltration

In order to minimize the potential impacts of development on the water balance, the use of Low Impact Development (LID) measures for stormwater management are generally recommended by the conservation authority. LID is based on the premise of trying to manage stormwater to minimize the runoff of rainfall and increase the potential for infiltration where possible. There are, as outlined in the MECP SWMP Design Manual (2003) and Low Impact Development (LID) Stormwater Management Planning and Design Guide published by the CVC and TRCA (2010), a number of best management practices and mitigation techniques that can be used to increase the potential for post-development infiltration and mitigate the reductions in infiltration that occur with residential land development.

Techniques to maximize the water availability in pervious areas such as designing grades to direct roof runoff towards lawns, side and rear yard swales, boulevards, parks, and other open space areas throughout the development where possible can increase infiltration and reduce the volume of runoff directed to stormwater management facilities. Increasing the topsoil thickness is a method to increase the soil water storage area and potentially increase recharge volumes. Other LID practices that may be considered to control stormwater runoff for residential development areas include, but are not limited to, the use of vegetated buffer strips, rain gardens, construction of bioretention cells or bioswales, tree pits, cisterns and the use of porous pavers. The Functional Servicing

Report completed for the proposed development includes additional details on the proposed LIDs for stormwater management.

## 5.8 Post-Development Infiltration with LID Measures in Place

The basic premise for low impact development is to try to manage stormwater to minimize the runoff of rainfall and increase the potential for infiltration. The Functional Servicing/Stormwater Management Report (DSEL, 2022) indicates the LIDs recommended for the subject lands will include roof leader disconnection and increased topsoil.

Quantification of these surficial LID techniques is challenging and there are no widely accepted quantification standards. To assess the potential effectiveness of the recommended LID measures for groundwater infiltration for the subject lands, the water balance component values were recalculated. Based on the suitability of the local soils for roof leader disconnection, the impact of this LID measure was evaluated as part of the current assessment. This measure was applied as outlined below.

In the single detached and townhome residential areas roof areas will be disconnected and directed to front/rear/side yards. The TRCA/CVC Low Impact Development Stormwater Management Planning and Design Guide allows for a 50% runoff reduction (contribution to recharge) from roof leader disconnection and discharge to pervious areas. This 50% runoff reduction is based on the hydrologic soil group A and B (sandy to sandy loam) soils being present at the site. Recalculation of the water balance for the subject lands with these LID measures in place are presented in Tables G-6 and G-7, Appendix G and are summarized below in Table 6.

**Table 6: Post-Development Infiltration with Roof Leader Disconnection**

| Water Balance Component | Pre-Development Infiltration ($m^3$/year) | Post-Development Infiltration with LIDs ($m^3$/year) | Decrease in Infiltration ($m^3$/year) |
|---|---|---|---|
| 5552 Eighth Line | 60,700 | 52,200 | 8,500 |
| 5520 Eighth Line | 87,100 | 90,600 | -3,500 |
| **Total** | **147,800** | **142,800** | **5,000** |

The calculations demonstrate that the decrease in infiltration across the entire subject lands can be mitigated with roof leader disconnection down to 5,000 $m^3$/year which is a decrease from pre-development conditions of 3%. Based on the required assumptions and the known variations in the values used, a 3% deficit can be regarded as a match to pre-development infiltration. Due to the success of roof leader disconnection in mitigating impacts to groundwater recharge, no further analysis of post-development LID impact on groundwater was completed.

## 5.9 Feature Based Water Balance

As a further assessment of development impact a feature based water balance was completed for the wetland features located on the subject lands. This assessment was completed by Geo Morphix Ltd. and included a characterization of the subject lands and pre- and post-development water balance to account for the impact of the proposed development on the wetland features. The full feature-based water balance report is included as Appendix H of the Functional Servicing Report and indicates that the post-development annual runoff volumes will be maintained within +/-10% of pre-development runoff at each of the seven surface water features on the subject lands.

# 6.0 Development Considerations

## 6.1 Construction Below the Water Table

Based on groundwater level data collected as part of this study water table on the subject lands range from 1 to 4 m in the topographically low area and 7 to greater than 12 m in the topographically higher lands.

Should excavations during construction of servicing extend below the water table the local soils may need to be dewatered. Due to the potential for encountering the water table during construction, the dewatering of local aquifers may be required in order for services to be installed below the water table. The undertaking of dewatering according to industry standards and in accordance with a MECP processes will ensure that adequate attention is paid to potential adverse impacts to the environment. Currently the MECP allows for construction dewatering of less than 400,000 L/d to proceed under the Environmental Activity Sector Registry (EASR) process. If dewatering is to be above this threshold, then the standard Permit to Take Water (PTTW) process applies. In both cases, a scientific study is required in support of EASR registration or PTTW application. This scientific study must review the potential for environmental impacts and provide mitigation and monitoring measures to the satisfaction of the MECP or other review agency. The requirements for construction dewatering will be confirmed by geotechnical/hydrogeological investigations completed in support of detailed design.

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.

## 6.2 Source Water Protection

The subject lands are located within the Credit Valley Source Protection Area for which policies in the CTC Source Protection Plan (SPP) apply. Since the subject lands are located within the wellhead protection areas for the Town of Erin's Well 8 (Figure 13) the proposed development will be subject to policies if activities include any of the prescribed drinking water threats (Clean Water Act, 2006) that would be a significant drinking water threat. Potential drinking water threats are discussed in the Drinking Water Threats Disclosure Report submitted under separate cover.

A review of the MECP's Source Protection Atlas indicates that the subject lands are mapped as a highly vulnerability aquifer (HVA) area (Figure 14). Depending on land use, runoff from urban developments may contain a variety of dilute contaminants such as suspended solids, chloride from road salt, oil and grease, metals, pesticide residues, bacteria and viruses. For groundwater, generally, with the exception of the dissolved constituents such as nitrogen and salt, most contaminants are attenuated by filtration during groundwater transport through the soils. The potential for effects on local groundwater quality from infiltration in the urban areas is therefore expected to be limited. There are no policies for HVAs in the CTC Source Protection Plan (SPP).

## 6.3 Local Groundwater Supply Wells

The Village of Erin is supplied with municipal water and subject lands will be serviced by municipal water supply however, the surrounding rural properties fall outside of the serviced area and are supplied by individual domestic water wells. A review of MECP water well records within 500 m of the subject lands indicates that all water supply wells are located in the bedrock with depths ranging from 17 m to 68 m. The capacity of the wells reviewed generally ranged between 18 L/min (4 gpm) and 180 L/min (40 gpm).

A review of the MECP records for Permits to Take Water (PTTW) issued in the area show that the Town of Erin has a PTTW for the municipal well (Erin Well 8) and the golf course north of the subject lands has a PTTW for surface and groundwater sources.

During construction, dewatering activities if required will be limited to groundwater within the overburden.

It is recommended that a water supply well survey be completed to establish baseline conditions in surrounding wells before construction.

## 6.4 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.

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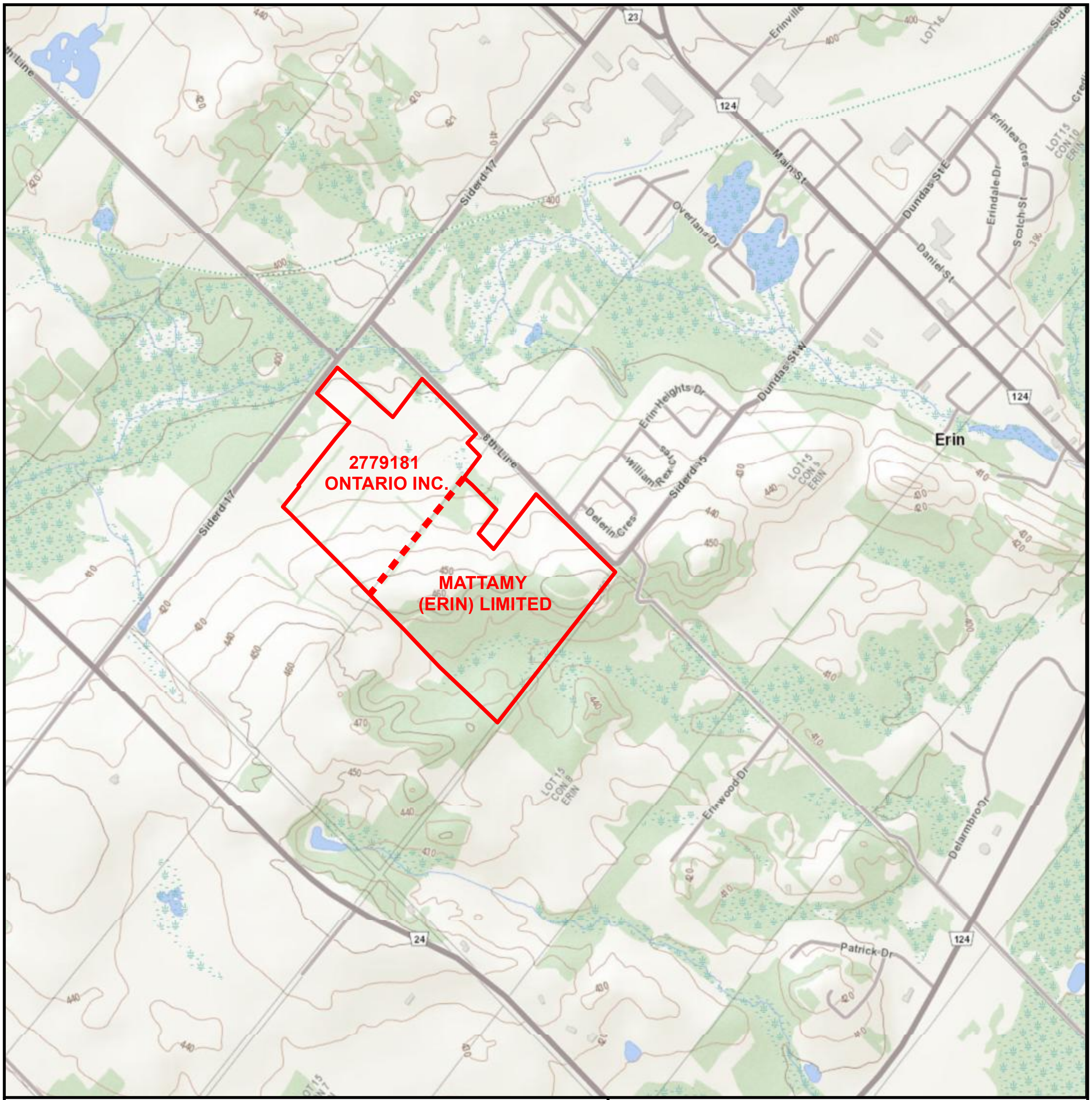
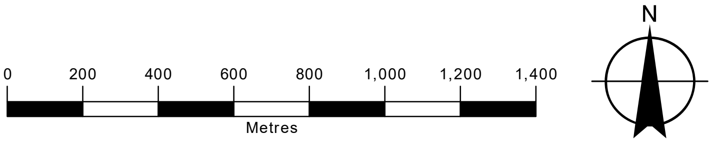
# Figures



LEGEND

▭ SUBJECT LANDS



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## SITE LOCATION

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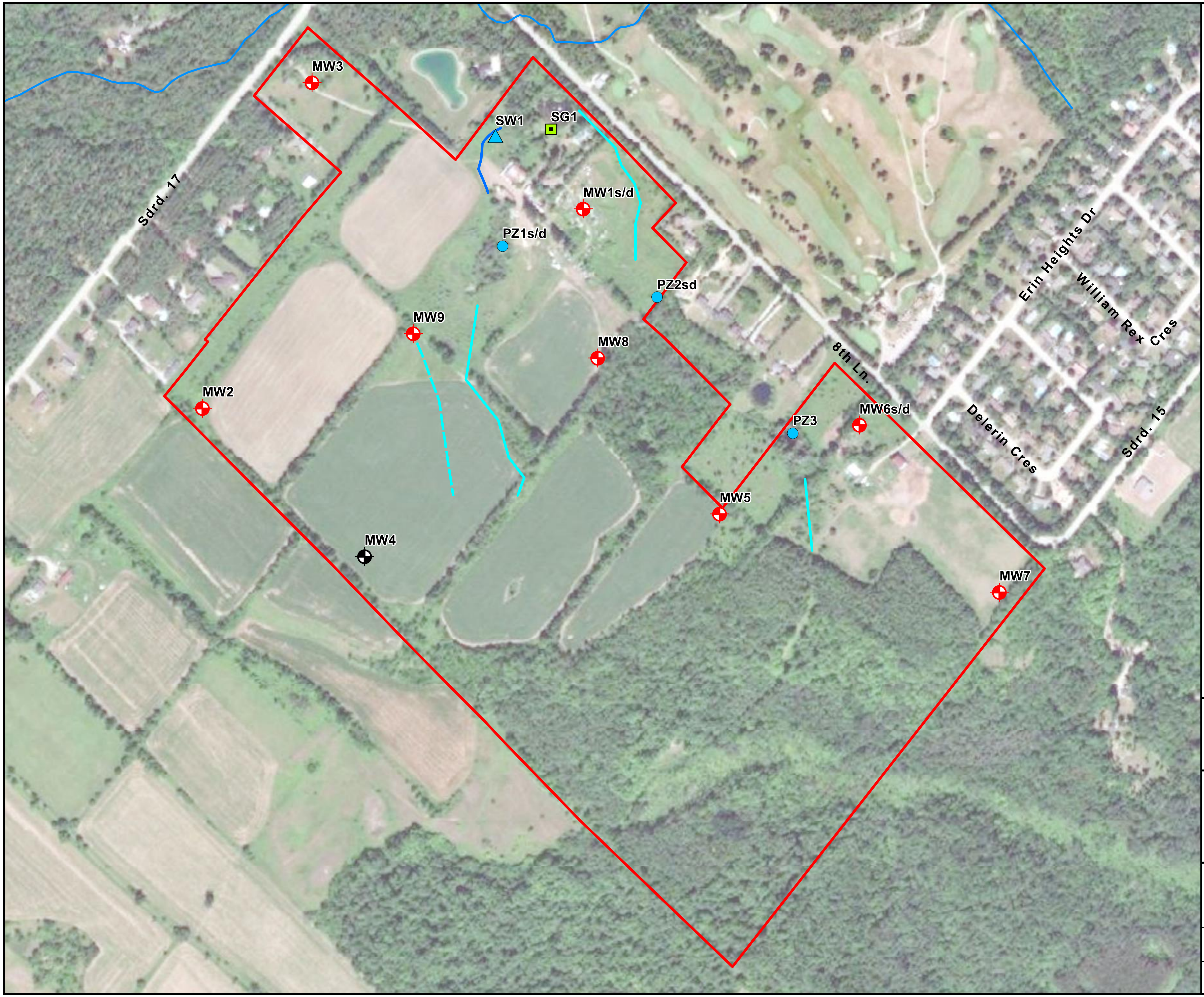

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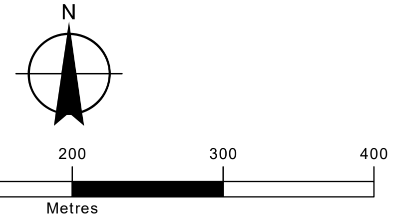
| | |
|---|---|
| ▭ | SUBJECT LANDS |
| — | WATERCOURSE |
| - - | HEADWATER DRAINAGE FEATURE (HDF) |
| — | INTERMITTENT WATERCOURSE |
| — | PERMANENET WATERCOURSE |
| ⊕ | MONITORING WELL (RJB, 2021) |
| ⊕ | MONITORING WELL (SOURCE UNKNOWN) |
| ● | PIEZOMETER |
| ▣ | STAFF GAUGE |
| ▲ | SURFACE WATER MONITORING LOCATION |

**Sources:**

1. Ministry of Natural Resources, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.



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## MONITORING LOCATIONS

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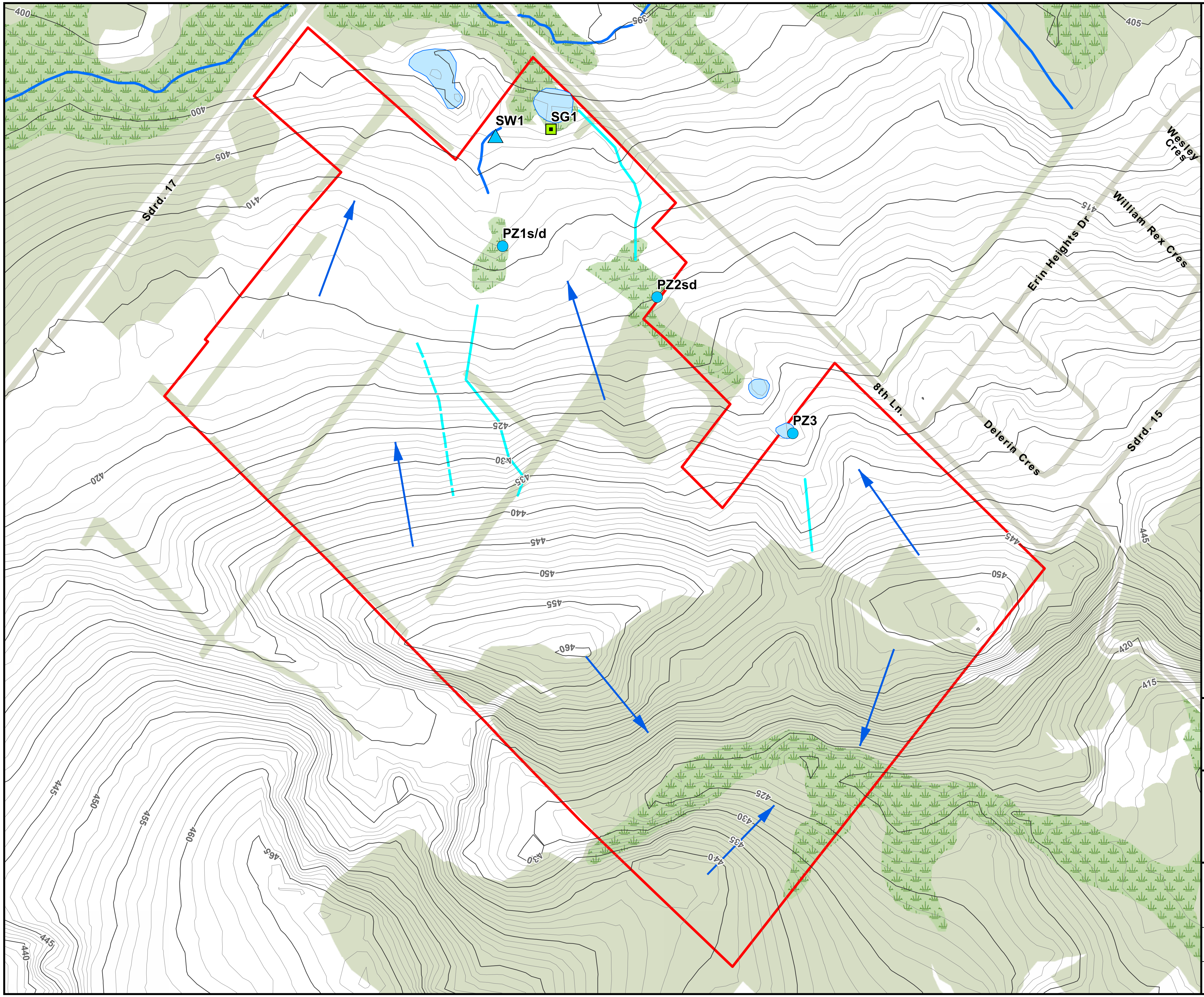

LEGEND

| | |
|---|---|
| ▭ | SUBJECT LANDS |
| — | CONTOUR (5m intervals - masl) |
| — | CONTOUR (1m intervals) |
| ▨ | OPEN WATER / POND |
| ▬ | ROADWAY |
| - - | HEADWATER DRAINAGE FEATURE (HDF) |
| — | INTERMITTENT WATERCOURSE |
| — | PERMANENET WATERCOURSE |
| 🟩 | WETLAND (MNRF, 2017) |
| ▨ | WOODED AREA |
| ● | PIEZOMETER |
| ▣ | STAFF GAUGE |
| ▲ | SURFACE WATER MONITORING LOCATION |
| ← | INFERRED SURFACE WATER DRAINAGE DIRECTION |

Sources:

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Metres

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## TOPOGRAPHY AND DRAINAGE

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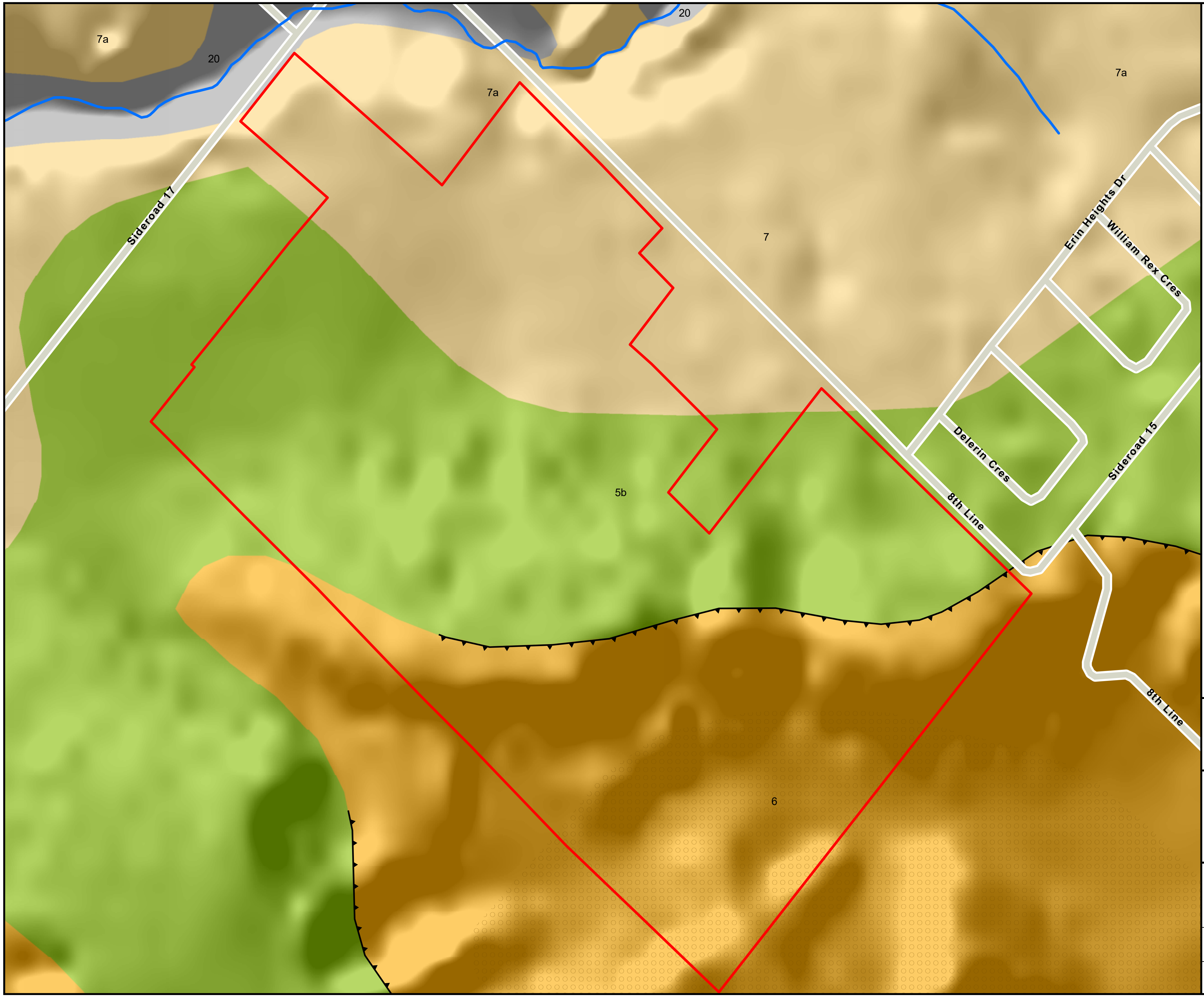

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| | |
|---|---|
| 🟥 | SUBJECT LANDS |
| ▬ | ROADWAY |
| — | WATERCOURSE |
| ▾ | ICE-CONTACT SLOPE |
| ○ | HUMMOCKY TOPOGRAPHY |
| 🟩 | 5b: Stone-poor, carbonate-derived silty to sandy till |
| 🟧 | 6: Ice-contact stratified deposits: sand and gravel, minor silt and clay |
| 🟨 | 7: Glaciofluvial deposits: river deposits and delta topset facies |
| 🟨 | 7a: Sandy deposits |
| ⬜ | 20: Organic deposits: peat, muck, marl |

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## SURFICIAL GEOLOGY

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| 1:5,000 | | 300052075 | |

File Path: Nigel/Shared Work Areas/0502075 Mattamy Erin/06_GIS/052075 Surficial Geology.mxd

LEGEND

🟥 SUBJECT LANDS

▬ ROADWAY

LOWER SILURIAN - 56 Sandstone, shale, dolostone, siltstone

▨ 56c Amabel Fm.

**Sources:**

1. Ontario Geological Survey 2011. 1:250 000 scale bedrock geology of Ontario; Ontario Geological Survey, Miscellaneous Release–Data 126 - Revision 1.
2. Ministry of Natural Resources and Forestry, © Queen's Printer for Ontario
3. Natural Resources Canada © Her Majesty the Queen in Right of Canada

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## BEDROCK GEOLOGY

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| Scale<br>1:5,000 | | Project No.<br>300052075 | |

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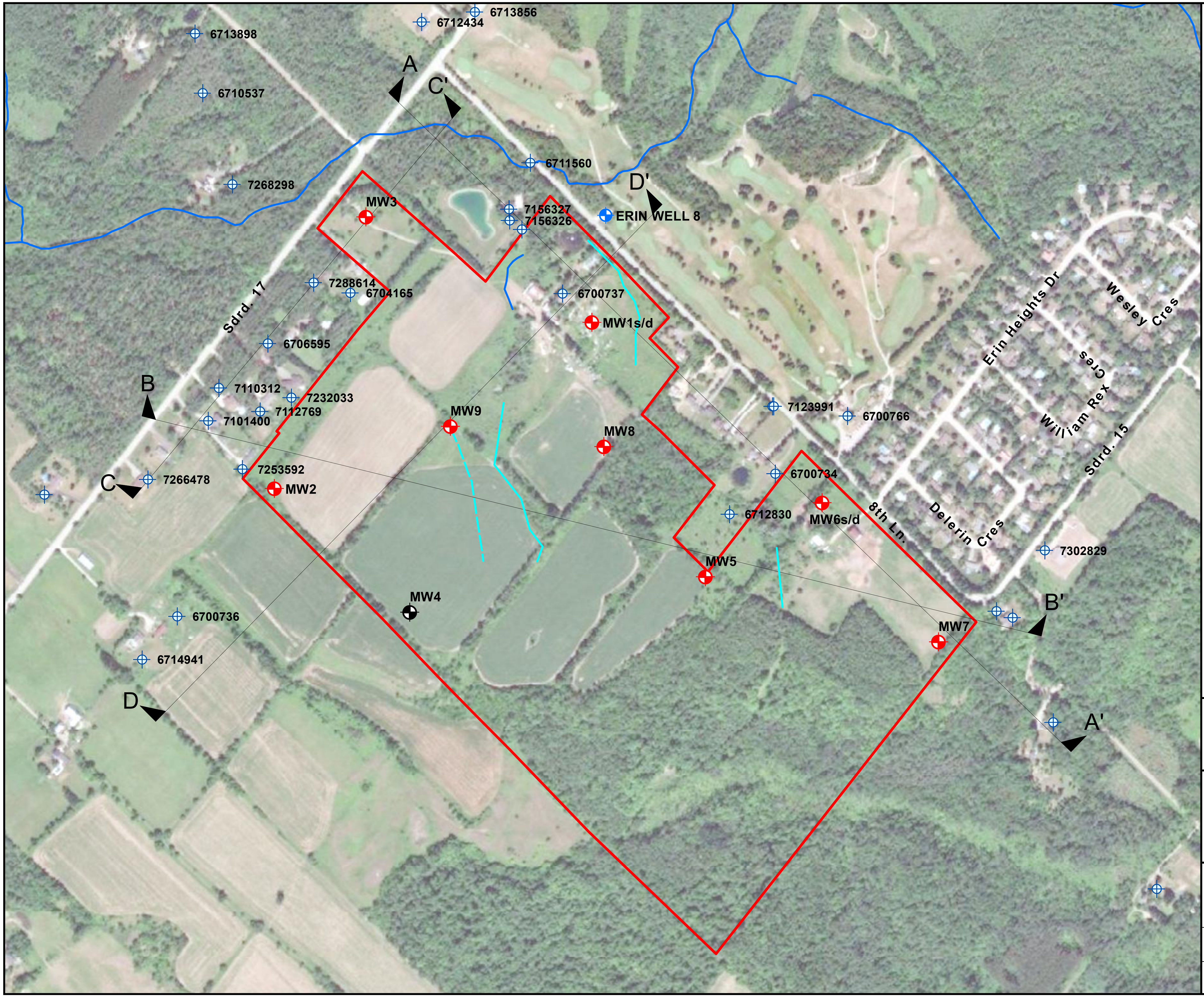

LEGEND

| | |
|---|---|
| ▭ | SUBJECT LANDS |
| - - | HEADWATER DRAINAGE FEATURE (HDF) |
| — | INTERMITTENT WATERCOURSE |
| — | PERMANENT WATERCOURSE |
| ⊕ | MONITORING WELL (RJB, 2021) |
| ⊕ | MONITORING WELL (SOURCE UNKNOWN) |
| ⊕ | MUNICIPAL SUPPLY WELL |
| ⊕ | MECP WELL RECORD LOCATION |
| ⌊ ⌋ | CROSS-SECTION LOCATION KEY |

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## WELL AND CROSS-SECTION LOCATIONS

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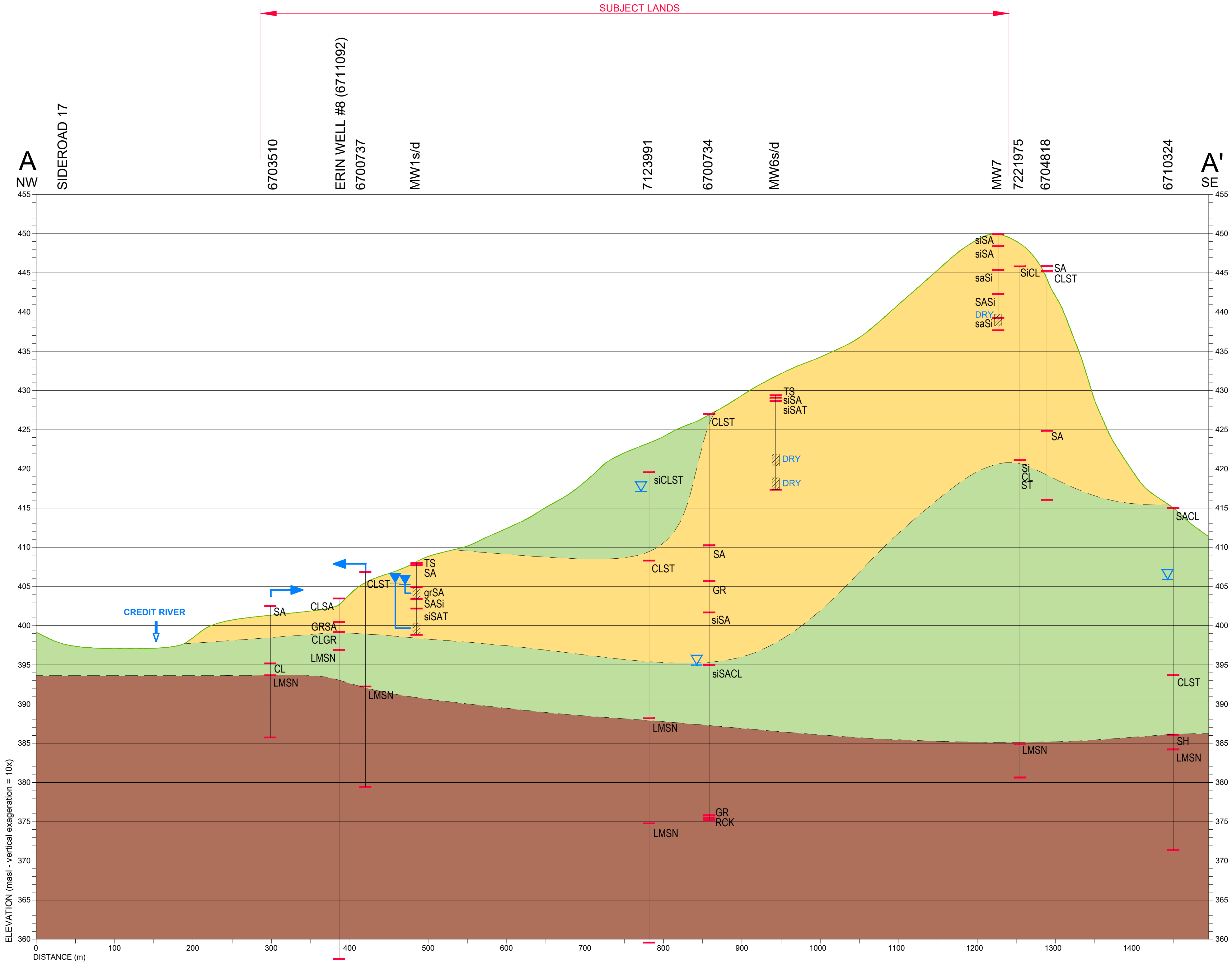

## LEGEND

BH1 WELL NUMBER / ID

EXISTING GROUND PROFILE

GEOLOGICAL CONTACT

▽ STATIC WATER LEVEL
(MECP WELL RECORD)

▼ MEASURED WATER LEVEL
(June 30, 2021)

▨ WELL SCREEN

| | |
|---|---|
| si | SILTY |
| sa | SANDY |
| gr | GRAVELLY |
| cl | CLAYEY |
| TS | TOPSOIL |
| LM | LOAM |
| F | FILL |
| T | TILL |
| GR | GRAVEL |
| SA | SAND |
| Si | SILT |
| CL | CLAY |
| ST | STONES |
| RCK | ROCK |
| LSMN | LIMESTONE |

– – – INTERPRETED BEDROCK SURFACE

🟨 SILT / SAND

🟩 CLAY / SILT / STONES

🟫 BEDROCK

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## INTERPRETED GEOLOGICAL CROSS-SECTION A-A'

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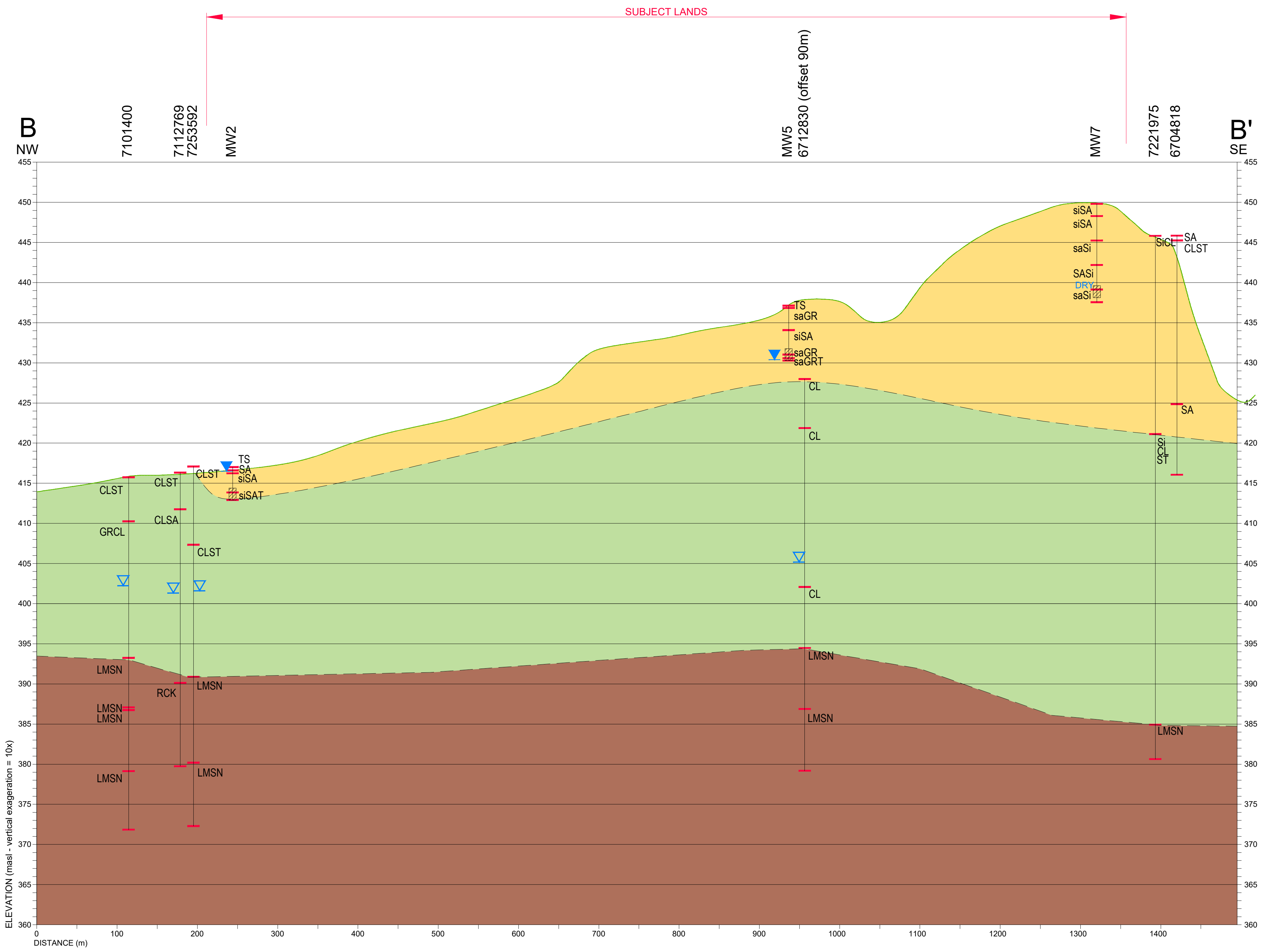

## LEGEND

BH1 WELL NUMBER / ID

EXISTING GROUND PROFILE

GEOLOGICAL CONTACT

▽ STATIC WATER LEVEL
(MECP WELL RECORD)

▼ MEASURED WATER LEVEL
(June 30, 2021)

▨ WELL SCREEN

| | |
|---|---|
| si | SILTY |
| sa | SANDY |
| gr | GRAVELY |
| cl | CLAYEY |
| TS | TOPSOIL |
| LM | LOAM |
| F | FILL |
| T | TILL |
| GR | GRAVEL |
| SA | SAND |
| Si | SILT |
| CL | CLAY |
| ST | STONES |
| RCK | ROCK |
| LSMN | LIMESTONE |

INTERPRETED BEDROCK SURFACE

🟨 SILT / SAND

🟩 CLAY / SILT / STONES

🟫 BEDROCK

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**INTERPRETED GEOLOGICAL CROSS-SECTION B-B'**

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| Scale | | Project No. | |
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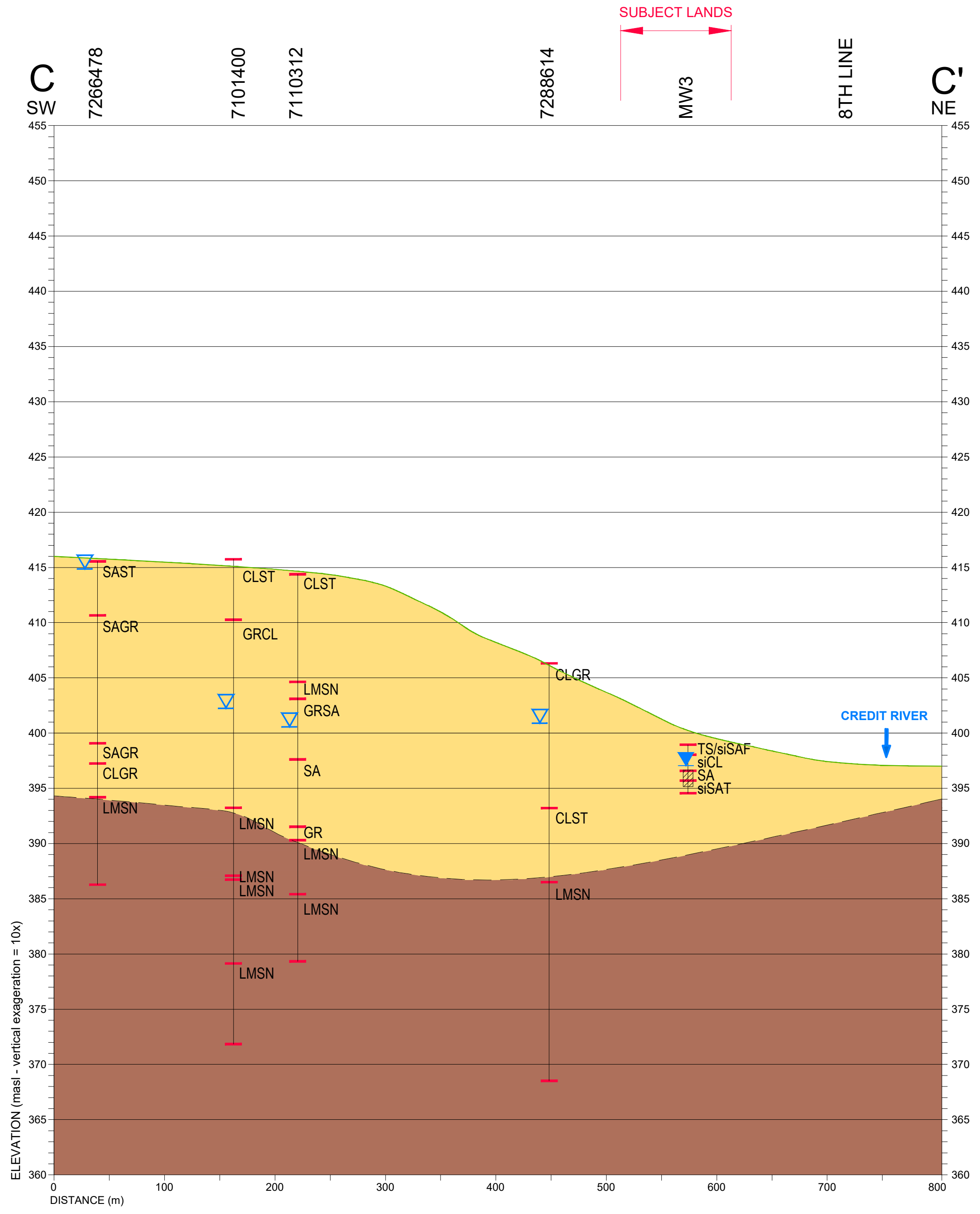

## LEGEND

| | |
|---|---|
| BH1 | WELL NUMBER / ID |
| | EXISTING GROUND PROFILE |
| | GEOLOGICAL CONTACT |
| ▽ | STATIC WATER LEVEL<br>(MECP WELL RECORD) |
| ▼ | MEASURED WATER LEVEL<br>(June 30, 2021) |
| ▨ | WELL SCREEN |

| | |
|---|---|
| si | SILTY |
| sa | SANDY |
| gr | GRAVELY |
| cl | CLAYEY |
| TS | TOPSOIL |
| LM | LOAM |
| F | FILL |
| T | TILL |
| GR | GRAVEL |
| SA | SAND |
| Si | SILT |
| CL | CLAY |
| ST | STONES |
| RCK | ROCK |
| LSMN | LIMESTONE |

| | |
|---|---|
| — — — | INTERPRETED BEDROCK SURFACE |
| 🟨 | SILT / SAND |
| 🟩 | CLAY / SILT / STONES |
| 🟫 | BEDROCK |

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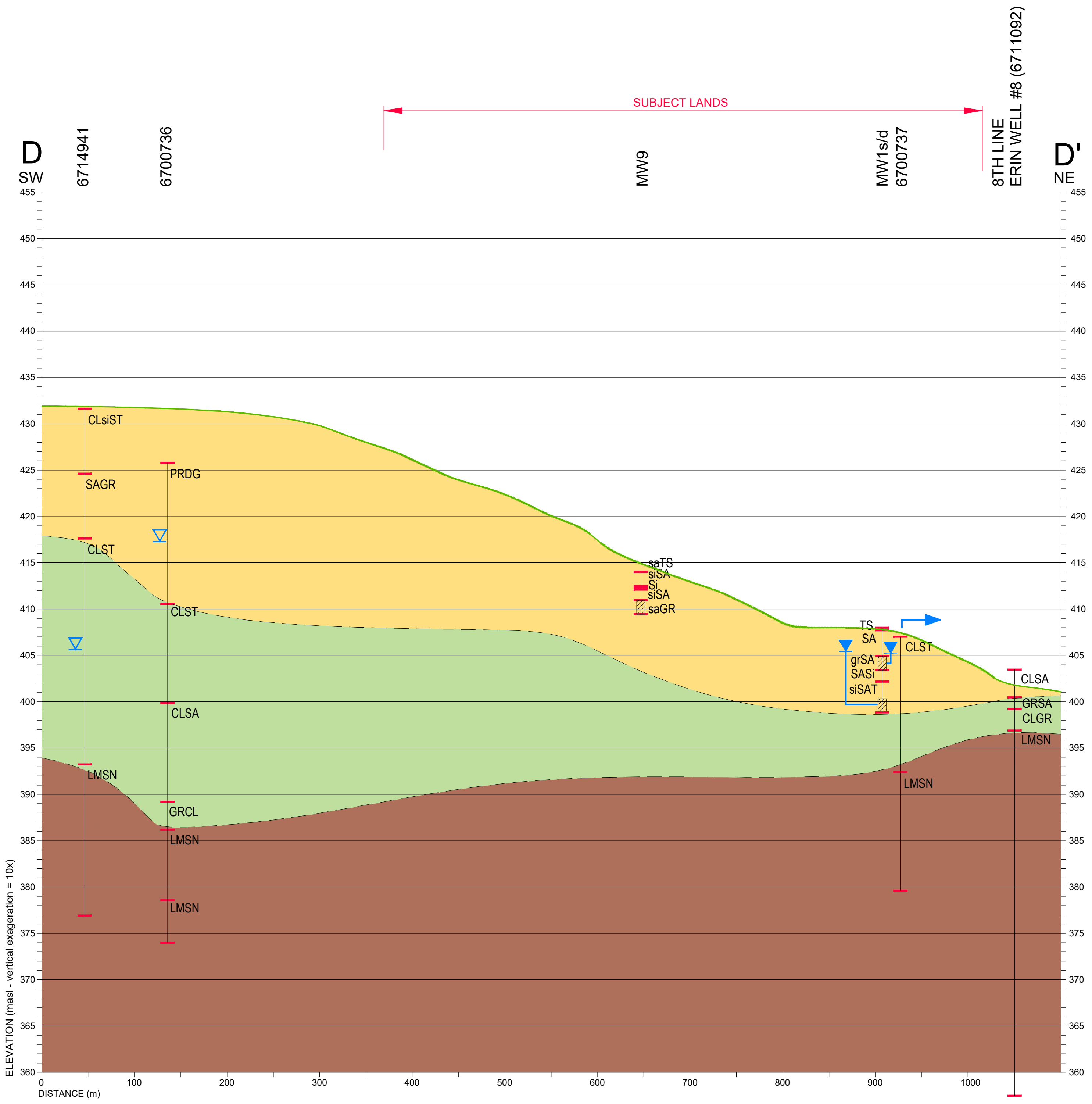
*LANGEN PROPERTY*

Figure Title

**INTERPRETED GEOLOGICAL**
**CROSS-SECTION C-C'**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | SC | OCTOBER 2023 | 9 |
| Scale | | Project No. | |
| 1:6,000 | | 300052075 | |

File Name:Nigel/Shared Work Areas/050344 Mattamy Erin/02_Production/ 052075 Cross-Sections.dwg Date Plotted: May 27, 2022 - 1:59 PM



## LEGEND

BH1 WELL NUMBER / ID

EXISTING GROUND PROFILE

GEOLOGICAL CONTACT

▽ STATIC WATER LEVEL (MECP WELL RECORD)

▼ MEASURED WATER LEVEL (June 30, 2021)

▨ WELL SCREEN

| | |
|---|---|
| si | SILTY |
| sa | SANDY |
| gr | GRAVELY |
| cl | CLAYEY |
| TS | TOPSOIL |
| LM | LOAM |
| F | FILL |
| T | TILL |
| GR | GRAVEL |
| SA | SAND |
| Si | SILT |
| CL | CLAY |
| ST | STONES |
| RCK | ROCK |
| LSMN | LIMESTONE |

— — — INTERPRETED BEDROCK SURFACE

🟨 SILT / SAND

🟩 CLAY / SILT / STONES

🟫 BEDROCK

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Figure Title

## INTERPRETED GEOLOGICAL CROSS-SECTION D-D'

| | | | |
|---|---|---|---|
| Drawn<br>SK | Checked<br>SC | Date<br>OCTOBER 2023 | Figure No.<br>10 |
| Scale<br>1:6,000 | | Project No.<br>300052075 | |

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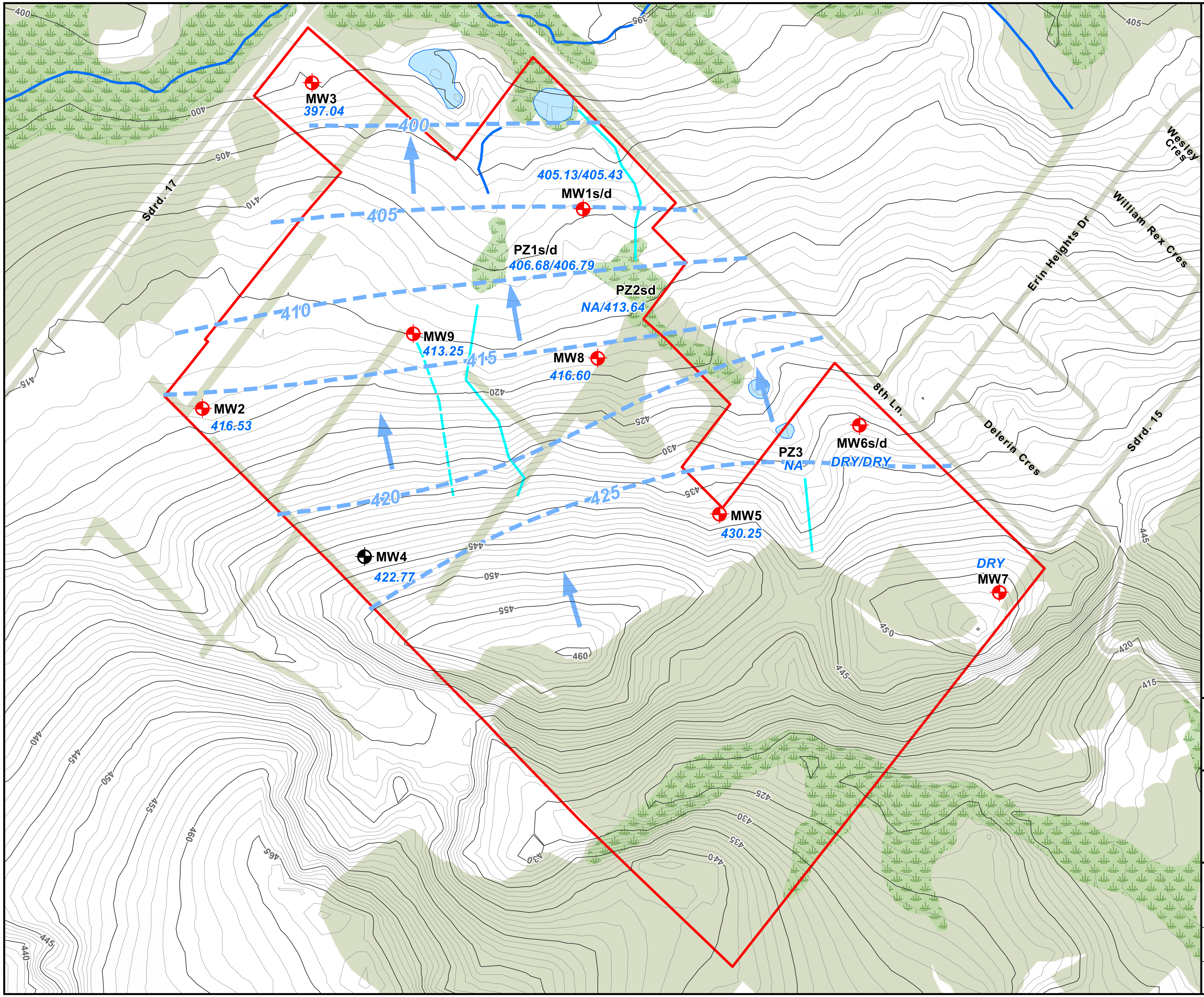

LEGEND

- 🟥 SUBJECT LANDS
- — CONTOUR (5m intervals - masl)
- — CONTOUR (1m intervals)
- ▬ ROADWAY
- - - HEADWATER DRAINAGE FEATURE (HDF)
- — INTERMITTENT WATERCOURSE
- — PERMANENET WATERCOURSE
- 🟦 OPEN WATER / POND
- ▨ WETLAND (MNRF, 2017)
- ▬ WOODED AREA
- ⊕ MONITORING WELL (RJB, 2021)
- ⊕ MONITORING WELL (SOURCE UNKNOWN)
- ● PIEZOMETER
- - - INTERPRETED GROUNDWATER CONTOUR (masl)
- → INTERPRETED GROUNDWATER FLOW DIRECTION
- 422.77 MEASURED WATER LEVEL (June 30, 2021)

Sources:

1. Ministry of Natural Resources, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.

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Figure Title

## INTERPRETED GROUNDWATER FLOW

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | SC | OCTOBER 2023 | 11 |
| Scale | | Project No. | |
| 1:5,000 | | 300052075 | |

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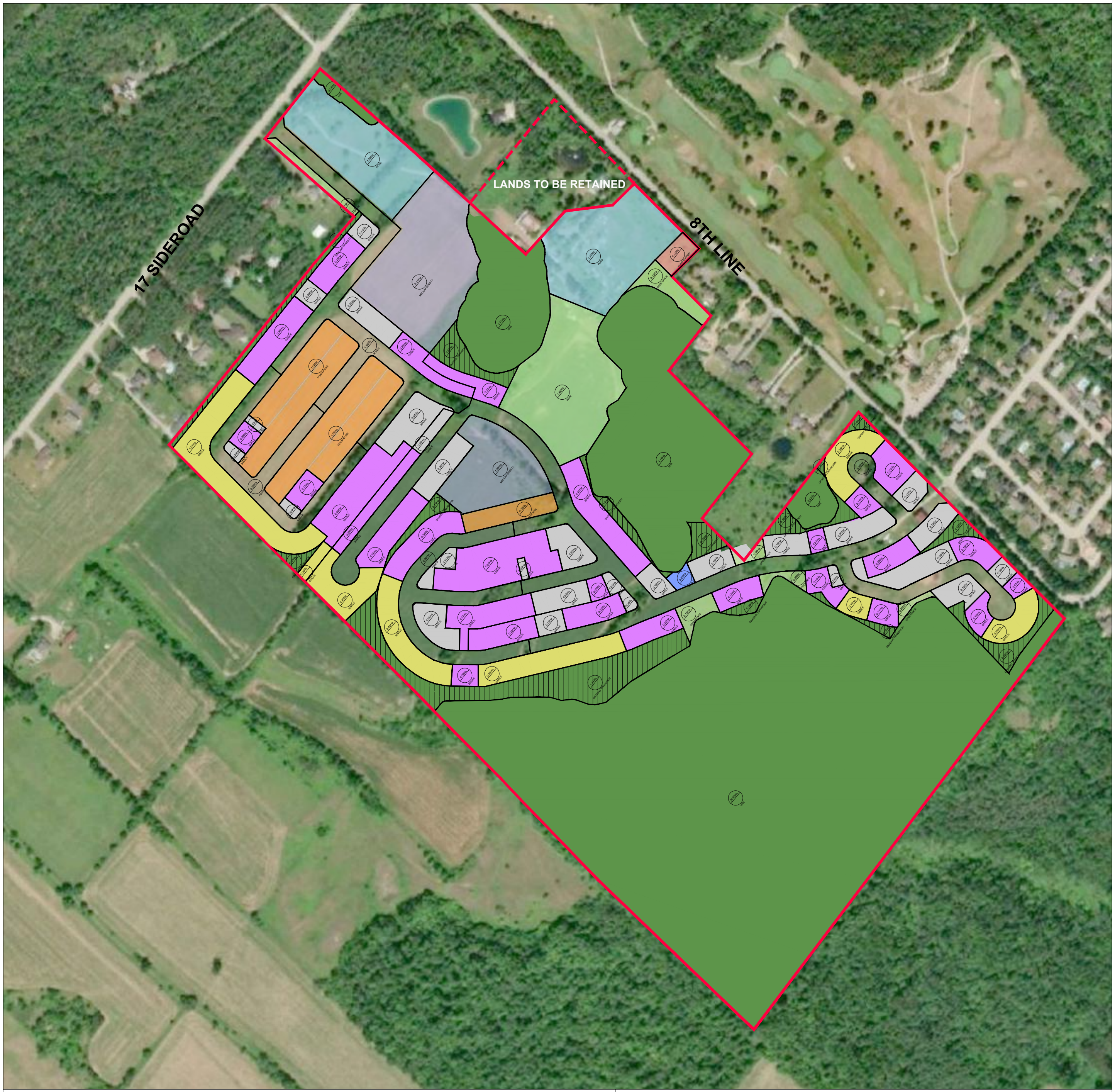

## LEGEND

- 🟥 SUBJECT LANDS
- 🟨 SINGLE
- 🟧 TOWNHOUSE
- 🟦 MEDIUM DENSITY
- 🟪 SINGLE
- ⬜ SINGLE
- 🟩 NATURAL HERITAGE SYSTEM
- ▨ GRADING TRANSITION

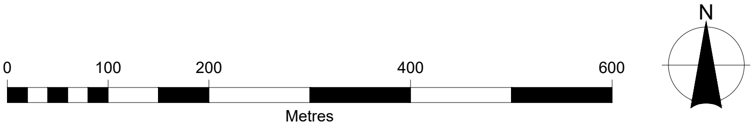

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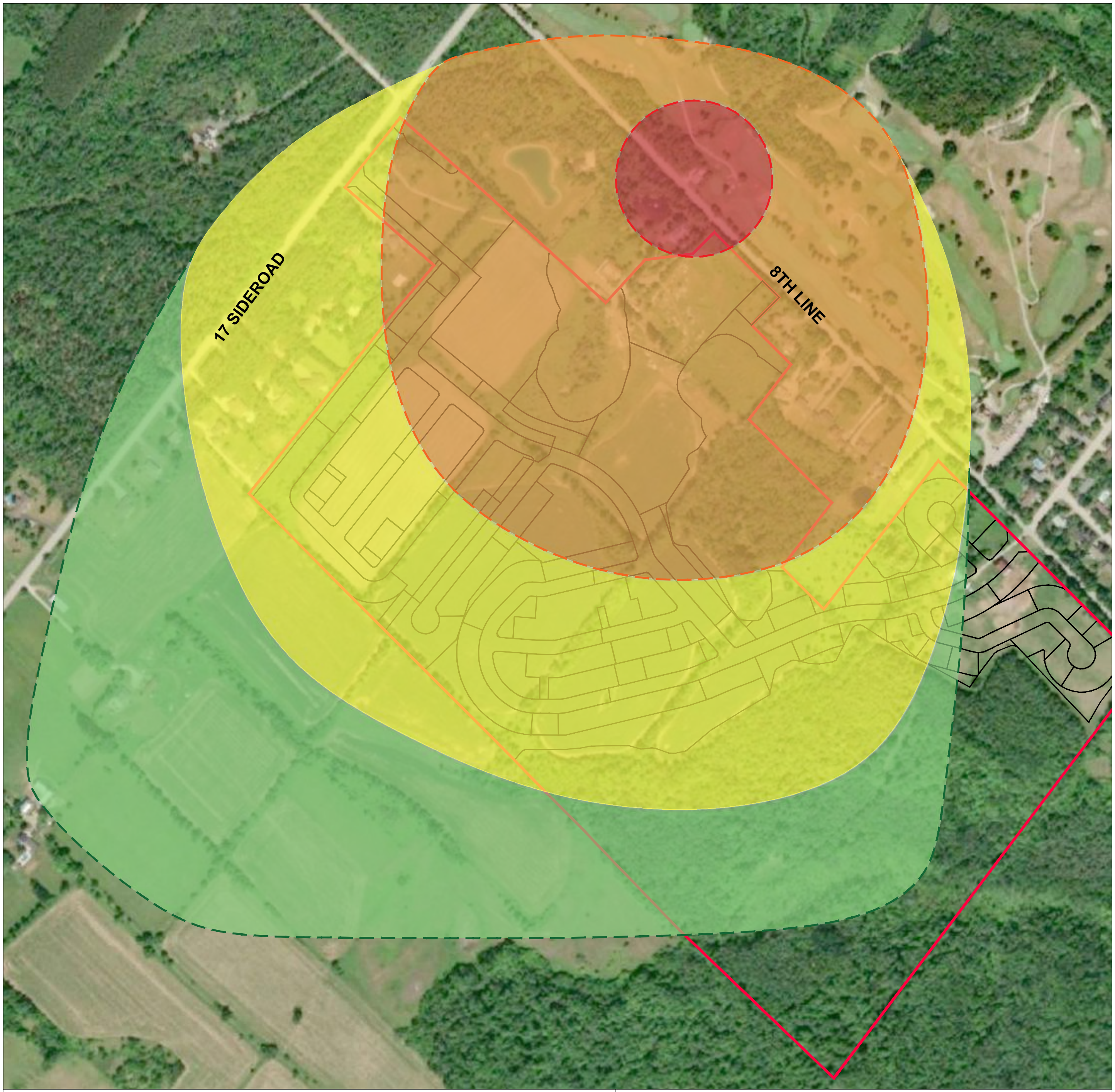
Figure Title

## POST-DEVELOPMENT LAND USE

Drawn SK
Checked SC
Date OCTOBER 2023
Figure No. 12
Scale 1:6,000
Project No. 300052075

File: Nigel\Shared Work Areas\A:\052075 Mattamy Erin\02_Production\052075 Source Protection Areas.dwg  Date Plotted: May 27, 2022 - 4:17 PM



## LEGEND

- ☐ SUBJECT LANDS
- 🟥 WHPA A : 100m RADIUS
- 🟧 WHPA B: 2 YEAR TIME OF TRAVEL
- 🟨 WHPA C: 2 TO 5 YEAR TIME OF TRAVEL
- 🟩 WHPA D: 5 TO 25 YEAR TIME OF TRAVEL

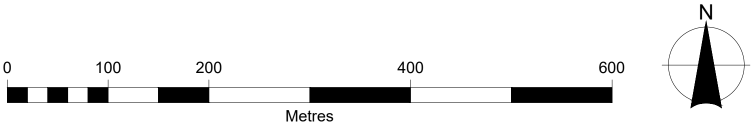


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Figure Title

## WELL HEAD PROTECTION AREAS

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | SC | OCTOBER 2023 | 13 |
| Scale | | Project No. | |
| 1:6,000 | | 300052075 | |

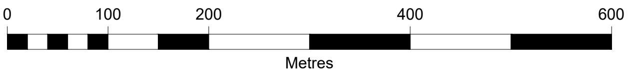
File: Nigel\Shared Work Areas\A:\052075 Mattamy Erin\02_Production\052075 Source Protection Areas.dwg Date Plotted: May 27, 2022 - 4:16 PM

## LEGEND

🟥 SUBJECT LANDS

🟨 HIGHLY VULNERABLE AQUIFER AREAS

▨ SIGNIFICANT GROUNDWATER RECHARGE AREAS



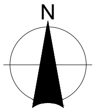


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Figure Title

**RECHARGE AREAS**

| | | | |
|---|---|---|---|
| Drawn<br>SK | Checked<br>SC | Date<br>OCTOBER 2023 | Figure No. |
| Scale<br>1:6,000 | | Project No.<br>300052075 | 14 |

File: Nigel\Shared Work Areas\A:\052075 Mattamy Erin\02_Production\052075 Source Protection Areas.dwg Date Plotted: May 27, 2022 - 4:15 PM

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# Appendix A

## MECP Well Records

| TOWNSHIP CON LOT | UTM | DATE CNTR | CASING DIA | WATER | PUMP TEST | WELL USE | SCREEN | WELL | FORMATION |
|---|---|---|---|---|---|---|---|---|---|
| ERIN TOWNSHIP CON 08 004 | 17 572737 4846553 W | 2008/07 2663 | 6.25 6.25 | FR 0115 | 45/48/20/1: | DO |  | 7110312 (Z83937) A056242 | BRWN CLAY STNS GRVL 0032 GREY LMSN LYRD 0037 BRWN GRVL SAND CLAY 0055 BRWN SAND 0075 GREY GRVL 0079 GREY LMSN FCRD 0095 GREY LMSN 0115 BRWN |
| ERIN TOWNSHIP CON 08 014 | 17 574227 4845480 W | 1987/06 3317 | 5 5 | FR 0130 | 27/35/14/1:15 | DO |  | 6708822 (09497) | BRWN CLAY SAND 0018 GREY CLAY 0053 GREY CLAY STNS 0079 BRWN ROCK 0104 GREY LMSN 0120 GREY LMSN PORS 0130 |
| ERIN TOWNSHIP CON 08 014 | 17 574239 4845516 W | 1987/08 3317 | 5 5 | FR 0130 | 26/35/10/1:30 | DO |  | 6709055 (18017) | BRWN SAND CLAY 0044 GREY CLAY STNS 0066 GREY ROCK 0075 GREY LMSN 0140 |
| ERIN TOWNSHIP CON 08 015 | 17 573987 4846191 W | 1973/07 4320 | 4 4 | FR 0098 | 27/35/8/3:30 | DO |  | 6704818 () | BRWN SAND 0002 BRWN CLAY STNS 0069 BLUE SNDS 0098 |
| ERIN TOWNSHIP CON 08 015 | 17 574214 4845763 W | 1973/09 4320 | 4 4 | FR 0105 | 8/9/4/10:0 | DO |  | 6704820 () | BRWN SAND 0019 BRWN CLAY SAND 0048 GREY CLAY STNS 0073 GREY LMSN 0105 GREY SNDS 0128 |
| ERIN TOWNSHIP CON 08 015 | 17 573852 4845291 W | 2010/05 7154 | 6.25 6 | FR 0181 | 88/90/15/1:0 | DO |  | 7150211 (Z107364) A084655 | BRWN SAND SILT 0021 BRWN CLAY SILT 0043 GREY CLAY STNS 0171 GREY LMSN 0182 |
| ERIN TOWNSHIP CON 08 015 | 17 574051 4846026 W | 1990/01 3317 | 5 5 | FR 0120 FR 0135 | 30/36/10/1:30 | DO |  | 6710324 (57343) | BRWN SAND CLAY 0070 GREY CLAY STNS 0095 GREY SHLE 0101 GREY LMSN 0143 |
| ERIN TOWNSHIP CON 08 016 | 17 573541 4846354 W | 1998/12 3317 | 6 6 | FR 0140 FR 0155 | 75/90/10/1:30 | DO |  | 6712830 (192048) | BRWN CLAY SAND 0020 GREY CLAY STNS SAND 0085 GREY CLAY STNS 0110 BRWN LMSN 0135 GREY LMSN 0160 |
| ERIN TOWNSHIP CON 08 016 | 17 573609 4846524 W | 2009/03 7154 | 4.25 4 | FR 0136 FR 0154 FR 0174 | 54//10/1:0 | MO |  | 7123991 (Z89737) A073328 | BRWN CLAY STNS SLTY 0037 GREY CLAY STNS 0103 BRWN LMSN 0147 GREY LMSN 0197 |
| ERIN TOWNSHIP CON 08 016 | 17 573613 4846418 W | 1963/08 2406 | 5 | FR 0170 | 105/110/10/6:30 | ST DO |  | 6700734 () | LOAM 0002 BRWN CLAY STNS 0055 FSND 0070 GRVL 0083 BRWN FSND SILT 0105 GREY FSND SILT CLAY 0168 GRVL 0169 GREY ROCK 0170 |
| ERIN TOWNSHIP CON 08 017 | 17 573214 4846803 W | 1969/07 3316 | 4 4 | FR 0049 | /20/20/1:0 | ST DO |  | 6703510 () | MSND GRVL 0024 CLAY 0029 GREY LMSN 0055 |
| ERIN TOWNSHIP CON 08 017 | 17 572944 4846703 W | 1971/09 3316 | 4 4 | FR 0116 | 15/24/8/1:0 | DO |  | 6704165 () | CLAY STNS GRVL 0056 GREY LMSN CLAY 0075 GREY LMSN 0120 |
| ERIN TOWNSHIP CON 08 017 | 17 572814 4846623 W | 1977/08 3317 | 5 5 | FR 0105 | 22/30/9/3:0 | DO |  | 6706595 () | CLAY STNS 0070 GREY LMSN 0116 |
| ERIN TOWNSHIP CON 08 017 | 17 573278 4846702 W | 1967/12 3316 | 4 4 | FR 0085 | /0/5/: | ST DO |  | 6700737 () | CLAY STNS 0048 GREY LMSN 0090 |
| ERIN TOWNSHIP CON 08 017 | 17 572873 4846310 L | 2001/11 7154 | 6 6 | FR 0076 | 6/34/10/3: | DO |  | 6713898 (238263) | BRWN SAND 0031 BRWN LMSN 0042 GREY LMSN 0080 |

| TOWNSHIP CON LOT | UTM | DATE CNTR | CASING DIA | WATER | PUMP TEST | WELL USE | SCREEN | WELL | FORMATION |
|---|---|---|---|---|---|---|---|---|---|
| ERIN TOWNSHIP CON 08 017 | 17 573227 4846908 W | 1994/09 2663 | 8 8 | FR 0050 FR 0060 FR 0078 FR 0103 | 7/40/40/1: | DO | | 6711560 (141439) | LOAM 0001 BRWN SAND CLAY STNS 0029 GREY LMSN 0103 |
| ERIN TOWNSHIP CON 08 017 | 17 572462 4846385 W | 1995/06 3317 | 6 6 | FR 0100 | 43/55/10/1:30 | DO | | 6711737 (158302) | GRVL STNS 0010 BRWN CLAY STNS 0016 GREY CLAY STNS SAND 0078 GREY LMSN 0115 |
| ERIN TOWNSHIP CON 08 017 | 17 572671 4846193 W | 1961/01 2414 | 4 4 | FR 0160 | 28/40/10/1:0 | DO | | 6700736 () | PRDG 0050 GREY CLAY BLDR 0085 CLAY FSND 0120 GRVL CLAY 0130 GREY LMSN 0155 BLCK LMSN 0170 |
| ERIN TOWNSHIP CON 08 017 | 17 573194 4846835 W | 7407 | 1.97 | | | DO | | 7156327 (Z50894) A095369 | |
| ERIN TOWNSHIP CON 08 017 | 17 572616 4846125 W | 2004/06 7154 | 6.21 | FR 0142 FR 0176 | 85/115/12/2:0 | DO | | 6714941 (Z06940) A006855 | BRWN CLAY SILT STNS 0023 GREY SAND GRVL 0046 GREY CLAY STNS 0126 GREY LMSN 0180 |
| ERIN TOWNSHIP CON 08 017 | 17 572720 4846501 W | 2008/01 2663 | 15.6 | FR 0044 | 45/48/15/1:0 | DO | | 7101400 (Z79473) A056198 | BRWN CLAY STNS 0018 BRWN GRVL CLAY STNS 0074 GREY LMSN FCRD 0094 GREY LMSN 0095 LMSN 0120 LMSN DKCL 0144 |
| ERIN TOWNSHIP CON 08 017 | 17 572886 4846719 W | 2017/05 7154 | 6.25 6 | FR 0018 | 18/61/10/1: | DO | | 7288614 (Z250142) A205311 | BRWN CLAY GRVL 0043 GREY CLAY STNS 0065 BRWN LMSN 0124 |
| ERIN TOWNSHIP CON 08 017 | 17 572802 4846516 W | 2008/09 7385 | 6.11 6.11 | FR 0012 | 49/66/12/1:0 | DO | | 7112769 (Z80651) A066875 | BRWN CLAY STNS 0015 GREY CLAY SAND GRVL 0086 GREY ROCK 0120 |
| ERIN TOWNSHIP CON 08 017 | 17 572625 4846409 W | 2016/06 2576 | 6 6 | FR 0080 FR 0091 | 4/9/6/1: | DO | | 7266478 (Z227731) A202051 | BRWN SAND STNS 0016 BRWN SAND GRVL 0054 GREY SAND GRVL 0060 BRWN CLAY GRVL 0076 GREY LMSN 0096 |
| ERIN TOWNSHIP CON 08 017 | 17 573195 4846817 W | 2010/11 7407 | 14.1 | | 62///: | DO | | 7156326 (Z50895) A | |
| ERIN TOWNSHIP CON 08 017 | 17 572774 4846425 W | 2015/11 7154 | 6.25 6 | | 51/71/10/1: | DO | | 7253592 (Z220234) A173691 | BRWN CLAY STNS 0032 GREY CLAY STNS 0086 BRWN LMSN 0121 GREY LMSN 0147 |
| ERIN TOWNSHIP CON 08 017 | 17 572851 4846538 W | 2014/10 7154 | 6.25 6 | FR 0116 | 47/61/20/1: | DO | | 7232033 (Z197982) A146175 | BRWN SILT CLAY STNS 0028 GREY CLAY STNS 0075 BRWN LMSN 0122 |
| ERIN TOWNSHIP CON 08 018 | 17 572758 4846874 W | 2016/05 7407 | 6 | | | DO | | 7268298 (Z216896) A161195 | |
| ERIN TOWNSHIP CON 08 018 | 17 572357 4846270 W | 2012/08 7154 | 6.25 6 | FR 0087 | 28/48/10/1:0 | DO | | 7185587 (Z152157) A125535 | BRWN CLAY STNS GRVL 0021 GREY CLAY STNS 0069 BRWN LMSN 0092 |
| ERIN TOWNSHIP CON 08 018 | 17 572489 4847289 W | 1987/07 3317 | 5 5 | FR 0059 | ///: | DO | | 6709062 (09525) | BRWN SAND CLAY GRVL 0028 GREY CLAY 0035 CLAY STNS 0047 GREY LMSN 0061 |

| TOWNSHIP CON LOT | UTM | DATE CNTR | CASING DIA | WATER | PUMP TEST | WELL USE | SCREEN | WELL | FORMATION |
|---|---|---|---|---|---|---|---|---|---|
| ERIN TOWNSHIP CON 08 018 | 17 572711 4847018 W | 1990/08 3317 | 6 6 | FR 0059 | //10/1:30 | DO | | 6710537 (57467) | BRWN CLAY STNS SAND 0008 GREY CLAY STNS 0032 GREY LMSN 0061 |
| ERIN TOWNSHIP CON 09 | 17 574038 4846297 W | 2017/11 7154 | 6.23 6 | FR 0217 | 112/138/10/1: | DO | | 7302829 (Z270833) A219404 | BRWN SILT CLAY 0034 GREY CLAY SILT 0127 GREY CLAY STNS 0190 BRWN LMSN 0222 |
| ERIN TOWNSHIP CON 09 017 | 17 573350 4847367 W | 1985/07 2332 | 5 5 | FR 0120 | 24/28/12/2:0 | IN | | 6708395 () | BRWN LOAM SAND GRVL 0017 BRWN CLAY STNS 0032 GREY CLAY STNS 0052 GREY LMSN 0165 |
| ERIN TOWNSHIP CON 09 018 | 17 573140 4847146 W | 2001/09 7154 | 6 | FR 0106 | /3/15/1: | DO | | 6713856 (235936) | BRWN GRVL STNS 0036 GREY GRVL TILL STNS 0055 GREY LMSN 0100 BRWN LMSN LYRD 0110 |
| ERIN TOWNSHIP CON 09 018 | 17 573611 4846524 W | 2009/03 7154 | 4.25 4 | FR 0087 FR 0101 FR 0112 | 8/9/10/1:0 | MO | | 7123992 (Z89738) A073327 | BRWN CLAY STNS SLTY 0027 GREY CLAY STNS 0032 BRWN LMSN 0117 GREY LMSN 0150 |
| ERIN TOWNSHIP CON 09 018 | 17 573056 4847130 W | 1997/09 3317 | 6 6 | FR 0124 | 0/5/10/1:30 | DO | | 6712434 (181348) | FILL 0003 BRWN CLAY GRVL BLDR 0025 CLAY BLDR 0042 BRWN LMSN 0079 GREY LMSN 0125 |
| ERIN TOWNSHIP CON 08 017 | 17 573962 4846201 W | 2014/04 7154 | 6.25 6 | FR 0212 | 130/135/10/1:0 | DO | | 7221975 (Z181424) A133138 | BRWN SILT CLAY 0081 GREY SILT CLAY STNS 0200 BRWN LMSN 0214 |
| ERIN VILLAGE | 17 574403 4846376 W | 2017/12 7407 | 5 | | | DO | | 7310912 (Z247313) A161179 | |
| ERIN VILLAGE | 17 573727 4846509 W | 1963/04 3316 | 4 4 | FR 0217 | 53/55/10/2:0 | CO | | 6700766 () | CLAY STNS 0138 GREY LMSN 0218 |

Notes:

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

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

## 1. Core Material and Descriptive terms

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

## 2. Core Color

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

## 3. Well Use

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

## 4. Water Detail

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

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# Appendix B

# Borehole Logs

# LOG OF DRILLING OPERATIONS

## MW1d

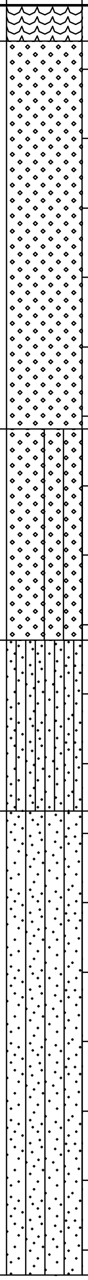
BURNSIDE
R.J. Burnside & Associates Limited
292 Speedvale Avenue West, Unit 20, Guelph, Ontario, N1H 1C4
telephone (519) 823-4995 fax (519) 836-5447

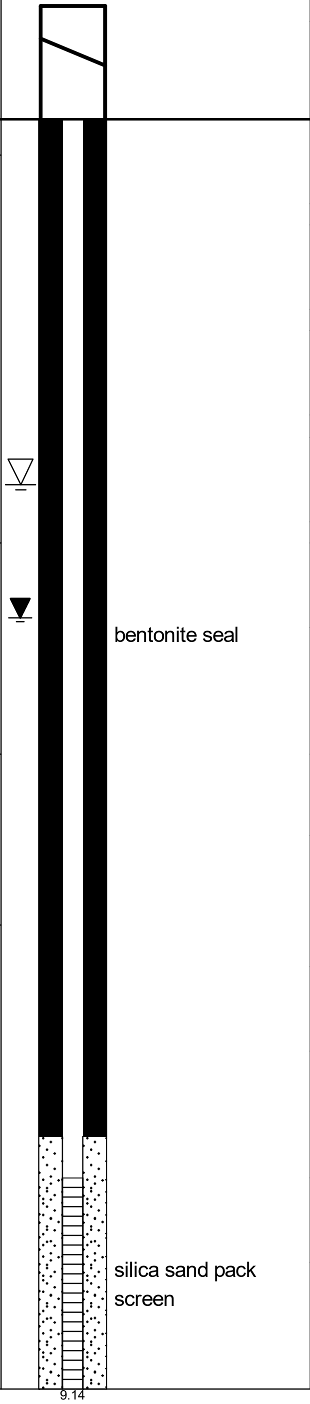
| | | |
|---|---|---|
| Client: **Mattamy Homes** | Project Name: **Hydrogeological Study** | Logged by: **E. Pentney** |
| Project No.: **300052075.0002** | Location: **Erin, ON** | Ground (m amsl): **408.46** |
| Drilling Co.: **Orbit Garant Drilling** | Date Started: **5/5/2021** | Static Water Level Depth (m): **2.63** |
| Drilling Method: **Hollow Stem Auger** | Date Completed: **5/5/2021** | Sand Pack Depth (m) : **7.3 - 9.1** |

Surface Elevation (m): **408.46**

| Stratigraphic Description | Elev. / Depth (m) |
|---|---|
| TOPSOIL<br>brown, moist | 408.20<br>0.26 |
| SAND<br>brown, compact, well-graded sands, some gravel, trace silt, moist<br>layering of medium sand @ 0.78 m<br>layering of medium sand @ 2.3 m<br>saturated by 2.4 m | 405.41<br>3.05 |
| GRAVELLY SAND<br>grey-brown, compact, well-graded sand, sub-angular gravel, some silt, saturated | 403.89<br>4.57 |
| SAND AND SILT<br>reddish-grey, dense, medium to fine sand, some gravel, trace clay, slightly plastic, wet | 402.66<br>5.80 |
| SILTY SAND TILL<br>reddish-grey, dense, medium to fine sand, silt, some gravel, trace clay, wet<br>grading finer sand/siltier @ 7.6 m<br>consistent drilling to 9.1 m<br>no sample recovered at 9.1 m due to rock in split spoon | 399.32<br>9.14 |

End of Borehole





SAMPLE

| Num. | Type | Int. | N.Val |
|---|---|---|---|
| 1 | SS | ☒ | 5 |
| 2 | SS | ☒ | 45 |
| 3 | SS | ☒ | 29 |
| 4 | SS | ☒ | 41 |
| 5 | SS | ☒ | 57 |
| 6 | SS | ☒ | 4 |
| 7 | SS | ☒ | 61 |
| 8 | SS | ☒ | >50 |

Prepared By: **J. Donkersgoed** Checked By: **S. Charity** Date Prepared: **5/15/2021**

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 - 5/21/2021

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

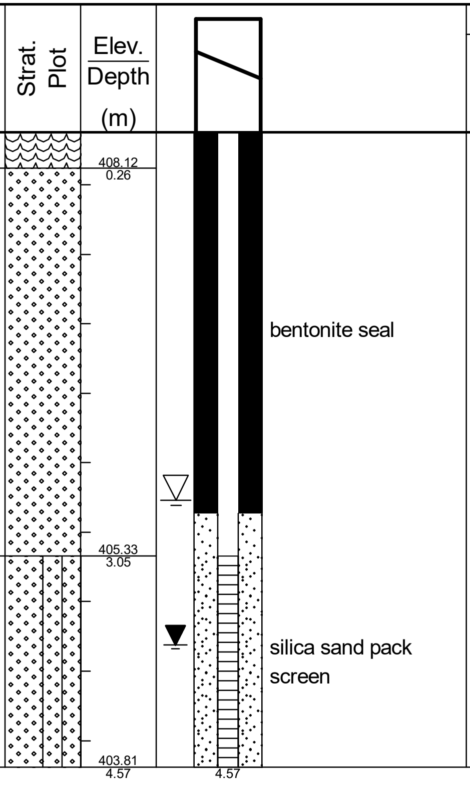
## MW1s

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

Page 1 of 1

| | | |
|---|---|---|
| Client: **Mattamy Homes** | Project Name: **Hydrogeological Study** | Logged by: **E. Pentney** |
| Project No.: **300052075.0002** | Location: **Erin, ON** | Ground (m amsl): **408.38** |
| Drilling Co.: **Orbit Garant Drilling** | Date Started: **5/5/2021** | Static Water Level Depth (m): **2.65** |
| Drilling Method: **Hollow Stem Auger** | Date Completed: **5/5/2021** | Sand Pack Depth (m) : **2.7 - 4.6** |

| Stratigraphic Description<br>Surface Elevation (m): **408.38** | Elev.<br>Depth<br>(m) | Num. | Type | Int. | N.Val |
|---|---|---|---|---|---|
| TOPSOIL<br>brown, moist | 408.12<br>0.26 | | | | |
| SAND<br>brown, compact, well-graded sands, some gravel, trace silt, moist<br>layering of medium sand @ 0.78 m<br>layering of medium sand @ 2.3 m<br>saturated by 2.4 m | 405.33<br>3.05 | | | | |
| GRAVELLY SAND<br>grey-brown, compact, well-graded sand, sub-angular gravel, some silt, saturated | 403.81<br>4.57 | | | | |
| End of Borehole | | | | | |



Prepared By: **J. Donkersgoed** Checked By: **S. Charity** Date Prepared: **5/15/2021**

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LEGEND
- ▼ Water found @ time of drilling
- ▽ Static Water Level - 5/21/2021

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

SAMPLE TYPE

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

# LOG OF DRILLING OPERATIONS

**MW2**

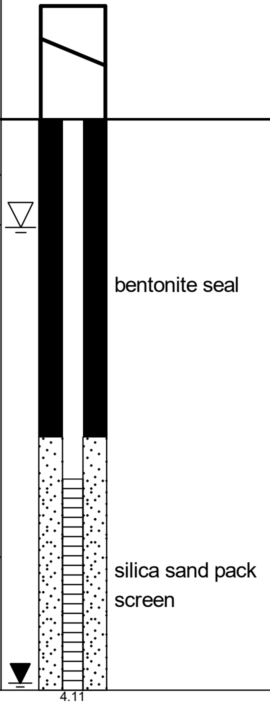
R.J. Burnside & Associates Limited
292 Speedvale Avenue West, Unit 20, Guelph, Ontario, N1H 1C4
telephone (519) 823-4995 fax (519) 836-5447

Page 1 of 1

| | | |
|---|---|---|
| Client: **Mattamy Homes** | Project Name: **Hydrogeological Study** | Logged by: **E. Pentney** |
| Project No.: **300052075.0002** | Location: **Erin, ON** | Ground (m amsl): **417.38** |
| Drilling Co.: **Orbit Garant Drilling** | Date Started: **5/6/2021** | Static Water Level Depth (m): **0.78** |
| Drilling Method: **Hollow Stem Auger** | Date Completed: **5/6/2021** | Sand Pack Depth (m) : **2.3 - 4.1** |

Surface Elevation (m): **417.38**

| Stratigraphic Description | Elev. / Depth (m) |
|---|---|
| TOPSOIL<br>dark brown, wet | 416.98<br>0.40 |
| SAND<br>reddish-brown, compact, medium to fine grained, massive, moist | 416.62<br>0.76 |
| SILTY SAND<br>reddish-brown, compact, coarse to fine grained, trace gravel, trace clay, wet<br>grading finer sand/siltier, saturated by 2.7 m | 414.23<br>3.15 |
| SILTY SAND TILL<br>grey, very dense, course to fine grained sands, some sub-angular gravel, trace clay, limestone pieces, moist | 413.27<br>4.11 |
| End of Borehole | |



SAMPLE

| Num. | Type | Int. | N.Val |
|---|---|---|---|
| 1 | SS | ☒ | <1 |
| 2 | SS | ☒ | 8 |
| 3 | SS | ☒ | 4 |
| 4 | SS | ☒ | 25 |
| 5 | SS | ☒ | 75 |

Depth Scale (ft): 5.0, 10.0
Depth Scale (m): 1.0, 2.0, 3.0, 4.0

Prepared By: **J. Donkersgoed** Checked By: **S. Charity** Date Prepared: **5/15/2021**

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LEGEND
▼ Water found @ time of drilling
▽ Static Water Level - 5/21/2021

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

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

BURNSIDE

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292 Speedvale Avenue West, Unit 20, Guelph, Ontario, N1H 1C4
telephone (519) 823-4995 fax (519) 836-5447

# LOG OF DRILLING OPERATIONS

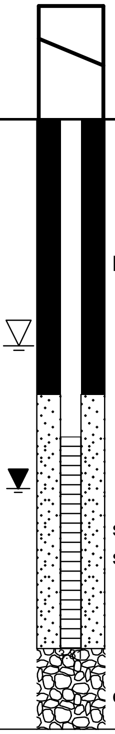
## MW3

Page 1 of 1

| | | |
|---|---|---|
| Client: **Mattamy Homes** | Project Name: **Hydrogeological Study** | Logged by: **J. Donkersgoed** |
| Project No.: **300052075.0002** | Location: **Erin, ON** | Ground (m amsl): **399.29** |
| Drilling Co.: **Orbit Garant Drilling** | Date Started: **5/7/2021** | Static Water Level Depth (m): **1.63** |
| Drilling Method: **Hollow Stem Auger** | Date Completed: **5/7/2021** | Sand Pack Depth (m) : **2.0 - 3.8** |

Surface Elevation (m): **399.29**

| Stratigraphic Description | Elev. / Depth (m) |
|---|---|
| TOPSOIL<br>brown, wet | 399.17<br>0.13 |
| SILTY SAND FILL<br>brown, loose, some gravel, trace clay, occasional organics, moist to wet | 398.38<br>0.91 |
| SILTY CLAY<br>blue-black mottled, soft, occasional organic pockets, trace gravel, plastic, moist to wet | 396.94<br>2.35 |
| SAND<br>brown, compact, medium sand, trace gravel, trace to some silt, saturated<br>grading to silty sand, trace clay @ 2.6m<br>some gravel, layered @ 3.0m | 396.04<br>3.25 |
| SILTY SAND TILL<br>reddish-grey, very dense, some gravel, trace clay, occasional rust, limestone pieces, moist | 394.90<br>4.39 |
| End of Borehole | |



| Num. | Type | Int. | N.Val |
|---|---|---|---|
| 1 | SS | ☒ | 5 |
| 2 | SS | ☒ | 4 |
| 3 | SS | ☒ | 3 |
| 4 | SS | ☒ | 27 |
| 5 | SS | ☒ | 56 |
| 6 | SS | ☒ | 85 |

Prepared By: **J. Donkersgoed** Checked By: **S. Charity** Date Prepared: **5/15/2021**

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LEGEND
▼ Water found @ time of drilling
▽ Static Water Level - 5/21/2021

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

## MW5

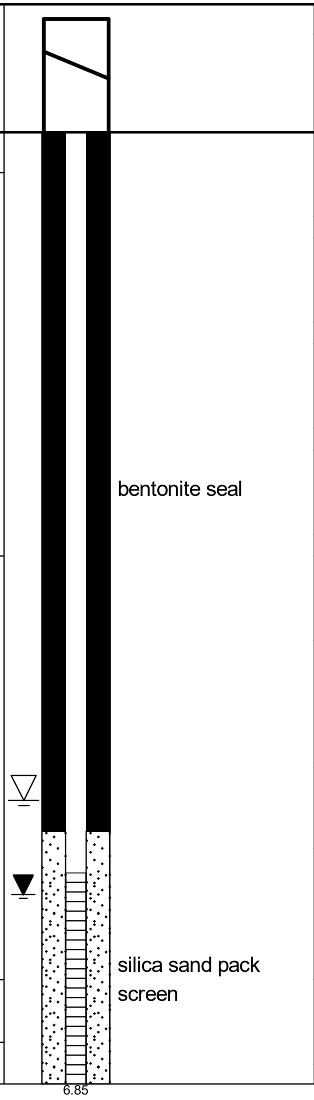
R.J. Burnside & Associates Limited
292 Speedvale Avenue West, Unit 20, Guelph, Ontario, N1H 1C4
telephone (519) 823-4995 fax (519) 836-5447

Page 1 of 1

| | | |
|---|---|---|
| Client: **Mattamy Homes** | Project Name: **Hydrogeological Study** | Logged by: **E. Pentney** |
| Project No.: **300052075.0002** | Location: **Erin, ON** | Ground (m amsl): **437.26** |
| Drilling Co.: **Orbit Garant Drilling** | Date Started: **5/6/2021** | Static Water Level Depth (m): **4.81** |
| Drilling Method: **Solid Stem Auger** | Date Completed: **5/6/2021** | Sand Pack Depth (m) : **5.1 - 6.9** |

Surface Elevation (m): **437.26**

| Stratigraphic Description | Elev. / Depth (m) |
|---|---|
| TOPSOIL<br>brown, moist | 436.97<br>0.29 |
| SANDY GRAVEL<br>brown, compact, well-graded sand, sub-angular gravel, trace silt, moist | 434.21<br>3.05 |
| SILTY SAND<br>brown, compact to dense, medium to fine sand, some gravel, massive, moist | 431.16<br>6.10 |
| SANDY GRAVEL<br>grey, compact, well-graded sand, sub-angular gravel, trace silt, wet | 430.71<br>6.55 |
| SANDY GRAVEL TILL<br>grey-brown, dense, well-graded sand, sub-angular gravel, limestone pieces, some silt, moist | 430.41<br>6.85 |
| End of Borehole | |



| Num. | Type | Int. | N.Val |
|---|---|---|---|
| 1 | SS | ☒ | 8 |
| 2 | SS | ☒ | 10 |
| 3 | SS | ☒ | 20 |
| 4 | SS | ☒ | 21 |
| 5 | SS | ☒ | 24 |
| 6 | SS | ☒ | >50 |
| 7 | SS | ☒ | 74 |

Prepared By: **J. Donkersgoed** Checked By: **S. Charity** Date Prepared: **5/15/2021**

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LEGEND
▼ Water found @ time of drilling
▽ Static Water Level - 5/21/2021

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

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

# LOG OF DRILLING OPERATIONS

## MW6d

Page 1 of 2

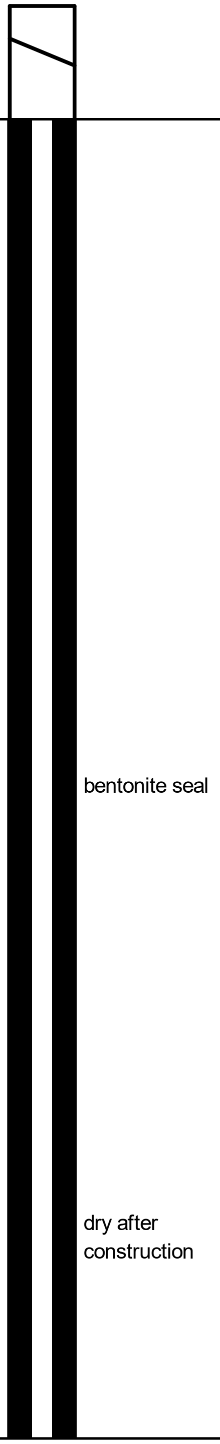
BURNSIDE
R.J. Burnside & Associates Limited
292 Speedvale Avenue West, Unit 20, Guelph, Ontario, N1H 1C4
telephone (519) 823-4995 fax (519) 836-5447

| | | |
|---|---|---|
| Client: **Mattamy Homes** | Project Name: **Hydrogeological Study** | Logged by: **J. Donkersgoed** |
| Project No.: **300052075.0002** | Location: **Erin, ON** | Ground (m amsl): **430.29** |
| Drilling Co.: **Orbit Garant Drilling** | Date Started: **5/4/2021** | Static Water Level Depth (m): **Dry** |
| Drilling Method: **Hollow Stem Auger** | Date Completed: **5/4/2021** | Sand Pack Depth (m) : **10.0 - 12.0** |

Stratigraphic Description

Surface Elevation (m): **430.29**

| Stratigraphic Description | Elev. / Depth (m) |
|---|---|
| TOPSOIL<br>dark brown, moist | 429.99<br>0.30 |
| SILTY SAND<br>brown, loose, moist<br>organics | 429.53<br>0.76 |
| SILTY SAND TILL<br>brown, fine to medium sand, some gravel, trace clay, loose to very dense, moist<br>occasional cobble<br>grading finer sand/siltier @ 1.8m<br>grading finer sand/siltier, trace gravel @ 5.0m | |



SAMPLE

| Num. | Type | Int. | N.Val |
|---|---|---|---|
| 1 | SS | ☒ | 4 |
| 2 | SS | ☒ | 12 |
| 3 | SS | ☒ | 5 |
| 4 | SS | ☒ | 45 |
| 5 | SS | ☒ | 58 |
| 6 | SS | ☒ | 72 |
| 7 | SS | ☒ | 64 |
| 8 | SS | ☒ | 90 |
| 9 | SS | ☒ | 97 |

Prepared By: **J. Donkersgoed** Checked By: **S. Charity** Date Prepared: **5/15/2021**

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LEGEND
▼ Water found @ time of drilling
▽ Static Water Level - 5/21/2021

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

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

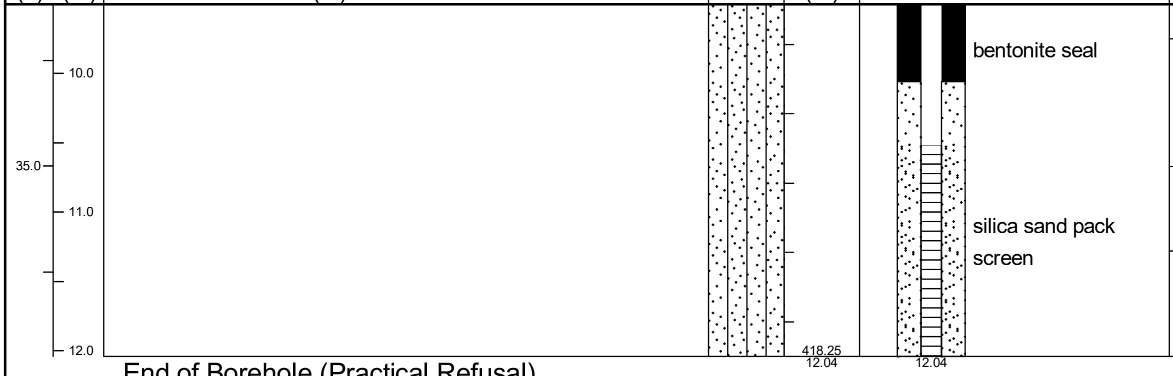
# LOG OF DRILLING OPERATIONS

## MW6d

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

| | | |
|---|---|---|
| Client: **Mattamy Homes** | Project Name: **Hydrogeological Study** | Logged by: **J. Donkersgoed** |
| Project No.: **300052075.0002** | Location: **Erin, ON** | Ground (m amsl): **430.29** |
| Drilling Co.: **Orbit Garant Drilling** | Date Started: **5/4/2021** | Static Water Level Depth (m): **Dry** |
| Drilling Method: **Hollow Stem Auger** | Date Completed: **5/4/2021** | Sand Pack Depth (m) : **10.0 - 12.0** |

Depth Scale (ft) (m) | Stratigraphic Description | Surface Elevation (m): **430.29** | Strat. Plot | Elev. Depth (m)



End of Borehole (Practical Refusal)

| SAMPLE Num. | Type | Int. | N.Val | Depth Scale (ft) (m) |
|---|---|---|---|---|
| | | ☒ | | |
| 10 | SS | ☒ | 57 | |

Prepared By: **J. Donkersgoed** Checked By: **S. Charity** Date Prepared: **5/15/2021**

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| 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 - 5/21/2021 | Screen: **51 mm dia. PVC #10 slot** | CS | ▯ | Continuous | AR | ▯ | Air Rotary |
| | | RC | ▨ | Rock Core | WC | ▭ | Wash Cuttings |

BURNSIDE
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# LOG OF DRILLING OPERATIONS

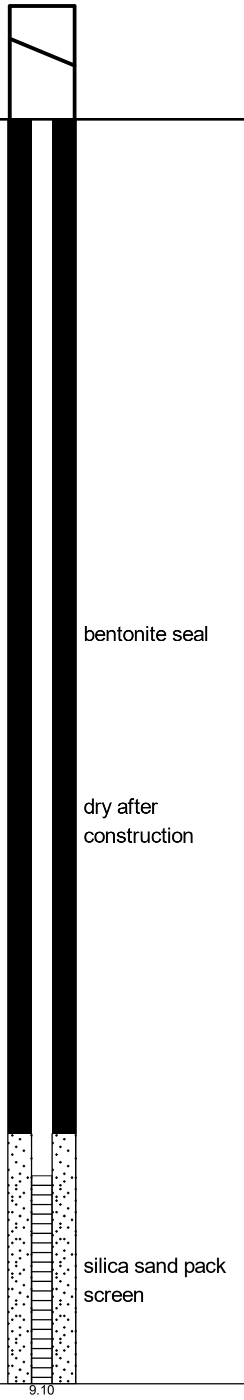
## MW6s

Page 1 of 1

| | | |
|---|---|---|
| Client: **Mattamy Homes** | Project Name: **Hydrogeological Study** | Logged by: **J. Donkersgoed** |
| Project No.: **300052075.0002** | Location: **Erin, ON** | Ground (m amsl): **430.29** |
| Drilling Co.: **Orbit Garant Drilling** | Date Started: **5/4/2021** | Static Water Level Depth (m): **Dry** |
| Drilling Method: **Hollow Stem Auger** | Date Completed: **5/4/2021** | Sand Pack Depth (m) : **7.3 - 9.1** |

Surface Elevation (m): **430.29**

| Stratigraphic Description | Elev. / Depth (m) |
|---|---|
| TOPSOIL<br>dark brown, moist | 429.99<br>0.30 |
| SILTY SAND<br>brown, loose, moist<br>organics | 429.53<br>0.76 |
| SILTY SAND TILL<br>brown, fine to medium sand, some gravel, trace clay, loose to very dense, moist<br>occasional cobble<br>grading finer sand/siltier @ 1.8m<br>grading finer sand/siltier, trace gravel @ 5.0m | 421.19<br>9.10 |
| End of Borehole | |



Prepared By: **J. Donkersgoed** Checked By: **S. Charity** Date Prepared: **5/15/2021**

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LEGEND
- ▼ Water found @ time of drilling
- ▽ Static Water Level - 5/21/2021

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

## MW7

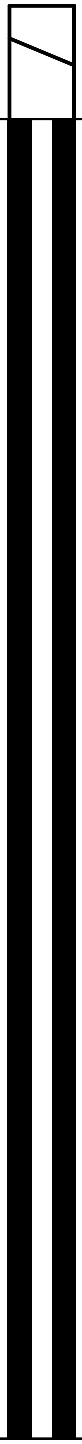
BURNSIDE
R.J. Burnside & Associates Limited
292 Speedvale Avenue West, Unit 20, Guelph, Ontario, N1H 1C4
telephone (519) 823-4995 fax (519) 836-5447

| | | |
|---|---|---|
| Client: **Mattamy Homes** | Project Name: **Hydrogeological Study** | Logged by: **E. Pentney** |
| Project No.: **300052075.0002** | Location: **Erin, ON** | Ground (m amsl): **451.06** |
| Drilling Co.: **Orbit Garant Drilling** | Date Started: **5/5/2021** | Static Water Level Depth (m): **Dry** |
| Drilling Method: **Solid Stem Auger** | Date Completed: **5/5/2021** | Sand Pack Depth (m) : **9.9 - 12.0** |

Surface Elevation (m): **451.06**

| Stratigraphic Description | Elev. / Depth (m) |
|---|---|
| TOPSOIL<br>brown, moist | 450.86<br>0.20 |
| SILTY SAND<br>brown, compact, medium sand, silt, some gravel, moist to dry | 449.54<br>1.52 |
| SILTY SAND<br>grey-brown, loose, fine sand, massive, moist to dry<br>some coarse sand, layered @ 1.9 m | 446.49<br>4.57 |
| SANDY SILT<br>grey-brown, dense, fine sand, small silt inclusions, massive, moist<br>increase in silt content @ 5.1 m, hard<br>some medium sand, layered @ 6.1 m | 443.44<br>7.62 |
| SAND AND SILT<br>grey, dense, fine sand, massive, moist to dry | |

Depth Scale (ft): 5.0, 10.0, 15.0, 20.0, 25.0, 30.0
Depth Scale (m): 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0



bentonite seal

dry after construction

| SAMPLE Num. | Type | Int. | N.Val |
|---|---|---|---|
| 1 | SS | ☒ | 6 |
| 2 | SS | ☒ | 18 |
| 3 | SS | ☒ | 24 |
| 4 | SS | ☒ | 28 |
| 5 | SS | ☒ | 59 |
| 6 | SS | ☒ | 52 |
| 7 | SS | ☒ | >50 |
| 8 | SS | ☒ | >50 |
| 9 | SS | ☒ | 93 |

Prepared By: **J. Donkersgoed** Checked By: **S. Charity** Date Prepared: **5/15/2021**

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LEGEND
▼ Water found @ time of drilling
▽ Static Water Level - 5/21/2021

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

SAMPLE TYPE

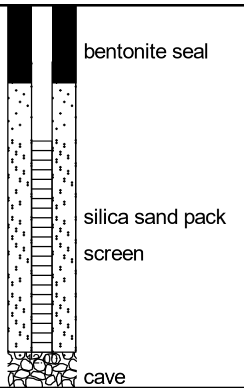
| | | | |
|---|---|---|---|
| AC | Auger Cutting | SS | Split Spoon |
| CS | Continuous | AR | Air Rotary |
| RC | Rock Core | WC | Wash Cuttings |

# LOG OF DRILLING OPERATIONS

**MW7**

| | | |
|---|---|---|
| Client: **Mattamy Homes** | Project Name: **Hydrogeological Study** | Logged by: **E. Pentney** |
| Project No.: **300052075.0002** | Location: **Erin, ON** | Ground (m amsl): **451.06** |
| Drilling Co.: **Orbit Garant Drilling** | Date Started: **5/5/2021** | Static Water Level Depth (m): **Dry** |
| Drilling Method: **Solid Stem Auger** | Date Completed: **5/5/2021** | Sand Pack Depth (m) : **9.9 - 12.0** |

| Depth Scale (ft) (m) | Stratigraphic Description<br>Surface Elevation (m): **451.06** | Elev. Depth (m) | SAMPLE Num. | Type | Int. | N.Val | Depth Scale (ft) (m) |
|---|---|---|---|---|---|---|---|
| 10.0 | | | | | ☒ | | 10.0 |
| 35.0 — 11.0 | SANDY SILT<br>grey-brown, dense, fine sand, moist | 440.39<br>10.67 | 10 | SS | ☒ | >50 | 35.0 — 11.0 |
| 12.0 — 40.0 | | 438.81<br>12.25 | | | | | 12.0 — 40.0 |
| | End of Borehole | | | | | | |



Prepared By: **J. Donkersgoed** Checked By: **S. Charity** Date Prepared: **5/15/2021**

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 - 5/21/2021 | Screen: **51 mm dia. PVC #10 slot** | CS ◫ Continuous — AR ◫ Air Rotary |
| | | RC ▨ Rock Core — WC ▭ Wash Cuttings |

# LOG OF DRILLING OPERATIONS

## MW8

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

Page 1 of 1

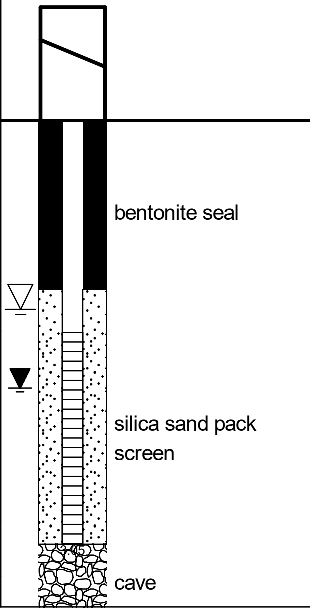
| | | |
|---|---|---|
| Client: **Mattamy Homes** | Project Name: **Hydrogeological Study** | Logged by: **E. Pentney** |
| Project No.: **300052075.0002** | Location: **Erin, ON** | Ground (m amsl): **418.38** |
| Drilling Co.: **Orbit Garant Drilling** | Date Started: **5/5/2021** | Static Water Level Depth (m): **1.36** |
| Drilling Method: **Hollow Stem Auger** | Date Completed: **5/6/2021** | Sand Pack Depth (m) : **1.2 - 3.0** |

Surface Elevation (m): **418.38**

| Stratigraphic Description | Elev. Depth (m) |
|---|---|
| TOPSOIL<br>brown, moist | 418.05<br>0.33 |
| SAND<br>brown, loose, coarse to medium sand, trace silt, moist<br>grading finer sand/siltier @ 1.2 m | 416.86<br>1.52 |
| SILTY SAND<br>brown, dense, well graded sand, moist | 415.49<br>2.89 |
| SANDY GRAVEL<br>brown-grey, compact, well-graded sand, sub-angular gravel, trace silt, wet | 415.10<br>3.28 |
| SILTY SAND TILL<br>reddish-grey, very dense, well-graded sand, some gravel, trace clay, occasional rust, limestone pieces, moist | 414.88<br>3.50 |

End of Borehole

Depth Scale (ft) (m): 1.0, 5.0, 2.0, 3.0, 10.0



| SAMPLE | | | |
|---|---|---|---|
| Num. | Type | Int. | N.Val |
| 1 | SS | ☒ | 7 |
| 2 | SS | ☒ | 5 |
| 3 | SS | ☒ | 6 |
| 4 | SS | ☒ | 50 |
| 5 | SS | ☒ | 90 |

Prepared By: **J. Donkersgoed** Checked By: **S. Charity** Date Prepared: **5/15/2021**

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 - 5/21/2021

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

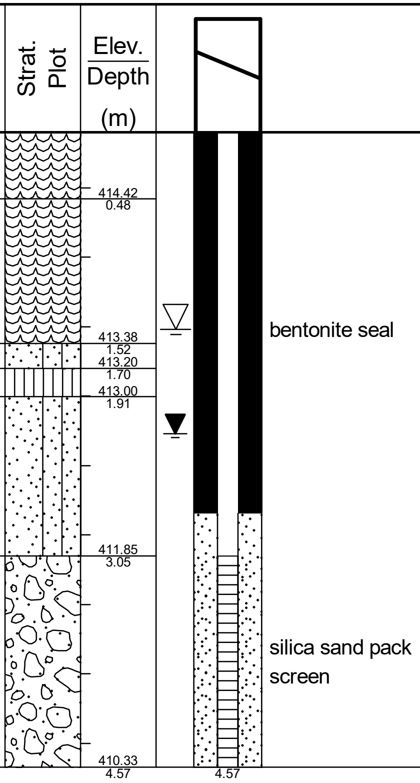
## MW9

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

Page 1 of 1

| | | |
|---|---|---|
| Client: **Mattamy Homes** | Project Name: **Hydrogeological Study** | Logged by: **E. Pentney** |
| Project No.: **300052075.0002** | Location: **Erin, ON** | Ground (m amsl): **414.90** |
| Drilling Co.: **Orbit Garant Drilling** | Date Started: **5/6/2021** | Static Water Level Depth (m): **1.42** |
| Drilling Method: **Hollow Stem Auger** | Date Completed: **5/6/2021** | Sand Pack Depth (m) : **2.7 - 4.5** |

| Depth Scale (ft) (m) | Stratigraphic Description<br>Surface Elevation (m): **414.90** | Elev. Depth (m) |
|---|---|---|
| | TOPSOIL<br>brown, wet | 414.42<br>0.48 |
| 1.0 | SANDY ORGANIC TOPSOIL<br>dark brown, loose, medium sand, trace silt, trace clay, moist to wet | 413.38<br>1.52 |
| 5.0 | SILTY SAND<br>dark brown, compact, fine sands, moist to wet | 413.20<br>1.70 |
| 2.0 | SILT<br>dark brown, dense, trace clay, lightly plastic, moist | 413.00<br>1.91 |
| 10.0 3.0 | SILTY SAND<br>brown, compact, medium sand, some gravel, moist<br>greying, increase in silt content, hard at 2.7 m | 411.85<br>3.05 |
| 4.0 | SANDY GRAVEL<br>grey, compact, well-graded sand, angular gravel, trace silt, wet | 410.33<br>4.57 |
| | End of Borehole | |



| SAMPLE Num. | Type | Int. | N.Val |
|---|---|---|---|
| 1 | SS | ☒ | 5 |
| 2 | SS | ☒ | 4 |
| 3 | SS | ☒ | 8 |
| 4 | SS | ☒ | 9 |
| 5 | SS | ☒ | 9 |

Prepared By: **J. Donkersgoed** Checked By: **S. Charity** Date Prepared: **5/15/2021**

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 - 5/21/2021

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 |

# Appendix C

## Grainsize and Hydraulic Conductivity

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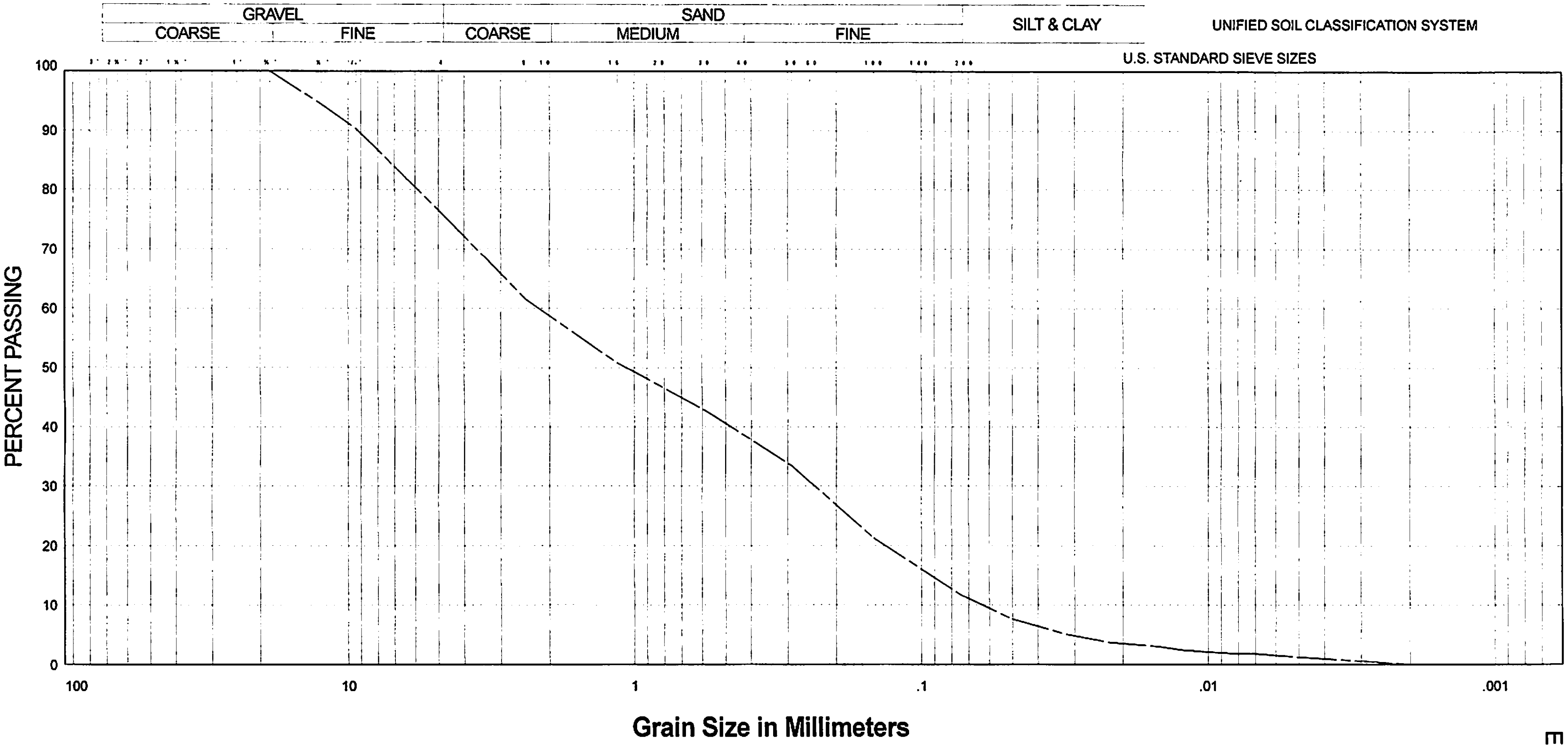
# Appendix C-1

# Grainsize Analysis

# GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G4420-21-5



PROJECT: #300052075.0002
LOCATION:
BOREHOLE N°: MW 1
SAMPLE N°:
DEPTH: 3.0 m
ELEVATION:

COEFFICIENT OF UNIFORMITY: 35.0
COEFFICIENT OF CURVATURE: 0.4

**Classification of Sample and Group Symbol:**

GRAVELLY SAND, some silt (SW-SM)

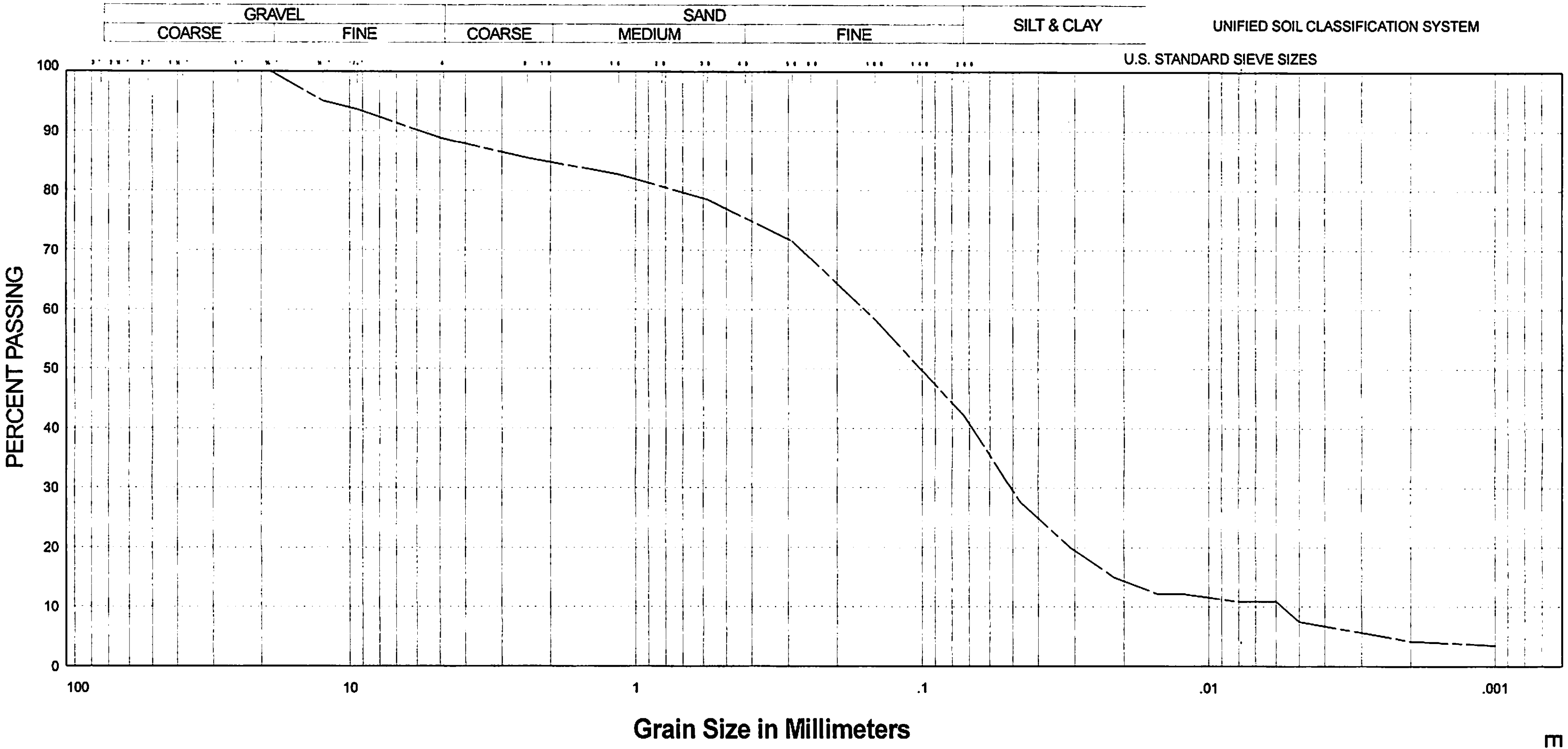
PLASTIC PROPERTIES
LIQUID LIMIT % =
PLASTIC LIMIT % =
PLASTICITY INDEX % =
MOISTURE CONTENT % = 6.8

ENCLOSURE N° 1

# GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G4420-21-5

UNIFIED SOIL CLASSIFICATION SYSTEM



PROJECT: #300052075.0002
LOCATION:
BOREHOLE N°: MW 1
SAMPLE N°:
DEPTH: 4.6 m
ELEVATION:

COEFFICIENT OF UNIFORMITY:
COEFFICIENT OF CURVATURE:

**Classification of Sample and Group Symbol:**

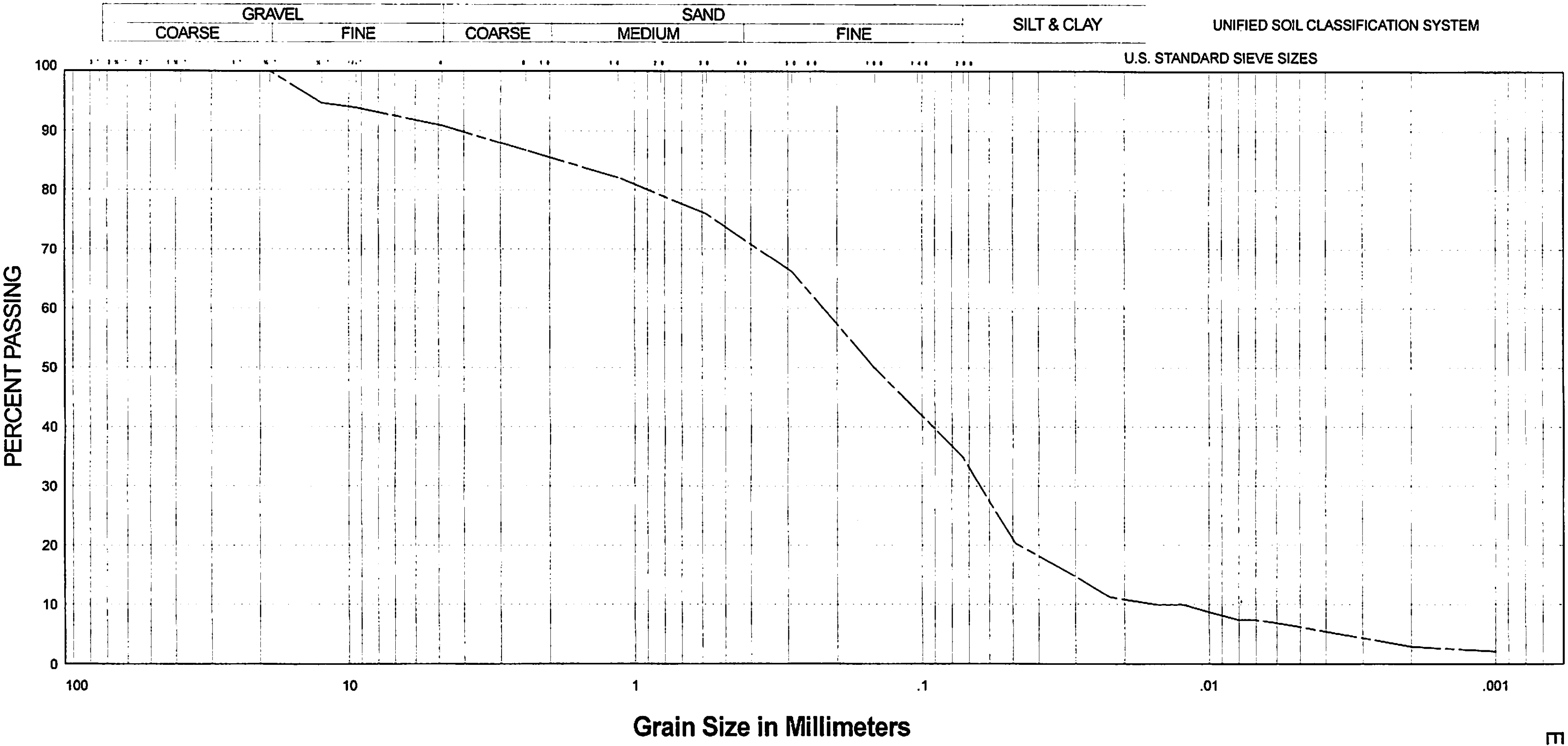
SAND AND SILT, some gravel, trace clay

PLASTIC PROPERTIES
LIQUID LIMIT % =
PLASTIC LIMIT % =
PLASTICITY INDEX % =
MOISTURE CONTENT % = 10.5

ENCLOSURE N° 2

# GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G4420-21-5



PROJECT: #300052075.0002

LOCATION:

BOREHOLE N°: MW 2

SAMPLE N°:

DEPTH: 2.3 m

ELEVATION:

COEFFICIENT OF UNIFORMITY:

COEFFICIENT OF CURVATURE:

**Classification of Sample and Group Symbol:**

SILTY SAND, trace gravel, trace clay

PLASTIC PROPERTIES

LIQUID LIMIT % =

PLASTIC LIMIT % =

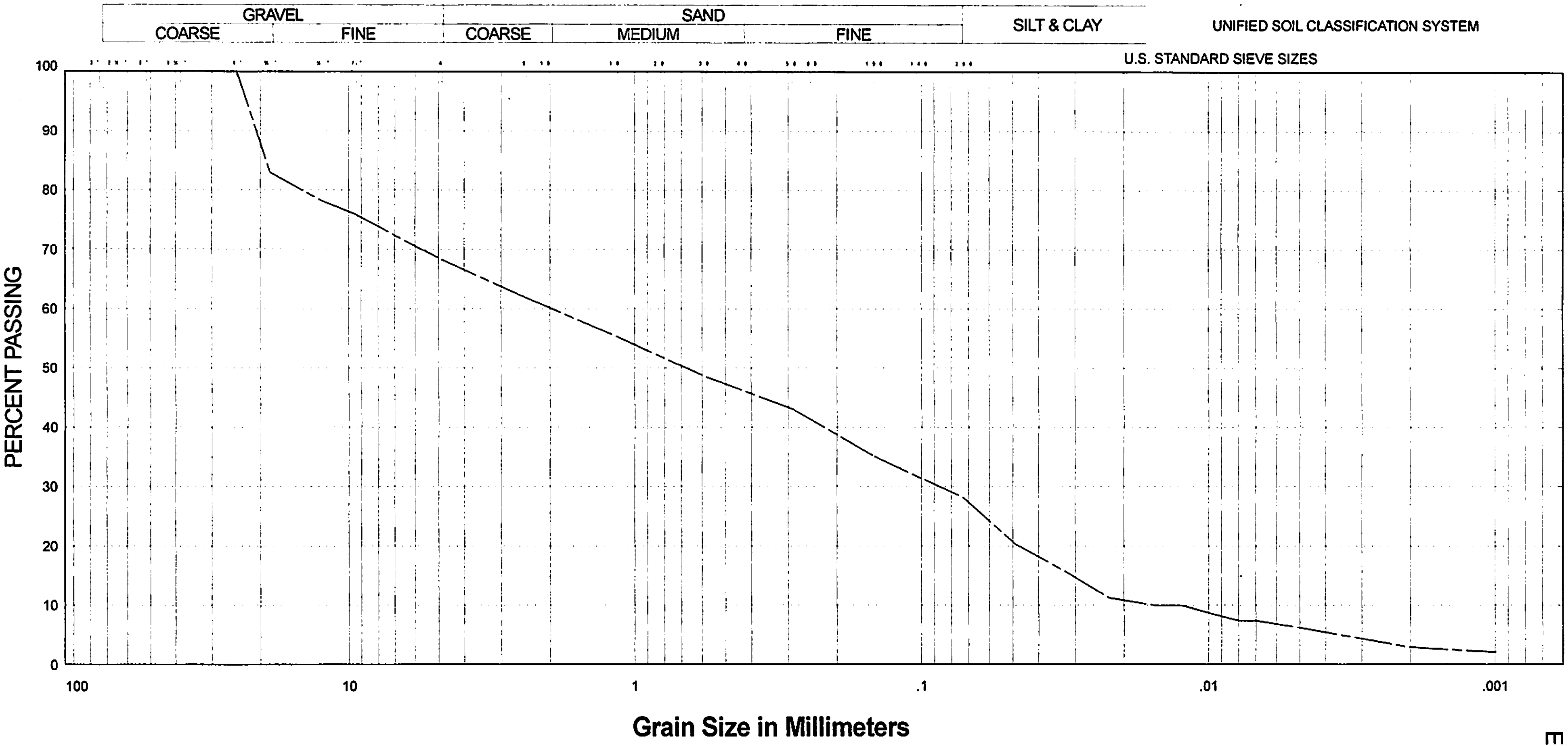
PLASTICITY INDEX % =

MOISTURE CONTENT % = 10.1

ENCLOSURE N° 3

# GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G4420-21-5



PROJECT: #300052075.0002

LOCATION:

BOREHOLE N°: MW 3

SAMPLE N°:

DEPTH: 3.8 m

ELEVATION:

COEFFICIENT OF UNIFORMITY:

COEFFICIENT OF CURVATURE:

**Classification of Sample and Group Symbol:**

SILTY GRAVELLY SAND, trace clay

PLASTIC PROPERTIES

LIQUID LIMIT % =

PLASTIC LIMIT % =

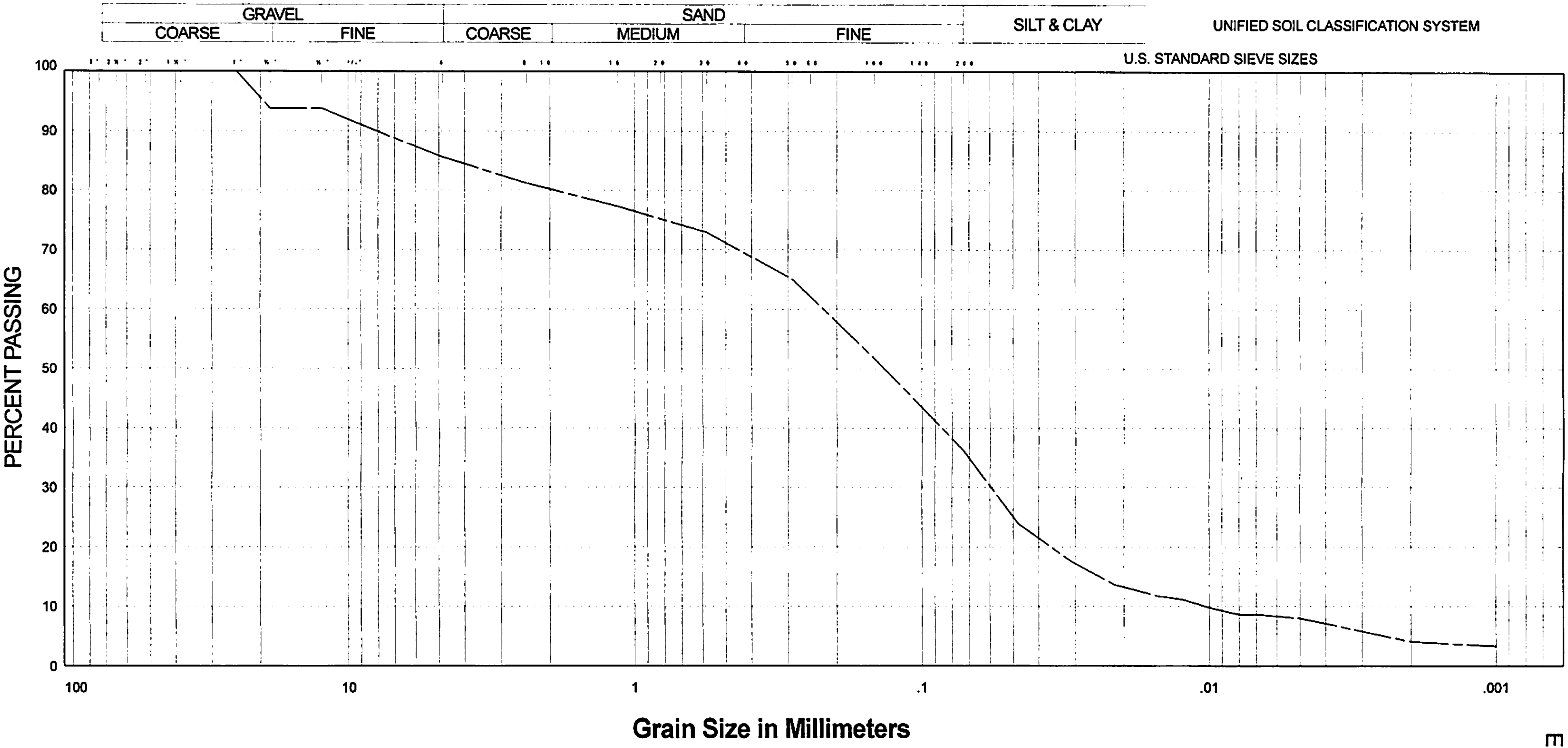
PLASTICITY INDEX % =

MOISTURE CONTENT % = 5.0

ENCLOSURE N° 4

# GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G4420-21-5



PROJECT: #300052075.0002

LOCATION:

BOREHOLE N°: MW 6

SAMPLE N°:

DEPTH: 12.2 m

ELEVATION:

COEFFICIENT OF UNIFORMITY:

COEFFICIENT OF CURVATURE:

**Classification of Sample and Group Symbol:**

SILTY SAND, some gravel, trace clay

PLASTIC PROPERTIES

LIQUID LIMIT % =

PLASTIC LIMIT % =

PLASTICITY INDEX % =

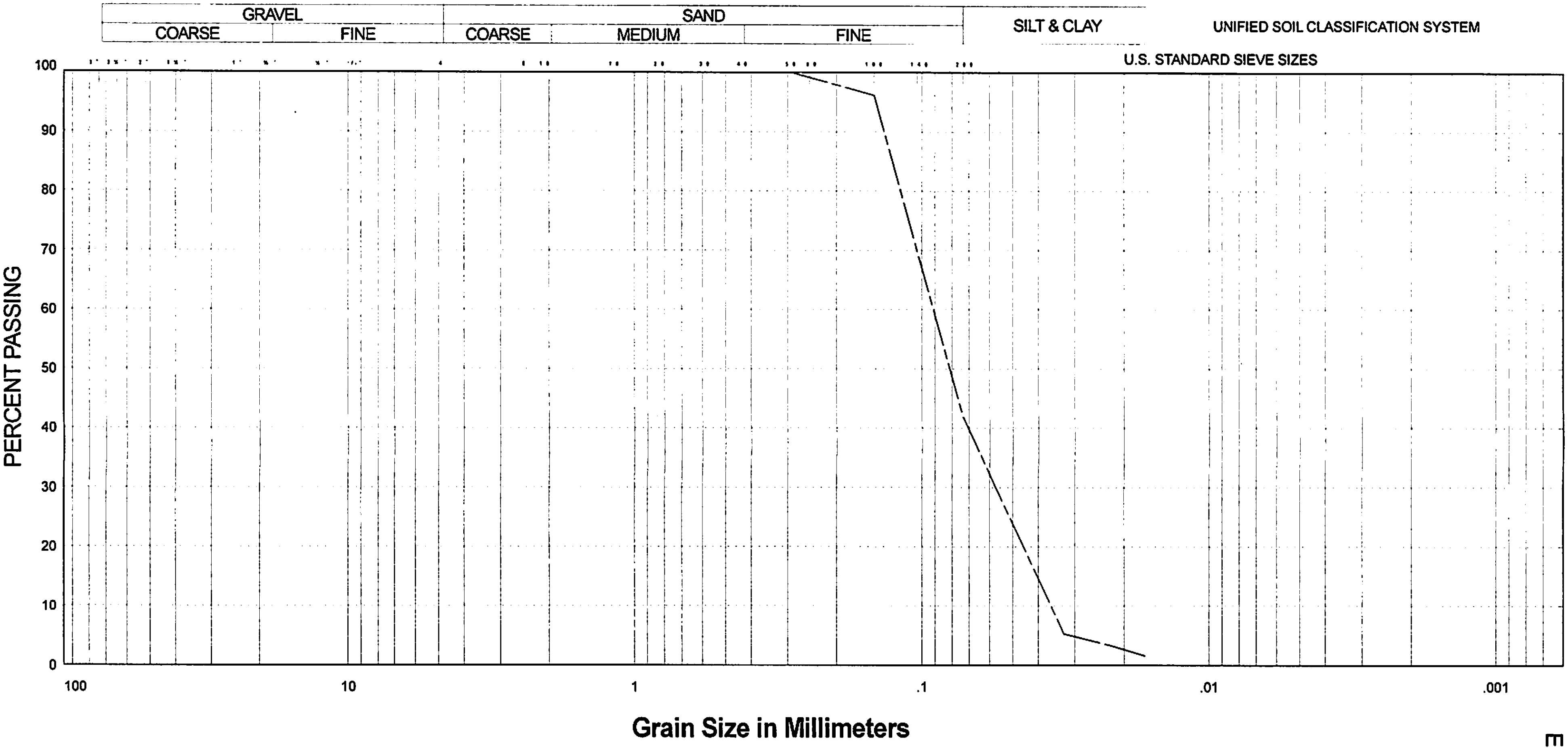
MOISTURE CONTENT % = 6.7

ENCLOSURE N° 5

**V. A. WOOD (GUELPH) INCORPORATED**

# GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G4420-21-5



PROJECT: #300052075.0002

LOCATION:

BOREHOLE N°: MW 7

SAMPLE N°:

DEPTH: 7.6 m

ELEVATION:

COEFFICIENT OF UNIFORMITY:

COEFFICIENT OF CURVATURE:

**Classification of Sample and Group Symbol:**

SAND AND SILT

PLASTIC PROPERTIES

| | |
|---|---|
| LIQUID LIMIT | % = |
| PLASTIC LIMIT | % = |
| PLASTICITY INDEX | % = |
| MOISTURE CONTENT | % = 2.9 |

ENCLOSURE N° 6

**V. A. WOOD (GUELPH) INCORPORATED**

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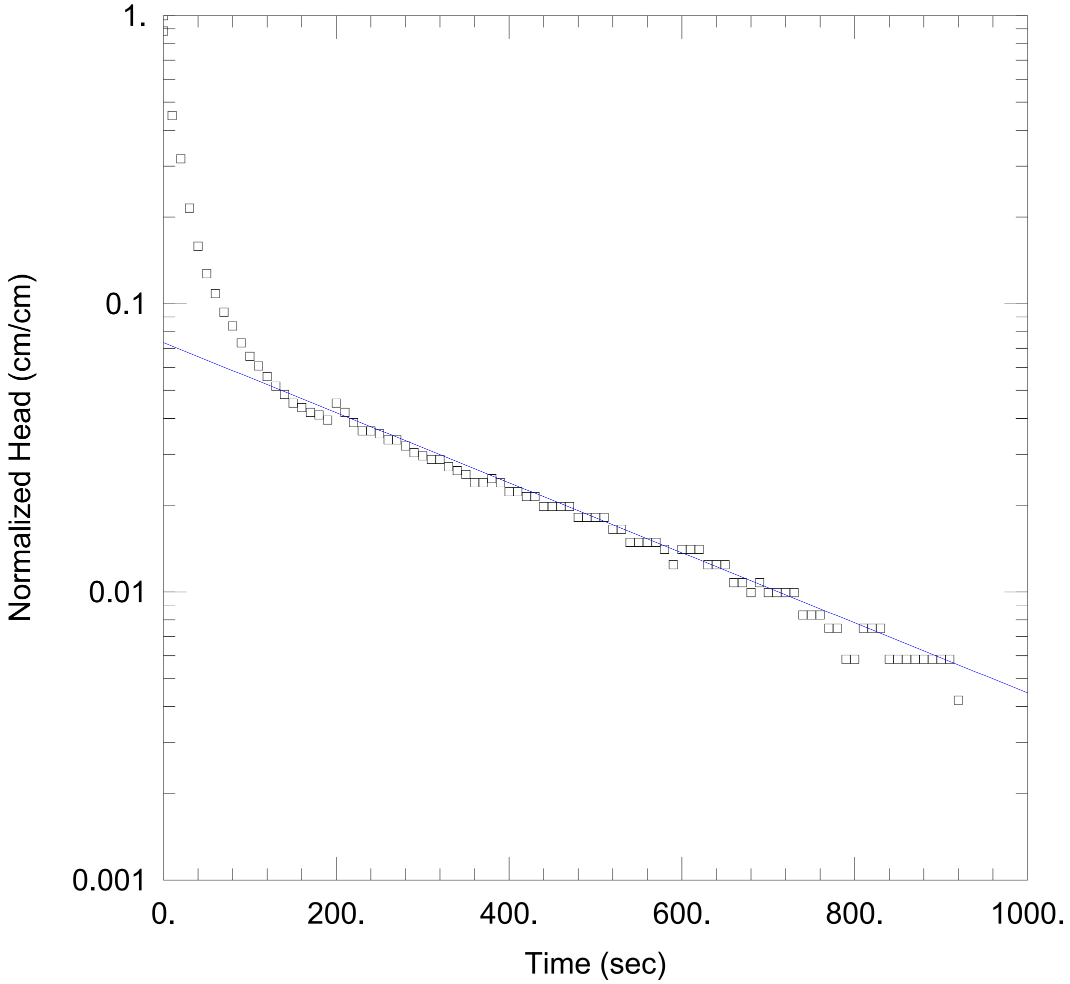
# Appendix C-2

## Hydraulic Conductivity



## HYDRAULIC CONDUCTIVITY TEST AT MW1S - SCREENED IN GRAVELLY SAND

### PROJECT INFORMATION

Company: R.J. Burnside
Client: Erin Developments
Project: 300052075
Test Well: MW1s
Test Date: June 30, 2021

### AQUIFER DATA

Saturated Thickness: 127. cm
Anisotropy Ratio (Kz/Kr): 0.1

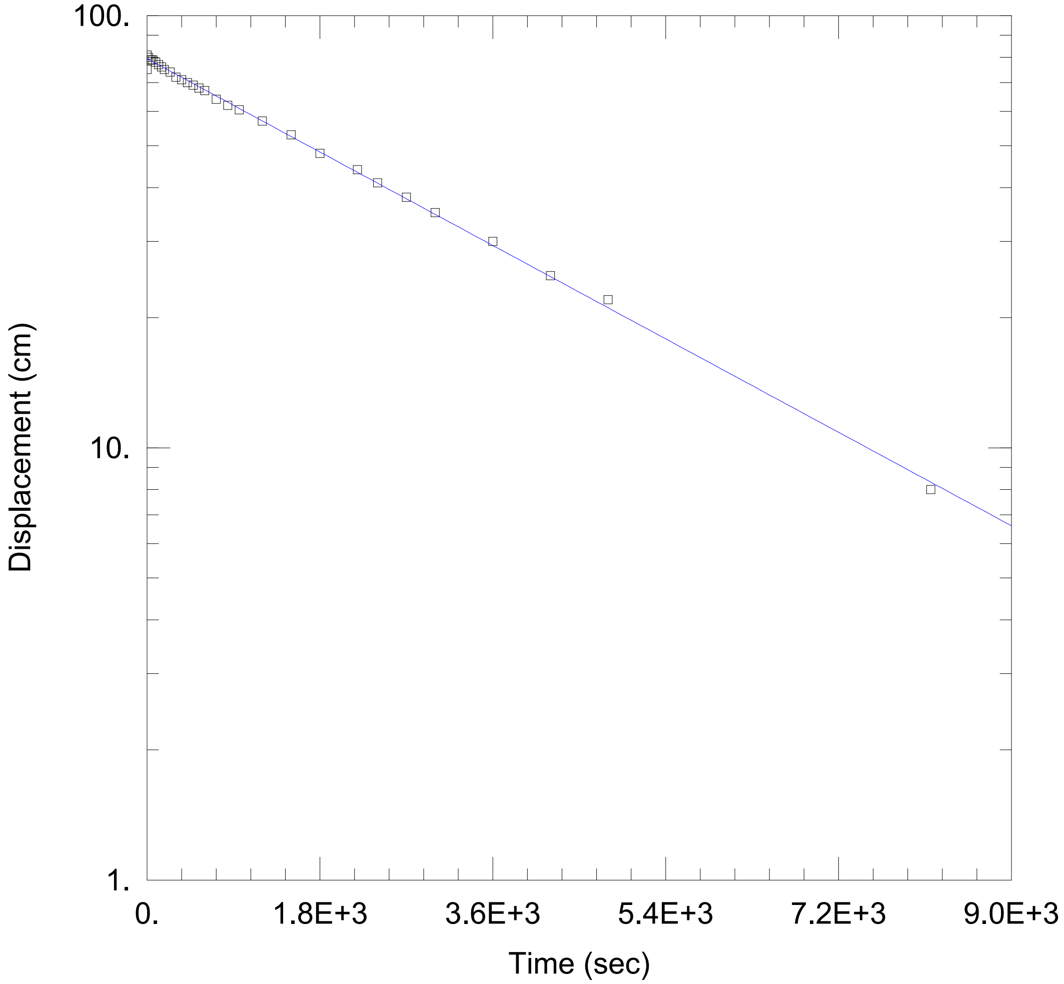
### WELL DATA (MW1s)

Initial Displacement: 122. cm
Total Well Penetration Depth: 152. cm
Casing Radius: 2.54 cm
Static Water Column Height: 127. cm
Screen Length: 152. cm
Well Radius: 7.62 cm
Gravel Pack Porosity: 0.3

### SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev

K = 0.001281 cm/sec
y0 = 8.941 cm



## HYDRAULIC CONDUCTIVITY TEST AT MW1D - SCREENED IN SILTY SAND TILL

### PROJECT INFORMATION

Company: R.J. Burnside
Client: Erin Developments Inc
Project: 300052075
Test Well: MW1d
Test Date: June 30, 2021

### AQUIFER DATA

Saturated Thickness: 604. cm
Anisotropy Ratio (Kz/Kr): 1.

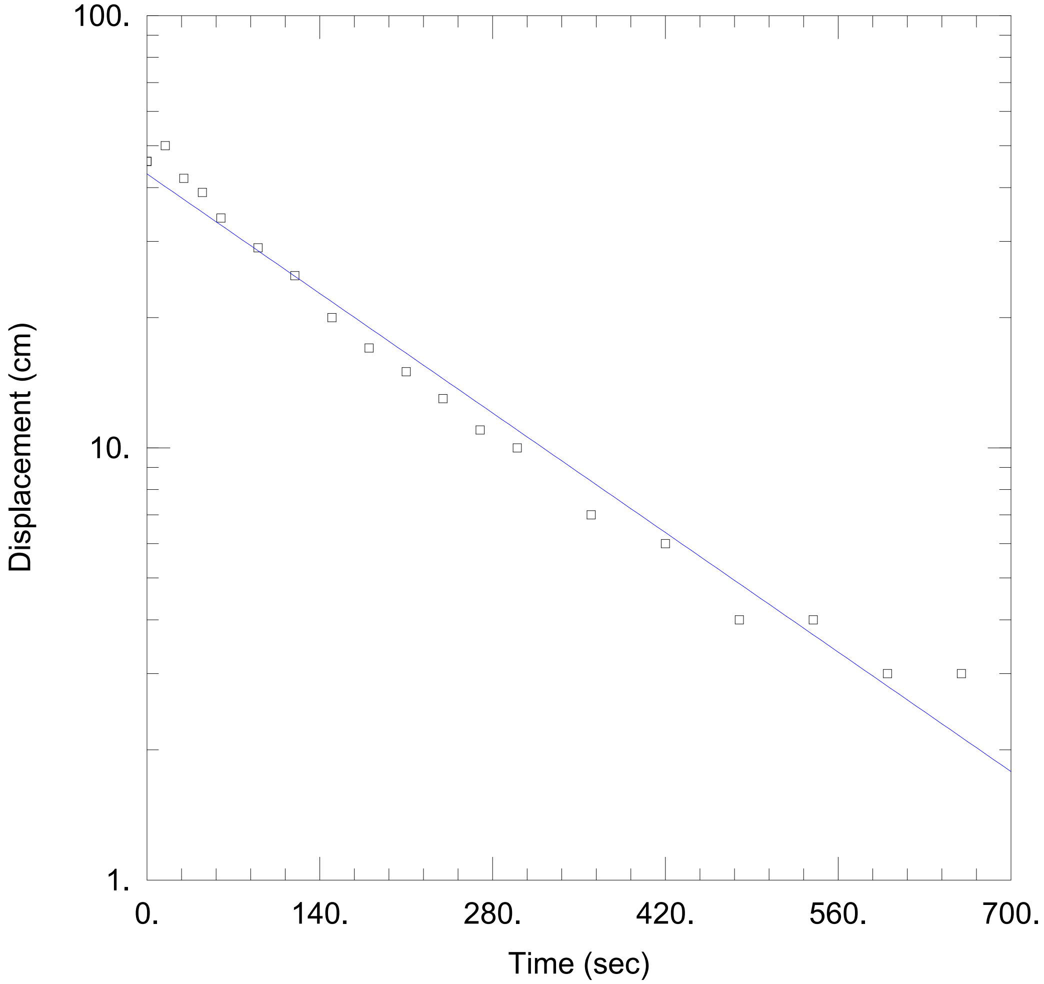
### WELL DATA (MW1d)

Initial Displacement: 75. cm
Total Well Penetration Depth: 604. cm
Casing Radius: 2.54 cm
Static Water Column Height: 604. cm
Screen Length: 152. cm
Well Radius: 7.62 cm

### SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev

K = 2.163E-5 cm/sec
y0 = 79.49 cm



## HYDRAULIC CONDUCTIVITY TEST AT MW2 - SCREENED IN SILTY SAND

### PROJECT INFORMATION

Company: R.J. Burnside
Client: Erin Developments Inc
Project: 300052075
Test Well: MW2
Test Date: June 30, 2021

### AQUIFER DATA

Saturated Thickness: 286. cm
Anisotropy Ratio (Kz/Kr): 1.

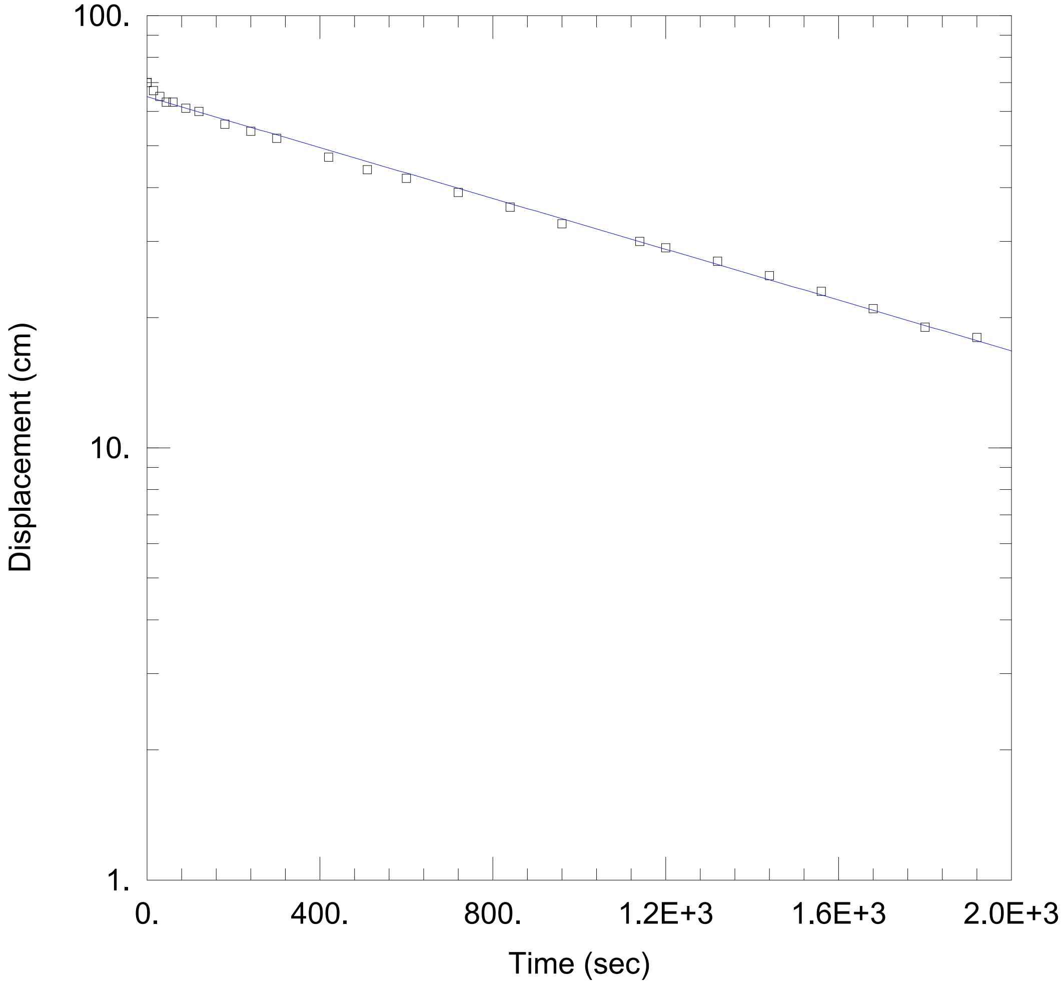
### WELL DATA (MW2)

Initial Displacement: 46. cm
Total Well Penetration Depth: 286. cm
Casing Radius: 2.54 cm
Static Water Column Height: 286. cm
Screen Length: 152. cm
Well Radius: 7.62 cm

### SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev

K = 0.0003558 cm/sec
y0 = 42.99 cm



## HYDRAULIC CONDUCTIVITY TEST AT MW3 - SCREENED IN SAND/SILTY SAND TILL

### PROJECT INFORMATION

Company: R.J. Burnside
Client: Erin Developments Inc
Project: 300052075
Test Well: MW3
Test Date: June 30, 2021

### AQUIFER DATA

Saturated Thickness: 252. cm
Anisotropy Ratio (Kz/Kr): 1.

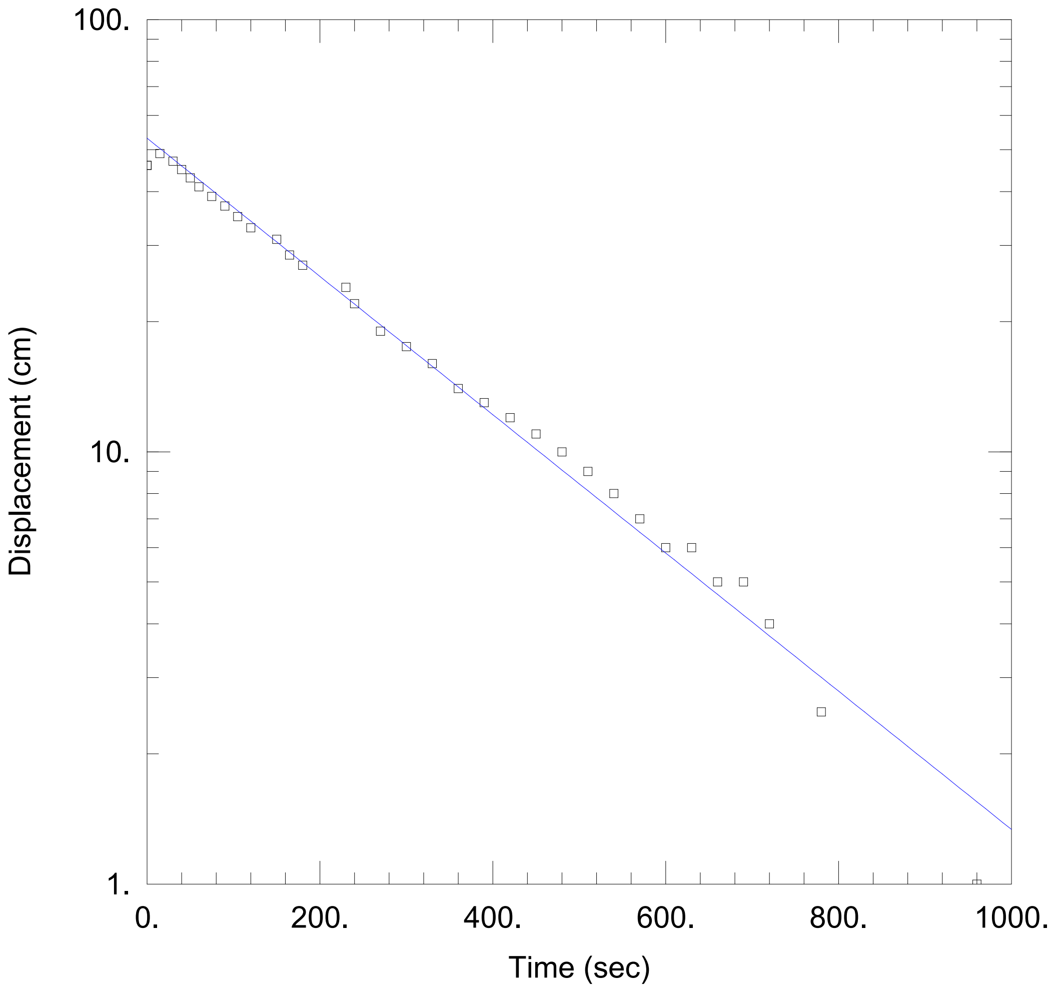
### WELL DATA (MW3)

Initial Displacement: 70. cm
Total Well Penetration Depth: 252. cm
Casing Radius: 2.54 cm
Static Water Column Height: 252. cm
Screen Length: 152. cm
Well Radius: 7.62 cm

### SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev

K = 5.295E-5 cm/sec
y0 = 64.86 cm



## HYDRAULIC CONDUCTIVITY TEST AT MW9 - SCREENED IN SANDY GRAVEL

### PROJECT INFORMATION

Company: R.J. Burnside
Client: Erin Developments Inc
Project: 300052075
Test Well: MW9
Test Date: June 30, 2021

### AQUIFER DATA

Saturated Thickness: 290. cm
Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (MW9)

Initial Displacement: 46. cm
Total Well Penetration Depth: 290. cm
Casing Radius: 2.54 cm
Static Water Column Height: 290. cm
Screen Length: 152. cm
Well Radius: 7.62 cm

### SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.0002881 cm/sec
y0 = 53.13 cm

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# Appendix D

## Groundwater Levels

Appendix D

# Table D-1
# Groundwater Elevations - Monitoring Wells and Piezometers

| Monitoring Well and Piezometer | Well Depth (mbgl) | Ground Elevation (masl) | 21-May-21 | | 30-Jun-21 | | 12-Jul-21 | | 28-Jul-21 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Water Level (mbgl) | Water Elevation (masl) | Water Level (mbgl) | Water Elevation (masl) | Water Level (mbgl) | Water Elevation (masl) | Water Level (mbgl) | Water Elevation (masl) |
| **MW1s** | **4.26** | **408.38** | 2.48 | 405.90 | 2.90 | 405.48 | 3.03 | 405.36 | 3.18 | 405.20 |
| **MW1d** | **8.99** | **408.46** | 2.55 | 405.91 | 2.95 | 405.51 | 3.08 | 405.38 | 3.22 | 405.24 |
| **MW2** | **3.71** | **417.38** | 0.72 | 416.66 | 0.85 | 416.53 | -- | -- | 1.02 | 416.36 |
| **MW3** | **4.77** | **399.29** | 1.63 | 397.66 | 2.25 | 397.04 | 2.36 | 396.93 | 2.53 | 396.76 |
| **MW4** | **19.67** | **442.41** | Dry | Dry | 19.64 | 422.77 | -- | -- | Dry | Dry |
| **MW5** | **6.92** | **437.26** | 4.75 | 432.51 | 6.91 | 430.35 | -- | -- | 6.76 | 430.50 |
| **MW6s** | **9.32** | **430.10** | Dry | Dry | Dry | Dry | Dry | Dry | 9.24 | 420.86 |
| **MW6d** | **11.99** | **430.29** | Dry | Dry | Dry | Dry | 11.80 | 418.49 | 11.85 | 418.44 |
| **MW7** | **11.86** | **451.06** | Dry | Dry | Dry | Dry | -- | -- | Dry | Dry |
| **MW8** | **3.17** | **418.38** | 1.36 | 417.03 | 1.78 | 416.60 | -- | -- | 2.08 | 416.30 |
| **MW9** | **4.54** | **414.90** | 1.40 | 413.50 | 1.65 | 413.25 | 1.73 | 413.17 | 1.86 | 413.04 |
| **PZ1s** | **0.74** | **406.80** | -0.02 | 406.82 | -0.06 | 406.86 | -- | -- | -0.06 | 406.86 |
| **PZ1d** | **1.46** | **406.83** | 0.57 | 406.26 | 0.04 | 406.79 | -- | -- | -0.08 | 406.91 |
| **PZ2s** | **0.77** | **414.56** | - | - | - | - | - | - | Dry | Dry |
| **PZ2d** | **1.55** | **414.59** | 1.20 | 413.39 | 0.95 | 413.64 | -- | -- | 1.12 | 413.47 |
| **PZ3** | **1.40** | **424.92** | - | - | - | - | - | - | -0.08 | 425.00 |

mbgl - metres below ground level

masl - metres above sea level

' - ' - instrument not installed

' -- ' - data that was not collected

# Table D-1
# Groundwater Elevations - Monitoring Wells and Piezometers

| Monitoring Well and Piezometer | Well Depth (mbgl) | Ground Elevation (masl) | 31-Aug-21 | | 12-Oct-21 | | 05-Nov-21 | | 17-Dec-21 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Water Level (mbgl) | Water Elevation (masl) | Water Level (mbgl) | Water Elevation (masl) | Water Level (mbgl) | Water Elevation (masl) | Water Level (mbgl) | Water Elevation (masl) |
| **MW1s** | **4.26** | **408.38** | 3.49 | 404.89 | 3.08 | 405.30 | 2.64 | 405.74 | 2.09 | 406.29 |
| **MW1d** | **8.99** | **408.46** | 3.52 | 404.94 | 3.09 | 405.37 | 2.67 | 405.79 | 2.13 | 406.33 |
| **MW2** | **3.71** | **417.38** | 0.87 | 416.51 | 0.24 | 417.14 | 0.18 | 417.20 | 0.16 | 417.22 |
| **MW3** | **4.77** | **399.29** | 2.65 | 396.64 | 1.43 | 397.86 | 1.03 | 398.26 | 0.66 | 398.63 |
| **MW4** | **19.67** | **442.41** | Dry | Dry | Dry | Dry | Dry | Dry | Dry | Dry |
| **MW5** | **6.92** | **437.26** | 6.78 | 430.48 | 6.79 | 430.47 | 6.81 | 430.45 | 5.53 | 431.73 |
| **MW6s** | **9.32** | **430.10** | Dry | Dry | 8.92 | 421.18 | Dry | Dry | Dry | Dry |
| **MW6d** | **11.99** | **430.29** | Dry | Dry | Dry | Dry | Dry | Dry | Dry | Dry |
| **MW7** | **11.86** | **451.06** | Dry | Dry | Dry | Dry | Dry | Dry | Dry | Dry |
| **MW8** | **3.17** | **418.38** | 2.56 | 415.82 | 1.23 | 417.15 | 1.04 | 417.34 | 0.65 | 417.73 |
| **MW9** | **4.54** | **414.90** | 1.72 | 413.18 | 0.88 | 414.02 | 0.92 | 413.98 | 0.85 | 414.05 |
| **PZ1s** | **0.74** | **406.80** | -0.03 | 406.83 | -0.08 | 406.88 | -0.08 | 406.88 | -0.09 | 406.89 |
| **PZ1d** | **1.46** | **406.83** | -0.14 | 406.97 | -0.22 | 407.05 | -0.25 | 407.08 | -0.29 | 407.12 |
| **PZ2s** | **0.77** | **414.56** | Dry | Dry | Dry | Dry | 0.11 | 414.45 | -0.01 | 414.57 |
| **PZ2d** | **1.55** | **414.59** | Dry | Dry | 0.95 | 413.64 | 0.18 | 414.41 | 0.04 | 414.55 |
| **PZ3** | **1.40** | **424.92** | 0.32 | 424.60 | 0.21 | 424.71 | 0.07 | 424.85 | -0.26 | 425.18 |

mbgl - metres below ground level

masl - metres above sea level

' - ' - instrument not installed

' -- ' - data that was not collected

# Table D-1
# Groundwater Elevations - Monitoring Wells and Piezometers

| Monitoring Well and Piezometer | Well Depth (mbgl) | Ground Elevation (masl) | 26-Jan-22 | | 11-Feb-22 | | 07-Mar-22 | | 26-Apr-22 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Water Level (mbgl) | Water Elevation (masl) | Water Level (mbgl) | Water Elevation (masl) | Water Level (mbgl) | Water Elevation (masl) | Water Level (mbgl) | Water Elevation (masl) |
| **MW1s** | **4.26** | **408.38** | 2.39 | 405.99 | 2.58 | 405.80 | 1.95 | 406.43 | 1.32 | 407.06 |
| **MW1d** | **8.99** | **408.46** | 2.58 | 405.88 | 2.63 | 405.83 | 1.94 | 406.52 | 1.40 | 407.06 |
| **MW2** | **3.71** | **417.38** | 0.08 | 417.30 | 0.15 | 417.23 | 0.08 | 417.30 | 0.12 | 417.26 |
| **MW3** | **4.77** | **399.29** | 1.90 | 397.39 | 1.57 | 397.72 | 0.39 | 398.90 | 0.41 | 398.88 |
| **MW4** | **19.67** | **442.41** | Dry | Dry | Dry | Dry | Dry | Dry | Dry | Dry |
| **MW5** | **6.92** | **437.26** | 4.79 | 432.47 | 5.17 | 432.09 | 4.28 | 432.98 | 2.34 | 434.92 |
| **MW6s** | **9.32** | **430.10** | Dry | Dry | Dry | Dry | 8.97 | 421.13 | 8.00 | 422.10 |
| **MW6d** | **11.99** | **430.29** | 10.57 | 419.72 | -- | -- | 10.07 | 420.22 | 9.07 | 421.22 |
| **MW7** | **11.86** | **451.06** | -- | -- | Dry | Dry | Dry | Dry | Dry | Dry |
| **MW8** | **3.17** | **418.38** | 1.17 | 417.21 | 1.16 | 417.22 | 0.24 | 418.14 | 0.23 | 418.15 |
| **MW9** | **4.54** | **414.90** | 1.21 | 413.69 | 1.14 | 413.76 | 0.44 | 414.46 | 0.76 | 414.14 |
| **PZ1s** | **0.74** | **406.80** | Frozen | Frozen | Frozen | Frozen | -0.07 | 406.87 | -0.08 | 406.88 |
| **PZ1d** | **1.46** | **406.83** | Frozen | Frozen | Frozen | Frozen | Frozen | Frozen | -0.30 | 407.13 |
| **PZ2s** | **0.77** | **414.56** | 0.38 | 414.18 | 0.40 | 414.16 | 0.54 | 414.02 | -0.01 | 414.57 |
| **PZ2d** | **1.55** | **414.59** | Frozen | Frozen | 0.10 | 414.49 | 0.12 | 414.47 | -0.01 | 414.60 |
| **PZ3** | **1.40** | **424.92** | Frozen | Frozen | Frozen | Frozen | Frozen | Frozen | -- | -- |

mbgl - metres below ground level

masl - metres above sea level

' - ' - instrument not installed

' -- ' - data that was not collected

# Table D-1
# Groundwater Elevations - Monitoring Wells and Piezometers

| Monitoring Well and Piezometer | Well Depth (mbgl) | Ground Elevation (masl) | 19-May-22 | | 29-Jun-22 | | 21-Jul-22 | | 22-Aug-22 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Water Level (mbgl) | Water Elevation (masl) | Water Level (mbgl) | Water Elevation (masl) | Water Level (mbgl) | Water Elevation (masl) | Water Level (mbgl) | Water Elevation (masl) |
| **MW1s** | **4.26** | **408.38** | 1.78 | 406.60 | 2.41 | 405.97 | 2.80 | 405.58 | 3.27 | 405.11 |
| **MW1d** | **8.99** | **408.46** | 1.87 | 406.59 | 2.52 | 405.94 | 2.91 | 405.55 | 3.34 | 405.12 |
| **MW2** | **3.71** | **417.38** | 0.51 | 416.87 | 1.25 | 416.13 | 1.41 | 415.97 | 1.67 | 415.71 |
| **MW3** | **4.77** | **399.29** | 0.92 | 398.37 | 1.84 | 397.45 | 2.27 | 397.02 | 2.64 | 396.65 |
| **MW4** | **19.67** | **442.41** | Dry | Dry | Dry | Dry | Dry | Dry | Dry | Dry |
| **MW5** | **6.92** | **437.26** | 3.45 | 433.81 | 5.48 | 431.78 | 6.75 | 430.51 | 6.79 | 430.47 |
| **MW6s** | **9.32** | **430.10** | 8.34 | 421.76 | Dry | Dry | Dry | Dry | 9.22 | 420.88 |
| **MW6d** | **11.99** | **430.29** | 9.42 | 420.87 | 10.86 | 419.43 | 11.51 | 418.78 | 11.91 | 418.38 |
| **MW7** | **11.86** | **451.06** | Dry | Dry | Dry | Dry | Dry | Dry | Dry | Dry |
| **MW8** | **3.17** | **418.38** | 0.70 | 417.68 | 1.54 | 416.84 | 1.86 | 416.52 | 2.33 | 416.05 |
| **MW9** | **4.54** | **414.90** | 1.25 | 413.65 | 1.86 | 413.04 | 2.17 | 412.73 | 2.34 | 412.56 |
| **PZ1s** | **0.74** | **406.80** | -0.09 | 406.89 | -0.09 | 406.89 | -0.04 | 406.84 | -0.03 | 406.83 |
| **PZ1d** | **1.46** | **406.83** | -0.30 | 407.13 | -0.33 | 407.16 | -0.32 | 407.15 | -0.35 | 407.18 |
| **PZ2s** | **0.77** | **414.56** | 0.01 | 414.55 | Dry | Dry | Dry | Dry | Dry | Dry |
| **PZ2d** | **1.55** | **414.59** | -0.02 | 414.61 | 0.57 | 414.02 | Dry | Dry | Dry | Dry |
| **PZ3** | **1.40** | **424.92** | -- | -- | - | - | -0.51 | 425.43 | -0.09 | 425.01 |

mbgl - metres below ground level

masl - metres above sea level

' - ' - instrument not installed

' -- ' - data that was not collected

# Table D-1
# Groundwater Elevations - Monitoring Wells and Piezometers

| Monitoring Well and Piezometer | Well Depth (mbgl) | Ground Elevation (masl) | 23-Sep-22 | | 21-Oct-22 | | 25-Nov-22 | | 19-Dec-22 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Water Level (mbgl) | Water Elevation (masl) | Water Level (mbgl) | Water Elevation (masl) | Water Level (mbgl) | Water Elevation (masl) | Water Level (mbgl) | Water Elevation (masl) |
| **MW1s** | **4.26** | **408.38** | 3.59 | 404.79 | 3.77 | 404.61 | 3.92 | 404.46 | 3.95 | 404.43 |
| **MW1d** | **8.99** | **408.46** | 3.63 | 404.83 | 3.80 | 404.66 | 3.93 | 404.53 | 3.95 | 404.51 |
| **MW2** | **3.71** | **417.38** | 1.62 | 415.76 | 1.22 | 416.16 | 0.96 | 416.42 | 0.83 | 416.55 |
| **MW3** | **4.77** | **399.29** | 2.79 | 396.50 | 2.83 | 396.46 | 2.89 | 396.40 | 2.76 | 396.53 |
| **MW4** | **19.67** | **442.41** | Dry | Dry | Dry | Dry | Dry | Dry | Dry | Dry |
| **MW5** | **6.92** | **437.26** | 6.90 | 430.36 | 6.88 | 430.38 | 6.81 | 430.45 | Dry | Dry |
| **MW6s** | **9.32** | **430.10** | 9.22 | 420.88 | 9.21 | 420.89 | 9.21 | 420.89 | Dry | Dry |
| **MW6d** | **11.99** | **430.29** | 11.93 | 418.36 | 11.92 | 418.37 | Dry | Dry | 11.92 | 418.37 |
| **MW7** | **11.86** | **451.06** | 11.77 | 439.29 | 11.75 | 439.31 | 11.75 | 439.31 | 11.74 | 439.32 |
| **MW8** | **3.17** | **418.38** | 2.75 | 415.63 | Dry | Dry | 3.09 | 415.29 | 3.09 | 415.29 |
| **MW9** | **4.54** | **414.90** | 2.36 | 412.54 | 2.09 | 412.81 | 1.96 | 412.94 | 1.76 | 413.14 |
| **PZ1s** | **0.74** | **406.80** | -0.03 | 406.83 | -0.06 | 406.86 | -0.08 | 406.88 | -0.06 | 406.86 |
| **PZ1d** | **1.46** | **406.83** | -0.37 | 407.20 | -0.39 | 407.22 | -0.35 | 407.18 | Frozen | Frozen |
| **PZ2s** | **0.77** | **414.56** | Dry | Dry | Dry | Dry | 0.76 | 413.80 | Dry | Dry |
| **PZ2d** | **1.55** | **414.59** | Dry | Dry | Dry | Dry | Dry | Dry | Dry | Dry |
| **PZ3** | **1.40** | **424.92** | 0.44 | 424.48 | 0.74 | 424.18 | 1.07 | 423.85 | 0.97 | 423.95 |

mbgl - metres below ground level

masl - metres above sea level

' - ' - instrument not installed

' -- ' - data that was not collected

# Table D-1
# Groundwater Elevations - Monitoring Wells and Piezometers

| Monitoring Well and Piezometer | Well Depth (mbgl) | Ground Elevation (masl) | 27-Jan-23 | | 17-Feb-23 | | 31-Mar-23 | | 28-Apr-23 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Water Level (mbgl) | Water Elevation (masl) | Water Level (mbgl) | Water Elevation (masl) | Water Level (mbgl) | Water Elevation (masl) | Water Level (mbgl) | Water Elevation (masl) |
| **MW1s** | **4.26** | **408.38** | 3.30 | 405.08 | 3.03 | 405.35 | 2.01 | 406.37 | 1.39 | 406.99 |
| **MW1d** | **8.99** | **408.46** | 3.34 | 405.12 | 3.08 | 405.38 | 2.06 | 406.40 | 1.51 | 406.95 |
| **MW2** | **3.71** | **417.38** | 0.30 | 417.08 | 0.13 | 417.25 | 0.12 | 417.26 | 0.25 | 417.13 |
| **MW3** | **4.77** | **399.29** | 1.84 | 397.45 | 0.90 | 398.39 | 0.24 | 399.05 | 0.32 | 398.97 |
| **MW4** | **19.67** | **442.41** | Dry | Dry | Dry | Dry | Dry | Dry | 19.56 | 422.85 |
| **MW5** | **6.92** | **437.26** | Dry | Dry | Dry | Dry | 4.02 | 433.24 | 1.21 | 436.05 |
| **MW6s** | **9.32** | **430.10** | 9.22 | 420.88 | 9.22 | 420.88 | 9.22 | 420.88 | 9.22 | 420.88 |
| **MW6d** | **11.99** | **430.29** | 11.93 | 418.36 | 11.93 | 418.36 | 11.93 | 418.36 | 11.87 | 418.42 |
| **MW7** | **11.86** | **451.06** | 11.76 | 439.30 | 11.76 | 439.30 | 11.76 | 439.30 | 11.75 | 439.31 |
| **MW8** | **3.17** | **418.38** | 1.68 | 416.70 | 0.79 | 417.59 | 0.51 | 417.87 | 0.36 | 418.02 |
| **MW9** | **4.54** | **414.90** | 1.11 | 413.79 | 0.56 | 414.34 | 0.55 | 414.35 | 0.91 | 413.99 |
| **PZ1s** | **0.74** | **406.80** | -0.07 | 406.87 | Frozen | Frozen | -0.09 | 406.89 | -0.09 | 406.89 |
| **PZ1d** | **1.46** | **406.83** | Frozen | Frozen | Frozen | Frozen | Frozen | Frozen | -0.35 | 407.18 |
| **PZ2s** | **0.77** | **414.56** | Dry | Dry | Frozen | Frozen | -0.02 | 414.58 | -0.02 | 414.58 |
| **PZ2d** | **1.55** | **414.59** | Dry | Dry | 0.02 | 414.57 | 0.01 | 414.58 | 0.01 | 414.58 |
| **PZ3** | **1.40** | **424.92** | 0.71 | 424.21 | Frozen | Frozen | Frozen | Frozen | Flooded | Flooded |

mbgl - metres below ground level
masl - metres above sea level
' - ' - instrument not installed
' -- ' - data that was not collected

# Table D-1
# Groundwater Elevations - Monitoring Wells and Piezometers

| Monitoring Well and Piezometer | Well Depth (mbgl) | Ground Elevation (masl) | 26-May-23 | | 23-Jun-23 | | 28-Jul-23 | | 25-Aug-23 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Water Level (mbgl) | Water Elevation (masl) | Water Level (mbgl) | Water Elevation (masl) | Water Level (mbgl) | Water Elevation (masl) | Water Level (mbgl) | Water Elevation (masl) |
| **MW1s** | **4.26** | **408.38** | 1.76 | 406.62 | 2.36 | 406.02 | 2.72 | 405.66 | 2.87 | 405.51 |
| **MW1d** | **8.99** | **408.46** | 1.88 | 406.58 | 2.47 | 405.99 | 2.78 | 405.68 | 2.93 | 405.53 |
| **MW2** | **3.71** | **417.38** | 0.61 | 416.77 | 1.12 | 416.26 | 0.76 | 416.62 | 0.89 | 416.49 |
| **MW3** | **4.77** | **399.29** | 0.77 | 398.52 | 1.64 | 397.65 | 2.00 | 397.29 | 2.26 | 397.03 |
| **MW4** | **19.67** | **442.41** | 19.44 | 422.97 | 19.53 | 422.88 | DRY | DRY | DRY | DRY |
| **MW5** | **6.92** | **437.26** | 1.90 | 435.36 | 3.56 | 433.70 | 5.35 | 431.91 | 6.77 | 430.49 |
| **MW6s** | **9.32** | **430.10** | 8.00 | 422.10 | 8.58 | 421.52 | 9.20 | 420.90 | 9.24 | 420.86 |
| **MW6d** | **11.99** | **430.29** | 9.42 | 420.87 | 9.82 | 420.47 | 10.46 | 419.83 | 10.92 | 419.37 |
| **MW7** | **11.86** | **451.06** | 11.75 | 439.31 | 11.75 | 439.31 | 11.75 | 439.31 | 11.75 | 439.31 |
| **MW8** | **3.17** | **418.38** | 0.70 | 417.68 | 1.31 | 417.07 | 1.21 | 417.17 | 1.64 | 416.74 |
| **MW9** | **4.54** | **414.90** | 1.24 | 413.66 | 1.69 | 413.21 | 1.50 | 413.40 | 1.73 | 413.17 |
| **PZ1s** | **0.74** | **406.80** | -0.08 | 406.88 | -0.07 | 406.87 | -0.09 | 406.89 | -0.07 | 406.87 |
| **PZ1d** | **1.46** | **406.83** | -0.38 | 407.21 | -0.39 | 407.22 | -0.47 | 407.30 | - | - |
| **PZ2s** | **0.77** | **414.56** | 0.01 | 414.55 | 0.69 | 413.87 | 0.46 | 414.10 | DRY | DRY |
| **PZ2d** | **1.55** | **414.59** | 0.02 | 414.57 | 0.61 | 413.98 | 0.56 | 414.03 | DRY | DRY |
| **PZ3** | **1.40** | **424.92** | Flooded | Flooded | Flooded | Flooded | Flooded | Flooded | -0.47 | 425.39 |

mbgl - metres below ground level

masl - metres above sea level

' - ' - instrument not installed

' -- ' - data that was not collected

# Table D-1
# Groundwater Elevations - Monitoring Wells and Piezometers

| Monitoring Well and Piezometer | Well Depth (mbgl) | Ground Elevation (masl) | 29-Sep-23 | |
|---|---|---|---|---|
| | | | Water Level (mbgl) | Water Elevation (masl) |
| **MW1s** | **4.26** | **408.38** | 3.17 | 405.21 |
| **MW1d** | **8.99** | **408.46** | 3.23 | 405.23 |
| **MW2** | **3.71** | **417.38** | 1.34 | 416.04 |
| **MW3** | **4.77** | **399.29** | 2.60 | 396.69 |
| **MW4** | **19.67** | **442.41** | DRY | DRY |
| **MW5** | **6.92** | **437.26** | 6.79 | 430.47 |
| **MW6s** | **9.32** | **430.10** | 9.24 | 420.86 |
| **MW6d** | **11.99** | **430.29** | 11.50 | 418.79 |
| **MW7** | **11.86** | **451.06** | 11.75 | 439.31 |
| **MW8** | **3.17** | **418.38** | 2.02 | 416.36 |
| **MW9** | **4.54** | **414.90** | 2.05 | 412.85 |
| **PZ1s** | **0.74** | **406.80** | -0.08 | 406.88 |
| **PZ1d** | **1.46** | **406.83** | -0.46 | 407.29 |
| **PZ2s** | **0.77** | **414.56** | DRY | DRY |
| **PZ2d** | **1.55** | **414.59** | DRY | DRY |
| **PZ3** | **1.40** | **424.92** | -0.03 | 424.95 |

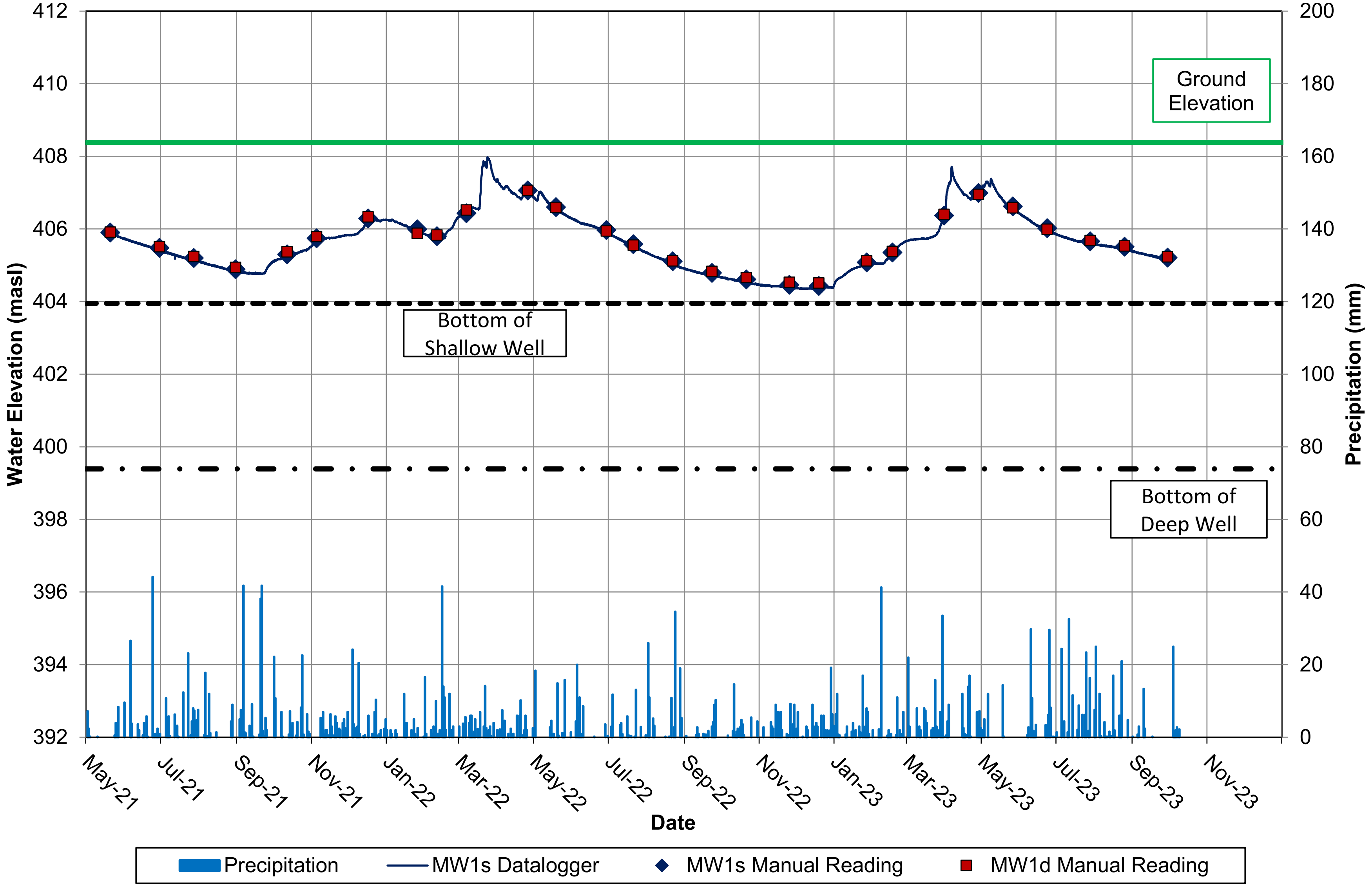
mbgl - metres below ground level

masl - metres above sea level

' - ' - instrument not installed

' -- ' - data that was not collected

# MW1s/d
# Groundwater Elevations
## (MW1s - Well Depth: 4.4m, Screened in Gravelly Sand)
## (MW1d - Well Depth: 9.0m, Screened in Silty Sand Till)



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300052075.0002

Figure D-1

# MW2
# Groundwater Elevations
# (Well Depth: 3.8 m, Screened in Silty Sand)

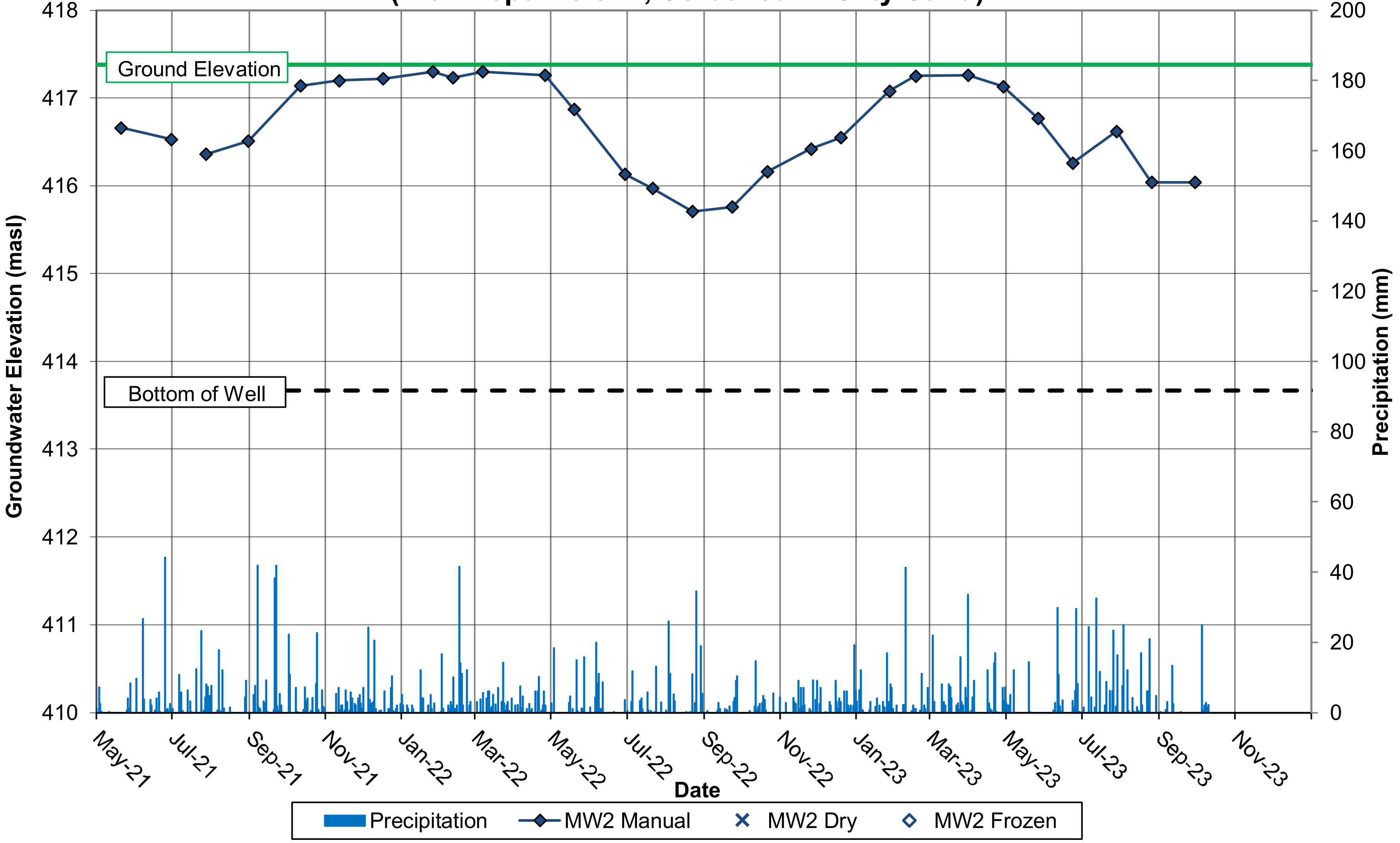

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Figure D-2

# MW3
# Groundwater Elevation
# (Well Depth: 4.8 m, Screened in Sand/Silty Sand)

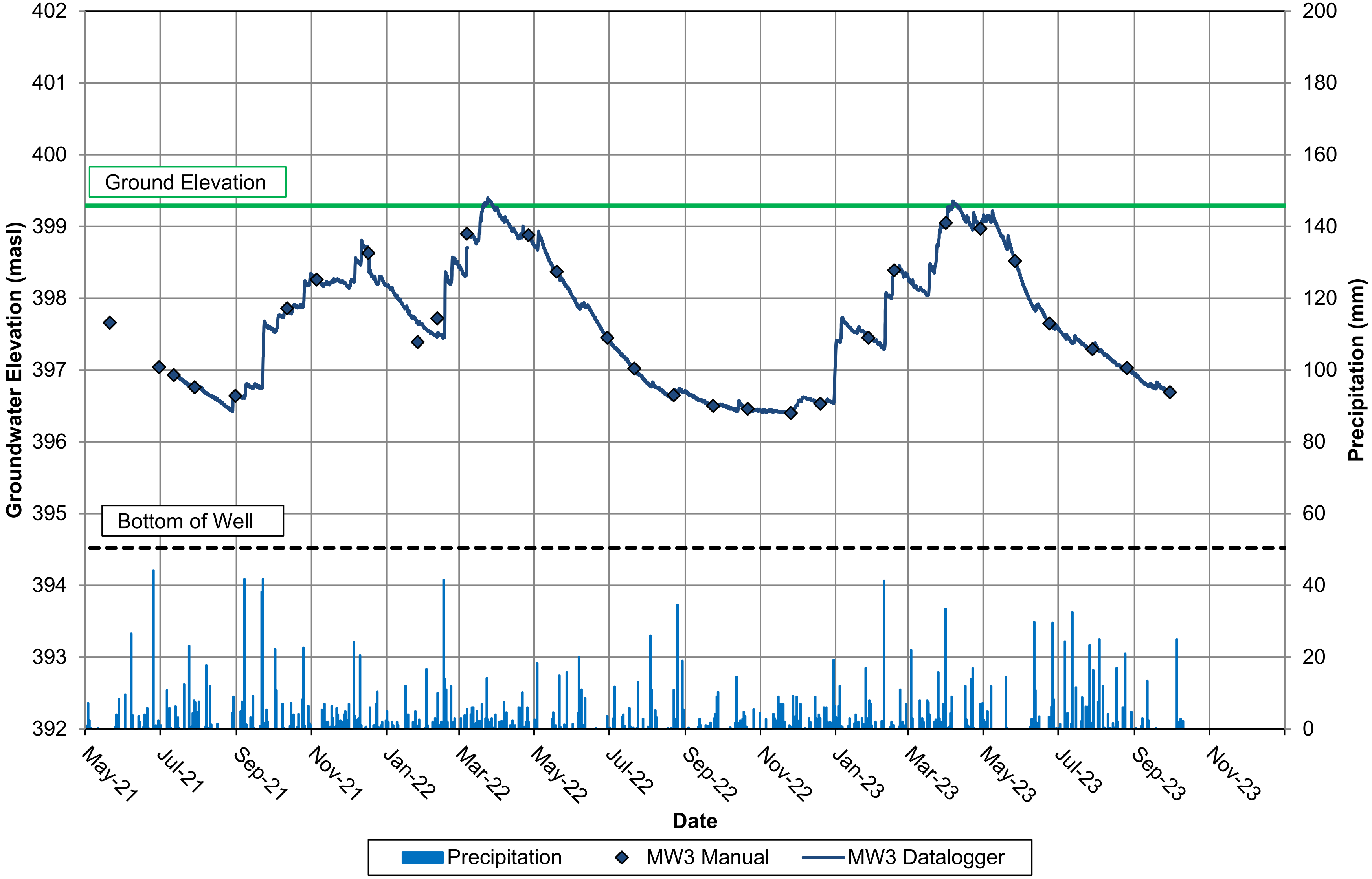

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Figure D-3

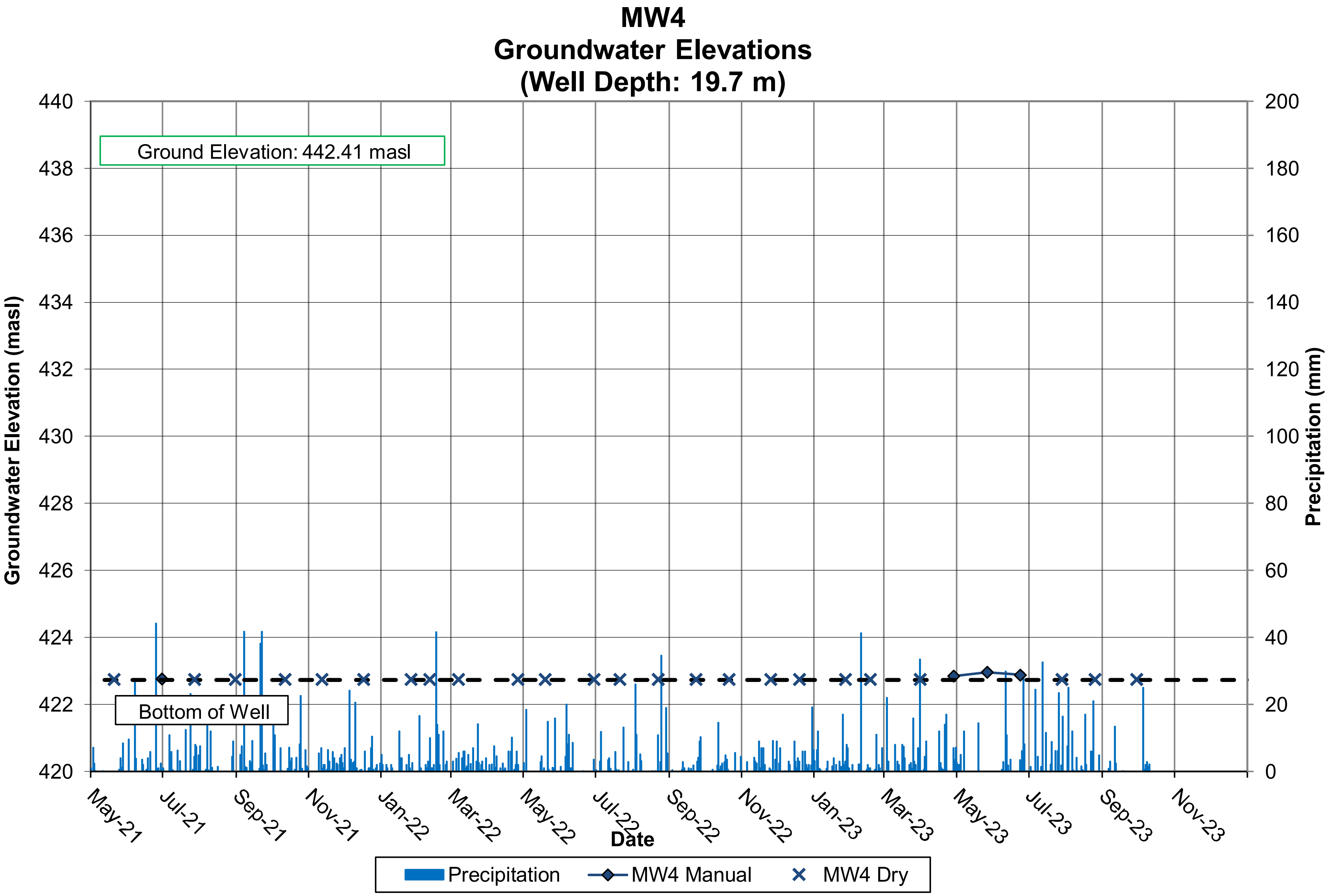

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Figure D-4

# MW5
# Groundwater Elevations
# (Well Depth: 7.0 m, Screened in Silty Sand/Sandy Gravel)

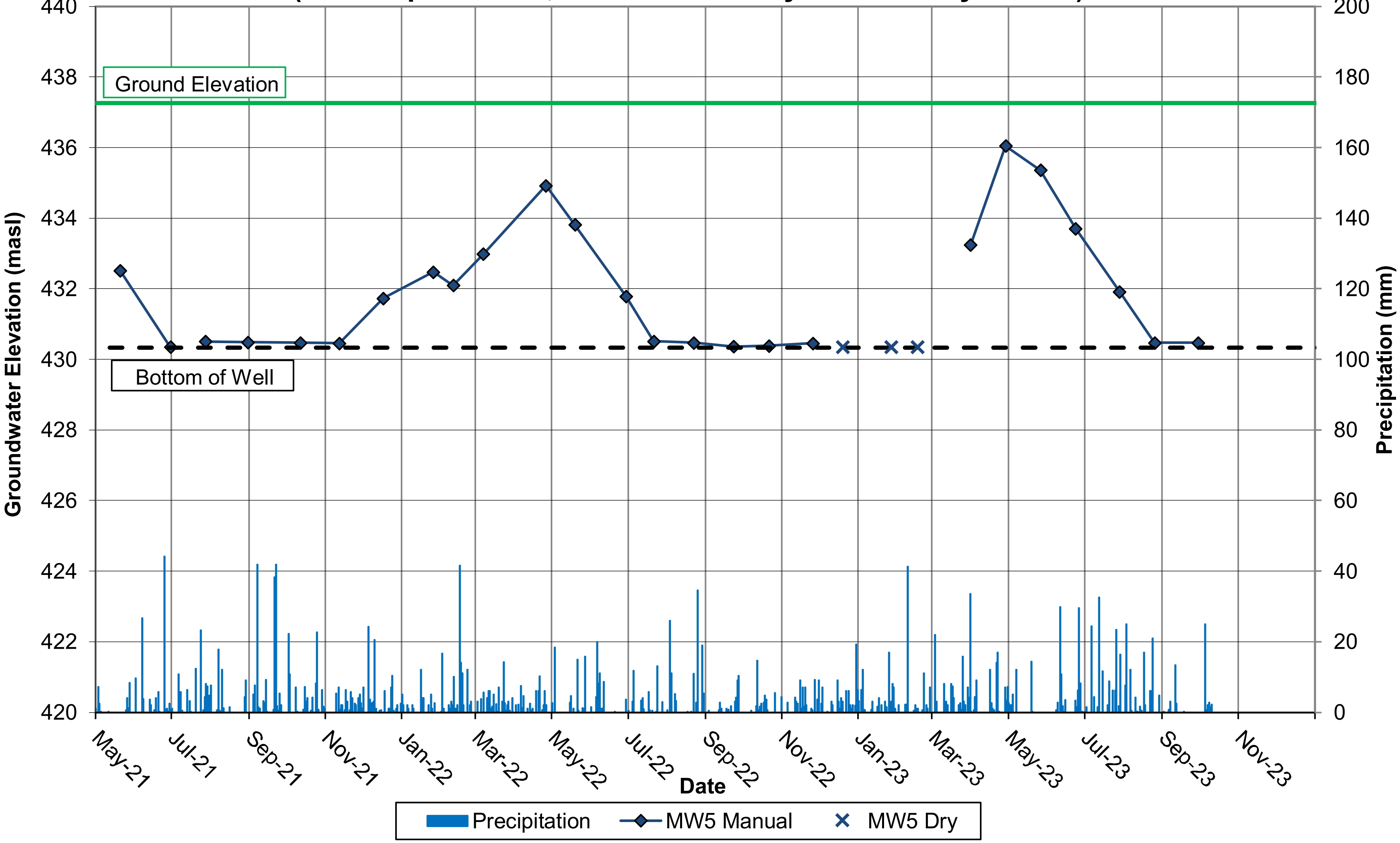

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Figure D-5

# MW6s/d
# Groundwater Elevations
# (MW6s - Well Depth: 9.3 m, Screened in Silty Sand Till)
# (MW6d - Well Depth: 12.0 m, Screened in Silty Sand Till)

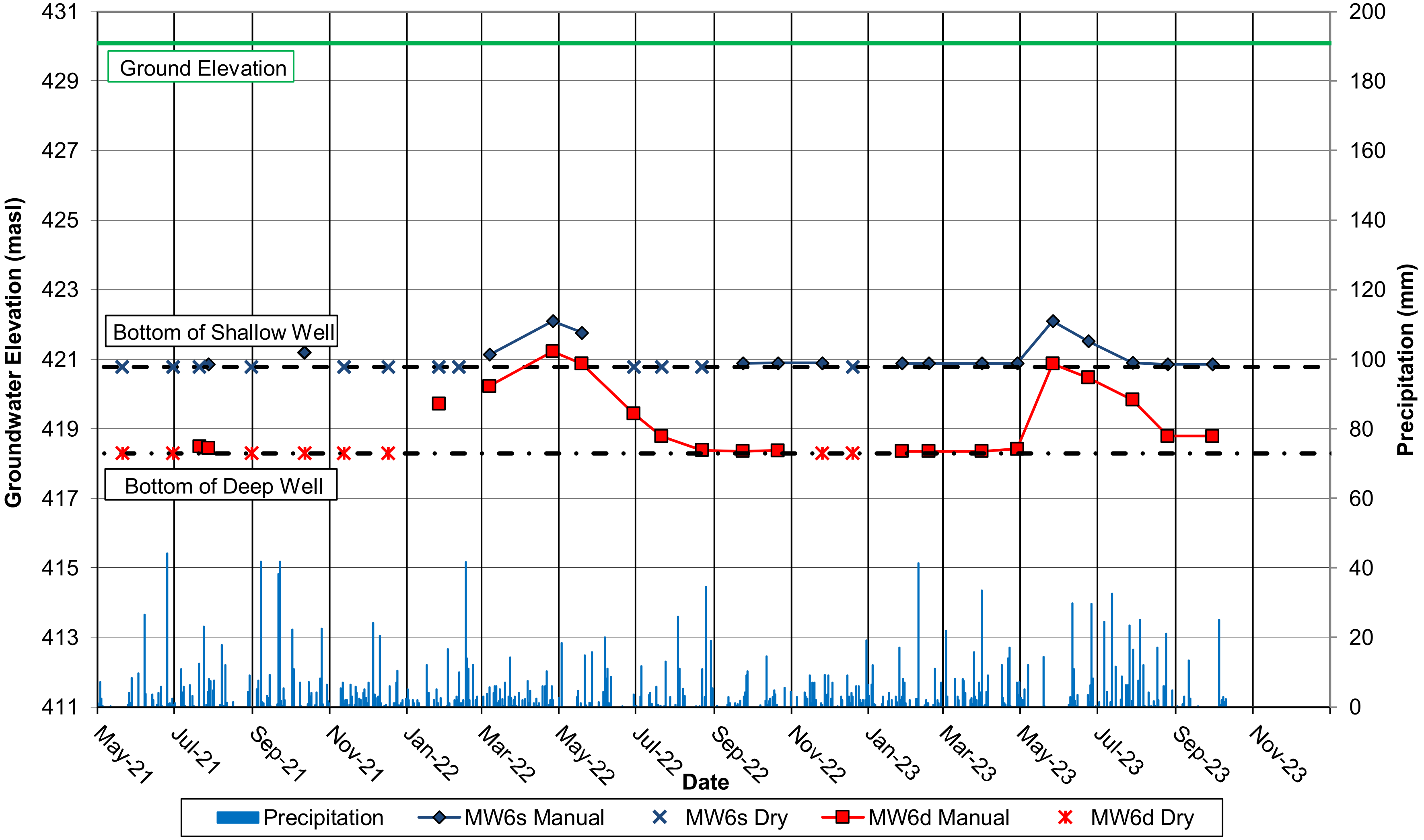

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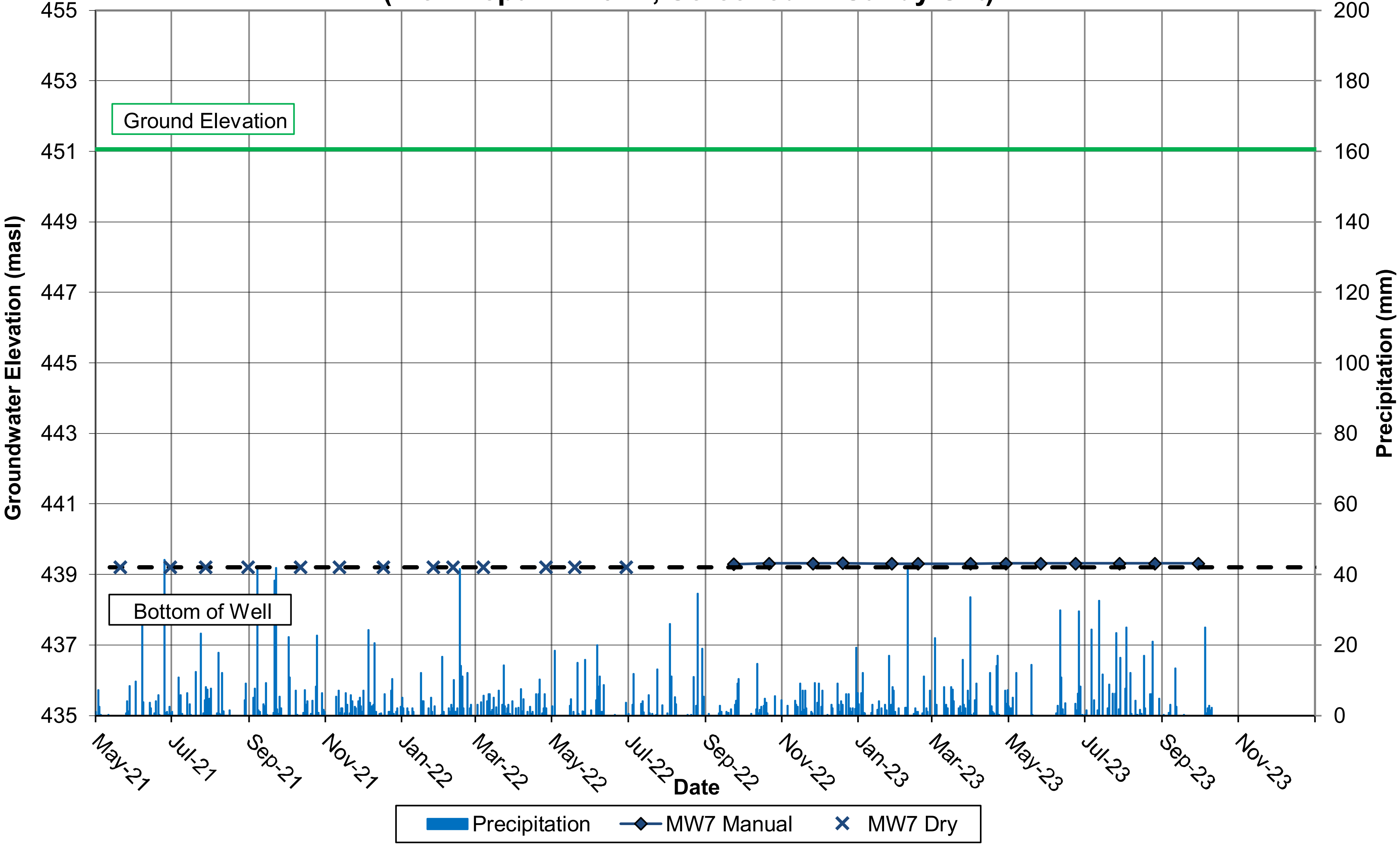
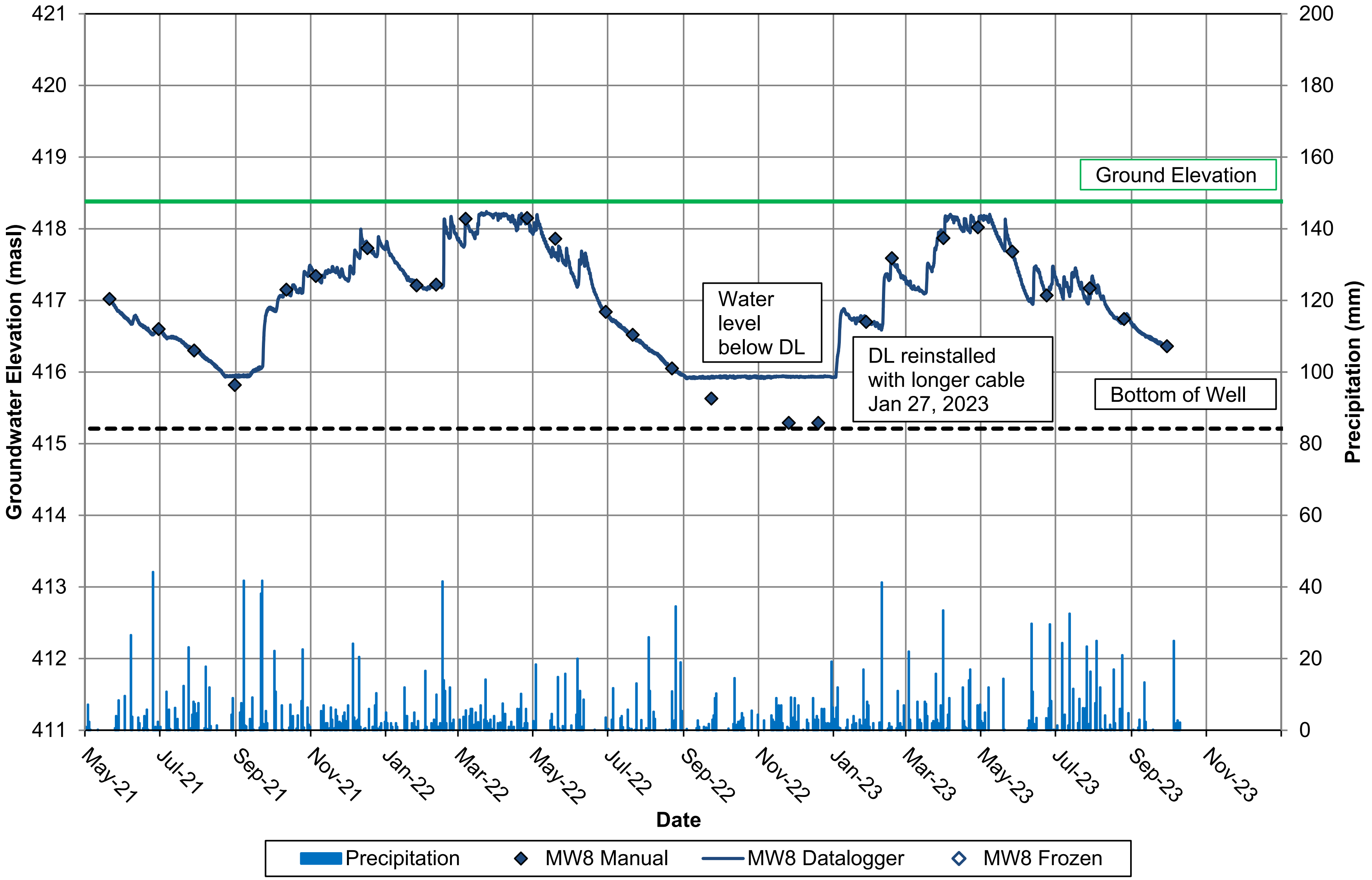
Figure D-6

# MW7
# Groundwater Elevations
# (Well Depth: 11.9 m, Screened in Sandy Silt)



# MW8
# Groundwater Elevation
# (Well Depth: 3.2 m, Screened in Silty Sand)



## MW9
## Groundwater Elevations
## (Well Depth: 4.6 m, Screened in Sandy Gravel)

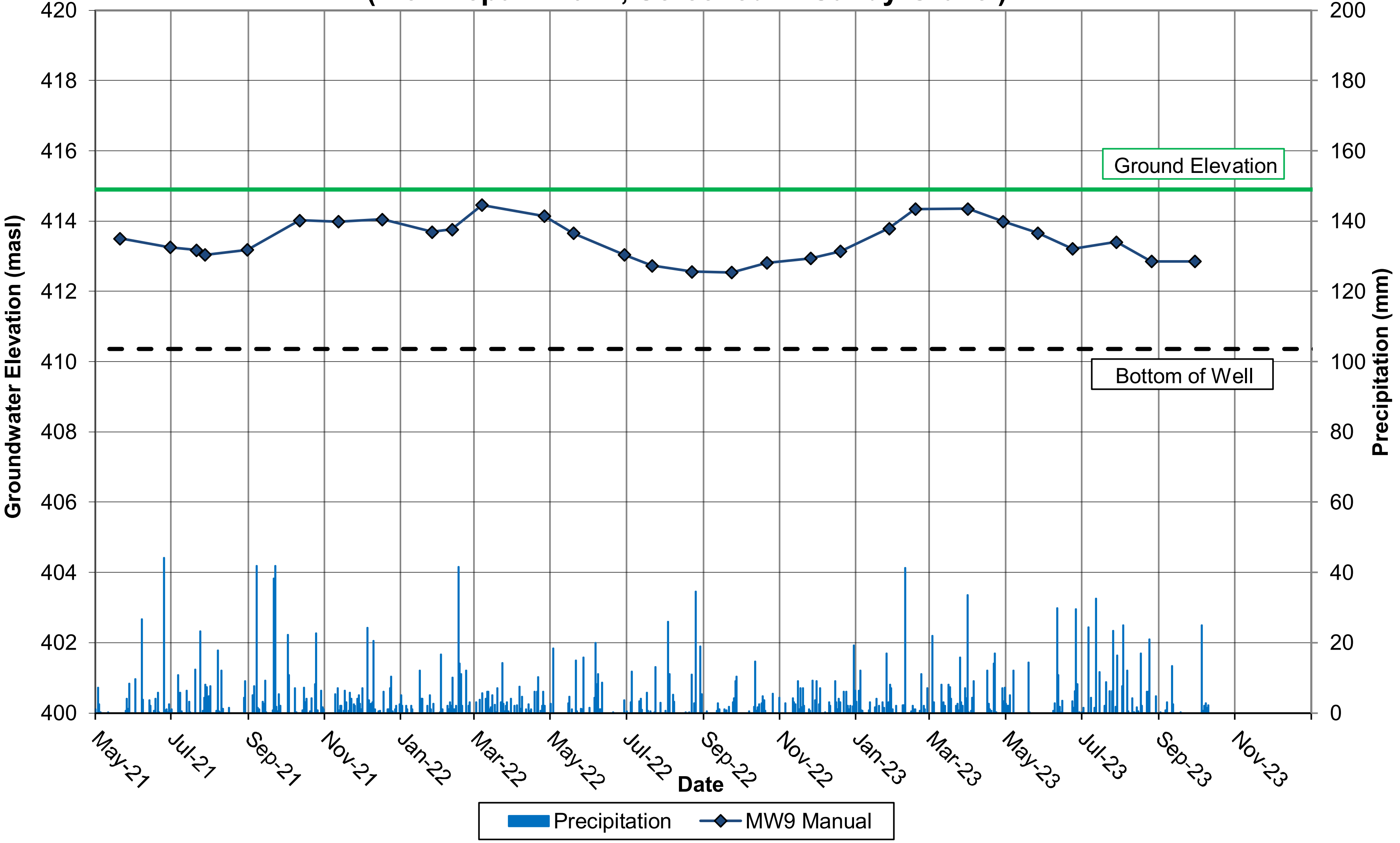


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Figure D-9

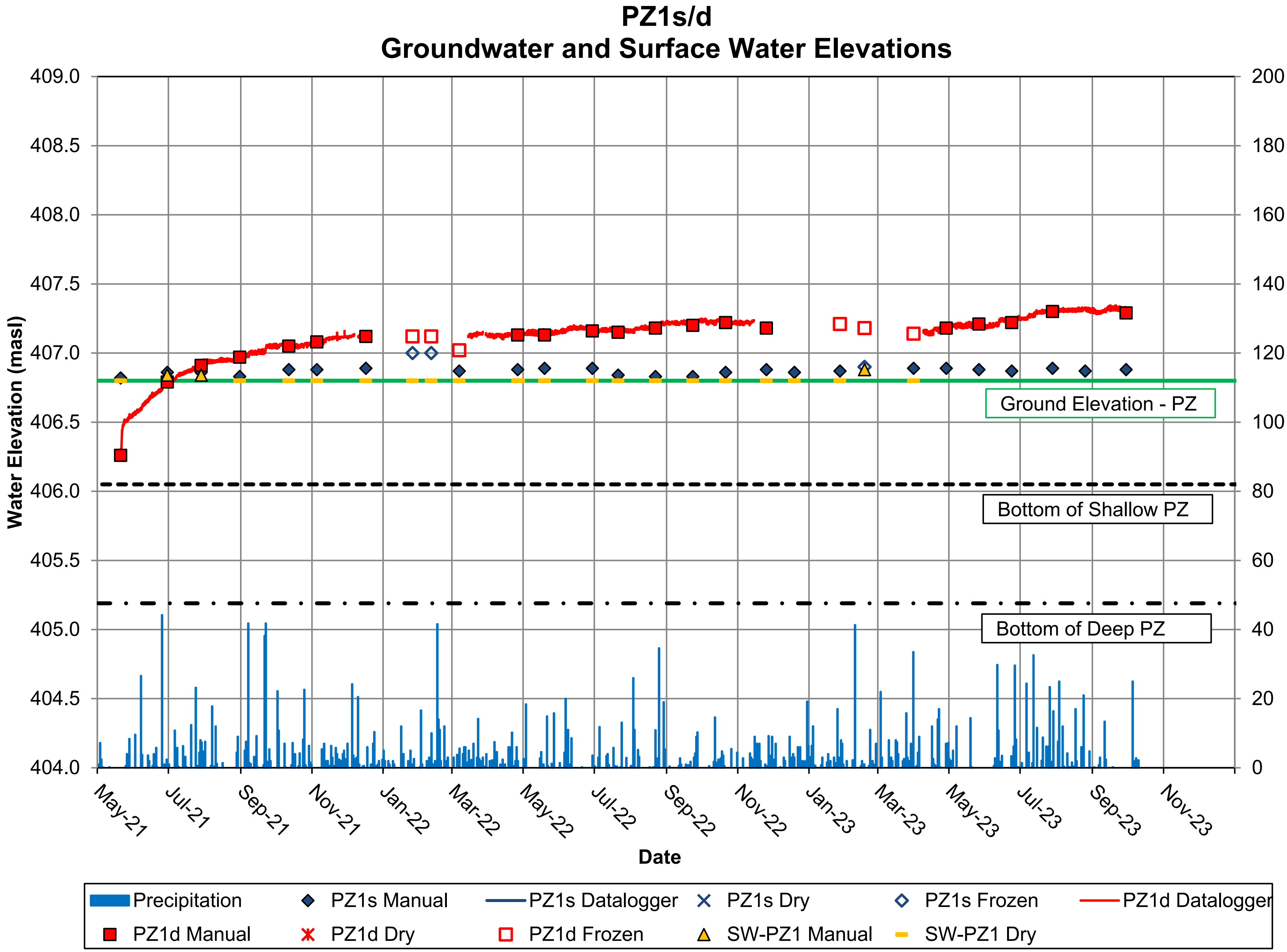
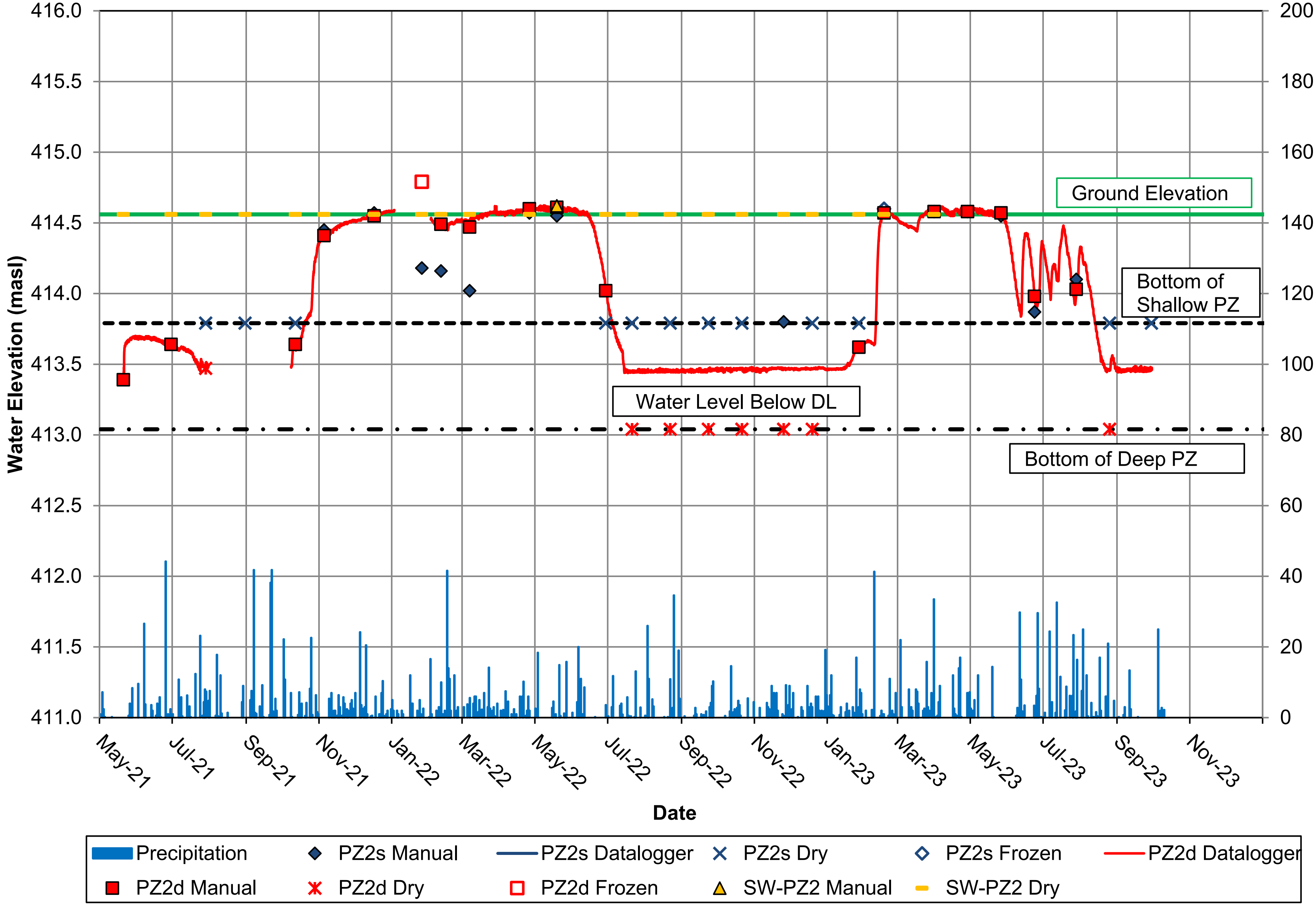
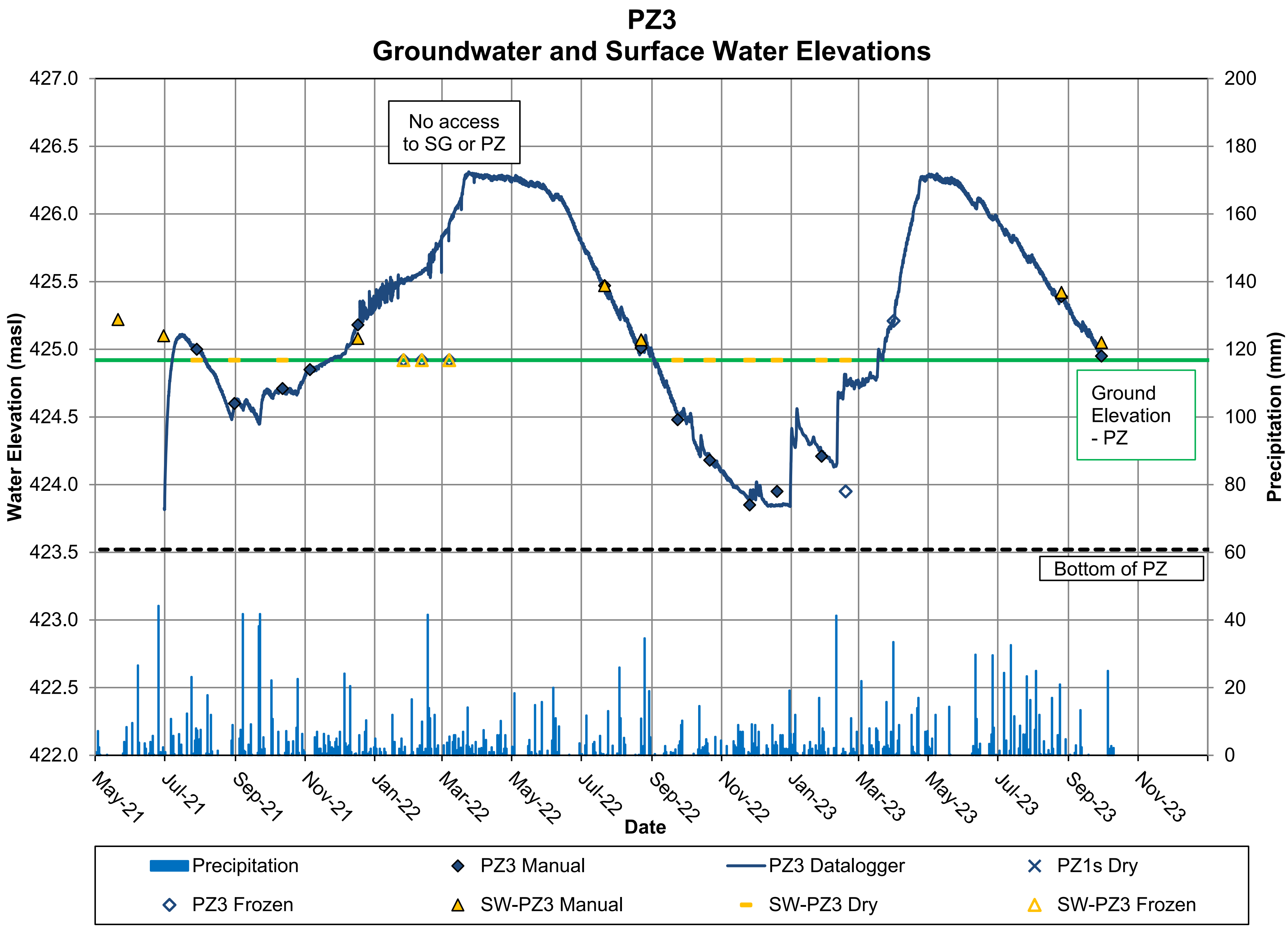

PZ1s/d
Groundwater and Surface Water Elevations
Water Elevation (masl)
409.0
408.5
408.0
407.5
407.0
406.5
406.0
405.5
405.0
404.5
404.0
Precipitation (mm)
200
180
160
140
120
100
80
60
40
20
0
Ground Elevation - PZ
Bottom of Shallow PZ
Bottom of Deep PZ
May-21
Jul-21
Sep-21
Nov-21
Jan-22
Mar-22
May-22
Jul-22
Sep-22
Nov-22
Jan-23
Mar-23
May-23
Jul-23
Sep-23
Nov-23
Date
Precipitation
PZ1s Manual
PZ1s Datalogger
PZ1s Dry
PZ1s Frozen
PZ1d Datalogger
PZ1d Manual
PZ1d Dry
PZ1d Frozen
SW-PZ1 Manual
SW-PZ1 Dry

Figure D-10

# PZ2s/d
# Groundwater and Surface Water Elevations




PZ3
Groundwater and Surface Water Elevations
Water Elevation (masl)
Precipitation (mm)
Date
427.0
426.5
426.0
425.5
425.0
424.5
424.0
423.5
423.0
422.5
422.0
200
180
160
140
120
100
80
60
40
20
0
May-21
Jul-21
Sep-21
Nov-21
Jan-22
Mar-22
May-22
Jul-22
Sep-22
Nov-22
Jan-23
Mar-23
May-23
Jul-23
Sep-23
Nov-23
No access to SG or PZ
Ground Elevation - PZ
Bottom of PZ
Precipitation
PZ3 Manual
PZ3 Datalogger
PZ1s Dry
PZ3 Frozen
SW-PZ3 Manual
SW-PZ3 Dry
SW-PZ3 Frozen

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# Appendix E

# Surface Water Monitoring

# Table E-1
# Surface Water Flow

| Date | Flow Rate (L/s) at SW1 |
|---|---|
| 21-May-21 | Dry |
| 30-Jun-21 | Dry |
| 28-Jul-21 | Dry |
| 31-Aug-21 | Dry |
| 10-Oct-21 | Dry |
| 12-Nov-21 | Dry |
| 17-Dec-21 | Dry |
| 26-Jan-22 | Dry |
| 11-Feb-22 | Dry |
| 7-Mar-22 | Dry |
| 26-Apr-22 | <0.5 |

Note:
"<0.5" minimal flow not measurable with equipment (estimated)

# Table E-2 -
# Surface Water Elevations

| **Staff Gauge** | **SG1** | | **SW-PZ1** | | **SW-PZ2** | | **SW-PZ3** | |
|---|---|---|---|---|---|---|---|---|
| **Ground Elevation (masl)** | **399.72** | | **406.83** | | **414.59** | | **424.92** | |
| **Date** | **Water Level (mags)** | **Water Elevation (masl)** | **Water Level (mags)** | **Water Elevation (masl)** | **Water Level (mags)** | **Water Elevation (masl)** | **Water Level (mags)** | **Water Elevation (masl)** |
| **21-May-21** | 0.11 | 399.83 | Dry | Dry | Dry | Dry | 0.3 | 425.22 |
| **30-Jun-21** | 0.34 | 400.06 | 0.04 | 406.87 | Dry | Dry | 0.18 | 425.10 |
| **28-Jul-21** | 0.20 | 399.92 | 0.04 | 406.87 | Dry | Dry | Dry | Dry |
| **31-Aug-21** | 0.04 | 399.76 | Dry | Dry | Dry | Dry | Dry | Dry |
| **10-Oct-21** | 0.20 | 399.92 | Dry | Dry | Dry | Dry | Dry | Dry |
| **12-Nov-21** | 0.30 | 400.02 | Dry | Dry | Dry | Dry | Dry | Dry |
| **17-Dec-21** | 0.57 | 400.29 | Dry | Dry | Dry | Dry | 0.16 | 425.08 |
| **26-Jan-22** | Frozen | Frozen | Dry | Dry | Dry | Dry | Frozen | Frozen |
| **11-Feb-22** | Frozen | Frozen | Dry | Dry | Frozen | Dry | Frozen | Frozen |
| **7-Mar-22** | Frozen | Frozen | Dry | Dry | Frozen | Dry | Frozen | Frozen |
| **26-Apr-22** | 0.75 | 400.47 | Dry | Dry | 1.00 | 415.59 | 0.15 | 425.07 |
| **19-May-22** | 0.65 | 400.37 | Dry | Dry | 1.00 | 415.59 | 0.20 | 425.12 |
| **29-Jun-22** | 0.60 | 400.32 | Dry | Dry | Dry | Dry | Dry | Dry |
| **21-Jul-22** | 0.45 | 400.17 | Dry | Dry | Dry | Dry | 0.55 | 425.47 |
| **22-Aug-22** | 0.34 | 400.06 | Dry | Dry | Dry | Dry | 0.15 | 425.07 |
| **23-Sep-22** | 0.15 | 399.87 | Dry | Dry | Dry | Dry | Dry | Dry |
| **21-Oct-22** | Dry | Dry | Dry | Dry | Dry | Dry | Dry | Dry |
| **25-Nov-22** | Staff Guage Destroyed | | Dry | Dry | Dry | Dry | Dry | Dry |
| **19-Dec-22** | - | - | Dry | Dry | Dry | Dry | Dry | Dry |
| **27-Jan-23** | - | - | Dry | Dry | Dry | Dry | Dry | Dry |
| **17-Feb-23** | - | - | 0.08 | 406.91 | Dry | Dry | Dry | Dry |
| **31-Mar-23** | - | - | Dry | Dry | Dry | Dry | Frozen | Frozen |
| **28-Apr-23** | - | - | Min | Min | Min | Min | Flooded | Flooded |
| **26-May-23** | - | - | Min | Min | Min | Min | Flooded | Flooded |
| **23-Jun-23** | - | - | Min | Min | Dry | Dry | Flooded | Flooded |
| **28-Jul-23** | - | - | Min | Min | Dry | Dry | Flooded | Flooded |
| **25-Aug-23** | - | - | Min | Min | Dry | Dry | 0.94 | 425.86 |
| **29-Sep-23** | - | - | Min | Min | Dry | Dry | 1.31 | 426.23 |

mags - metres above ground surface

masl - metres above sea level

Ground surface elevations surveyed by RP-E Surving Ltd. (Aug. 24, 2021)

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# Appendix F

# Water Quality

# Table F-1
# Groundwater Quality

| Sample Description | | | | MW1d | MW9 |
|---|---|---|---|---|---|
| Date Sampled | | | | 12-June-21 | 12-June-21 |
| **Parameter** | **Unit** | **ODWQS** | **RDL** | | |
| Electrical Conductivity | µS/cm | | 2 | 499 | 527 |
| pH | pH Units | (6.5-8.5) | NA | 8.13 | 8.02 |
| Saturation pH (Calculated) | | | | 7.01 | 7.03 |
| Langelier Index (Calculated) | | | | 1.12 | 0.992 |
| Hardness (as CaCO3) (Calculated) | mg/L | (80-100) | 0.5 | **267** | **270** |
| Total Dissolved Solids | mg/L | (500) | 10 | 284 | 310 |
| Alkalinity (as CaCO3) | mg/L | (30-500) | 5 | 245 | 252 |
| Bicarbonate (as CaCO3) | mg/L | | 5 | 245 | 252 |
| Carbonate (as CaCO3) | mg/L | | 5 | <5 | <5 |
| Hydroxide (as CaCO3) | mg/L | | 5 | <5 | <5 |
| Fluoride | mg/L | 1.5 | 0.05 | 0.09 | <0.05 |
| Chloride | mg/L | (250) | 0.10 | 11.2 | 5.31 |
| Nitrate as N | mg/L | 10 | 0.05 | <0.05 | 0.43 |
| Nitrite as N | mg/L | 1 | 0.05 | <0.05 | <0.05 |
| Bromide | mg/L | | 0.05 | <0.05 | <0.05 |
| Sulphate | mg/L | (500) | 0.10 | 18.7 | 26.8 |
| Ortho Phosphate as P | mg/L | | 0.10 | <0.10 | <0.10 |
| Ammonia as N | mg/L | | 0.02 | <0.02 | <0.02 |
| Total Phosphorus | mg/L | | 0.02 | <0.02 | <0.02 |
| Total Organic Carbon | mg/L | | 0.5 | 17.7 | 4.8 |
| True Colour | TCU | (5) | 5 | <5 | <5 |
| Turbidity | NTU | (5) | 0.5 | **21300** | **33600** |
| Dissolved Calcium | mg/L | | 0.05 | 42.2 | 68.4 |
| Dissolved Magnesium | mg/L | | 0.05 | 39.3 | 24.0 |
| Dissolved Potassium | mg/L | | 0.50 | 4.33 | 1.85 |
| Dissolved Sodium | mg/L | 20 (200) | 0.05 | 9.03 | 3.62 |
| Dissolved Aluminum | mg/L | | 0.004 | 0.020 | 0.039 |
| Dissolved Antimony | mg/L | 0.006 | 0.001 | <0.001 | <0.001 |
| Dissolved Arsenic | mg/L | 0.025 | 0.001 | 0.001 | <0.001 |
| Dissolved Barium | mg/L | 1 | 0.002 | 0.064 | 0.086 |
| Dissolved Beryllium | mg/L | | 0.0005 | <0.0005 | <0.0005 |
| Dissolved Boron | mg/L | 5 | 0.010 | 0.052 | 0.018 |
| Dissolved Cadmium | mg/L | 0.005 | 0.0001 | <0.0001 | <0.0001 |
| Dissolved Chromium | mg/L | 0.05 | 0.002 | <0.002 | <0.002 |
| Dissolved Cobalt | mg/L | | 0.0005 | 0.0012 | <0.0005 |
| Dissolved Copper | mg/L | (1) | 0.001 | 0.001 | 0.001 |
| Dissolved Iron | mg/L | (0.3) | 0.010 | <0.010 | 0.019 |
| Dissolved Lead | mg/L | 0.01 | 0.0005 | <0.0005 | <0.0005 |
| Dissolved Manganese | mg/L | (0.05) | 0.002 | **0.097** | 0.005 |
| Dissolved Mercury | mg/L | 0.001 | 0.0001 | <0.0001 | <0.0001 |
| Dissolved Molybdenum | mg/L | | 0.002 | 0.014 | 0.002 |
| Dissolved Nickel | mg/L | | 0.003 | 0.007 | <0.003 |
| Dissolved Selenium | mg/L | 0.01 | 0.001 | <0.001 | 0.003 |
| Dissolved Silver | mg/L | | 0.0001 | <0.0001 | <0.0001 |
| Dissolved Strontium | mg/L | | 0.005 | 0.278 | 0.147 |
| Dissolved Thallium | mg/L | | 0.0003 | <0.0003 | <0.0003 |
| Dissolved Tin | mg/L | | 0.002 | <0.002 | <0.002 |
| Dissolved Titanium | mg/L | | 0.002 | 0.002 | <0.002 |
| Dissolved Tungsten | mg/L | | 0.010 | <0.010 | <0.010 |
| Dissolved Uranium | mg/L | 0.02 | 0.0005 | 0.0012 | 0.0016 |
| Dissolved Vanadium | mg/L | | 0.002 | <0.002 | <0.002 |
| Dissolved Zinc | mg/L | (5) | 0.005 | <0.005 | <0.005 |
| Dissolved Zirconium | mg/L | | 0.004 | <0.004 | <0.004 |

**Notes**

ODWQS - Ontario Drinking Water Quality Standards - MAC and (AO & OG)

RDL - Reporting Detection Limit

Bold indicates an exceedance of the ODWQS

# Table F-2
# Surface Water Quality

| | | | Sample Location | Surface Water at PZ1sd |
|---|---|---|---|---|
| | | | Date Sampled | 12-June-21 |
| **Parameter** | **Unit** | **PWQO** | **RDL** | |
| Electrical Conductivity | µS/cm | | 2 | 587 |
| pH | pH Units | 6.5-8.5 | NA | 8.11 |
| Saturation pH (Calculated) | | | | 6.80 |
| Langelier Index (Calculated) | | | | 1.31 |
| Hardness (as CaCO3) (Calculated) | mg/L | | 0.5 | 363 |
| Total Dissolved Solids | mg/L | | 10 | 360 |
| Alkalinity (as CaCO3) | mg/L | | 5 | 315 |
| Bicarbonate (as CaCO3) | mg/L | | 5 | 315 |
| Carbonate (as CaCO3) | mg/L | | 5 | <5 |
| Hydroxide (as CaCO3) | mg/L | | 5 | <5 |
| Fluoride | mg/L | | 0.05 | 0.15 |
| Chloride | mg/L | | 0.10 | 3.52 |
| Nitrate as N | mg/L | | 0.05 | 1.01 |
| Nitrite as N | mg/L | | 0.05 | <0.05 |
| Bromide | mg/L | | 0.05 | <0.05 |
| Sulphate | mg/L | | 0.10 | 5.68 |
| Ortho Phosphate as P | mg/L | | 0.10 | <0.10 |
| Ammonia as N | mg/L | | 0.02 | 0.04 |
| Ammonia-Un-ionized (Calculated) | mg/L | 0.02 | 0.000002 | 0.00315 |
| Total Phosphorus | mg/L | 0.03 | 0.02 | **0.07** |
| Total Organic Carbon | mg/L | | 0.5 | 5.9 |
| True Colour | TCU | | 5 | 23 |
| Turbidity | NTU | | 0.5 | 49.6 |
| Total Calcium | mg/L | | 0.16 | 100 |
| Total Magnesium | mg/L | | 0.17 | 27.6 |
| Total Potassium | mg/L | | 0.58 | 0.75 |
| Dissolved Aluminum | mg/L | | 0.004 | 0.006 |
| Total Sodium | mg/L | | 0.22 | 2.57 |
| Total Antimony | mg/L | 0.020 | 0.002 | <0.002 |
| Total Arsenic | mg/L | 0.1 | 0.006 | <0.006 |
| Total Barium | mg/L | | 0.004 | 0.093 |
| Total Beryllium | mg/L | 1.1 | 0.0010 | <0.0010 |
| Total Boron | mg/L | 0.2 | 0.020 | 0.028 |
| Total Cadmium | mg/L | 0.0002 | 0.0002 | **0.0003** |
| Total Chromium | mg/L | | 0.006 | <0.006 |
| Total Cobalt | mg/L | 0.0009 | 0.0010 | **0.0015** |
| Total Copper | mg/L | 0.005 | 0.002 | **0.006** |
| Total Iron | mg/L | 0.3 | 0.020 | **12.1** |
| Total Lead | mg/L | 0.005 | 0.002 | **0.008** |
| Total Manganese | mg/L | | 0.004 | 1.16 |
| Dissolved Mercury | mg/L | 0.0002 | 0.0001 | <0.0001 |
| Total Molybdenum | mg/L | 0.040 | 0.004 | <0.004 |
| Total Nickel | mg/L | 0.025 | 0.006 | <0.006 |
| Total Selenium | mg/L | 0.1 | 0.004 | <0.004 |
| Total Silver | mg/L | 0.0001 | 0.0002 | <0.0002 |
| Total Strontium | mg/L | | 0.010 | 0.192 |
| Total Thallium | mg/L | 0.0003 | 0.0006 | <0.0006 |
| Total Tin | mg/L | | 0.004 | <0.004 |
| Total Titanium | mg/L | | 0.004 | 0.048 |
| Total Tungsten | mg/L | 0.030 | 0.020 | <0.020 |
| Total Uranium | mg/L | 0.005 | 0.004 | <0.004 |
| Total Vanadium | mg/L | 0.006 | 0.004 | 0.006 |
| Total Zinc | mg/L | 0.030 | 0.010 | **0.123** |
| Total Zirconium | mg/L | 0.004 | 0.008 | <0.008 |

**Notes**

PWQO - Provincial Water Quality Objectives

RDL - Reporting Detection Limit

**Bold** - exceeds PWQO

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# Appendix G

## Water Balance

**WATER BALANCE CALCULATIONS**

Hydrogeological Assessment - Langen Property
Erin, ON
PROJECT No.300052075

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# 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 Fergus Shand Dam Climate Station (1981 - 2010)**

| **Potential Evapotranspiration Calculation** | **JAN** | **FEB** | **MAR** | **APR** | **MAY** | **JUN** | **JUL** | **AUG** | **SEP** | **OCT** | **NOV** | **DEC** | **YEAR** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average Temperature (Degree C) | -7.4 | -6.3 | -1.9 | 5.7 | 12.2 | 17.5 | 20.0 | 19.0 | 14.9 | 8.3 | 2.1 | -3.9 | **6.7** |
| Heat index: i = $(t/5)^{1.514}$ | 0.00 | 0.00 | 0.00 | 1.22 | 3.86 | 6.66 | 8.16 | 7.55 | 5.22 | 2.15 | 0.27 | 0.00 | **35.1** |
| Unadjusted Daily Potential Evapotranspiration U (mm) | 0.00 | 0.00 | 0.00 | 26.65 | 59.36 | 86.76 | 99.85 | 94.61 | 73.26 | 39.58 | 9.32 | 0.00 | **489** |
| Adjusting Factor for U (Latitude $43^{o}$ 44' 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 | 30 | 75 | 112 | 130 | 114 | 76 | 38 | 7 | 0 | **582** |
| | | | | | | | | | | | | | |
| **WATER BALANCE COMPONENTS** | **JAN** | **FEB** | **MAR** | **APR** | **MAY** | **JUN** | **JUL** | **AUG** | **SEP** | **OCT** | **NOV** | **DEC** | **YEAR** |
| Precipitation (P) | 68 | 56 | 60 | 74 | 87 | 84 | 89 | 97 | 93 | 77 | 93 | 69 | **946** |
| Potential Evapotranspiration (PET) | 0 | 0 | 0 | 30 | 75 | 112 | 130 | 114 | 76 | 38 | 7 | 0 | **582** |
| P - PET | 68 | 56 | 60 | 44 | 12 | -28 | -41 | -17 | 17 | 40 | 86 | 69 | **364** |
| Change in Soil Moisture Storage | 0 | 0 | 0 | 0 | 0 | -28 | -41 | -17 | 17 | 40 | 29 | 0 | **0** |
| Soil Moisture Storage max 150 mm | 150 | 150 | 150 | 150 | 150 | 122 | 81 | 64 | 81 | 121 | 150 | 150 | |
| Actual Evapotranspiration (AET) | 0 | 0 | 0 | 30 | 75 | 112 | 130 | 114 | 76 | 38 | 7 | 0 | **582** |
| Soil Moisture Deficit max 150 mm | 0 | 0 | 0 | 0 | 0 | 28 | 69 | 86 | 69 | 29 | 0 | 0 | |
| Water Surplus - available for infiltration or runoff | 68 | 56 | 60 | 44 | 12 | 0 | 0 | 0 | 0 | 0 | 56 | 69 | **364** |
| Potential Infiltration (based on MOE methodology*; independent of temperature) | 41 | 34 | 36 | 26 | 7 | 0 | 0 | 0 | 0 | 0 | 34 | 41 | **218** |
| Potential Direct Surface Water Runoff (independent of temperature) | 27 | 22 | 24 | 18 | 5 | 0 | 0 | 0 | 0 | 0 | 23 | 27 | **146** |
| | | | | | | | | | | | | | |
| **IMPERVIOUS AREA WATER SURPLUS** | | | | | | | | | | | | | |
| Precipitation (P) | 946 | mm/year | | | | | | | | | | | |
| Potential Evaporation (PE) from impervious areas (assume 15%) | 142 | mm/year | | | | | | | | | | | |
| P-PE (surplus available for runoff from impervious areas) | 804 | 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 | 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**

Hydrogeological Assessment - Langen Property
Erin, ON
PROJECT No.300052075

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# TABLE G-2

**Water Balance Components**

**Based on Thornthwaite's Soil Moisture Balance Approach with a Soil Moisture Retention of 300 mm (wooded areas in sandy loam soils)**

**Precipitation data from Fergus Shand Dam Climate Station (1981 - 2010)**

| **Potential Evapotranspiration Calculation** | **JAN** | **FEB** | **MAR** | **APR** | **MAY** | **JUN** | **JUL** | **AUG** | **SEP** | **OCT** | **NOV** | **DEC** | **YEAR** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average Temperature (Degree C) | -7.4 | -6.3 | -1.9 | 5.7 | 12.2 | 17.5 | 20.0 | 19.0 | 14.9 | 8.3 | 2.1 | -3.9 | **6.7** |
| Heat index: $i = (t/5)^{1.514}$ | 0.00 | 0.00 | 0.00 | 1.22 | 3.86 | 6.66 | 8.16 | 7.55 | 5.22 | 2.15 | 0.27 | 0.00 | **35.1** |
| Unadjusted Daily Potential Evapotranspiration U (mm) | 0.00 | 0.00 | 0.00 | 26.65 | 59.36 | 86.76 | 99.85 | 94.61 | 73.26 | 39.58 | 9.32 | 0.00 | **489** |
| Adjusting Factor for U (Latitude 43° 44' 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 | 30 | 75 | 112 | 130 | 114 | 76 | 38 | 7 | 0 | **582** |
| | | | | | | | | | | | | | |
| **WATER BALANCE COMPONENTS** | **JAN** | **FEB** | **MAR** | **APR** | **MAY** | **JUN** | **JUL** | **AUG** | **SEP** | **OCT** | **NOV** | **DEC** | **YEAR** |
| Precipitation (P) | 68 | 56 | 60 | 74 | 87 | 84 | 89 | 97 | 93 | 77 | 93 | 69 | **946** |
| Potential Evapotranspiration (PET) | 0 | 0 | 0 | 30 | 75 | 112 | 130 | 114 | 76 | 38 | 7 | 0 | **582** |
| P - PET | 68 | 56 | 60 | 44 | 12 | -28 | -41 | -17 | 17 | 40 | 86 | 69 | **364** |
| Change in Soil Moisture Storage | 0 | 0 | 0 | 0 | 0 | -28 | -41 | -17 | 17 | 40 | 29 | 0 | **0** |
| Soil Moisture Storage max 300 mm | 300 | 300 | 300 | 300 | 300 | 272 | 231 | 214 | 231 | 271 | 300 | 300 | |
| Actual Evapotranspiration (AET) | 0 | 0 | 0 | 30 | 75 | 112 | 130 | 114 | 76 | 38 | 7 | 0 | **582** |
| Soil Moisture Deficit max 300 mm | 0 | 0 | 0 | 0 | 0 | 28 | 69 | 86 | 69 | 29 | 0 | 0 | |
| Water Surplus - available for infiltration or runoff | 68 | 56 | 60 | 44 | 12 | 0 | 0 | 0 | 0 | 0 | 56 | 69 | **364** |
| Potential Infiltration (based on MOE metholodogy*; independent of temperature) | 48 | 39 | 42 | 31 | 8 | 0 | 0 | 0 | 0 | 0 | 39 | 48 | **255** |
| Potential Direct Surface Water Runoff (independent of temperature) | 20 | 17 | 18 | 13 | 3 | 0 | 0 | 0 | 0 | 0 | 17 | 21 | **109** |
| | | | | | | | | | | | | | |
| **IMPERVIOUS AREA WATER SURPLUS** | | | | | | | | | | | | | |
| Precipitation (P) | 946 | mm/year | | | | | | | | | | | |
| Potential Evaporation (PE) from impervious areas (assume 15%) | 142 | mm/year | | | | | | | | | | | |
| P-PE (surplus available for runoff from impervious areas) | 804 | mm/year | | | | | | | | | | | |

Assume January storage is 100% of Soil Moisture Storage
Soil Moisture Storage 300 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 - woodlands | 0.2 | <-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003 |
| **Infiltration factor** | **0.7** | |

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

**WATER BALANCE CALCULATIONS**

Hydrogeological Assessment - Langen Property
Erin, ON
PROJECT No.300052075

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# TABLE G-3

**Post-Development Water Balance Components**

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

**Precipitation data from Fergus Shand Dam Climate Station (1981 - 2010)**

| **Potential Evapotranspiration Calculation** | **JAN** | **FEB** | **MAR** | **APR** | **MAY** | **JUN** | **JUL** | **AUG** | **SEP** | **OCT** | **NOV** | **DEC** | **YEAR** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average Temperature (Degree C) | -7.4 | -6.3 | -1.9 | 5.7 | 12.2 | 17.5 | 20.0 | 19.0 | 14.9 | 8.3 | 2.1 | -3.9 | **6.7** |
| Heat index: $i = (t/5)^{1.514}$ | 0.00 | 0.00 | 0.00 | 1.22 | 3.86 | 6.66 | 8.16 | 7.55 | 5.22 | 2.15 | 0.27 | 0.00 | **35.1** |
| Unadjusted Daily Potential Evapotranspiration U (mm) | 0.00 | 0.00 | 0.00 | 26.65 | 59.36 | 86.76 | 99.85 | 94.61 | 73.26 | 39.58 | 9.32 | 0.00 | **489** |
| Adjusting Factor for U (Latitude 43° 44' 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 | 30 | 75 | 112 | 130 | 114 | 76 | 38 | 7 | 0 | **582** |
| | | | | | | | | | | | | | |
| **WATER BALANCE COMPONENTS** | **JAN** | **FEB** | **MAR** | **APR** | **MAY** | **JUN** | **JUL** | **AUG** | **SEP** | **OCT** | **NOV** | **DEC** | **YEAR** |
| Precipitation (P) | 68 | 56 | 60 | 74 | 87 | 84 | 89 | 97 | 93 | 77 | 93 | 69 | **946** |
| Potential Evapotranspiration (PET) | 0 | 0 | 0 | 30 | 75 | 112 | 130 | 114 | 76 | 38 | 7 | 0 | **582** |
| P - PET | 68 | 56 | 60 | 44 | 12 | -28 | -41 | -17 | 17 | 40 | 86 | 69 | **364** |
| Change in Soil Moisture Storage | 0 | 0 | 0 | 0 | 0 | -28 | -41 | -6 | 17 | 40 | 18 | 0 | **0** |
| Soil Moisture Storage max 75 mm | 75 | 75 | 75 | 75 | 75 | 47 | 6 | 0 | 17 | 57 | 75 | 75 | |
| Actual Evapotranspiration (AET) | 0 | 0 | 0 | 30 | 75 | 112 | 130 | 103 | 76 | 38 | 7 | 0 | **571** |
| Soil Moisture Deficit max 75 mm | 0 | 0 | 0 | 0 | 0 | 28 | 69 | 75 | 58 | 18 | 0 | 0 | |
| Water Surplus - available for infiltration or runoff | 68 | 56 | 60 | 44 | 12 | 0 | 0 | 0 | 0 | 0 | 67 | 69 | **375** |
| Potential Infiltration (based on MOE metholodogy*; independent of temperature) | 41 | 34 | 36 | 26 | 7 | 0 | 0 | 0 | 0 | 0 | 40 | 41 | **225** |
| Potential Direct Surface Water Runoff (independent of temperature) | 27 | 22 | 24 | 18 | 5 | 0 | 0 | 0 | 0 | 0 | 27 | 27 | **150** |
| | | | | | | | | | | | | | |
| **IMPERVIOUS AREA WATER SURPLUS** | | | | | | | | | | | | | |
| Precipitation (P) | 946 | mm/year | | | | | | | | | | | |
| Potential Evaporation (PE) from impervious areas (assume 15%) | 142 | mm/year | | | | | | | | | | | |
| P-PE (surplus available for runoff from impervious areas) | 804 | 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 | 0.1 | <-- 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**

Hydrogeological Assessment - Langen Property
Erin, ON
PROJECT No.300052075

BURNSIDE

# TABLE G-4

## Water Balance for Pre- and Post-Development Land Use Conditions (with no SWM/LID measures in place) - 5552 Eighth Line

| | 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** | | | | | | | | | | | | |
| Agricultural | 156,000 | 0.00 | 0 | 0.804 | 0 | 156,000 | 0.146 | 22,706 | 0.218 | 34,060 | 22,706 | 34,060 |
| Rural Open Space/ Meadow | 93,034 | 0.00 | 0 | 0.804 | 0 | 93,034 | 0.146 | 13,541 | 0.225 | 20,907 | 13,541 | 20,907 |
| Woodland/Wetlands | 22,388 | 0.00 | 0 | 0.804 | 0 | 22,388 | 0.109 | 2,444 | 0.255 | 5,703 | 2,444 | 5,703 |
| **TOTAL PRE-DEVELOPMENT** | **271,422** | | **0** | | **0** | **271,422** | | **38,692** | | **60,670** | **38,692** | **60,670** |
| **Post-Development Land Use (with no LID measures in place)** | | | | | | | | | | | | |
| Single Detached | 71,478 | 0.64 | 45,746 | 0.804 | 36,780 | 25,732 | 0.150 | 3,855 | 0.225 | 5,783 | 40,635 | 5,783 |
| Townhouse | 24,500 | 0.71 | 17,395 | 0.804 | 13,986 | 7,105 | 0.150 | 1,064 | 0.225 | 1,597 | 15,050 | 1,597 |
| Medium Density Block | 32,000 | 1.00 | 32,000 | 0.804 | 25,728 | 0 | 0.150 | 0 | 0.225 | 0 | 25,728 | 0 |
| Pump Station | 1,500 | 1.00 | 1,500 | 0.804 | 1,206 | 0 | 0.150 | 0 | 0.225 | 0 | 1,206 | 0 |
| Grading Transition | 10,422 | 0.00 | 0 | 0.804 | 0 | 10,422 | 0.150 | 1,561 | 0.225 | 2,342 | 1,561 | 2,342 |
| Open Space | 4,000 | 0.00 | 0 | 0.804 | 0 | 4,000 | 0.150 | 599 | 0.225 | 899 | 599 | 899 |
| NHS | 32,600 | 0.00 | 0 | 0.804 | 0 | 32,600 | 0.109 | 3,559 | 0.255 | 8,304 | 3,559 | 8,304 |
| Parks | 19,600 | 0.36 | 7,056 | 0.804 | 5,673 | 12,544 | 0.150 | 1,879 | 0.225 | 2,819 | 7,552 | 2,819 |
| Roads | 42,422 | 0.86 | 36,483 | 0.804 | 29,333 | 5,939 | 0.150 | 890 | 0.225 | 1,335 | 30,223 | 1,335 |
| SWM Pond | 32,900 | 0.50 | 16,450 | 0.804 | 13,226 | 16,450 | 0.150 | 2,465 | 0.225 | 3,697 | 15,691 | 3,697 |
| **TOTAL POST-DEVELOPMENT** | **271,422** | | **156,630** | | **77,701** | **114,792** | | **15,873** | | **26,775** | **141,805** | **26,775** |
| | | | | | | | | | | % Change from Pre to Post | 366 | 56 |
| | | | | | | | | | | Effect of development (with no mitigation) | 3.7 times increase in runoff | 56% reduction of infiltration |

** figures from Tables G-1, G-2 and G-3.

To balance pre- to post-,
the infiltration target ($m^3$/a)= **33,895**

**WATER BALANCE CALCULATIONS**

Hydrogeological Assessment - Langen Property
Erin, ON
PROJECT No.300052075

BURNSIDE

# TABLE G-5

## Water Balance for Pre- and Post-Development Land Use Conditions (with no SWM/LID measures in place) - 5520 Eighth Line

| | 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** | | | | | | | | | | | | |
| Agricultural | 91,540 | 0.00 | 0 | 0.804 | 0 | 91,540 | 0.146 | 13,324 | 0.218 | 19,986 | 13,324 | 19,986 |
| Rural Open Space/ Meadow | 43,000 | 0.00 | 0 | 0.804 | 0 | 43,000 | 0.146 | 6,259 | 0.225 | 9,663 | 6,259 | 9,663 |
| Woodland/Wetlands | 225,610 | 0.00 | 0 | 0.804 | 0 | 225,610 | 0.109 | 24,629 | 0.255 | 57,467 | 24,629 | 57,467 |
| **TOTAL PRE-DEVELOPMENT** | **360,150** | | **0** | | **0** | **360,150** | | **44,212** | | **87,117** | **44,212** | **87,117** |
| **Post-Development Land Use (with no LID measures in place)** | | | | | | | | | | | | |
| Single Detached | 67,951 | 0.64 | 43,489 | 0.804 | 34,965 | 24,462 | 0.150 | 3,665 | 0.225 | 5,497 | 38,630 | 5,497 |
| Grading Transition | 21,349 | 0.00 | 0 | 0.804 | 0 | 21,349 | 0.150 | 3,199 | 0.225 | 4,798 | 3,199 | 4,798 |
| Open Space | 3,500 | 0.00 | 0 | 0.804 | 0 | 3,500 | 0.150 | 524 | 0.225 | 787 | 524 | 787 |
| NHS | 240,300 | 0.00 | 0 | 0.804 | 0 | 240,300 | 0.109 | 26,232 | 0.255 | 61,209 | 26,232 | 61,209 |
| Roads | 27,050 | 0.86 | 23,263 | 0.804 | 18,704 | 3,787 | 0.150 | 567 | 0.225 | 851 | 19,271 | 851 |
| **TOTAL POST-DEVELOPMENT** | **360,150** | | **66,752** | | **34,965** | **293,398** | | **34,188** | | **73,142** | **87,857** | **73,142** |
| | | | | | | | | | | % Change from Pre to Post | 199 | 16 |
| | | | | | | | | | | Effect of development (with no mitigation) | 2.0 times increase in runoff | 16% reduction of infiltration |

** figures from Tables G-1, G-2 and G-3.

To balance pre- to post-,
the infiltration target ($m^3$/a)= **13,975**

**WATER BALANCE CALCULATIONS**

Hydrogeological Assessment - Langen Property
Erin, ON
PROJECT No.300052075

BURNSIDE

# TABLE G-6

## Water Balance for Pre- and Post-Development Land Use Conditions (with SWM/LID measures) - 5552 Eighth Line

| | 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** | | | | | | | | | | | | |
| Agricultural | 156,000 | 0.00 | 0 | 0.804 | 0 | 156,000 | 0.146 | 22,706 | 0.218 | 34,060 | 22,706 | 34,060 |
| Rural Open Space/ Meadow | 93,034 | 0.00 | 0 | 0.804 | 0 | 93,034 | 0.146 | 13,541 | 0.225 | 20,907 | 13,541 | 20,907 |
| Woodland/Wetlands | 22,388 | 0.00 | 0 | 0.804 | 0 | 22,388 | 0.109 | 2,444 | 0.255 | 5,703 | 2,444 | 5,703 |
| **TOTAL PRE-DEVELOPMENT** | **271,422** | | **0** | | **0** | **271,422** | | **38,692** | | **60,670** | **38,692** | **60,670** |
| **Post-Development Land Use** | | | | | | | | | | | | |
| Single Detached | 71,478 | 0.64 | 45,746 | 0.804 | 36,780 | 25,732 | 0.150 | 3,855 | 0.225 | 5,783 | 22,245 | 5,783 |
| Roof leader disconnection (assume 50% of runoff volume infiltrates)[a] | | | | | | | | | | | 0 | 18,390 |
| Townhouse | 24,500 | 0.71 | 17,395 | 0.804 | 13,986 | 7,105 | 0.150 | 1,064 | 0.225 | 1,597 | 8,057 | 1,597 |
| Roof leader disconnection (assume 50% of runoff volume infiltrates)[a] | | | | | | | | | | | 0 | 6,993 |
| Medium Density Block | 32,000 | 1.00 | 32,000 | 0.804 | 25,728 | 0 | 0.150 | 0 | 0.225 | 0 | 25,728 | 0 |
| Pump Station | 1,500 | 1.00 | 1,500 | 0.804 | 1,206 | 0 | 0.150 | 0 | 0.225 | 0 | 1,206 | 0 |
| Grading Transition | 10,422 | 0.00 | 0 | 0.804 | 0 | 10,422 | 0.150 | 1,561 | 0.225 | 2,342 | 1,561 | 2,342 |
| Open Space | 4,000 | 0.00 | 0 | 0.804 | 0 | 4,000 | 0.150 | 599 | 0.225 | 899 | 599 | 899 |
| NHS | 32,600 | 0.00 | 0 | 0.804 | 0 | 32,600 | 0.109 | 3,559 | 0.255 | 8,304 | 3,559 | 8,304 |
| Parks | 19,600 | 0.36 | 7,056 | 0.804 | 5,673 | 12,544 | 0.150 | 1,879 | 0.225 | 2,819 | 7,552 | 2,819 |
| Roads | 42,422 | 0.86 | 36,483 | 0.804 | 29,333 | 5,939 | 0.150 | 890 | 0.225 | 1,335 | 30,223 | 1,335 |
| SWM Pond | 32,900 | 0.50 | 16,450 | 0.804 | 13,226 | 16,450 | 0.150 | 2,465 | 0.225 | 3,697 | 15,691 | 3,697 |
| **TOTAL POST-DEVELOPMENT** | **271,422** | | **156,630** | | **77,701** | **114,792** | | **15,873** | | **26,775** | **116,422** | **52,158** |
| % Change from Pre to Post | | | | | | | | | | | 301 | 14 |
| Effect of development (with mitigation) | | | | | | | | | | | 3.0 times increase in runoff | 14% reduction of infiltration |

Change in infiltration ($m^3/a$)= **-8,512**

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** figures from Tables G-1, G-2 and G-3.

[a] - based on estimation in LID SWM Planning and Design Guide for soils of hydrologic group A & B (CVC & TRCA, 2010)

**WATER BALANCE CALCULATIONS**

Hydrogeological Assessment - Langen Property
Erin, ON
PROJECT No.300052075

BURNSIDE

# TABLE G-7

## Water Balance for Pre- and Post-Development Land Use Conditions (with SWM/LID measures) - 5520 Eighth Line

| | 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** | | | | | | | | | | | | |
| Agricultural | 91,540 | 0.00 | 0 | 0.804 | 0 | 91,540 | 0.146 | 13,324 | 0.218 | 19,986 | 13,324 | 19,986 |
| Rural Open Space/ Meadow | 43,000 | 0.00 | 0 | 0.804 | 0 | 43,000 | 0.146 | 6,259 | 0.225 | 9,663 | 6,259 | 9,663 |
| Woodland/Wetlands | 225,610 | 0.00 | 0 | 0.804 | 0 | 225,610 | 0.109 | 24,629 | 0.255 | 57,467 | 24,629 | 57,467 |
| **TOTAL PRE-DEVELOPMENT** | **360,150** | | **0** | | **0** | **360,150** | | **44,212** | | **87,117** | **44,212** | **87,117** |
| **Post-Development Land Use** | | | | | | | | | | | | |
| Single Detached | 67,951 | 0.64 | 43,489 | 0.804 | 34,965 | 24,462 | 0.150 | 3,665 | 0.225 | 5,497 | 21,148 | 5,497 |
| Roof leader disconnection (assume 50% of runoff volume infiltrates)[a] | | | | | | | | | | | 0 | 17,483 |
| Grading Transition | 21,349 | 0.00 | 0 | 0.804 | 0 | 21,349 | 0.150 | 3,199 | 0.225 | 4,798 | 3,199 | 4,798 |
| Open Space | 3,500 | 0.00 | 0 | 0.804 | 0 | 3,500 | 0.150 | 524 | 0.225 | 787 | 524 | 787 |
| NHS | 240,300 | 0.00 | 0 | 0.804 | 0 | 240,300 | 0.109 | 26,232 | 0.255 | 61,209 | 26,232 | 61,209 |
| Roads | 27,050 | 0.86 | 23,263 | 0.804 | 18,704 | 3,787 | 0.150 | 567 | 0.225 | 851 | 19,271 | 851 |
| **TOTAL POST-DEVELOPMENT** | **360,150** | | **66,752** | | **34,965** | **293,398** | | **34,188** | | **73,142** | **70,374** | **90,625** |
| | | | | | | | | | | % Change from Pre to Post | 159 | -4 |
| | | | | | | | | | | Effect of development (with mitigation) | 1.6 times increase in runoff | 4% increase in infiltration |

** figures from Tables G-1, G-2 and G-3.

Change in infiltration (m$^3$/a)= **3,508**

[a] - based on estimation in LID SWM Planning and Design Guide for soils of hydrologic group A & B (CVC & TRCA, 2010)

R.J. Burnside & Associates Limited