



**Combined Level 1 and Level 2 Hydrogeological Assessment  
(Updated)**

**Duivenvoorden Pit Expansion**

**Melancthon, Ontario**

Prepared for:  
Duivenvoorden Haulage Ltd.

Prepared by:  
Azimuth Environmental  
Consulting, Inc.

September 2023

AEC 17-178a



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Environmental Assessments & Approvals

September 29, 2023

AEC 17-178a

Duivenvoorden Haulage Ltd.  
3425 9<sup>th</sup> Line  
Innisfil, Ontario  
L9S 3Z6

Attention: John Duivenvoorden

Re: **Combined Level 1 and Level 2 Hydrogeological Assessment (Updated)**  
**Duivenvoorden Pit Expansion**  
**Melancthon, ON**

Dear Mr. Duivenvoorden:

Azimuth Environmental Consulting, Inc. (Azimuth) is pleased to present this updated report consisting of a Level 1 and 2 Hydrogeological Assessment for the proposed expansion of the existing Duivenvoorden Pit, located in Melancthon, Ontario. The proponent (Duivenvoorden Haulage Ltd.) has filed an application with the Ministry of Natural Resources and Forestry (MNR) for an Aggregate Resources Act (ARA) Category 3, Class A Pit Above Water license for expansion of their existing Duivenvoorden Pit. This report update was completed to address the peer review comments received from Bluewater Geoscience Consultants Inc. (Bluewater) dated March 22, 2022.

Azimuth has completed a Level 2 Hydrogeological Assessment to enable expansion of the existing Duivenvoorden Pit. This assessment is based on a comprehensive field monitoring program which provides the basis to the conceptual understanding of the regional and local hydrogeological conditions.

The results of the hydrogeological assessment indicate that the potential impacts associated with the extraction of aggregate on the existing ground water and surface water regimes will be negligible. The proposed above water table extraction significantly decreases the potential for impacts to the underlying ground water table, as well as the deeper bedrock aquifer system. As a result, there will be no influence from the operations on local domestic water wells in the vicinity of the proposed operations. This



conclusion is supported by the long-term operation of the existing Duivenvoorden Pit with no complaints of well interference from local users.

We assume that this information is sufficient for the MNRF and other relevant reviewing agencies to approve expansion of the Duivenvoorden Pit. If you have any questions or comments please contact the undersigned.

Yours truly,

AZIMUTH ENVIRONMENTAL CONSULTING, INC.



Mike Jones, M.Sc., P.Geo.  
Senior Hydrogeologist / President



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## **1.0 INTRODUCTION**

Duivenvoorden Haulage Ltd. (Duivenvoorden) owns an approximate 82.6 ha property, located on Part Lots 13 & 14, Concession 4, Township of Melancthon, Dufferin County (Figure 1 – Appendix A). The property consists of an existing gravel pit (referred to as Duivenvoorden Pit) which is located on Part Lot 13, and Duivenvoorden wishes to expand the gravel pit into Part Lot 14 to the north. The southern parcel (Part Lot 13) containing the existing pit is approximately 40.2 ha and the northern parcel (Part Lot 14) is approximately 42.4 ha.

Duivenvoorden has filed an application with the Ministry of Natural Resources and Forestry (MNRF) for an Aggregate Resources Act (ARA) Category 3, Class A Pit Above Water license for expansion of the existing Duivenvoorden Pit. The expansion will extend the boundary of the existing pit into the majority of the northern parcel of land. The northern parcel currently consists primarily of active agricultural land, with a small area consisting of forest and wetland (southwest portion of parcel). Adjacent land uses consist primarily of active agricultural land and other active gravel pits.

Duivenvoorden has retained Azimuth to complete a combined Level 1 and Level 2 Hydrogeological Assessment in support of the proposed aggregate expansion and operation. Whitewater Hydrogeology Ltd. (Whitewater) also provided support to Azimuth in providing relevant hydrogeological data and background information in support of this application. Whitewater has completed aggregate license applications for other gravel pit properties in the immediate area.

Following the submission of the Level 1 and Level 2 Hydrogeological Assessment to the relevant reviewing agencies, Azimuth has received peer review comments from Bluewater Geoscience Consultants Inc. (Bluewater) dated March 22, 2022 regarding this report. This updated report addresses Bluewater's peer review comments and includes the results of Azimuth's additional subsurface drilling and ground water monitoring program (2023).

### **1.1 Study Approach**

Duivenvoorden Pit is currently licensed to extract sand and gravel from above the established water table, which is also proposed for the expansion lands to the north of the existing pit. Similarly, the Strata-owned gravel pits to the east/southeast of the Duivenvoorden lands are also licensed for above water table extraction. Locally, the presence and influence of these pits provides important hydrogeological information to determine the potential for long-term effect(s) of such operations on the ground water and surface water regimes in the local area.



Along with the compilation of existing hydrogeological data from existing aggregate extraction areas, a comprehensive hydrogeological field program was completed by Azimuth for the Duivenvoorden expansion lands (northern parcel). The results of this field program provided the basis for the conceptual understanding of the geology and hydrogeology beneath the proposed expansion area.

To develop a more regional understanding of the hydrogeological conditions, Whitewater provided their combined Level 1 and Level 2 Hydrogeological Assessment Report (2017) for the Prince and Bonnefield Pits (Strata). This report provides a comprehensive description of the regional setting, and excerpts have been provided in Section 2.0. When incorporated with data from the subject site, Whitewater's report also provided valuable ground water level data to understand regional ground water flow patterns.

In order to complete a Level 2 Hydrogeological Assessment for the proposed pit expansion, relevant legislation was referenced and a work plan was developed. Provincial Standards which support the ARA are referenced to define the technical deliverables for aggregate applications. Aggregate applications for Category 3 Pits Above Water ([https://files.ontario.ca/environment-and-energy/aggregates/provincial-standards/mnr\\_e000028.pdf](https://files.ontario.ca/environment-and-energy/aggregates/provincial-standards/mnr_e000028.pdf)) require a hydrogeological study to “*determine the elevation of the established ground water table within the Site or demonstrate that the final depth of extraction is at least 1.5 m above the water table.*” The Growth Plan for the Greater Golden Horseshoe (2017) states “*an application requiring a new approval under the Aggregate Resources Act to expand an existing mineral aggregate operation may be permitted in the Natural Heritage System, including in key natural heritage features, key hydrologic features and any associated vegetation protection zones, only if the related decision is consistent with the PPS and satisfies the rehabilitation requirements of the policies in this subsection.*” (s. 4.2.8.2.c)

The work program completed for this hydrogeological study was designed to comply with these requirements by characterizing the regional and local geological, hydrogeological, and hydrological conditions. To determine potential impacts (if any) of above water aggregate extraction to the natural environment, an impact assessment has also been completed.

## **2.0 REGIONAL SETTING**

### **2.1 Physiography**

The existing Duivenvoorden Pit and proposed expansion reside within the Horseshoe Moraine physiographic region (Chapman and Putnam, 1984). The moraine lies along the



slopes of the Niagara Escarpment, from Singhampton to Caledon Village. This moraine is known for its systems of broad gravel and sand terraces. The proposed expansion to the Duivenvoorden Pit will extract the sand and gravels from these spillways, also referred to as the Orangeville Moraine.

The dominant physiographic feature within this region is the glacial re-entrant valley of the Pine River. This valley extends east of Horning Mills, terminating at Terra Nova and is cut deeply into the bedrock escarpment from the east. The proposed pit expansion is located on the plateau formed by the dolostone cap rock, west of the Niagara Escarpment face (Whitewater Hydrogeology Ltd., 2017). Figure 2 (Appendix A) shows the local topography based on the 5 metre contours, which provides further refinement in the site topography. Elevations within the proposed expansion lands range from approximately 520 masl in the southwest portion of the property and 500 masl in the northeast portion.

## **2.2 Hydrology**

The proposed pit expansion is located within the Boyne River sub-watershed of the Nottawasaga watershed, which covers an area of 24,000 ha. The Boyne River sub-watershed flows easterly from the Shelburne area to Alliston, where it joins the main branch of the Nottawasaga River. The Nottawasaga River flows north to Nottawasaga Bay at Wasaga Beach. The NVCA Boyne River Subwatershed Health Check (2013) describes the western portion of the river corridor as “a rolling agricultural/rural/aggregate pit landscape”.

There are no permanent watercourses on the Duivenvoorden expansion lands, although multiple swales convey surface drainage on a seasonal basis (water only present during spring freshet). These swales direct surface drainage to a low-lying basin area within the northeast portion of the property where it collects and infiltrates/evaporates. There is no outlet to this basin feature, so surface water sits in this area until it dries up in late spring/early summer. Drainage from adjacent properties to the north and west contribute surface water to this feature (see Figure 5). A wetland feature is also present on the expansion lands within the southwest portion of the property. This wetland feature holds surface water typically between April (freshet) and August, although the hydroperiod is presumed to change depending on the amount of precipitation received during each year. During spring freshet it is believed this wetland receives direct surface runoff from surrounding areas, including offsite from the south and west. When the wetland reaches water levels high enough, it outlets to the basin feature on the property via a semi-defined swale. According to water level data collected by Azimuth in 2018, the wetland also receives some degree of seasonal ground water contribution.



**Figure 5: On-site Drainage Features**

The swales and low-lying basin are not Key Hydrologic Features due to their limited size, limited habitat function and that they are not connected to other features. Their function is to collect and infiltrate surface runoff and this function will continue in the future.

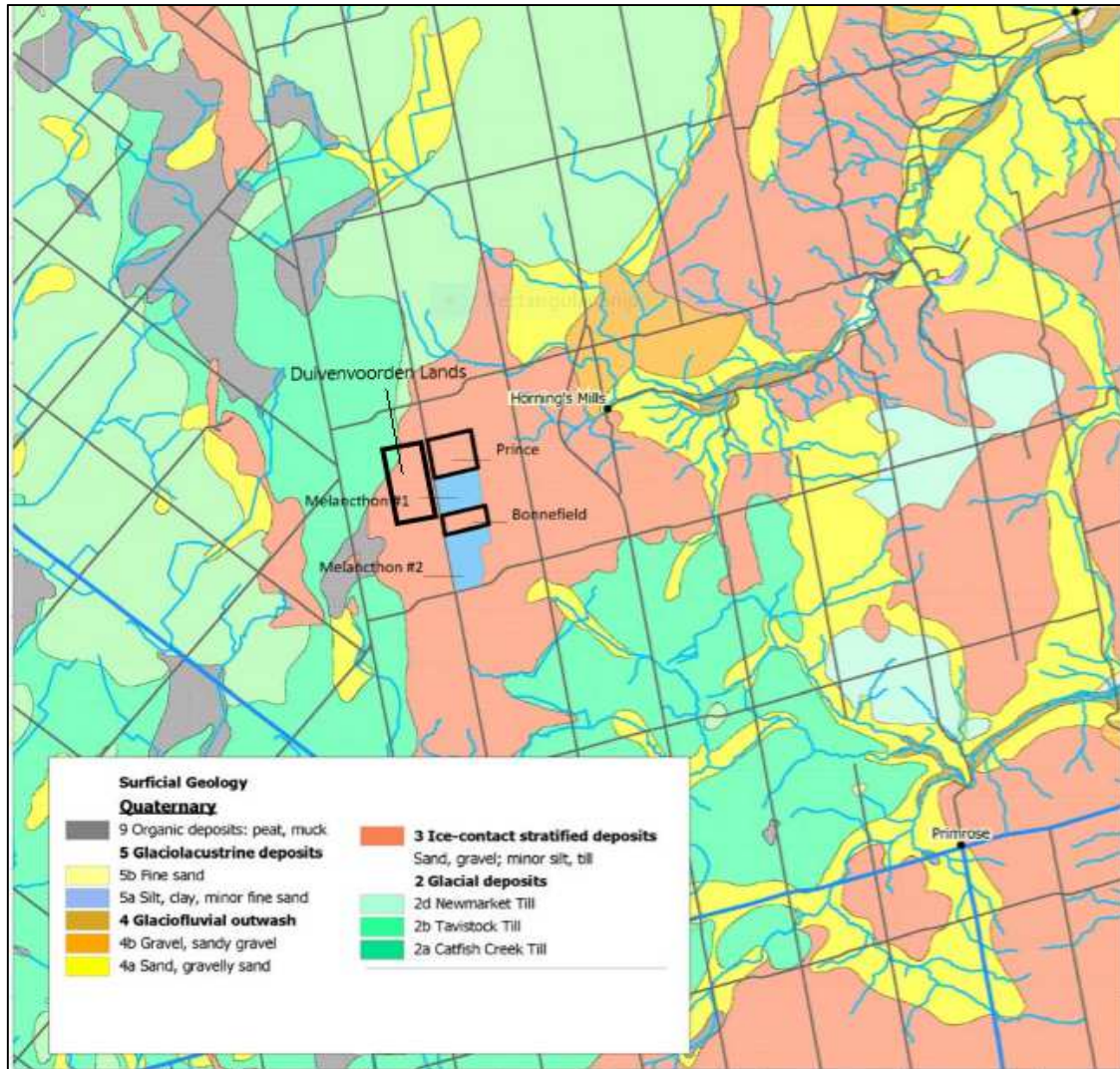
## **2.3 Geology**

### **2.3.1 Quaternary Geology**

The Quaternary deposits in the study area are presented on Figure 6 (figure from by Whitewater Hydrogeology Ltd., 2017). For reference purposes, other nearby aggregate pits are shown in this figure. The Quaternary soils primarily consist of ice-contact stratified sand and gravel that are incised into the underlying fine-grained till.



The unconsolidated sand and gravel resource is underlain by a clay till deposit that is part of the regionally extensive Tavistock Till. Tavistock Till is a calcareous silty clay to silt till largely derived from glaciolacustrine sediments. This till sheet overlies the Paleozoic bedrock (Whitewater Hydrogeology Ltd., 2017). The Tavistock Till was encountered on-site at MW-1, MW-2 and MW-3. All other locations have the ice-contact sand and gravel unconformably overlying the Amabel bedrock.



**Figure 6: Regional Quaternary Geology (Whitewater, 2017)**

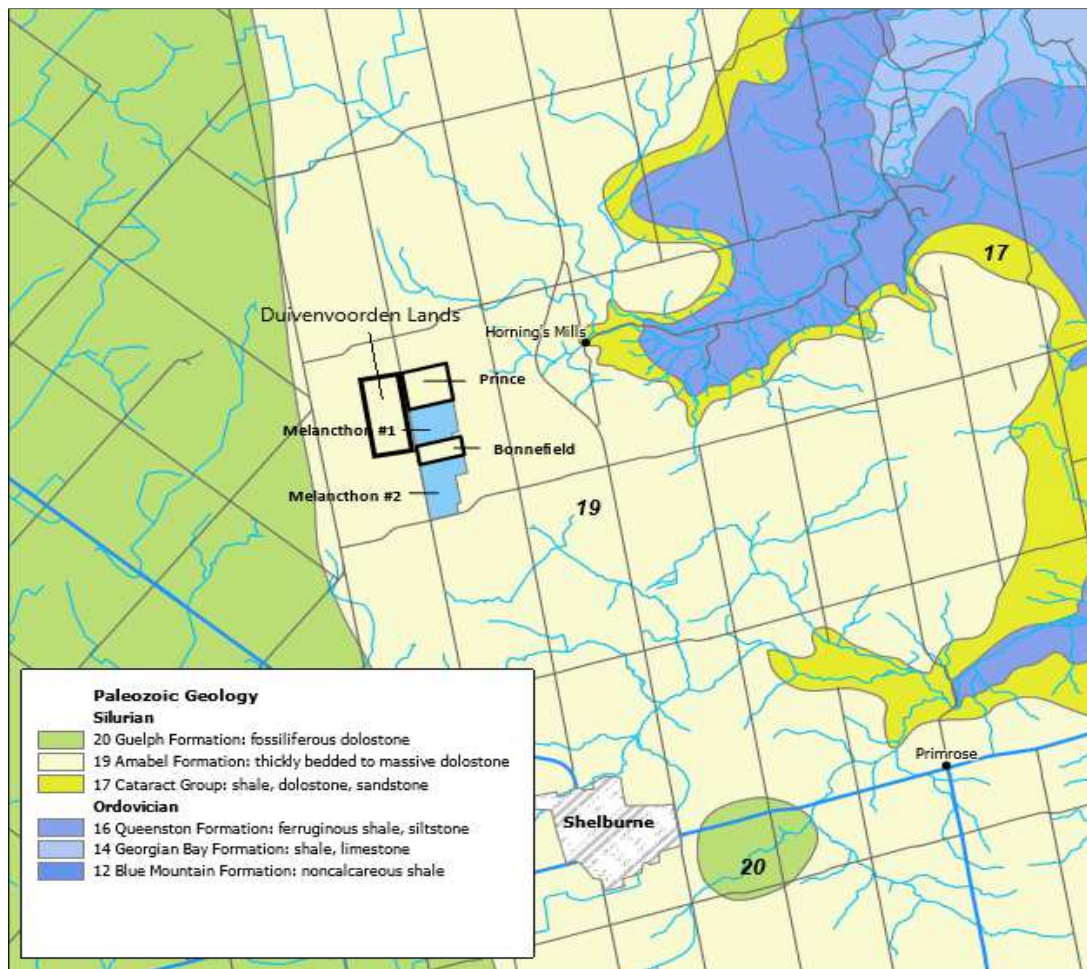
### 2.3.2 Paleozoic Geology

The Paleozoic bedrock geology of the study area is presented in Figure 7 (figure from by Whitewater Hydrogeology Ltd., 2017). For reference purposes, other nearby aggregate pits are shown in this figure. The extraction plans do not include extraction of the



bedrock, and the bedrock is at a depth of more than 2.5 m below the seasonally high water table.

The Paleozoic bedrock beneath the subject property is comprised of a sedimentary rock sequence consisting primarily of layered dolostone, shale and sandstone. Located at the top of the bedrock column is the Amabel Formation, the only formation exposed above the escarpment, followed by the underlying Fossil Hill Formation and Cabot Head Formation of the Cataract Group (Whitewater Hydrogeology Ltd., 2017).



**Figure 7: Regional Paleozoic Geology (Whitewater, 2017)**

The top of the bedrock ranges between approximately 500.2 masl and 489.6 masl beneath the Duivenvoorden expansion lands. The bedrock surface slopes down toward the east, similar to overburden ground water flow direction. In the vicinity of the subject property, the Amabel Formation combined with the lower limestone units are reported to be



approximately 80 m in thickness, and does not affect the hydrogeological regime of the overburden granular units.

## **2.4 Overburden Hydrogeology**

Across most of the site, the sand and gravel surficial unit is in direct contact with the bedrock and the flow characteristics of the ground water regime are controlled by the bedrock elevation (as a bounding unit of lower conductivity) and the permeability and gradients within the overburden. The permeability is moderate (estimated between  $1 \times 10^{-4}$  to  $10^{-5}$  m/s) and the lateral gradients are approximately 0.02. Ground water velocities are approximately 0.2 to 2m per day and flow is along the east-west axis of the Boyne River sub-watershed. The bedrock being of much lower permeability, acts as the lower boundary for the active flow zone in the overburden.

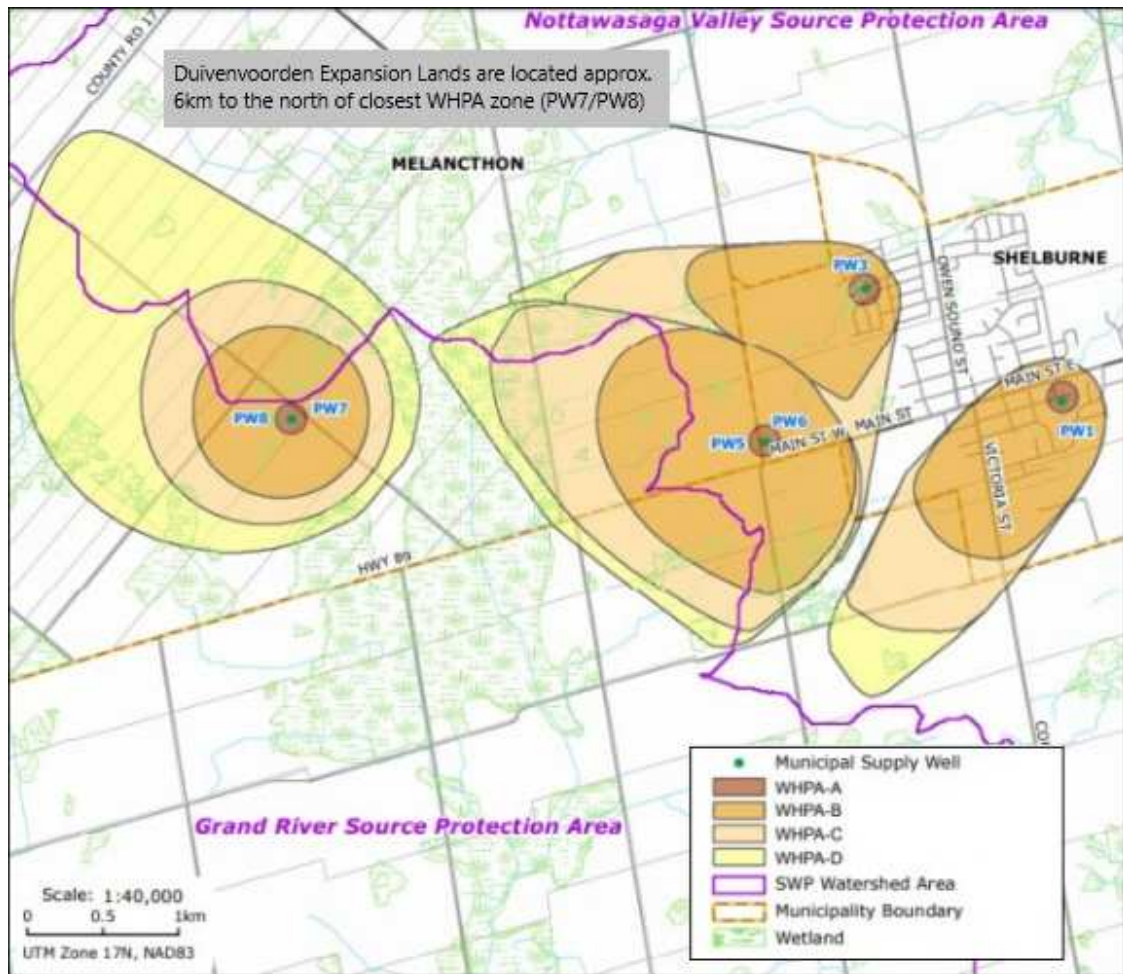
## **2.5 Ground Water Use**

Two principal aquifers were identified in the Town of Shelburne Ground Water Management Study (Burnside, 2001) being the overburden aquifer and the contact zone aquifer. The contact zone includes the upper fractured bedrock. Production wells in the Town of Shelburne utilize the contact zone aquifer (*i.e.* bedrock aquifer). The following sections provide a description of the ground water use (both municipal and private). The locations of the Town of Shelburne's municipal wells and wellhead protection zones, as well as domestic water wells which are on record with the Ministry of the Environment, Conservation and Park (MECP).

### **2.5.1 Town of Shelburne – Municipal Ground Water Wells**

The Town of Shelburne is currently serviced by six production wells all of which are constructed in the bedrock of the Amabel Formation. Four wells (PW1, PW3, PW5 and PW6) are located within the Nottawasaga Valley Source Protection Area. The fifth and sixth production wells (PW7 and PW8) were installed in 2010 and 2014 respectively, and are within the Grand River Source Protection Area. NVCA (2018) reported that the regional ground water flow in the vicinity of the Town of Shelburne generally flows from southwest to northeast following the general patterns of the surface watercourses.

The wellhead protection areas for the Town of Shelburne provide an indication of the area that supplies water to the municipal wells (NVCA, 2018). The capture zones extend up to 6 km from the wellhead areas in a southwesterly and westerly direction (see Figure 8 taken from NVCA (2018)). These capture zones are located in excess of 6 km from the proposed Duivenvoorden expansion lands.



**Figure 8: Town of Shelburne Wellhead Protection Zones**

### 2.5.2 Township of Melancthon – Domestic Water Wells

A desktop well survey was undertaken to evaluate the well supply characteristics within the local area. A search of the online MECP database was completed for a radius of 750m from the Duivenvoorden expansion site boundary. These well records were used to assess the number of domestic wells within this area, and identify the target aquifer for each well. As ground water is the primary water supply for the local area, it can be assumed that homes not listed in the MECP database will actually be serviced by a private well. Under this assumption, there are 9 domestic wells within a 750m radius of the proposed Duivenvoorden expansion lands. Of these 9 wells, only six are shown in the MECP water well database. The other four wells were added to Figure 9 below for visual purposes.



**Figure 9: MECP Database Well Locations**

The majority of domestic wells (where information is available) within the 750m study area obtain water from the Amabel Formation (bedrock aquifer), with the exceptions of Well No. 1701316 which is a shallow overburden well (presumably close to bedrock contact). It should be noted that Well No. 1701316 has been decommissioned as the house was torn down on this property. Also, Well No. 1705240 is not located within the area shown in Figure 9. It is assumed that the waypoint location used for this well in the MECP database is for a lot centroid, not the actual well location.

Table 1 (below) summarizes the well records available for domestic wells within the study area. Well records for these wells are also presented in Appendix B.



**Table 1: MECP Domestic Well Details**

| Tag/MECP No. | Well Depth | Target Aquifer | Observations                           |
|--------------|------------|----------------|----------------------------------------|
| A084702      | 37.2       | Bedrock        | Drilled Well                           |
| A061262      | 13.7       | Bedrock        | Drilled Well                           |
| 1705240      | 30.5       | Bedrock        | Drilled Well, Location Not Accurate    |
| 1700345      | 36.6       | Bedrock        | Drilled Well                           |
| 1702233      | 17.1       | Bedrock        | Drilled Well                           |
| 1701316      | 15.8       | Overburden     | Drilled Well (Well now decommissioned) |

If wells are dug or drilled prior to 1950's they were likely not registered with the MECP and therefore are not present within the provincial database. This is likely the case for the wells shown in orange on Figure 9. The wells shown in green within the study area are mostly monitoring wells associated with the Duivenvoorden and nearby aggregate pits.

The domestic wells listed in Table 1 are at a very low risk of being impacted by the proposed Duivenvoorden expansion operations, as the majority target the bedrock aquifer. There have been no known well complaints from this owner as all local operations are performed above the water table.

### **3.0 SOURCE WATER PROTECTION**

The Clean Water Act (CA S.O. 2006, Chapter 22) primarily focuses on sources of water that have been designated by a municipality as being a current or future source of residential municipal drinking water for the community. The general goal of Source Water Protection is protecting source water from overuse and contamination to ensure safe municipal drinking water supplies.

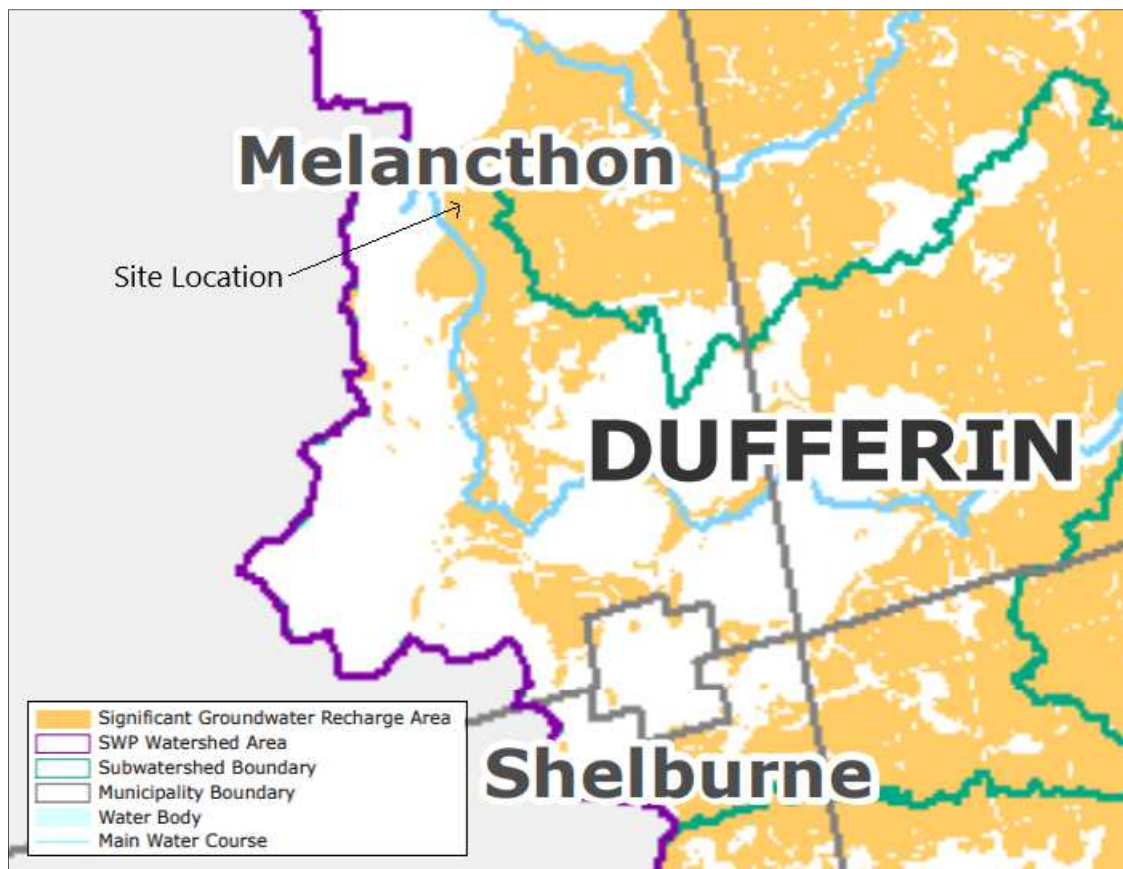
When assessing the Duivenvoorden expansion lands from a Source Water Protection perspective, potential impacts to local municipal and private water supplies from the extraction of aggregate must be considered. In Section 2.4 the closest municipal water supply (Town of Shelburne) was determined and the Duivenvoorden expansion lands fall at minimum 6 km from the delineated Town of Shelburne's WHPAs.

Although the proposed Duivenvoorden expansion lands are located well outside of a municipal WHPA, this assessment has included a review of the aquifer vulnerability in the local area. This review has also been applied to the domestic water wells, which are the primary source of potable water for local residents. Specifically, an assessment of the Significant Ground Water Recharge Areas (SGRAs) and Highly Vulnerable Aquifers (HVAs) has been completed.



### 3.1 Significant Ground Water Recharge Areas / Highly Vulnerable Aquifers

In the Nottawasaga Valley watershed, SGRAs are defined as an area that has an average annual recharge rate that is 15% greater than the average annual recharge rate for the watershed; and an area that has a hydrological connection to a surface water body or aquifer that is a source of drinking water for a drinking water system. The vulnerability of SGRAs is categorized as high, medium or low based on their mapped intrinsic susceptibility. The susceptibility of the overburden soil layers are classified based on how readily each transmits water, and the thickness of each is considered. Based on the local surficial geology and physiography, a portion of the Township of Melancthon is covered by permeable sand and gravel deposits. As shown in Figure 10, the Duivenvoorden expansion lands fall within a SGRA, as delineated in the Nottawasaga Valley Source Water Protection Assessment Report (2018).

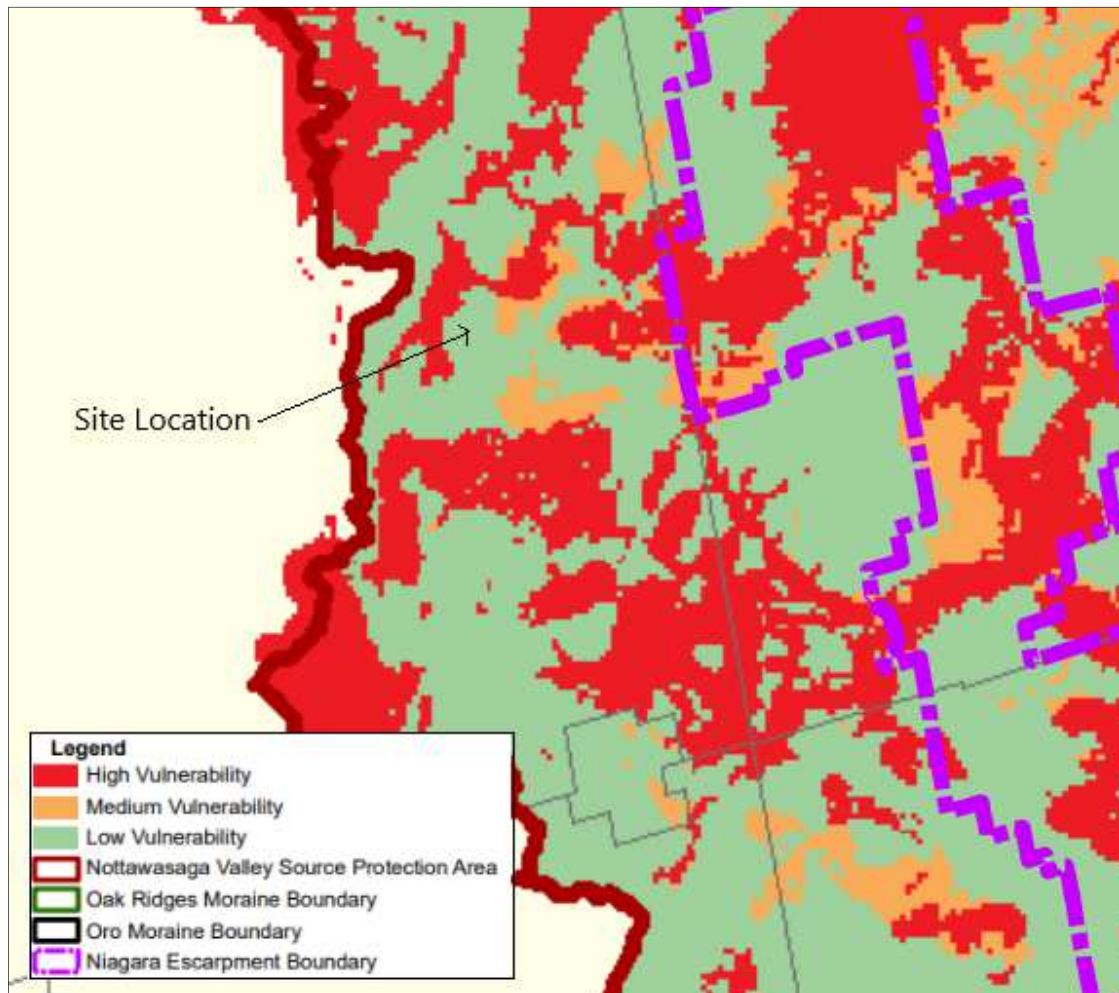


**Figure 10: Significant Ground Water Recharge Areas Mapping**

As shown in Figure 11 below, ground water vulnerability is considered “low” at the Duivenvoorden expansion lands, as delineated in the Nottawasaga Valley Source Water Protection Assessment Report (2015). The proposed change in land-use from agriculture



to aggregate extraction may increase the vulnerability rating; therefore it is important to assess the potential for changes associated with an aggregate operation (see Section 3.2).



**Figure 11: Highly Vulnerable Aquifer Mapping**

### **3.2 Source Water Protection and the Aggregate Industry**

The Ontario Stone, Sand and Gravel Association (OSSGA) supported a literature review study by the MNR to assess the role of the aggregate industry and associated lands in the context of source water programs. The MNR study (Applied Research on Source Water Protection Issues in the Aggregate Industry; Blackport and Golder, 2006) did not link the extraction and processing of stone, sand and gravel as a threat to drinking water sources.



The province of Ontario has identified 21 prescribed drinking water threats under the CWA. Nineteen of these relate to water quality and two to water quantity. The current land use at the proposed Duivenvoorden expansion lands is primarily agriculture, which results in at least five potential prescribed drinking water threats, including:

- Agricultural source material – application to land
- Agricultural source material – storage
- Agricultural source material – management
- Commercial fertilizer – application
- Pesticide – application

The site property is outside of the wellhead protection areas for any communal water supply wells. The proposed changing in land use (from agriculture to aggregate extraction) will temporarily reduce the number of prescribed drinking water threats. There is no proposed storage of fuel at the Duivenvoorden expansion site which further decreases the potential for threats to drinking water.

## **4.0 HYDROGEOLOGICAL/HYDROLOGICAL INVESTIGATION**

### **4.1 Subsurface Drilling Program (2017)**

In September 2017, a drilling program was completed by Orbit Garant Drilling (supervised by Azimuth field staff) for the purpose of installing a series of monitoring wells across the Duivenvoorden expansion lands. A total of seven monitoring wells at five locations (two nested sites) were installed for the purpose of long-term ground water level monitoring for the overburden aquifer underlying the site. The drilling program also provided useful geological logs at each drilling location to assess the extent of potential aggregate material across the property.

Bedrock refusal was encountered at each drilling location and determined well depth in most cases, which ranged between 12.2 and 20.7 mbgs (metres below ground surface). Two shallow wells (at nested sites) were drilled to depths of 6.7 mbgs (MW-2s) and 8.7 mbgs (MW-4s). All wells were screened into the water table, with the exception of MW-2s which was dry for the majority of the monitoring period (see Section 4.2).

Figure 3 (Appendix A) presents geological cross sections for the site showing northwest/southeast and southwest/northeast orientations.

### **4.2 Additional Subsurface Drilling Program (2023)**

In March 2023, an additional drilling program was completed by Orbit Garant Drilling (supervised by Azimuth field staff) for the purpose of adding to the existing monitoring



well network for future Petroleum Hydrocarbon (PHC) sampling in ground water. A new well location was also established (between MW-1 and MW-5) to ensure that the downgradient (underlying aquifer flows in an easterly direction) limits of the site have appropriate coverage for future water quality sampling. Bluewater's peer review also recommended that all monitoring well locations consist of a well which is constructed with the screened portion straddling the water table surface at some point during each year. This would allow for appropriate sampling of PHCs.

In total, three (3) additional monitoring wells at three separate locations (two existing nested locations and one new location) were installed for the purpose of long-term ground water quality monitoring for the overburden aquifer underlying the site. As none of the existing wells at MW-2 and MW-5 location were constructed with screens straddling the water table surface, additional wells were installed at these locations (named MW-2-III and MW-5-I, respectively). These additional wells were constructed to appropriate depths and with extended screen lengths to ensure straddling of the water table surface during each season. A new monitoring location was established with the drilling of MW-6 roughly halfway between MW-1 and MW-5 along eastern property limit.

Figure 2 (Appendix A) shows the locations of all monitoring wells. Borehole logs for each monitoring well are presented in Appendix C. Table 2 provides a summary of construction details for each monitoring well.

**Table 2: Duivenvoorden Monitoring Well Details**

| Well Name | Top of Casing                 | Ground Surface | Top of Screen | Bottom of Screen | Location |          |
|-----------|-------------------------------|----------------|---------------|------------------|----------|----------|
|           | Metres Above Sea Level (masl) |                |               |                  | Easting  | Northing |
| MW-1      | 510.21                        | 509.19         | 501.60        | 494.90           | 560990   | 4888189  |
| MW-2s     | 508.11                        | 507.15         | 501.95        | 500.45           | 560655   | 4888409  |
| MW-2d     | 508.10                        | 507.15         | 493.15        | 491.65           | 560655   | 4888409  |
| MW-2-III  | 508.10                        | 507.15         | 496.65        | 492.15           | 560655   | 4888409  |
| MW-3      | 518.86                        | 518.52         | 502.82        | 498.82           | 560483   | 4888249  |
| MW-4s     | 513.17                        | 512.25         | 503.05        | 500.05           | 560248   | 4888619  |
| MW-4d     | 513.22                        | 512.26         | 506.56        | 503.56           | 560248   | 4888619  |
| MW-5      | 511.17                        | 510.34         | 492.65        | 489.65           | 560903   | 4888686  |
| MW-5-I    | 511.20                        | 510.34         | 495.34        | 490.65           | 560903   | 4888686  |
| MW-6      | 510.00*                       | 509.00*        | 494.50*       | 490.00*          | 560948   | 4888424  |

\*approximate elevation based on site topography



### **4.3 Ground Water Level Monitoring**

Following completion of the initial drilling program/monitoring well installations, Azimuth staff initiated a long-term ground water level monitoring program at the Duivenvoorden expansion lands. In late September 2017, staff installed water level/temperature dataloggers (Solinst Levellogger – M30) in all monitoring wells. The dataloggers recorded hydrostatic pressure measurements at set intervals over time to determine changes in water level elevations. Datalogger accuracy was field-verified by taking quarterly ground water level measurements using a water level tape (Solinst – Model 101).

The dataloggers were installed in late September 2017 and recorded ground water levels within the monitoring wells until early October 2018. The dataloggers were programmed to collect water level measurements at hourly intervals throughout the monitoring period and data downloading occurred quarterly. A round of manual ground water level measurements were also completed in December 2018 when it was determined that the existing pit contains two monitoring wells (see Figure 4). Azimuth felt it was prudent to measure water levels in all wells (in both existing pit and expansion lands) to accurately determine regional ground water flow direction.

Manual water level measurements were also collected within the shallow piezometer on a monthly basis between April – October 2018 as the pipe diameter was too small to accommodate a datalogger installation.

Following the recent (March 2023) additional well installations, Azimuth staff re-installed dataloggers within the existing ground water monitoring network (MW-1, MW2-d, MW-3, MW-4s, MW-4d & MW-5), along with the new well location at MW-6. As no water level monitoring occurred for the pit expansion property since 2018, Azimuth is currently collecting additional ground water data for comparison to the 2017 – 2018. This new data is also being collected to ensure that the proposed pit floor elevation is based on accurate high water level conditions.

### **4.4 Surface Water Level Monitoring**

To monitor seasonal surface water levels in the on-site wetland feature, Azimuth staff installed a stilling well/staff gauge equipped with a water level/temperature datalogger. The stilling well was constructed from a “t-bar” fence post which was driven into the bottom of the deepest part of the wetland, and a 2” PVC well screen was affixed to the t-bar. The datalogger was installed in the bottom of the PVC well screen. A meter stick was also affixed to the t-bar to manually measure wetland water levels during monthly site visits. The manual water level measurements were completed to ensure accuracy of



the datalogger data. Surface water level monitoring was initiated in April 2018 following spring freshet and concluded in October 2018.

## 4.5 Monitoring Results

### 4.5.1 Ground Water Flow

The local (on-site) ground water flow patterns within the overburden are presented in Figure 12 below.



**Figure 12: Local Ground Water Contours**

The ground water contours shown in Figure 12 are based on manual measurements taken in December 2018, when measurements were taken from wells within both the existing pit and expansion lands. Data from other periods show consistent flow direction and



gradients. The contours show ground water within the overburden flows in an eastern to southeastern direction. Regional (on-site and off-site) ground water flow patterns within the overburden are presented in Figure 4 (Appendix A) which show both the existing pit and expansion lands.

Figure 13 below presents local bedrock elevation contours which shows that the bedrock forms a buried valley dipping towards the east. The contours of the buried valley follow the same general form as ground water contours, which points to bedrock topography locally influencing ground water flow patterns.



**Figure 13: Bedrock Contours**



It should be noted that the above bedrock contours are based on the assumption that auger refusal during drilling was due to the bedrock being contacted. No bedrock wells were completed during the subsurface drilling program.

#### 4.5.2 Overburden Ground Water Elevations

Figures 14 - 17 present all ground water level/elevation data collected for the monitoring wells installed across the Duivenvoorden expansion lands. The seasonally high water table is found within the overburden across the site. As the limit of excavation is based on the high water table, the excavation will also be completely within the overburden.

Figure 14 includes ground water levels below ground surface (mbgs) for the period between September 2017 – October 2018. Figure 15 includes ground water levels (mbgs) for the period between March 2023 – September 2023. Figure 16 includes ground water elevations (masl) for the period between September 2017 – October 2018. Figure 17 includes ground water elevations (masl) for the period between March 2023 – September 2023. It should be noted that ground water elevations for the new well (MW-6) were estimated using 1 metre ground elevation contour mapping

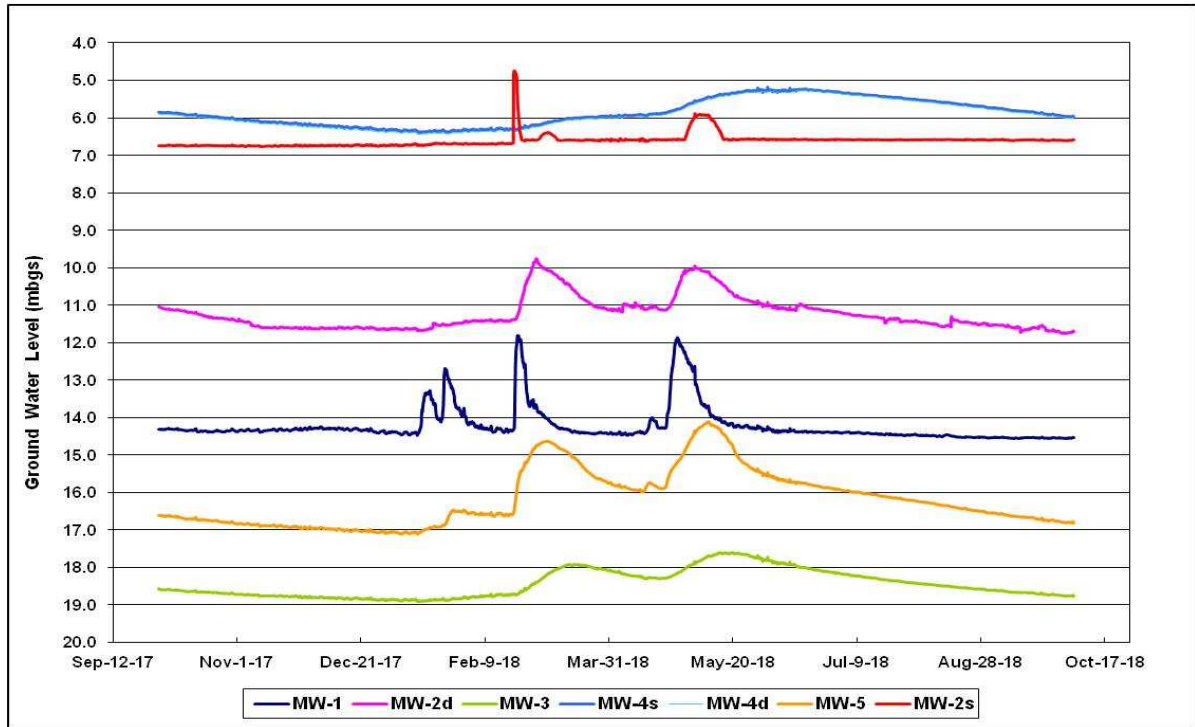


Figure 14: 2017 – 2018 Overburden Ground Water Level (mbgs)

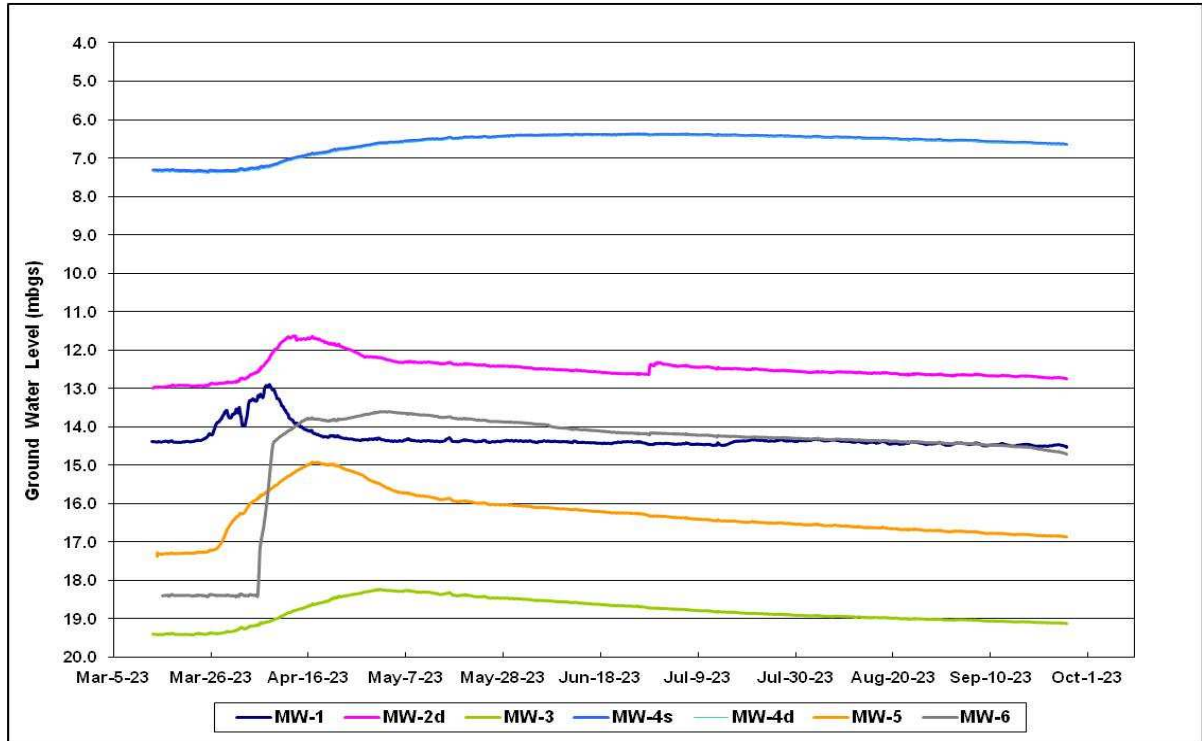


Figure 15: 2023 Overburden Ground Water Level (mbgs)

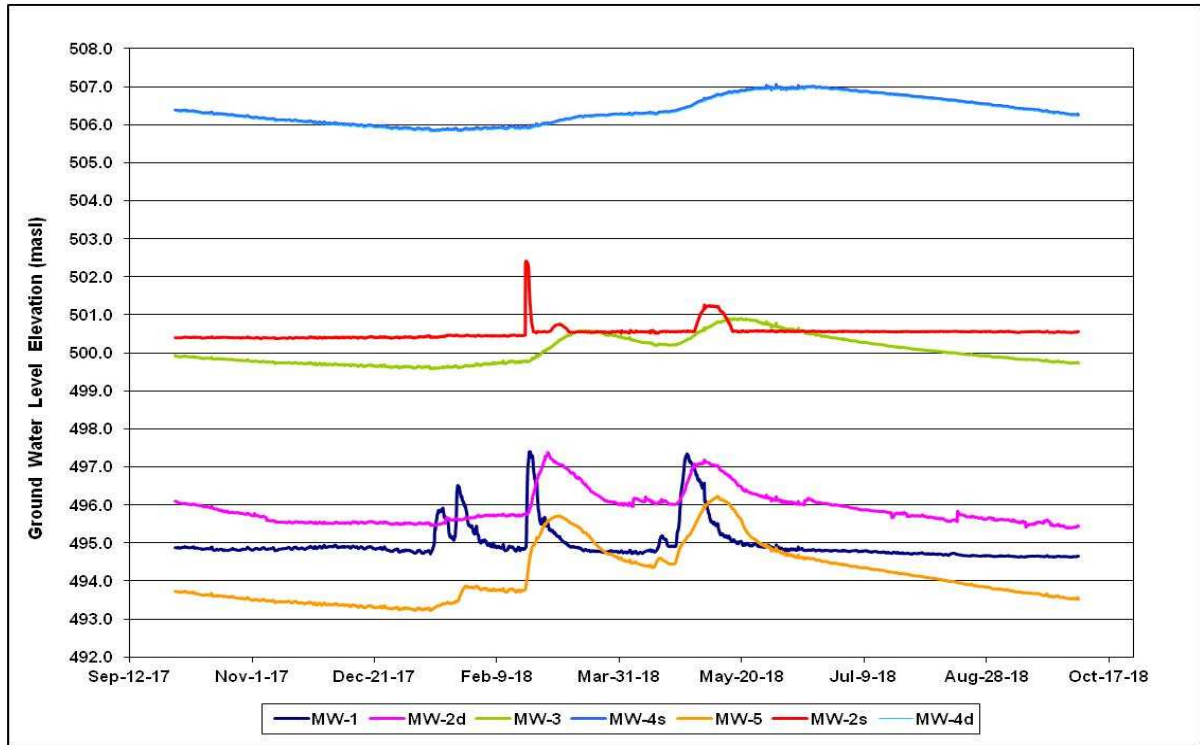


Figure 16: 2017 – 2018 Overburden Ground Water Elevations (masl)

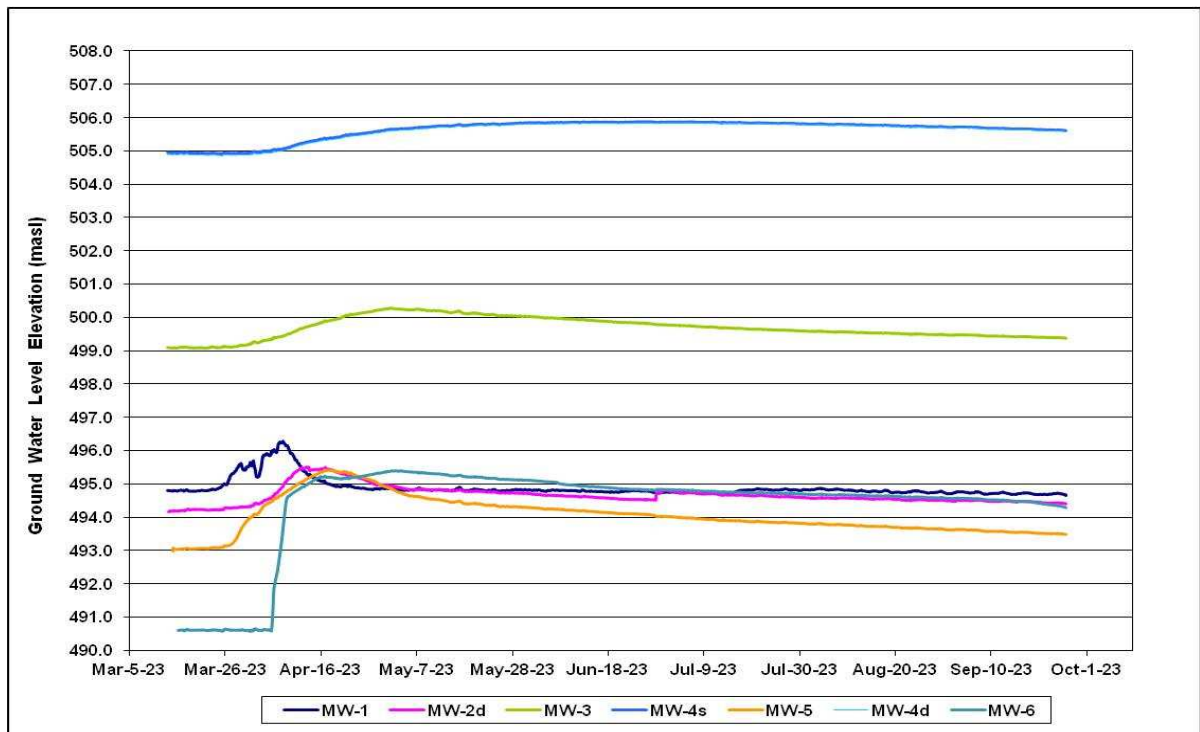


Figure 17: 2023 Overburden Ground Water Elevations (masl)



Generally, the water level trends are seasonal, with water levels peaking in the spring and decreasing over the warmer and drier summer/fall months. Some monitoring wells showed abrupt spikes during short warming trends in the winter months which represent times of snow melt. Based on the datalogger data, the water table elevations range between a high of approximately 507 masl and a low of <491 masl across the site. These elevations equate to a high of approximately 5.0 mbgs and a low of approximately 19.5 mbgs.

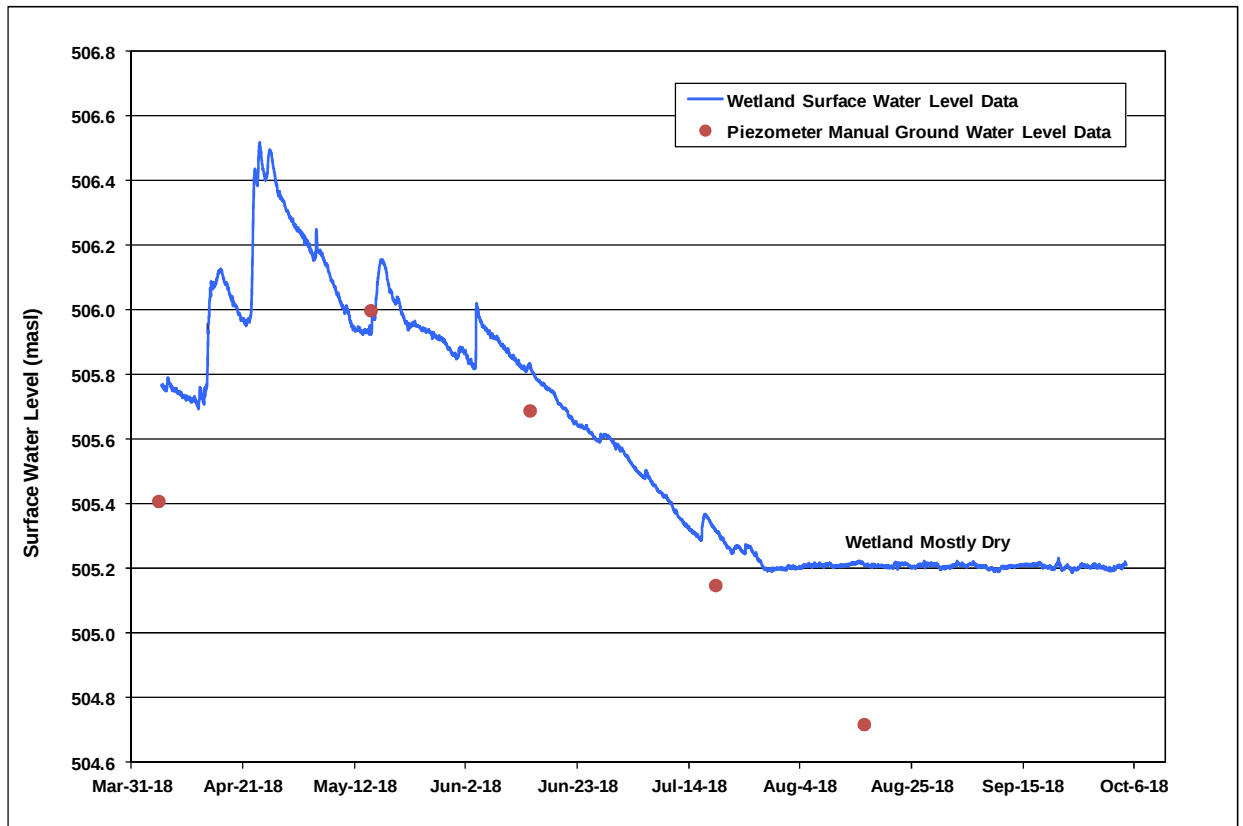
It should be noted that the new well (MW-6) was observed to be dry following drilling but has contained approximately 4 metres of water since spring freshet occurred in 2023. This well was drilled and installed within the overburden at bedrock surface, which shows that the upper aquifer fluctuates seasonally between the fractured bedrock and overburden within the eastern/southeastern portion of the property. This fluctuation was also reported to occur within the Prince Pit (located directed east of the Duivenvoorden expansion lands) by Whitewater Hydrogeology Ltd. within their Level 1 and Level 2 Hydrogeological Assessment Report (2017) for the Prince and Bonnefield Pits (Strata). Monitoring well MW-1 has been dry for much of the monitoring period (other than during times of snow melt/heavy rain) and it is assumed that the upper aquifer is within the bedrock for the majority of the year at this location.

It should be noted that the shallow well (MW-2s) at nest MW-2 was dry for the majority of the monitoring period, with only a few temporary spikes where water entered the well pipe. These spikes were related to spring freshet and periods of significant snow melt during the winter months. It is believed that MW-2s was screened within a perched sand seam rather than the water table, which explains the lack of water within the well pipe for extended periods of time. For this reason, ground water level monitoring for this well was not continued in 2023.

It should also be noted that ground water level conditions during the spring of 2018 were significantly higher (approximately 1 metre higher on average) than the spring of 2023. This comparison shows that the 2018 ground water levels likely reflect high water table conditions and should be considered accurate for proposed pit floor elevations (see Section 5.0).

#### 4.5.3 Surface Water Elevations

Figure 18 presents all surface water level data for the on-site wetland feature which was measured by a datalogger between early April and early October 2018.



**Figure 18: Wetland Water Levels**

Figure 18 shows water levels spiked to a high of approximately 1.35 metres within the wetland feature in spring during snow melt/increased rainfall and gradually decreased thereafter with less rainfall and warmer temperatures. The wetland began to dry out in late July and stayed dry for the majority of the remaining monitoring period. Figure 18 below shows decreasing shallow ground water levels adjacent to the wetland feature which also likely contributed to the wetland drying out in mid-summer. The manual measurements at both the wetland stilling well and shallow piezometer show a correlation between surface water and shallow ground water levels in this area of the site. Shallow ground water contribution is most evident in the spring (May measurement), although the degree of contribution from early summer to fall decreases. It should be noted that the final ground water measurement (October 4<sup>th</sup>) within the piezometer was observed as dry.

#### **4.6 Water Quality**

On-site monitoring wells and the wetland feature were sampled in July 2018 for general water quality parameters. The results for the three monitoring wells sampled were generally consistent, and results for the wetland showing a different chemical signature.



As can be seen in Table 3, major ion parameters for the wetland feature exhibited consistently lower levels than MW-2d, MW-4s and MW-5.

**Table 3: Major Ion Chemistry Results for Sampling Locations**

| Location | Bicarbonate<br>(mg/L) | Sulphate<br>(mg/L) | Calcium<br>(mg/L) | Magnesium<br>(mg/L) | Sodium<br>(mg/L) |
|----------|-----------------------|--------------------|-------------------|---------------------|------------------|
| MW-2d    | 237                   | 8.26               | 71.8              | 18.8                | 3.77             |
| MW-4s    | 307                   | 3.83               | 87.1              | 25.8                | 1.77             |
| MW-5     | 232                   | 25.9               | 84.8              | 32.0                | 3.43             |
| Wetland  | 115                   | 0.20               | 34.6              | 9.07                | 2.01             |

The relatively low levels in the wetland reflect that of a primary surface water source. Since sampling occurred in July the degree of ground water contribution to the wetland was likely low.

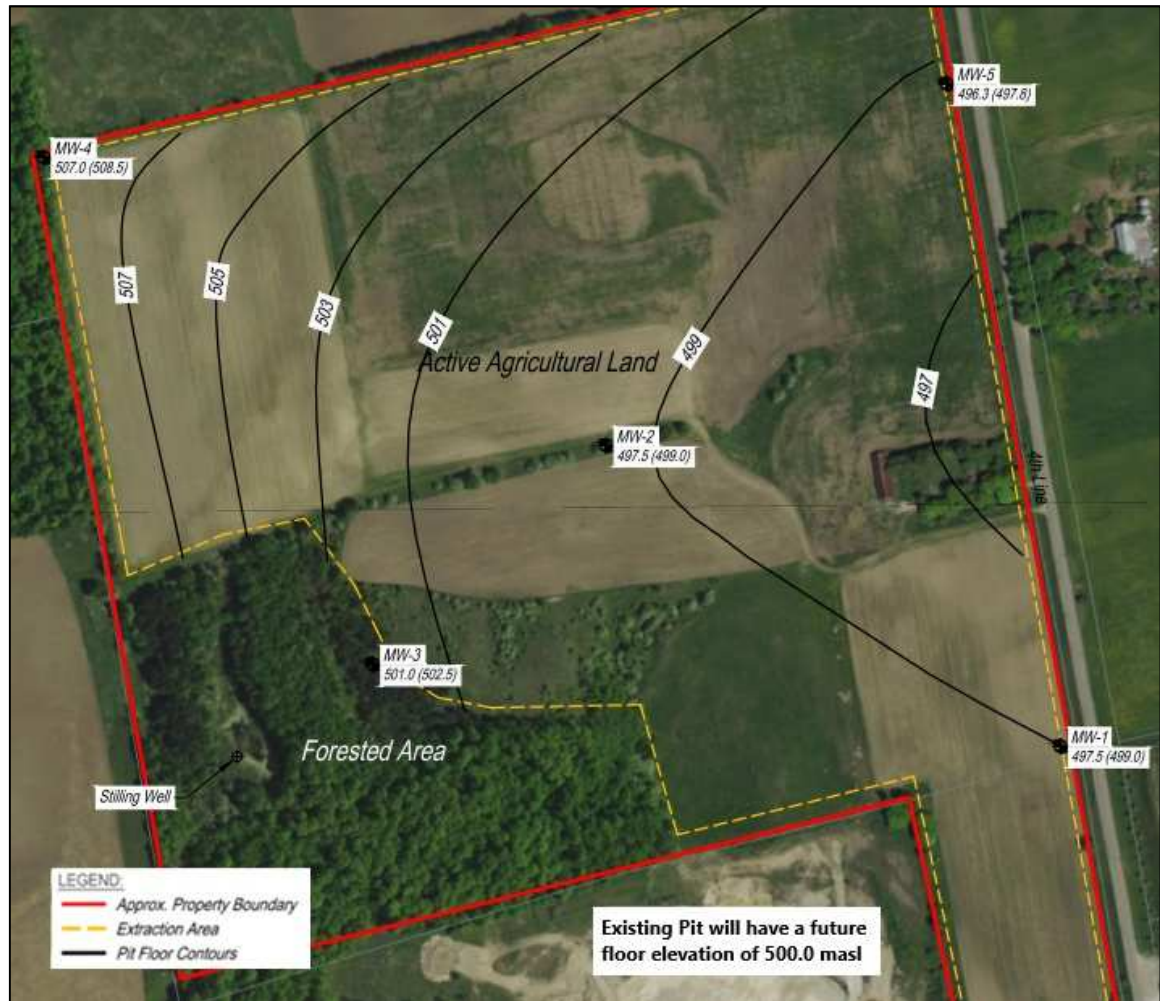
The ground water samples from MW-2d, MW-4s and MW-5 were compared to the Ontario Drinking Water Quality Standard (ODWQS), with only aesthetic and operational parameters such as hardness, turbidity and colour exceeding the guideline limits. Full water quality results are presented in Appendix D.

## **5.0 PIT FLOOR ELEVATIONS**

The proposed Duivenvoorden expansion would stay consistent with the existing Pit license, which consists of a Class A Pit Above Water and restricts the extraction of aggregate material within 1.5 metres above the established ground water table. To comply with the requirements of a Class A license, site plans must show floor elevations above the 1.5 metre water table separation mark across the proposed extraction area.

Based on the seasonal high water level elevations presented in Figures 16 and 17, the proposed pit floor elevations are presented in Figure 19. Since the monitoring completed by Azimuth captured a full year of water level data between 2017 – 2018 (spring 2018 has been shown to reflect high water table conditions), the high water table was captured making the proposed pit floor elevations accurate.

Figure 19 shows the high water table elevations recorded during monitoring at each well, along with elevations 1.5 metres higher (in brackets) than the water table measurements. It should be noted that the future floor elevation for the existing (active) pit to the south will eventually be 500.0 masl. This elevation will match up well with the proposed pit elevations within the expansion lands, which range between approximately 499.0 – 501.00 masl where these parcels will meet.



**Figure 19: Proposed Pit Floor Elevations**

## **6.0 IMPACT ASSESSMENT**

### **6.1 Water Balance**

A water balance has been completed as part of the impact assessment for the proposed extraction of aggregate from the Duivenvoorden expansion lands to ensure that the site operations will not have an adverse impact on the ground water and surface water systems. A water balance focuses on a comparison between pre and post-development conditions, or in this case pre and post-extraction. Specific focus is upon impacts to local ground water recharge and surface water runoff conditions. The purpose of this assessment was to present the limited influence of an above water table pit on the ground water and surface water regimes.

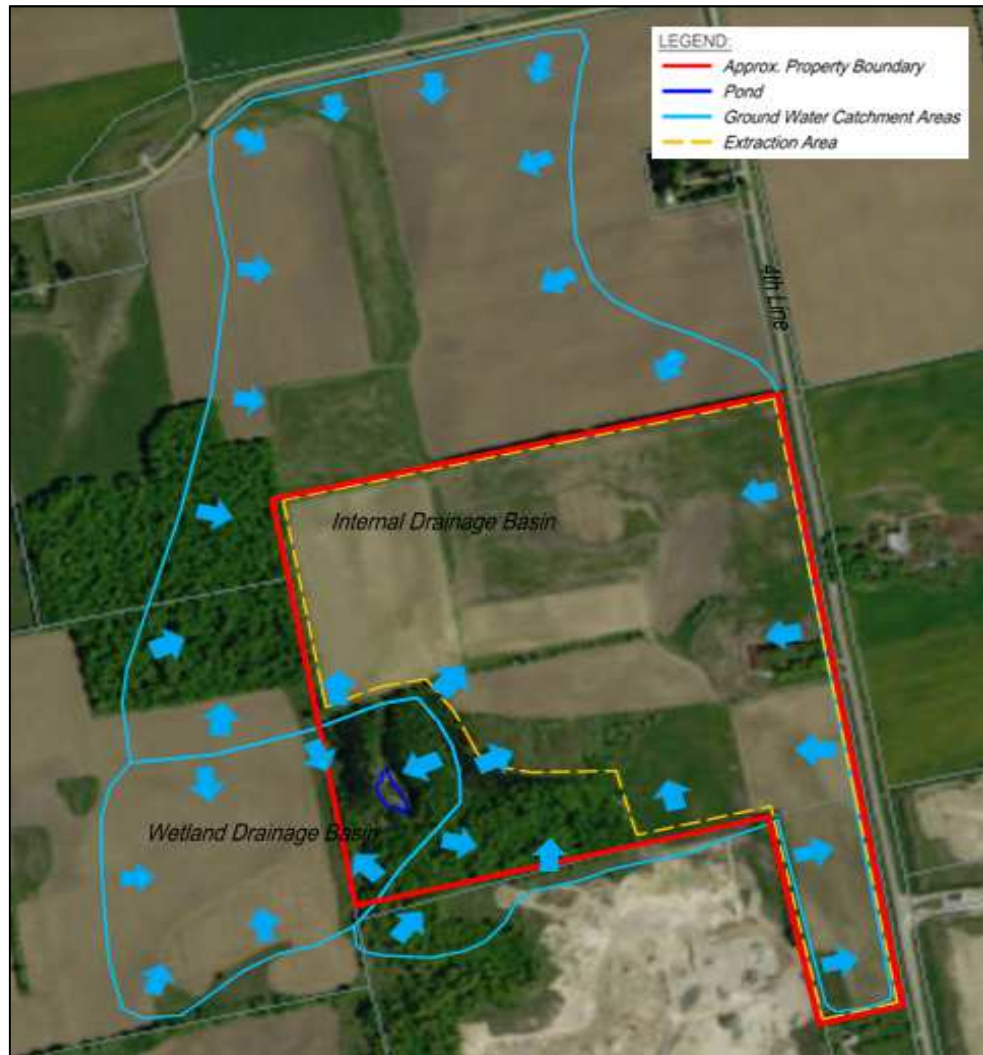


In order to determine the potential changes to the natural ground water recharge and surface water runoff conditions, a pre- and post-extraction water balance assessment has been completed using the Thornthwaite and Mather method (1957). This method evaluates evapotranspiration based on precipitation and temperature. Residual soil saturation is a function of topography and soil type. Monthly data are tabulated from daily average temperature and precipitation, and the water budget is a continuous calculation over the period of record. To clarify, the method and the approach used by many individuals in examining infiltration resets annual conditions (moisture deficit, snow storage, etc) over the winter months because of the general lack of infiltration during the frost period. However, we maintain those records and carry them forward from month to month during the entire period of record.

Values were determined on a monthly basis, compiled from daily Environment Canada meteorological data station located in Orangeville (No. 6155790) for the period between 1969 – 2015. The calculations are based on the average conditions during this period, including outputs for monthly potential and actual evapotranspiration, soil moisture storage, snow storage, surplus and runoff. The results indicate that the average annual precipitation for the regional area is 896 mm, with an average water surplus of 393 mm.

Infiltration factors are used to determine the fraction of water surplus that infiltrates into the ground and the fraction that runs off to nearby drainage features. Infiltration rates were estimated using the method listed in Table 2 of the MOEE Hydrogeological Technical Information Requirements for Land Development Applications (1995). Due to the highly permeable nature of the sand and gravel deposits at surface, the majority of the site being cultivated land and the ‘hilly’ nature of the local topography, it was determined that approximately 70% of the water surplus will infiltrate into the ground. Using an infiltration value of 0.7, the average infiltration rate for the site would be approximately 275 mm/year.

Recharge within the internally drained basins will be equal to the average water surplus (393 mm/year). The two delineated sub-catchment basins for the Duivenvoorden expansion site are presented in Figure 20. According to topographic mapping, the entire Duivenvoorden expansion site is internally drained, which explains the large drainage basin feature which collects surface runoff promoting ground water infiltration.



**Figure 20: Surface Water Catchment Areas**

Figure 20 shows large off-site areas which contribute surface runoff to the on-site drainage and wetland basins, but little to no flow leaving the site. Any drainage off-site would be negligible and limited to the roadside ditch at the eastern property boundary.

The infiltration rate of 393 mm/year (entire water surplus) has been applied to both drainage basins (internal and wetland). The combined area of the two drainage basins is approximately 968,400 m<sup>2</sup>, which equals a total annual ground water recharge of approximately 380,580 m<sup>3</sup>/year.

As aggregate is extracted, the flattening of the pit floor promotes infiltration as the average land slope lessens and the highly permeable materials are exposed (vegetation



and topsoil removed). Considering the entire site is internally drained (little to no runoff off-site), pre-extraction recharge conditions would not be impacted to a significant degree due to the proposed extraction operations.

The catchment area that provides surface runoff to the wetland feature will also not be impacted, as the majority of this catchment is off-site. The remainder of the catchment is within the forested area that will be preserved within the southwestern corner of the site.

## **6.2 Potential Interference with Local Ground Water Regime**

The proposed extraction of aggregate will occur at an elevation of at least 1.5 metres above the established high water table elevation. As discussed in Section 6.1, the permeable materials on the pit floor will allow for ground water to recharge at an increased rate of an average of 393 mm/year. Therefore, the pit operations will not require a water management plan.

The change in land use will maintain or slightly increase ground water recharge within the extraction area. An increase in recharge from the flattening of slopes and stripping of vegetation/topsoil will likely have no measureable change in water table elevations across the site and therefore will have no impact on off-site domestic water wells.

## **6.3 Potential Interference with Surface Water Features**

On-site surface water features include a wetland within the southwest portion of the site located within the forested area being preserved (not included within extraction area). This wetland has been found to have some degree of ground water contribution (likely only during times of elevated water table) and therefore has a seasonal connection to the local ground water regime. As determined in the water balance assessment for the site, no negative impacts to the existing pre-extraction recharge conditions are anticipated, so impacts to the wetland are also not expected. The wetland catchment area will also be maintained so changes to direct runoff will not occur during post-extraction conditions.

The temporary drainage features (swales and basin) shown in Figure 5 only contain surface water during spring freshet and have no connection to the local ground water regime. These features within the proposed extraction area would be eliminated due to extraction of material and grade changes. These features will not be required to convey/contain runoff post-extraction as perimeter berms will significantly reduce the amount of runoff into this area.

## **7.0 MITIGATION MEASURES**

Although there are no anticipated impacts associated with the proposed extraction of aggregate, which will occur at least 1.5 metres above the established water table, there



are preventative operational practices that are recommended to further protect ground water quality.

- Refueling of machinery should not be conducted in areas of the excavation that are within 1.5 metres of the water table (i.e., on the pit floor).
- Operator training should include understanding and the ability to implement the preventative measures provided above, in addition to the Spill Contingency Plan (as per prescribed conditions on Site Plans).

## 8.0 RECOMMENDED MONITORING PROGRAM

A monitoring program has been developed for the proposed Duivenvoorden expansion site. The program focuses on monitoring and continuing the characterization of the local overburden ground water regime, both from water level and water quality perspectives.

Considering the proposed aggregate operation will not be extracting from below the water table, there will be no influence on the bedrock aquifer system. Therefore, we do not recommend the installation of wells to monitor the bedrock aquifer. However, to continue the characterization of the water table aquifer within the overburden, continuous ground water elevation monitoring is recommended. It is also recommended that one upgradient and two downgradient monitoring locations be sampled for water quality on a semi-annual basis.

Table 4 provides a summary of the proposed monitoring program for the Duivenvoorden expansion site.

**Table 4: Proposed Monitoring Program**

| Monitor  | Water Levels<br>(Datalogger/Spring-Summer-<br>Fall Manuals) | Water Quality<br>(Semi-Annual) |
|----------|-------------------------------------------------------------|--------------------------------|
| MW-1     | X                                                           | X                              |
| MW-2-III | X                                                           | X                              |
| MW-3     | X                                                           | X                              |
| MW-4s    | X                                                           | X                              |
| MW-4d    | X                                                           |                                |
| MW-5-I   | X                                                           | X                              |
| MW-6     | X                                                           | X                              |

The proposed water quality package for the monitoring program consists of a wide range of metals, nutrients and inorganic parameters, including:



*pH, electrical conductivity, alkalinity, total phosphorus, ammonia, hardness, TDS, TOC, Colour, chloride, nitrate, nitrite, bromide, sulphate, ortho-phosphate, calcium, magnesium, sodium, potassium, aluminum, boron, copper, iron, lead, manganese, strontium, zinc, Total Petroleum Hydrocarbons (F1 – F4), VOC's (full suite) and Total Oil and Grease*

It is recommended that an annual monitoring report for the Duivenvoorden expansion site be prepared and submitted to the MNR and Township prior to March 31<sup>st</sup> of each year and include the monitoring data for the preceding calendar year. The report shall include the following:

- Monitoring data collected as per Table 4;
- Water quality sampling results;
- Data tabulated in graphical and tabular formats;
- Interpretation of all water level and water quality data;
- Recommendations pertaining to continuation of the monitoring program, and/or changes such as monitoring type, monitoring frequency, monitoring locations, etc., and;
- Summary and documentation of any water well complaint(s) and their resolution(s).

Also, if any detectable concentrations of VOC or PHC parameters are reported at any monitoring well location, it is recommended that the Township be notified immediately and the detection(s) triggers an immediate re-sampling of the monitoring well. Further, should any release or spill occur within the site, particularly the pit floor, it is recommended that the Township and MECP Spills Action Centre (SAC) be notified immediately. The proponent should have contingencies in place for the immediate extraction and secure storage of impacted ground water before any significant migration away from that source area can occur.

## **9.0 CONCLUSIONS**

The proposed Duivenvoorden Pit expansion lands were investigated to determine the suitability of the extraction of aggregate from above the water table. As there will be no water diversion or dewatering to maintain dry pit operating conditions, and the maximum depth of extraction will not be less than 1.5 metres of the seasonal high water table, there be no measureable influence on the underlying water table aquifer. Therefore, there will be no anticipated impact to local domestic water wells. Surface water features (i.e., on-site wetland) will also not be impacted due to the lack of proposed changes to local catchment areas and that the pit excavation will somewhat increase infiltration.



Considering all available data compiled during this assessment, the Duivenvoorden Pit expansion lands are suitable for above water table aggregate extraction.

## **10.0 REFERENCES**

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Combined Level 1 and 2 Hydrogeological Assessment Report. Proposed  
Bonfield and Prince Pits.



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## **APPENDICES**

**Appendix A: Figures**

**Appendix B: MECP Domestic Water Well Records**

**Appendix C: Borehole Logs**

**Appendix D: Water Quality Results**

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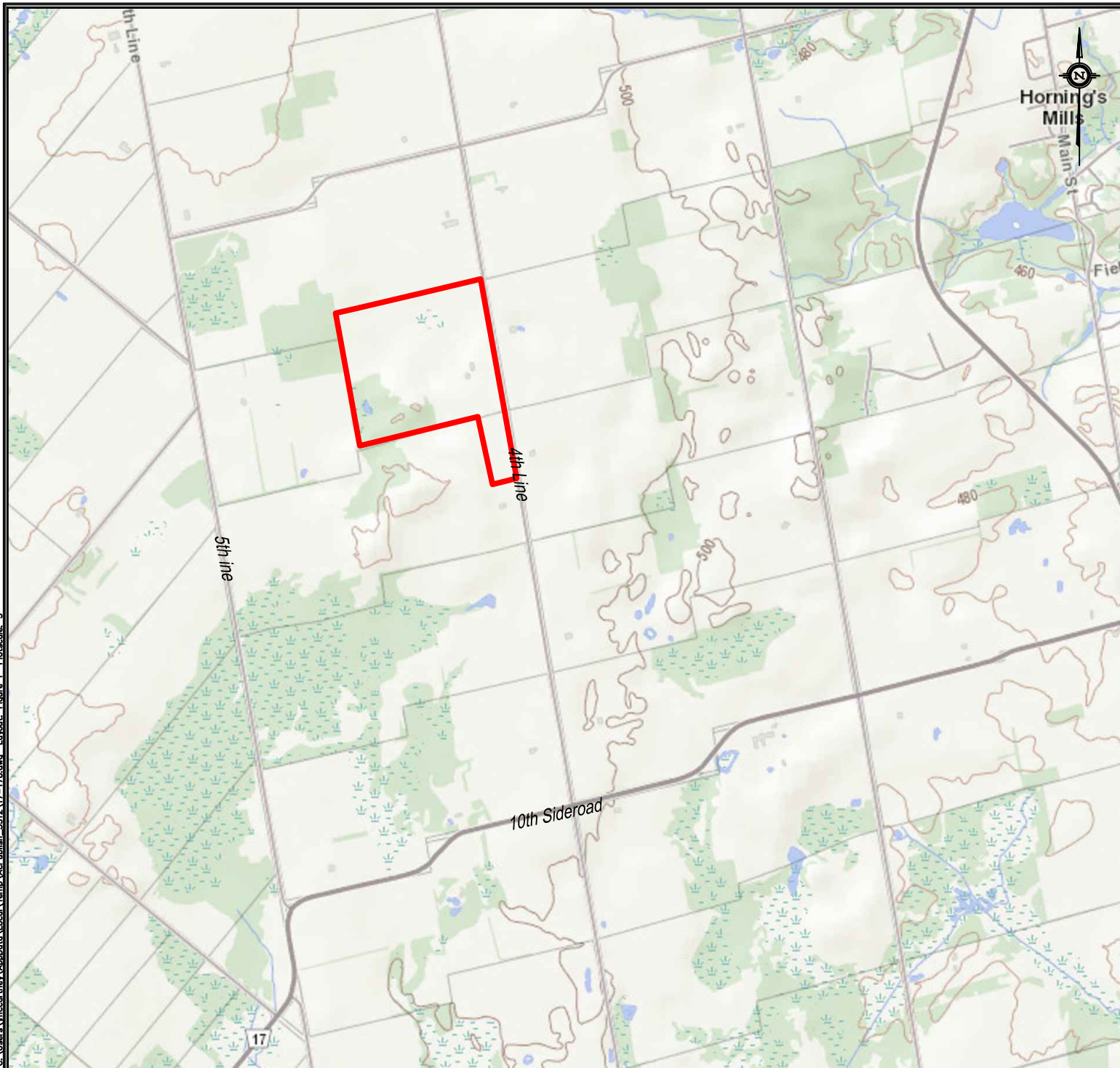
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## **APPENDIX A**

### **Figures**

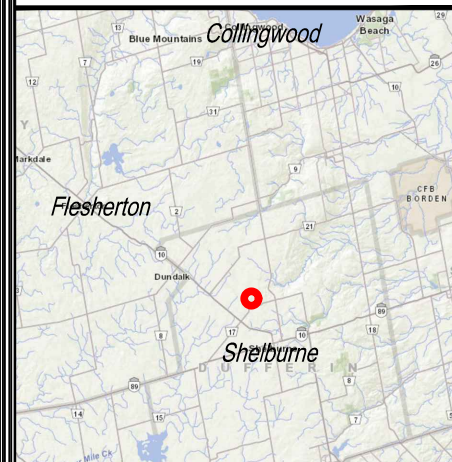
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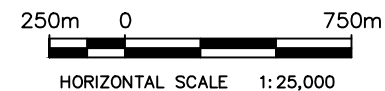


**LEGEND:**

 *Approx. Property Boundary*



REG MAP



Study Area Location

Melancthon Gravel Pit Expansion,  
Melancthon, ON

DATE ISSUED: November 2020

CREATED BY: JLM

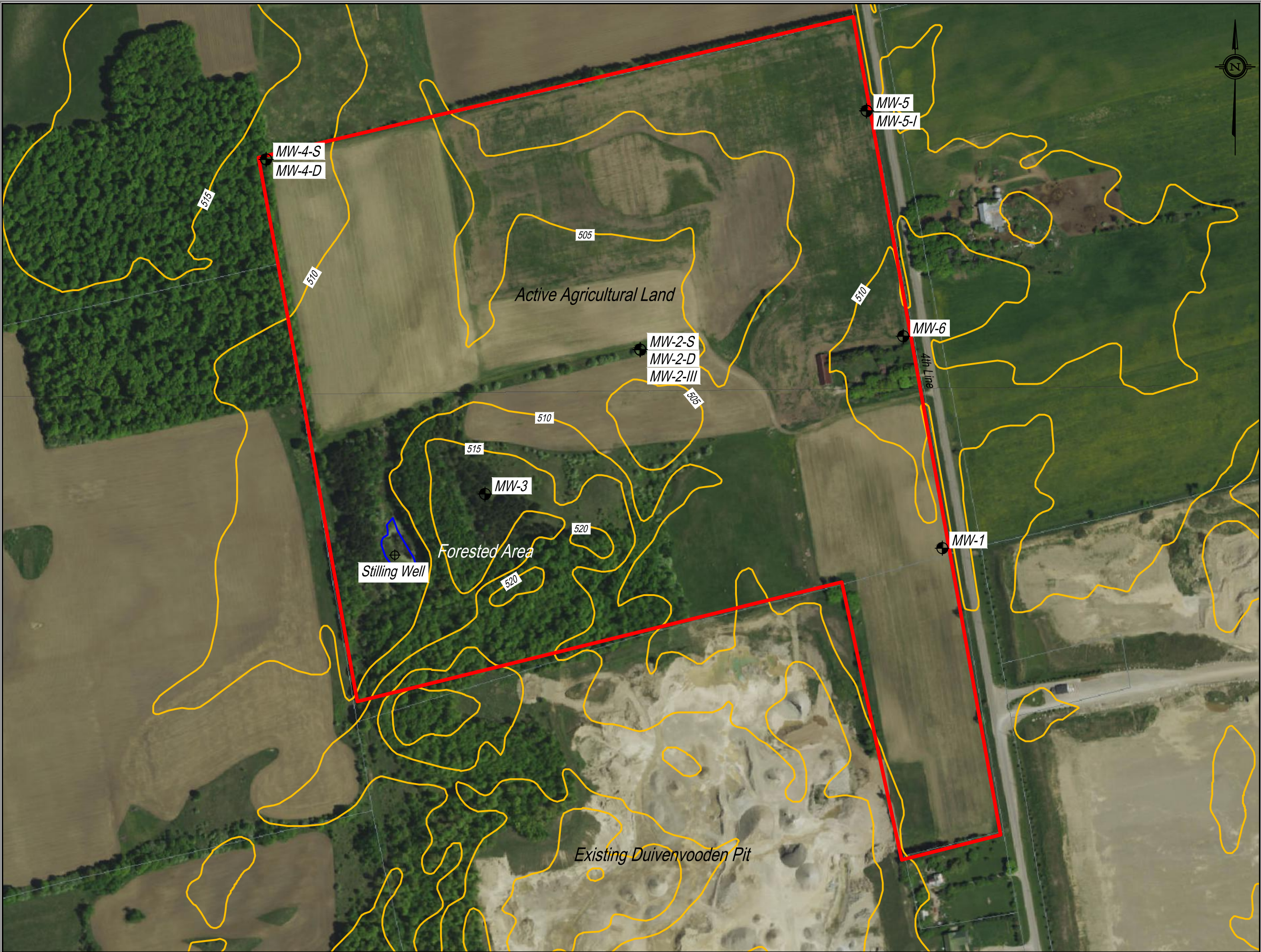
PROJECT NO.: 17-178

REFERENCE: MNR

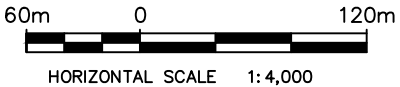
Figure No.

1

Plotted by: ALU on July 25, 2023 at 2:32pm  
File: P:\17 Projects\17-178 Melancthon Gravel Pit Expansion\04.0 - Drafting\17-178.dwg Layout: HYD2 PlotScale: 3



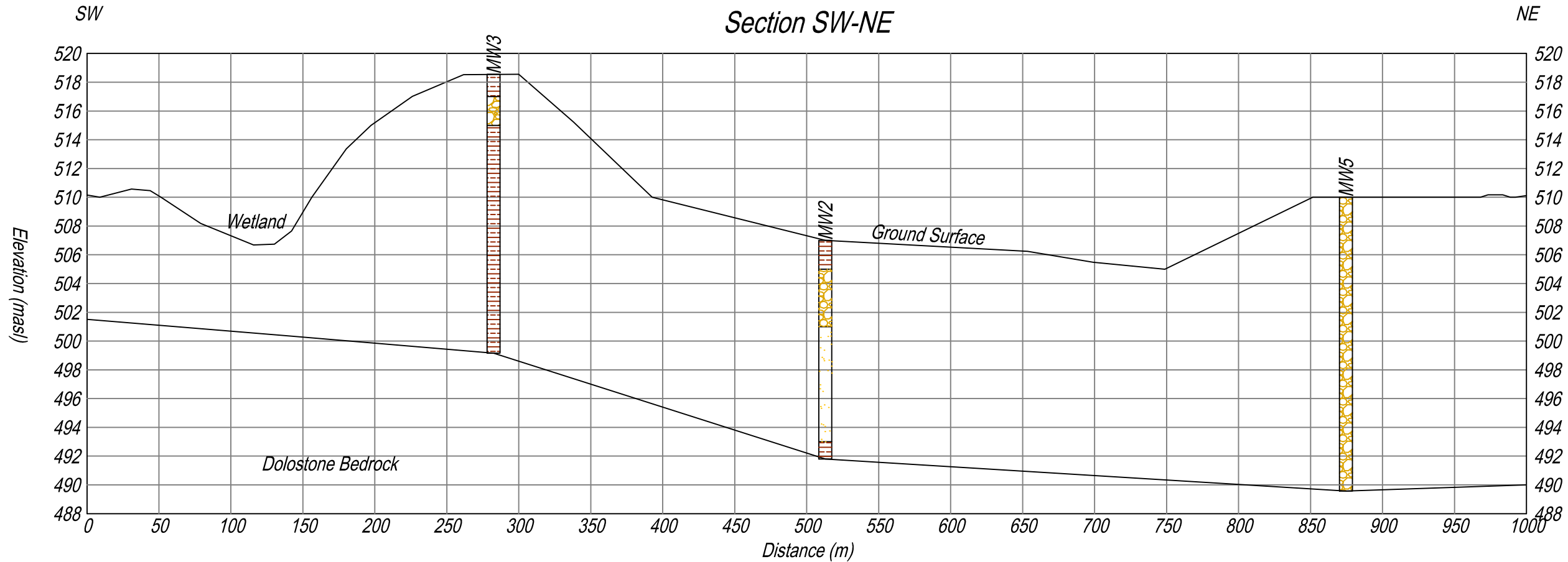
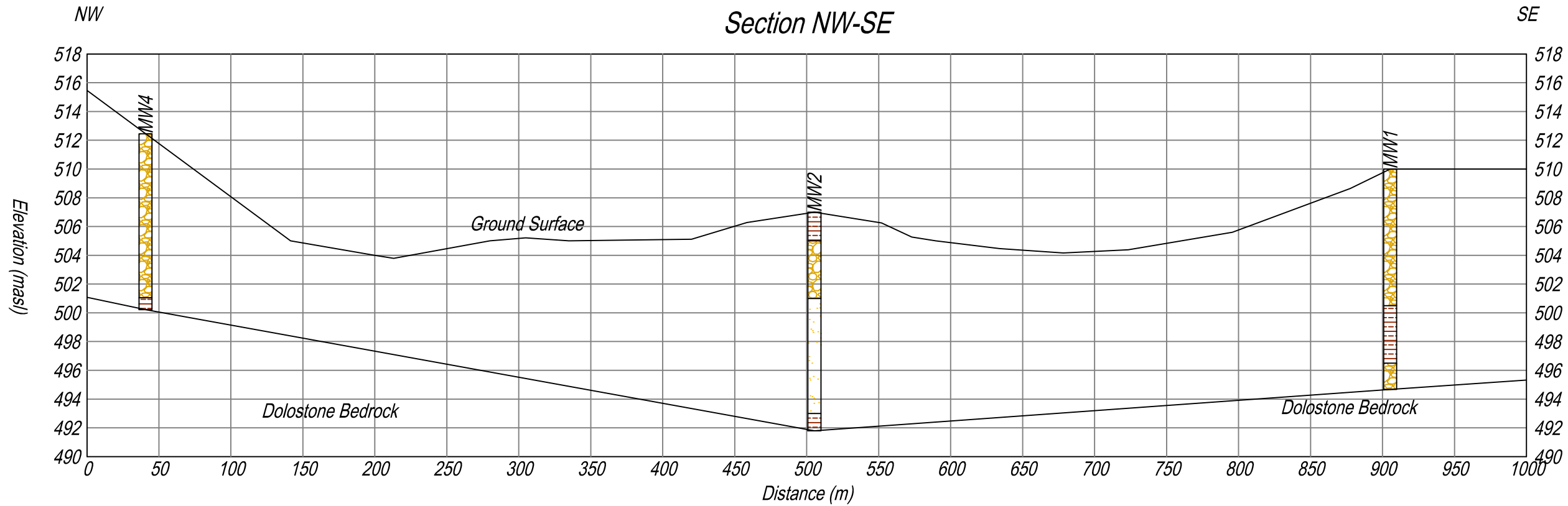
- LEGEND:**
- Approx. Expansion Property Boundary
  - Pond
  - Well Locations
  - 5m OBM Contours



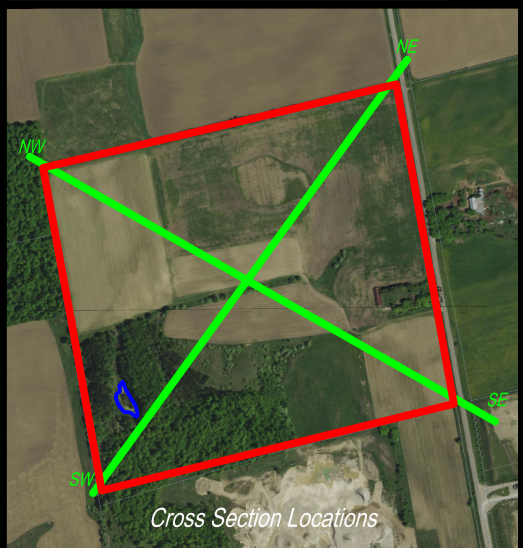
Environmental Features

Melancthon Gravel Pit Expansion,  
Melancthon, ON

|              |           |                     |
|--------------|-----------|---------------------|
| DATE ISSUED: | July 2023 | Figure No.<br><br>2 |
| CREATED BY:  | JLM       |                     |
| PROJECT NO.: | 17-178    |                     |
| REFERENCE:   | MNRF      |                     |



- LEGEND:
- Approx. Property Boundary
  - Pond
  - Cross Section Locations
  - Sand
  - Sand and Gravel
  - Till



Not to Scale  
10x Vertical Exaggeration



Cross Sections

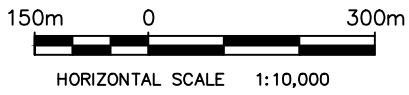
Melancthon Gravel Pit Expansion,  
Melancthon, ON

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| DATE ISSUED: | February 2019 | Figure No.<br>3 |
| CREATED BY:  | JLM           |                 |
| PROJECT NO.: | 17-178        |                 |
| REFERENCE:   | MNRF          |                 |



**LEGEND:**

- Approx. Property Boundary
- Pond
- Duivenvoorden Well Locations
- Strada Well Locations
- 2m Ground Water Contours (Dec. 2018)
- 494.78 Ground Water Elevations (Dec. 2018)



Regional Ground Water Contours

Melancthon Gravel Pit Expansion,  
Melancthon, ON

|              |               |                     |
|--------------|---------------|---------------------|
| DATE ISSUED: | November 2020 | Figure No.<br><br>4 |
| CREATED BY:  | JLM           |                     |
| PROJECT NO.: | 17-178        |                     |
| REFERENCE:   | MNRF          |                     |



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## **APPENDIX B**

### **MECP Domestic Water Well Records**

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4, A/E

2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

cont.

CON. BLOCK, TRACT, SURVEY, ETC.

22 23 24  
25-27

48-51

DATE COMPLETED 48-55  
DAY 28 MO. 04 YR. 72

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4887240

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166

1660

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[5

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1

11

IV

**LOG OF OVERBURDEN AND BEDROCK MATERIALS** (SEE INSTRUCTIONS)

|     |           |         |    |    |    |    |    |    |  |
|-----|-----------|---------|----|----|----|----|----|----|--|
| 31  | 004861105 | 0052211 |    |    |    |    |    |    |  |
| 32  |           |         |    |    |    |    |    |    |  |
| 1 2 | 10 14 15  | 21      | 32 | 43 | 54 | 65 | 75 | 80 |  |

## 51 CASING &amp; OPEN HOLE RECORD

| INSIDE DIAM.<br>INCHES |       | MATERIAL                                                                                                                                                            | WALL THICKNESS<br>INCHES | DEPTH - FEET |                                |
|------------------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------|--------------------------------|
|                        |       |                                                                                                                                                                     |                          | FROM         | TO                             |
| 05                     | 10-11 | 1 <input checked="" type="checkbox"/> STEEL<br>2 <input type="checkbox"/> GALVANIZED<br>3 <input type="checkbox"/> CONCRETE<br>4 <input type="checkbox"/> OPEN HOLE | 188                      | 0            | 13-16<br><del>58</del><br>0052 |
|                        | 17-18 | 1 <input type="checkbox"/> STEEL<br>2 <input type="checkbox"/> GALVANIZED<br>3 <input type="checkbox"/> CONCRETE<br>4 <input type="checkbox"/> OPEN HOLE            |                          |              | 20-23                          |
| 0                      | 24-25 | 1 <input type="checkbox"/> STEEL<br>2 <input type="checkbox"/> GALVANIZED<br>3 <input type="checkbox"/> CONCRETE<br>4 <input type="checkbox"/> OPEN HOLE            |                          |              | 27-30                          |

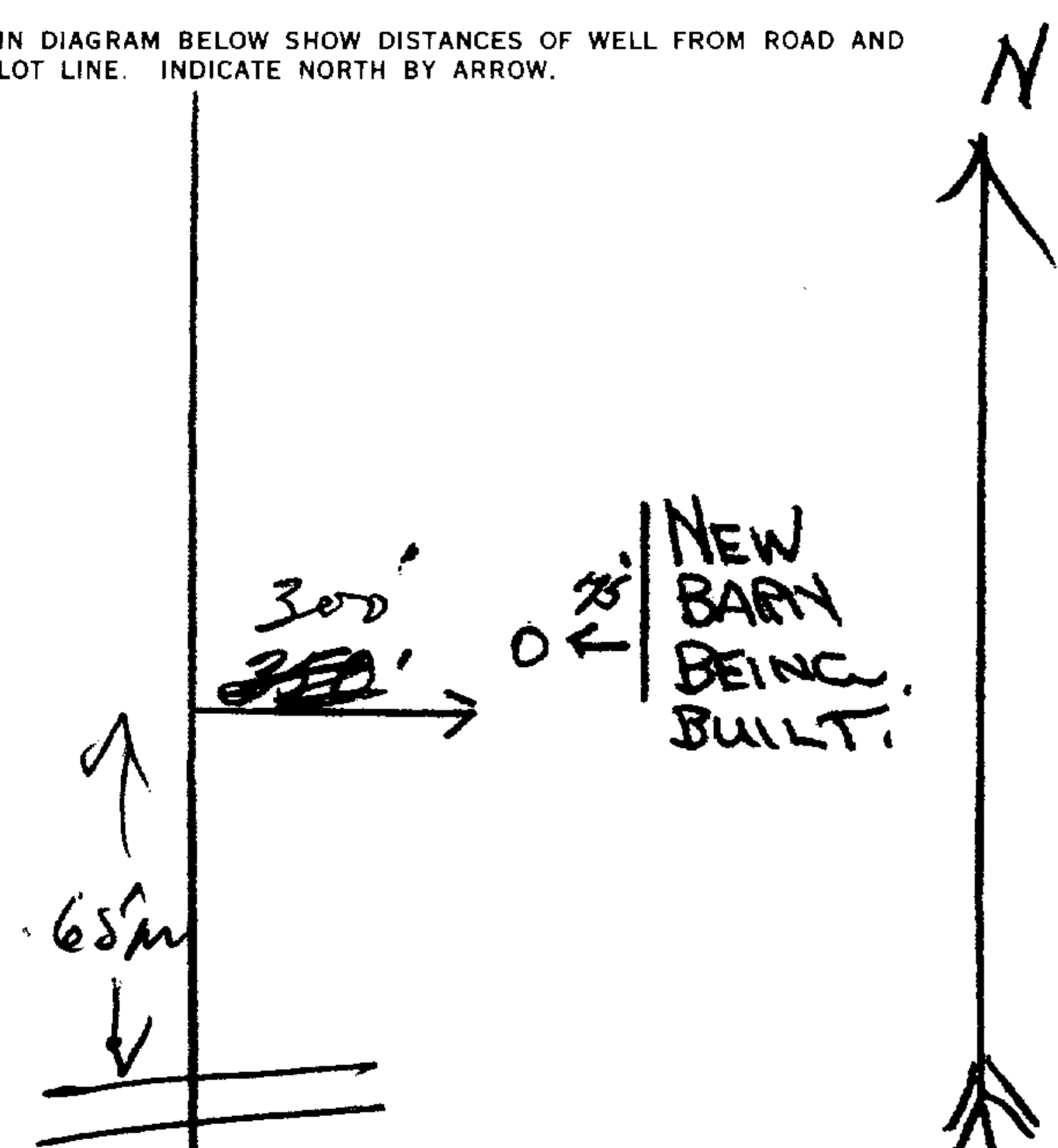
| 61 PLUGGING & SEALING RECORD |       |                                                           |    |
|------------------------------|-------|-----------------------------------------------------------|----|
| DEPTH SET AT - FEET          |       | MATERIAL AND TYPE<br>(CEMENT GROUT,<br>LEAD PACKER, ETC.) |    |
| FROM                         | TO    |                                                           |    |
| 10-13                        | 14-17 | <del>CEMENT GROUT</del>                                   |    |
| 18-21                        | 22-25 |                                                           |    |
| 26-29                        | 30-33 |                                                           | 80 |

|                                        |                                                                                                    |                   |                                           |                                 |                                                                                                          |                                 |                                                                                      |
|----------------------------------------|----------------------------------------------------------------------------------------------------|-------------------|-------------------------------------------|---------------------------------|----------------------------------------------------------------------------------------------------------|---------------------------------|--------------------------------------------------------------------------------------|
| PUMPING TEST                           | <input type="checkbox"/> PUMP    2 <input checked="" type="checkbox"/> BAILER                      |                   | 0015 GPM.                                 |                                 | 01 15-16 HOURS 30 MIN.                                                                                   |                                 | 17-18                                                                                |
|                                        | STATIC LEVEL                                                                                       |                   | WATER LEVEL END OF PUMPING                |                                 | 25 WATER LEVELS DURING                                                                                   |                                 | 1 <input type="checkbox"/> PUMPING<br>2 <input checked="" type="checkbox"/> RECOVERY |
|                                        | 19-21<br>025 FEET                                                                                  | 22-24<br>030 FEET | 15 MINUTES<br>26-28<br>025 FEET           | 30 MINUTES<br>29-31<br>025 FEET | 45 MINUTES<br>32-34<br>025 FEET                                                                          | 60 MINUTES<br>35-36<br>025 FEET |                                                                                      |
|                                        | IF FLOWING, GIVE RATE<br><del>0000</del> 38-41 GPM.                                                |                   | PUMP INTAKE SET AT<br><del>100</del> FEET |                                 | WATER AT END OF TEST<br>1 <input type="checkbox"/> CLEAR    2 <input checked="" type="checkbox"/> CLOUDY |                                 | 4                                                                                    |
|                                        | RECOMMENDED PUMP TYPE<br><input type="checkbox"/> SHALLOW <input checked="" type="checkbox"/> DEEP |                   | RECOMMENDED PUMP SETTING<br>035 FEET      |                                 | 43-45 RECOMMENDED PUMPING RATE<br>0010 GPM.                                                              |                                 | 46-47                                                                                |
| 50-53 003.0 GPM./FT. SPECIFIC CAPACITY |                                                                                                    |                   |                                           |                                 |                                                                                                          |                                 |                                                                                      |

|                                            |                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                   |
|--------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>FINAL<br/>STATUS<br/>OF WELL</b></p> | <p>54</p> <p>1 <input checked="" type="checkbox"/> WATER SUPPLY</p> <p>2 <input type="checkbox"/> OBSERVATION WELL</p> <p>3 <input type="checkbox"/> TEST HOLE</p> <p>4 <input type="checkbox"/> RECHARGE WELL</p>                                                           | <p>5 <input type="checkbox"/> ABANDONED, INSUFFICIENT SUPPLY</p> <p>6 <input type="checkbox"/> ABANDONED, POOR QUALITY</p> <p>7 <input type="checkbox"/> UNFINISHED</p>                                                                           |
| <p><b>WATER<br/>USE</b> 01</p>             | <p>55-56</p> <p>1 <input checked="" type="checkbox"/> DOMESTIC</p> <p>2 <input type="checkbox"/> STOCK</p> <p>3 <input type="checkbox"/> IRRIGATION</p> <p>4 <input type="checkbox"/> INDUSTRIAL</p> <p><input type="checkbox"/> OTHER _____</p>                             | <p>5 <input type="checkbox"/> COMMERCIAL</p> <p>6 <input type="checkbox"/> MUNICIPAL</p> <p>7 <input type="checkbox"/> PUBLIC SUPPLY</p> <p>8 <input type="checkbox"/> COOLING OR AIR CONDITIONING</p> <p>9 <input type="checkbox"/> NOT USED</p> |
| <p><b>METHOD<br/>OF<br/>DRILLING</b></p>   | <p>57</p> <p>1 <input type="checkbox"/> CABLE TOOL</p> <p>2 <input checked="" type="checkbox"/> ROTARY (CONVENTIONAL)</p> <p>3 <input type="checkbox"/> ROTARY (REVERSE)</p> <p>4 <input type="checkbox"/> ROTARY (AIR)</p> <p>5 <input type="checkbox"/> AIR PERCUSSION</p> | <p>6 <input type="checkbox"/> BORING</p> <p>7 <input type="checkbox"/> DIAMOND</p> <p>8 <input type="checkbox"/> JETTING</p> <p>9 <input type="checkbox"/> DRIVING</p>                                                                            |

### LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS:

|            |                               |  |                    |  |
|------------|-------------------------------|--|--------------------|--|
| CONTRACTOR | NAME OF WELL CONTRACTOR       |  | LICENCE NUMBER     |  |
|            | LUNNEY WELL DRILLING          |  | 3406               |  |
|            | ADDRESS                       |  |                    |  |
|            | 36 BUENA VISTA DR ORANGEVILLE |  |                    |  |
| CONTRACTOR | NAME OF DRILLER OR BORER      |  | LICENCE NUMBER     |  |
|            | GORDON LUNNEY                 |  | 3406               |  |
|            | SIGNATURE OF CONTRACTOR       |  | SUBMISSION DATE    |  |
|            | Gordon Lunney                 |  | DAY 7 MO. 6 YR. 77 |  |

|                 |                    |    |            |       |               |        |    |
|-----------------|--------------------|----|------------|-------|---------------|--------|----|
| OFFICE USE ONLY | DATA SOURCE        | 58 | CONTRACTOR | 59-62 | DATE RECEIVED | 63-68  | 80 |
|                 | 1                  |    | 3406       |       | 090672        |        |    |
|                 | DATE OF INSPECTION |    | INSPECTOR  |       |               |        |    |
|                 | REMARKS:           |    |            |       |               | CSS.S8 | P  |
|                 |                    |    |            |       |               |        | WI |

OWRC COPY





# The Ontario Water Resources Act WATER WELL RECORD

Mark correct box with a checkmark, where applicable.

1705240

Con.

17004

CON

44

East 69th St

|                    |       |                                    |                 |                              |       |      |    |
|--------------------|-------|------------------------------------|-----------------|------------------------------|-------|------|----|
| County or District | Du Ar | Township/Borough/City/Town/Village | Melancthon      | Con block tract survey, etc. | 14    | Lot  | 14 |
| Owner's surname    | 28-47 | First name                         | Address         | Date completed               | 14    | 11   | 98 |
|                    |       |                                    | PR #2 SHELBURNE | day                          | month | year |    |

21

Zone

U  
T  
M

10

Easting

12

17

Northing

18

24

HC

25

Elevation

26

30

HC

31

Basin Code

47

### LOG OF OVERBURDEN AND BEDROCK MATERIALS (see instructions)

[illegible][illegible]

| 41 WATER RECORD       |                                             |                                     |  |  |    |
|-----------------------|---------------------------------------------|-------------------------------------|--|--|----|
| Water found at - feet |                                             | Kind of water                       |  |  |    |
| 10-13<br><b>90</b>    | 1 <input checked="" type="checkbox"/> Fresh | 3 <input type="checkbox"/> Sulphur  |  |  | 14 |
|                       | 2 <input type="checkbox"/> Salty            | 4 <input type="checkbox"/> Minerals |  |  |    |
| 15-18                 | 1 <input type="checkbox"/> Fresh            | 3 <input type="checkbox"/> Sulphur  |  |  | 19 |
|                       | 2 <input type="checkbox"/> Salty            | 4 <input type="checkbox"/> Minerals |  |  |    |
| 20-23                 | 1 <input type="checkbox"/> Fresh            | 3 <input type="checkbox"/> Sulphur  |  |  | 24 |
|                       | 2 <input type="checkbox"/> Salty            | 4 <input type="checkbox"/> Minerals |  |  |    |
| 25-28                 | 1 <input type="checkbox"/> Fresh            | 3 <input type="checkbox"/> Sulphur  |  |  | 29 |
|                       | 2 <input type="checkbox"/> Salty            | 4 <input type="checkbox"/> Minerals |  |  |    |
| 30-33                 | 1 <input type="checkbox"/> Fresh            | 3 <input type="checkbox"/> Sulphur  |  |  | 34 |
|                       | 2 <input type="checkbox"/> Salty            | 4 <input type="checkbox"/> Minerals |  |  |    |

| CASING & OPEN HOLE RECORD |                                                                                                                                                                                                           |                       |              |       |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|--------------|-------|
| 51                        |                                                                                                                                                                                                           |                       |              |       |
| Inside diam inches        | Material                                                                                                                                                                                                  | Wall thickness inches | Depth - feet |       |
|                           |                                                                                                                                                                                                           |                       | From         | To    |
| 10-11                     | 1 <input checked="" type="checkbox"/> Steel<br>2 <input type="checkbox"/> Galvanized<br>3 <input type="checkbox"/> Concrete<br>4 <input type="checkbox"/> Open hole<br>5 <input type="checkbox"/> Plastic | 12                    |              | 13-16 |
| 17-18                     | 1 <input type="checkbox"/> Steel<br>2 <input type="checkbox"/> Galvanized<br>3 <input type="checkbox"/> Concrete<br>4 <input type="checkbox"/> Open hole<br>5 <input type="checkbox"/> Plastic            | 19                    |              | 20-23 |
| 24-25                     | 1 <input type="checkbox"/> Steel<br>2 <input type="checkbox"/> Galvanized<br>3 <input type="checkbox"/> Concrete<br>4 <input type="checkbox"/> Open hole<br>5 <input type="checkbox"/> Plastic            | 26                    |              | 27-30 |

|               |                                |       |          |       |                        |       |
|---------------|--------------------------------|-------|----------|-------|------------------------|-------|
| <b>SCREEN</b> | Sizes of opening<br>(Slot No.) | 31-33 | Diameter | 34-38 | Length                 | 39-40 |
|               |                                |       | inches   |       | feet                   |       |
|               | Material and type              |       |          |       | Depth at top of screen | 30    |
|               |                                |       |          |       | feet                   |       |

|                                        |       |                                                   |  |
|----------------------------------------|-------|---------------------------------------------------|--|
| 61                                     |       | <b>PLUGGING &amp; SEALING RECORD</b>              |  |
| <input type="checkbox"/> Annular space |       | <input type="checkbox"/> Abandonment              |  |
| Depth set at - feet                    |       | Material and type (Cement grout, bentonite, etc.) |  |
| From                                   | To    |                                                   |  |
| 10-13                                  | 14-17 |                                                   |  |
| 18-21                                  | 22-25 |                                                   |  |
| 26-29                                  | 30-33 |                                                   |  |
|                                        |       | 80                                                |  |

|                                                                                                                     |                                                                                                                  |                                                   |                                     |                                                                                                                 |                                                                                            |  |
|---------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|-------------------------------------|-----------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|--|
| PUMPING TEST                                                                                                        | 71 Pumping test method <sup>10</sup><br><input type="checkbox"/> Pump <input checked="" type="checkbox"/> Bailor |                                                   | Pumping rate <sup>11-14</sup> 5 GPM |                                                                                                                 | Duration of pumping <sup>15-16</sup> 2 Hours <sup>17-18</sup> Mins                         |  |
|                                                                                                                     | Static level                                                                                                     |                                                   | Water level end of pumping          |                                                                                                                 | Water levels during <input type="checkbox"/> 1 Pumping <input type="checkbox"/> 2 Recovery |  |
|                                                                                                                     | 19-21 65 feet                                                                                                    |                                                   | 22-24 90 feet                       |                                                                                                                 | 25 15 minutes 26-28 90 feet                                                                |  |
|                                                                                                                     |                                                                                                                  |                                                   |                                     |                                                                                                                 | 30 minutes 29-31 90 feet                                                                   |  |
|                                                                                                                     |                                                                                                                  |                                                   |                                     |                                                                                                                 | 45 minutes 32-34 90 feet                                                                   |  |
| If flowing give rate <sup>38-41</sup> GPM                                                                           |                                                                                                                  | Pump intake set at feet                           |                                     | Water at end of test <sup>42</sup><br><input type="checkbox"/> Clear <input checked="" type="checkbox"/> Cloudy |                                                                                            |  |
| Recommended pump type <sup>43-45</sup><br><input type="checkbox"/> Shallow <input checked="" type="checkbox"/> Deep |                                                                                                                  | Recommended pump setting <sup>46-49</sup> 98 feet |                                     | Recommended pump rate 3 GPM                                                                                     |                                                                                            |  |

|                                                             |                                                           |                                              |
|-------------------------------------------------------------|-----------------------------------------------------------|----------------------------------------------|
| <b>FINAL STATUS OF WELL</b>                                 |                                                           | 54                                           |
| 1 <input checked="" type="checkbox"/> Water supply          | 5 <input type="checkbox"/> Abandoned, insufficient supply | 9 <input type="checkbox"/> Unfinished        |
| 2 <input checked="" type="checkbox"/> Observation well      | 6 <input type="checkbox"/> Abandoned, poor quality        | 10 <input type="checkbox"/> Replacement well |
| 3 <input type="checkbox"/> Test hole                        | 7 <input type="checkbox"/> Abandoned (Other)              |                                              |
| 4 <input type="checkbox"/> Recharge well                    | 8 <input type="checkbox"/> Dewatering                     |                                              |
| <b>WATER USE</b>                                            |                                                           |                                              |
| 55-56                                                       |                                                           |                                              |
| 1 <input checked="" type="checkbox"/> Domestic              | 5 <input type="checkbox"/> Commercial                     | 9 <input type="checkbox"/> Not used          |
| 2 <input checked="" type="checkbox"/> Stock                 | 6 <input type="checkbox"/> Municipal                      | 10 <input type="checkbox"/> Other .....      |
| 3 <input type="checkbox"/> Irrigation                       | 7 <input type="checkbox"/> Public supply                  |                                              |
| 4 <input type="checkbox"/> Industrial                       | 8 <input type="checkbox"/> Cooling & air conditioning     |                                              |
| <b>METHOD OF CONSTRUCTION</b>                               |                                                           | 57                                           |
| 1 <input checked="" type="checkbox"/> Cable tool            | 5 <input type="checkbox"/> Air percussion                 | 9 <input type="checkbox"/> Driving           |
| 2 <input checked="" type="checkbox"/> Rotary (conventional) | 6 <input type="checkbox"/> Boring                         | 10 <input type="checkbox"/> Digging          |
| 3 <input type="checkbox"/> Rotary (reverse)                 | 7 <input type="checkbox"/> Diamond                        | 11 <input type="checkbox"/> Other .....      |
| 4 <input type="checkbox"/> Rotary (air)                     | 8 <input type="checkbox"/> Jetting                        |                                              |

**LOCATION OF WELL**

In diagram below show distances of well from road and lot line.  
Indicate north by arrow.

10<sup>th</sup> Side Rd.

700 ft

1/4 mile

5<sup>th</sup> Side Rd

lot line

199520

|                                                       |                                                |
|-------------------------------------------------------|------------------------------------------------|
| Name of Well Contractor<br><i>Same</i>                | Well Contractor's Licence No.<br><i>3561</i>   |
| Address<br><i>156 Plumy Hill</i>                      |                                                |
| Name of Well Technician<br><i>Same</i>                | Well Technician's Licence No.<br><i>T-0298</i> |
| Signature of Technician/Contractor<br><i>Bob Paul</i> | Submission date<br>day      mo      yr         |

|                   |                    |    |            |       |               |       |    |
|-------------------|--------------------|----|------------|-------|---------------|-------|----|
| MINISTRY USE ONLY | Data source        | 58 | Contractor | 59-62 | Date received | 63-68 | 69 |
|                   |                    |    | 3561       |       | DEC 14 1998   |       |    |
|                   | Date of inspection |    | Inspector  |       |               |       |    |
|                   | Remarks            |    |            |       |               |       |    |
|                   | CSS. ES9           |    |            |       |               |       |    |



Measurements recorded in: ☐ Metric ☐ Imperial

**Well Owner's Information**

|                                                                  |                                  |                        |                                                         |
|------------------------------------------------------------------|----------------------------------|------------------------|---------------------------------------------------------|
| First Name<br><b>HIGHLAND COMPANIES</b>                          | Last Name / Organization         | E-mail Address         | <input type="checkbox"/> Well Constructed by Well Owner |
| Mailing Address (Street Number/Name)<br><b>477476 THIRD LINE</b> | Municipality<br><b>SHELBURNE</b> | Province<br><b>ONT</b> | Postal Code<br><b>L6N1S6</b>                            |
| Telephone No. (inc. area code)                                   |                                  |                        |                                                         |

**Well Location**

|                                                                            |                                  |                            |                        |
|----------------------------------------------------------------------------|----------------------------------|----------------------------|------------------------|
| Address of Well Location (Street Number/Name)                              | Township<br><b>MELANTHON</b>     | Lot<br><b>15</b>           | Concession<br><b>4</b> |
| County/District/Municipality<br><b>DUFFERIN</b>                            | City/Town/Village                | Province<br><b>Ontario</b> | Postal Code            |
| UTM Coordinates<br>NAD 83<br>Zone 17<br>Easting 560745<br>Northing 4889111 | Municipal Plan and Sublot Number | Other                      |                        |

**Overburden and Bedrock Materials/Abandonment Sealing Record (see instructions on the back of this form)**

| General Colour | Most Common Material | Other Materials | General Description | Depth (m/ft)<br>From | To    |
|----------------|----------------------|-----------------|---------------------|----------------------|-------|
| brown          | clay & stones        |                 |                     | 0                    | 19ft  |
| grown          | gravel               |                 |                     | 19ft                 | 41ft  |
| gray           | clay & stones        |                 |                     | 41ft                 | 51ft  |
| brown          | rock                 |                 |                     | 51ft                 | 89ft  |
| gray           | rock                 |                 |                     | 89ft                 | 122ft |
|                |                      |                 |                     |                      |       |
|                |                      |                 |                     |                      |       |
|                |                      |                 |                     |                      |       |
|                |                      |                 |                     |                      |       |
|                |                      |                 |                     |                      |       |

| Annular Space               |      |                                             |                           |
|-----------------------------|------|---------------------------------------------|---------------------------|
| Depth Set at (m/ft)<br>From | To   | Type of Sealant Used<br>(Material and Type) | Volume Placed<br>(m³/ft³) |
| 0                           | 58ft | BENTONITE SLURRY                            |                           |
|                             |      |                                             |                           |
|                             |      |                                             |                           |
|                             |      |                                             |                           |

| Method of Construction                                                                                                                                                                                                                                                       | Well Use                                                                                                                                                                                                                                                                                  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <input type="checkbox"/> Cable Tool<br><input checked="" type="checkbox"/> Rotary (Conventional)<br><input type="checkbox"/> Rotary (Reverse)<br><input type="checkbox"/> Boring<br><input type="checkbox"/> Air percussion<br><input type="checkbox"/> Other, specify _____ | <input type="checkbox"/> Public<br><input checked="" type="checkbox"/> Domestic<br><input type="checkbox"/> Livestock<br><input type="checkbox"/> Irrigation<br><input type="checkbox"/> Industrial<br><input type="checkbox"/> Other, specify _____                                      |
| <input type="checkbox"/> Diamond<br><input type="checkbox"/> Jetting<br><input type="checkbox"/> Driving<br><input type="checkbox"/> Digging                                                                                                                                 | <input type="checkbox"/> Commercial<br><input type="checkbox"/> Municipal<br><input type="checkbox"/> Test Hole<br><input type="checkbox"/> Cooling & Air Conditioning<br><input type="checkbox"/> Not used<br><input type="checkbox"/> Dewatering<br><input type="checkbox"/> Monitoring |

| Construction Record - Casing |                                                                          |                        |                      | Status of Well |                                                             |
|------------------------------|--------------------------------------------------------------------------|------------------------|----------------------|----------------|-------------------------------------------------------------|
| Inside Diameter (cm/in)      | Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel) | Wall Thickness (cm/in) | Depth (m/ft)<br>From | To             |                                                             |
| 6 1/4                        | steel                                                                    | .188                   | 0                    | 58ft           | <input checked="" type="checkbox"/> Water Supply            |
| 6in                          | open hole                                                                |                        | 58ft                 | 122ft          | <input type="checkbox"/> Replacement Well                   |
|                              |                                                                          |                        |                      |                | <input type="checkbox"/> Test Hole                          |
|                              |                                                                          |                        |                      |                | <input type="checkbox"/> Recharge Well                      |
|                              |                                                                          |                        |                      |                | <input type="checkbox"/> Dewatering Well                    |
|                              |                                                                          |                        |                      |                | <input type="checkbox"/> Observation and/or Monitoring Hole |
|                              |                                                                          |                        |                      |                | <input type="checkbox"/> Alteration (Construction)          |
|                              |                                                                          |                        |                      |                | <input type="checkbox"/> Abandoned, Insufficient Supply     |
|                              |                                                                          |                        |                      |                | <input type="checkbox"/> Abandoned, Poor Water Quality      |
|                              |                                                                          |                        |                      |                | <input type="checkbox"/> Abandoned, other, specify _____    |
|                              |                                                                          |                        |                      |                | <input type="checkbox"/> Other, specify _____               |

| Construction Record - Screen |                                       |          |                      |
|------------------------------|---------------------------------------|----------|----------------------|
| Outside Diameter (cm/in)     | Material (Plastic, Galvanized, Steel) | Slot No. | Depth (m/ft)<br>From |
|                              |                                       |          |                      |
|                              |                                       |          |                      |
|                              |                                       |          |                      |

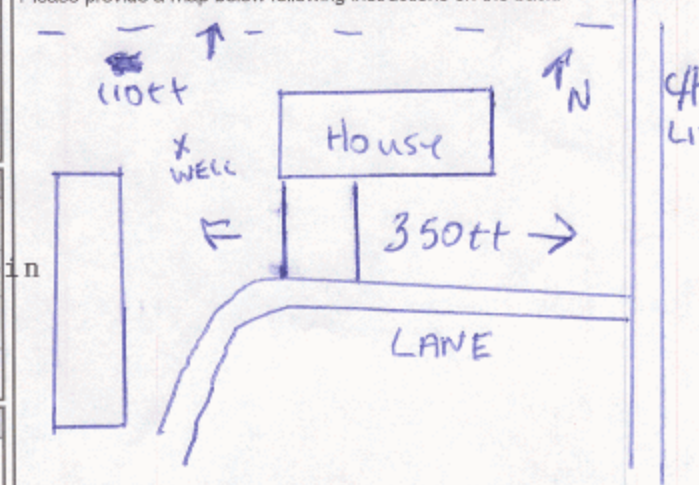
| Water Details               |                                                                                                                                                                       | Hole Diameter        |                        |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|------------------------|
| Water found at Depth (m/ft) | Kind of Water: <input checked="" type="checkbox"/> Fresh <input type="checkbox"/> Untested <input type="checkbox"/> Gas <input type="checkbox"/> Other, specify _____ | Depth (m/ft)<br>From | Diameter (cm/in)<br>To |
| 116ft                       |                                                                                                                                                                       | 0                    | 8.75in                 |
|                             |                                                                                                                                                                       | 58ft                 | 6in                    |
|                             |                                                                                                                                                                       |                      |                        |
|                             |                                                                                                                                                                       |                      |                        |

|                                                                           |                                                             |                                                                      |  |
|---------------------------------------------------------------------------|-------------------------------------------------------------|----------------------------------------------------------------------|--|
| Business Name of Well Contractor<br><b>KEITH LANG WELL DRILLING INC</b>   |                                                             | Well Contractor's Licence No.<br><b>7154</b>                         |  |
| Business Address (Street Number/Name)<br><b>251 ELDON ST GODERICH ONT</b> |                                                             | Municipality                                                         |  |
| Province                                                                  | Postal Code<br><b>N7A3R9</b>                                | Business E-mail Address                                              |  |
| Bus. Telephone No. (inc. area code)                                       |                                                             | Name of Well Technician (Last Name, First Name)<br><b>KEITH LANG</b> |  |
| Well Technician's Licence No.<br><b>T446</b>                              | Signature of Technician and/or Contractor<br><i>K. Lang</i> | Date Submitted<br>Y Y Y Y M M D D                                    |  |

| Results of Well Yield Testing                                                                            |  |              |                    |
|----------------------------------------------------------------------------------------------------------|--|--------------|--------------------|
| After test of well yield, water was:                                                                     |  | Draw Down    |                    |
| <input checked="" type="checkbox"/> Clear and sand free<br><input type="checkbox"/> Other, specify _____ |  | Time (min)   | Water Level (m/ft) |
| If pumping discontinued, give reason:                                                                    |  | Static Level | 33ft               |
|                                                                                                          |  | 1            | 1                  |
|                                                                                                          |  | 2            | 2                  |
|                                                                                                          |  | 3            | 3                  |
|                                                                                                          |  | 4            | 4                  |
|                                                                                                          |  | 5            | 35ft               |
|                                                                                                          |  | 10           | 37ft               |
|                                                                                                          |  | 15           | 15                 |
|                                                                                                          |  | 20           | 20                 |
|                                                                                                          |  | 25           | 25                 |
|                                                                                                          |  | 30           | 30                 |
|                                                                                                          |  | 40           | 40                 |
|                                                                                                          |  | 50           | 50                 |
|                                                                                                          |  | 60           | 37ft               |
|                                                                                                          |  | 60           | 33ft               |

**Map of Well Location**

Please provide a map below following instructions on the back.



|                   |                                                                                                                      |                                                        |                                        |
|-------------------|----------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|----------------------------------------|
| Comments:         | Well owner's information package delivered<br><input checked="" type="checkbox"/> Yes<br><input type="checkbox"/> No | Date Package Delivered<br>Y Y Y Y M M D D<br>2010 12 3 | Date Work Completed<br>Y Y Y Y M M D D |
| Ministry Use Only |                                                                                                                      | Audit No.<br><b>z119189</b>                            |                                        |
|                   |                                                                                                                      | APR 29 2011                                            |                                        |



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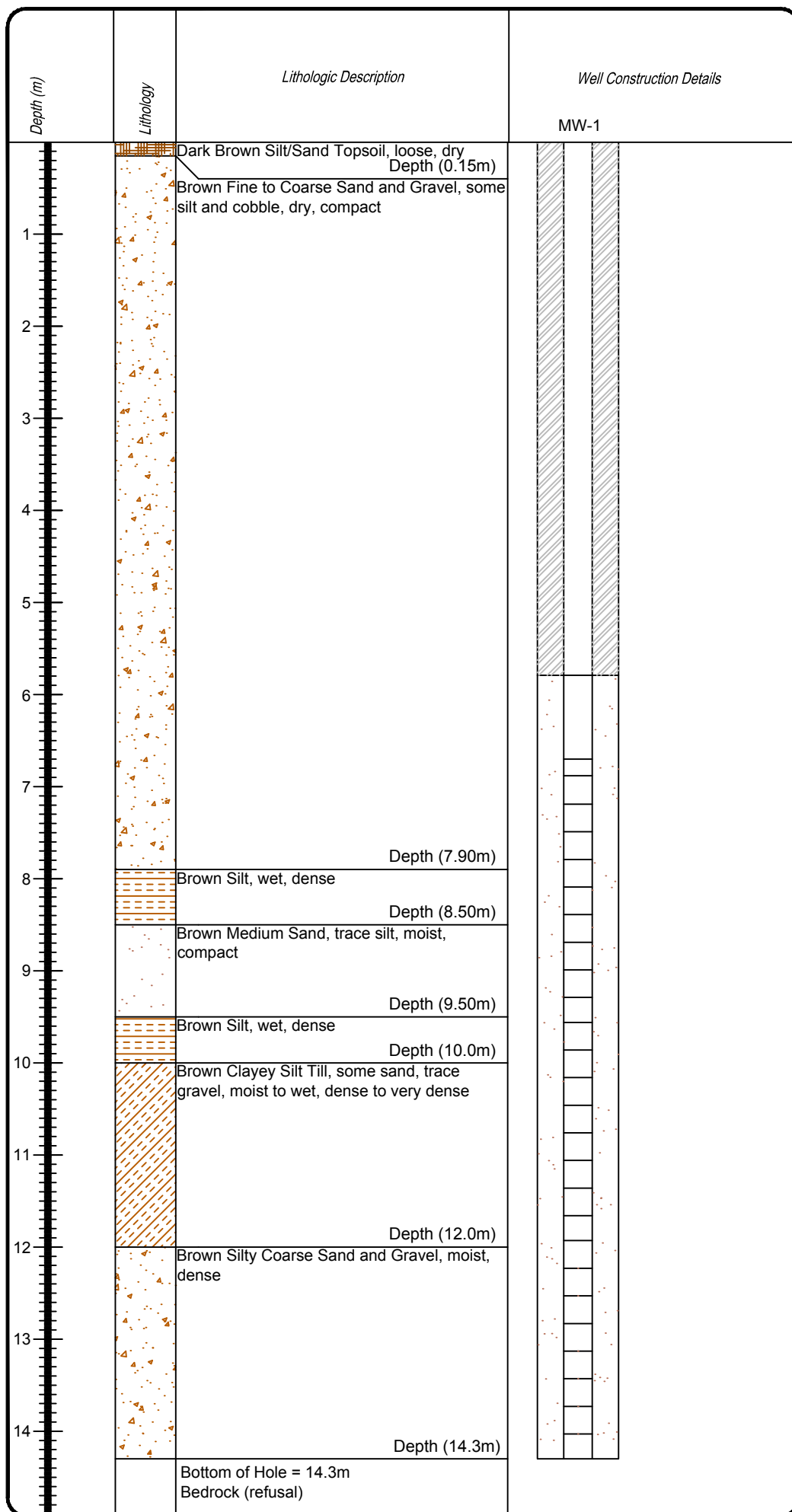
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## **APPENDIX C**

### **Borehole Logs**

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Monitoring Well  
**MW-1**

*Duivenvoorden Gravel  
Pit Expansion*

*Melancthon, ON*

**DRILLING DETAILS**  
Drill Date: Sept. 15, 2017  
Drilling Method: -  
Driller: Orbit Garant  
Geologist: Drew West

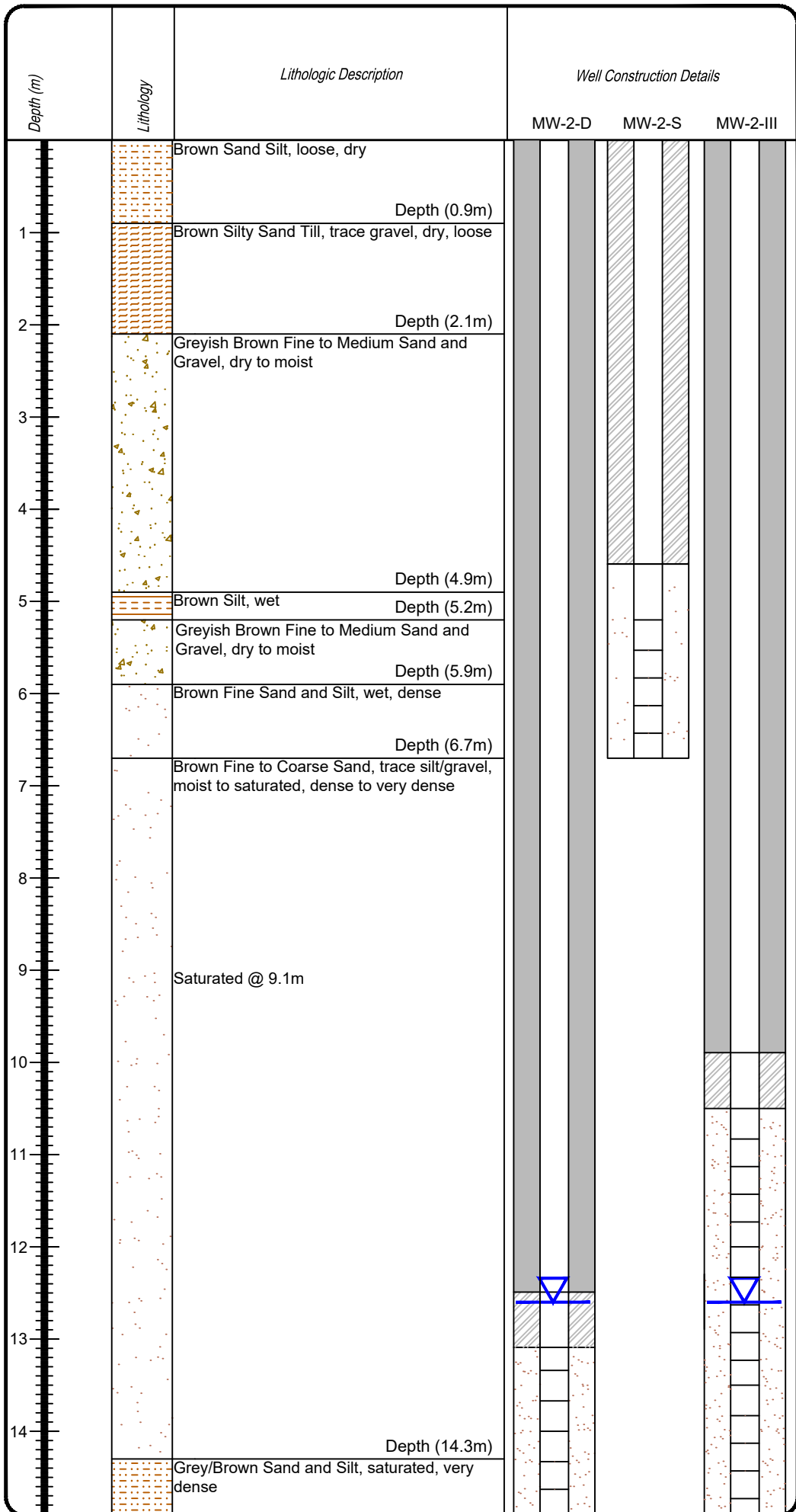
**MONITORING WELL INFORMATION**  
NAD Easting: 560990  
Northing: 4888189

|                                           |      |  |  |
|-------------------------------------------|------|--|--|
| Monitoring Well                           | MW-1 |  |  |
| Ground Elev.                              |      |  |  |
| Top of Casing Elev.                       |      |  |  |
| Stick Up (m)                              | 1.0  |  |  |
| Well Depth (m)                            | 14.3 |  |  |
| High Water Level<br>(date of water level) | -    |  |  |

All units expressed as metres above sea level unless otherwise noted

**LEGEND**  
 Water Level Elevation  
 Perched Water Table Elevation  
 Grout  
 Bentonite  
 Silica Sand  
 Schedule 40 (2") PVC Riser Pipe  
 Schedule 40 (2") 10-slot PVC Screen  
 Steel Casing (6")  
Geologic materials recovered and evaluated by: \_\_\_\_\_

|                            |                       |
|----------------------------|-----------------------|
| Date Issued: November 2017 | Page<br><b>1 of 1</b> |
| Created By: JLM            |                       |
| Project No. 17-178a        |                       |
| File Name: 17-178bh        |                       |



### Monitoring Well

## MW-2

Duivenvoorden Gravel Pit Expansion

Melancthon, ON

**DRILLING DETAILS**

Drill Date: Sept. 18, 2017

Drilling Method: -

Driller: Orbit Garant

Geologist: Drew West

**MONITORING WELL INFORMATION**

NAD Easting: 560655  
Northing: 4888409

| Monitoring Well                           | MW-2D            | MW-2S  |  |
|-------------------------------------------|------------------|--------|--|
| Ground Elev.                              |                  |        |  |
| Top of Casing Elev.                       |                  |        |  |
| Stick Up (m)                              | 0.95             | 0.95   |  |
| Well Depth (m)                            | 15.5             | 6.70   |  |
| High Water Level<br>(date of water level) | 12.6<br>18/09/17 | -<br>- |  |

All units expressed as metres above sea level unless otherwise noted

**LEGEND**

- Water Level Elevation
- Perched Water Table Elevation
- Grout
- Bentonite
- Silica Sand
- Schedule 40 (2") PVC Riser Pipe
- Schedule 40 (2") 10-slot PVC Screen
- Steel Casing (6")

Geologic materials recovered and evaluated by: \_\_\_\_\_

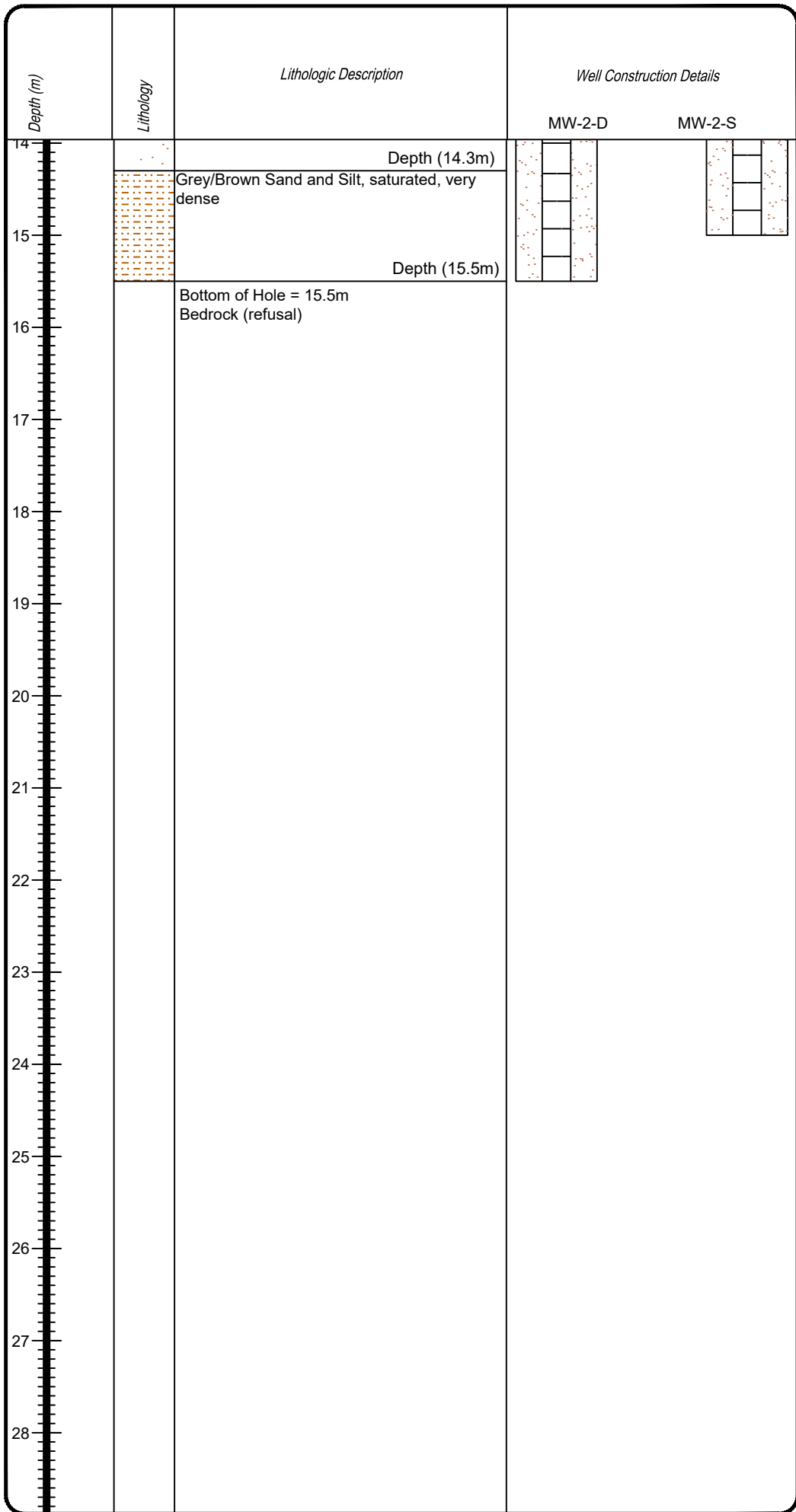
**DATE** Issued: July 2023

Created By: JLM

Project No: 17-178a

File Name: 17-178bh

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Monitoring Well

MW-2

Duivenvoorden Gravel  
Pit Expansion

Melancthon, ON

DRILLING DETAILS

Drill Date: Sept. 18, 2017

Drilling Method: -

Driller: Orbit Garant

Geologist: Drew West

MONITORING WELL INFORMATION

NAD Easting: 560655  
Northing: 4888409

| Monitoring Well                           | MW-2D            | MW-2S  |  |
|-------------------------------------------|------------------|--------|--|
| Ground Elev.                              |                  |        |  |
| Top of Casing Elev.                       |                  |        |  |
| Stick Up (m)                              | 0.95             | 0.95   |  |
| Well Depth (m)                            | 15.5             | 6.70   |  |
| High Water Level<br>(date of water level) | 12.6<br>18/09/17 | -<br>- |  |

All units expressed as metres above sea level unless otherwise noted

LEGEND

Water Level Elevation

Perched Water Table Elevation

Grout

Bentonite

Silica Sand

Schedule 40 (2") PVC Riser Pipe

Schedule 40 (2") 10-slot PVC Screen

Steel Casing (6")

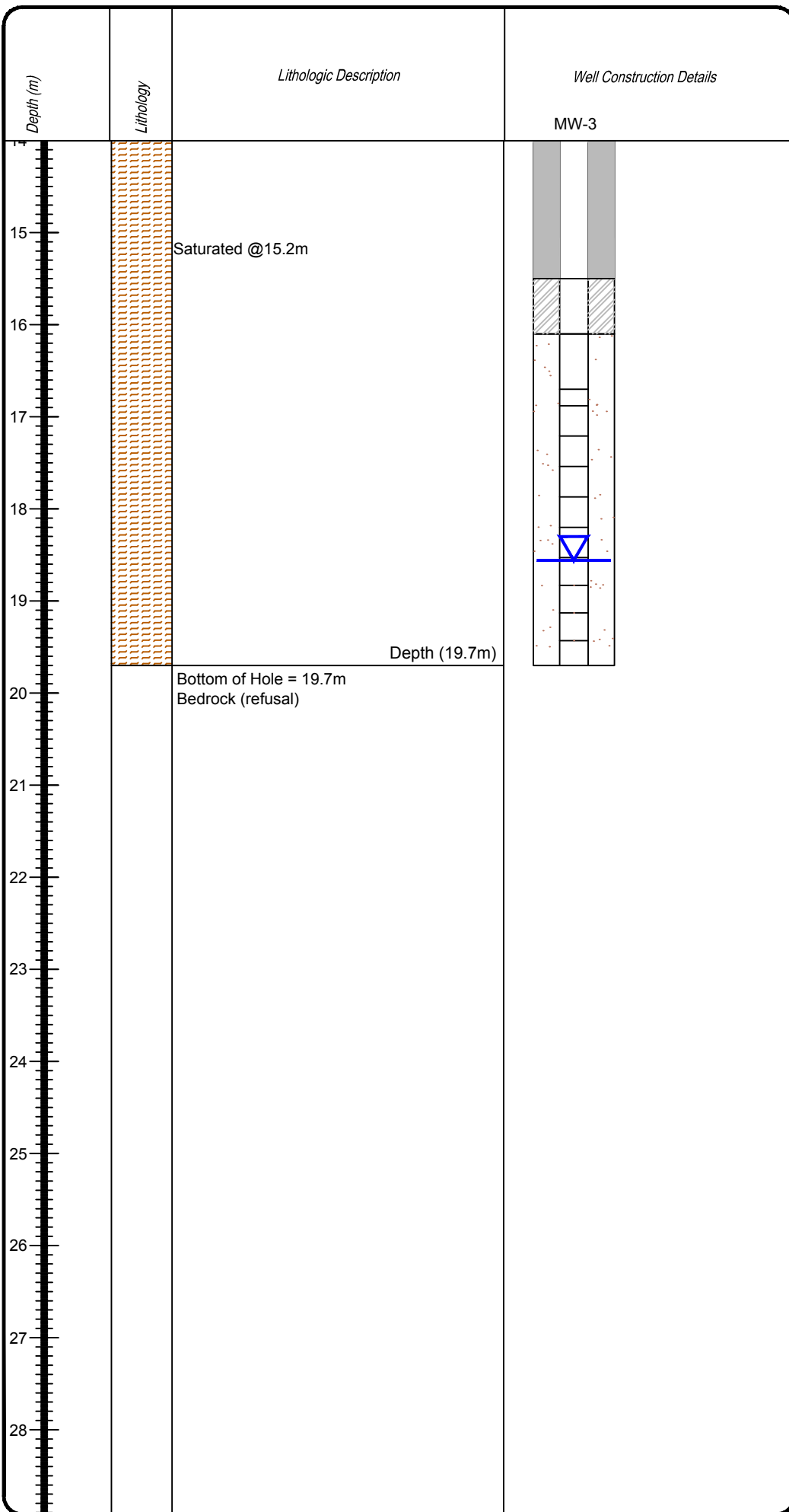
Geologic materials recovered and  
evaluated by: \_\_\_\_\_

AZIMUTH ENVIRONMENTAL CONSULTING, INC.

|                        |                |
|------------------------|----------------|
| Date Issued: July 2023 | Page<br>2 of 2 |
| Created By: JLM        |                |
| Project No: 17-178a    |                |
| File Name: 17-178bh    |                |



1 of 2



Monitoring Well

MW-3

Duivenvoorden Gravel  
Pit Expansion

Melancthon, ON

**DRILLING DETAILS**

Drill Date: Sept. 19, 2017

Drilling Method: -

Driller: Orbit Garant

Geologist: Steven Krbavcic

**MONITORING WELL INFORMATION**

NAD Easting: 560483  
Northing: 4888249

| Monitoring Well                           | MW-3                 |  |  |
|-------------------------------------------|----------------------|--|--|
| Ground Elev.                              |                      |  |  |
| Top of Casing Elev.                       |                      |  |  |
| Stick Up (m)                              | 0.95                 |  |  |
| Well Depth (m)                            | 19.7                 |  |  |
| High Water Level<br>(date of water level) | 18.56mbs<br>19/09/17 |  |  |

All units expressed as metres above sea level unless otherwise noted

**LEGEND**

Water Level Elevation

Perched Water Table Elevation

Grout

Bentonite

Silica Sand

Schedule 40 (2") PVC Riser Pipe

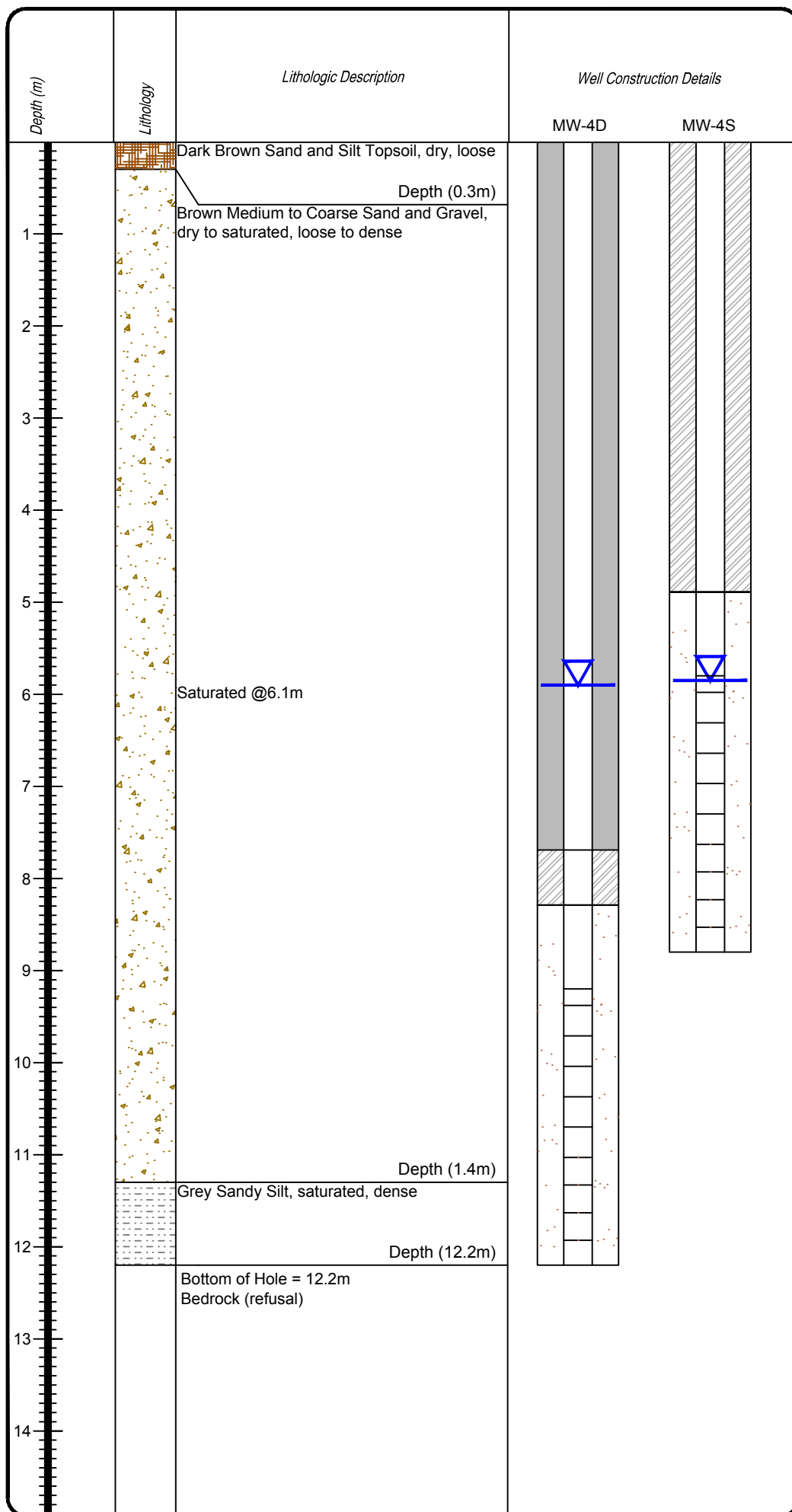
Schedule 40 (2") 10-slot PVC Screen

Steel Casing (6")

Geologic materials recovered and  
evaluated by: \_\_\_\_\_

**AZIMUTH ENVIRONMENTAL CONSULTING, INC.**

| Date Issued: | November 2017 | Page<br>2 of 2 |
|--------------|---------------|----------------|
| Created By:  | JLM           |                |
| Project No.  | 17-178a       |                |
| File Name:   | 17-178bh      |                |



## Monitoring Well

**MW-4**

*Duivenvoorden Gravel  
Pit Expansion*

*Melancthon, ON*

### DRILLING DETAILS

Drill Date: Sept. 18, 2017  
Drilling Method: -  
Driller: Orbit Garant  
Geologist: Steve Krbavcic

| Monitoring Well                           | MW-4D               | MW-4S                |  |
|-------------------------------------------|---------------------|----------------------|--|
| Ground Elev.                              |                     |                      |  |
| Top of Casing Elev.                       |                     |                      |  |
| Stick Up (m)                              | 1.0                 | 1.0                  |  |
| Well Depth (m)                            | 12.2                | 8.80                 |  |
| High Water Level<br>(date of water level) | 5.9mbgs<br>18/09/17 | 5.85mbgs<br>18/09/17 |  |

All units expressed as metres above sea level unless otherwise noted

### LEGEND

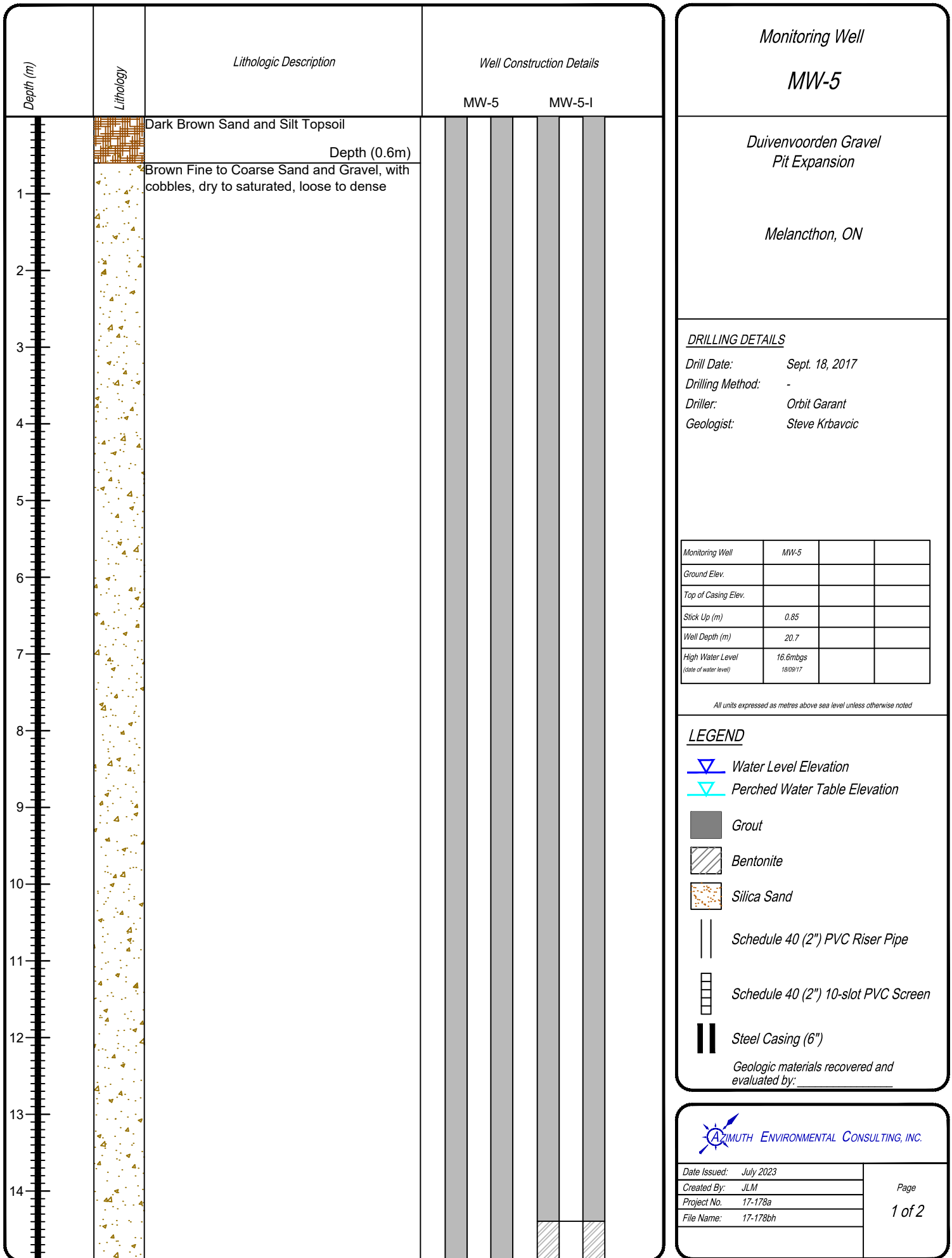
- Water Level Elevation
  - Perched Water Table Elevation
  - Grout
  - Bentonite
  - Silica Sand
  - Schedule 40 (2") PVC Riser Pipe
  - Schedule 40 (2") 10-slot PVC Screen
  - Steel Casing (6")
- Geologic materials recovered and evaluated by: \_\_\_\_\_

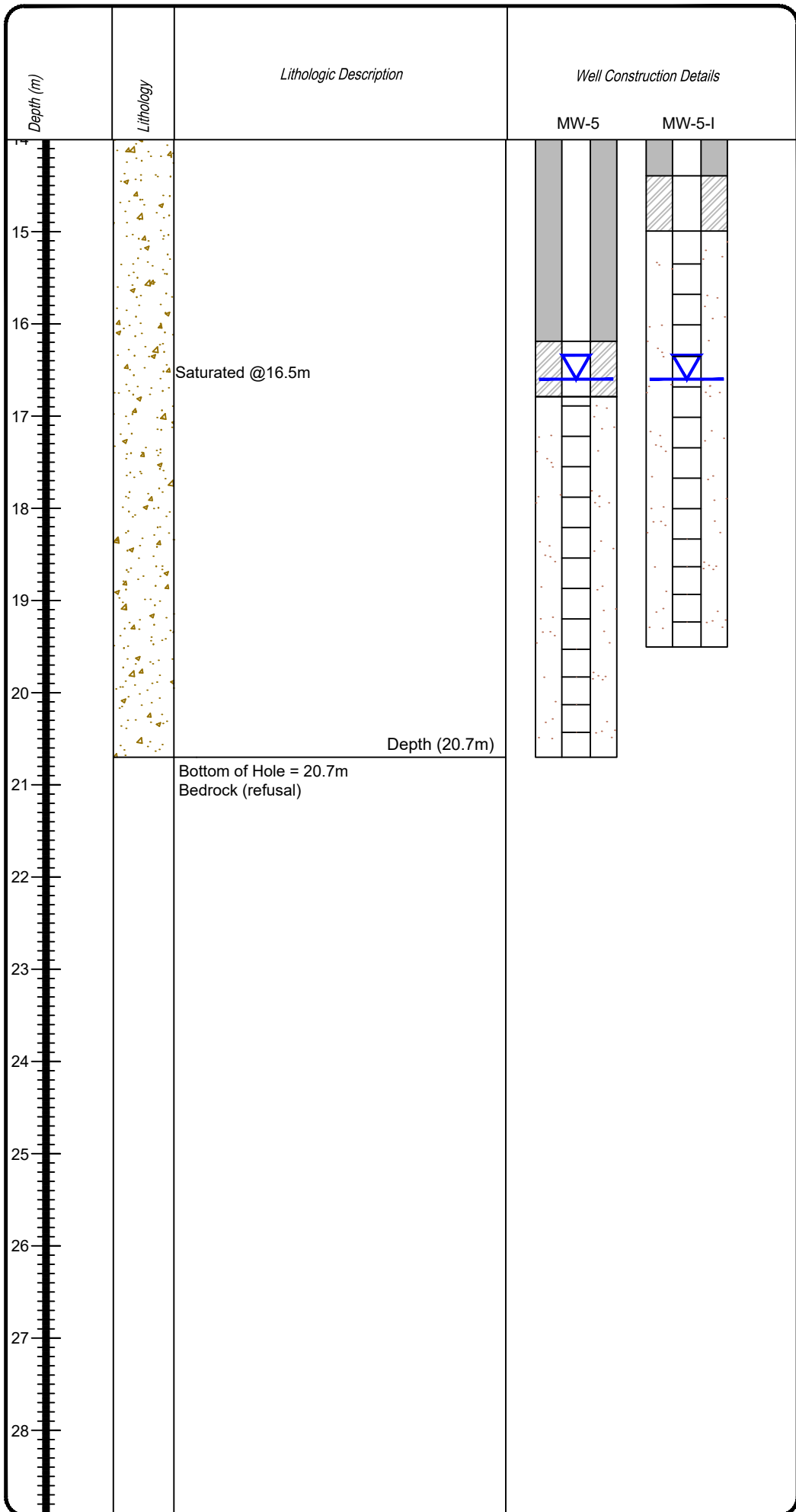


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Date Issued: November 2017  
Created By: JLM  
Project No. 17-178a  
File Name: 17-178bh

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1 of 1





### Monitoring Well

## MW-5

Duivenvoorden Gravel  
Pit Expansion

Melancthon, ON

#### DRILLING DETAILS

Drill Date: Sept. 18, 2017  
Drilling Method: -  
Driller: Orbit Garant  
Geologist: Steve Krbavcic

|                                           |                      |  |  |
|-------------------------------------------|----------------------|--|--|
| Monitoring Well                           | MW-5                 |  |  |
| Ground Elev.                              |                      |  |  |
| Top of Casing Elev.                       |                      |  |  |
| Stick Up (m)                              | 0.85                 |  |  |
| Well Depth (m)                            | 20.7                 |  |  |
| High Water Level<br>(date of water level) | 16.6mbgs<br>18/09/17 |  |  |

All units expressed as metres above sea level unless otherwise noted

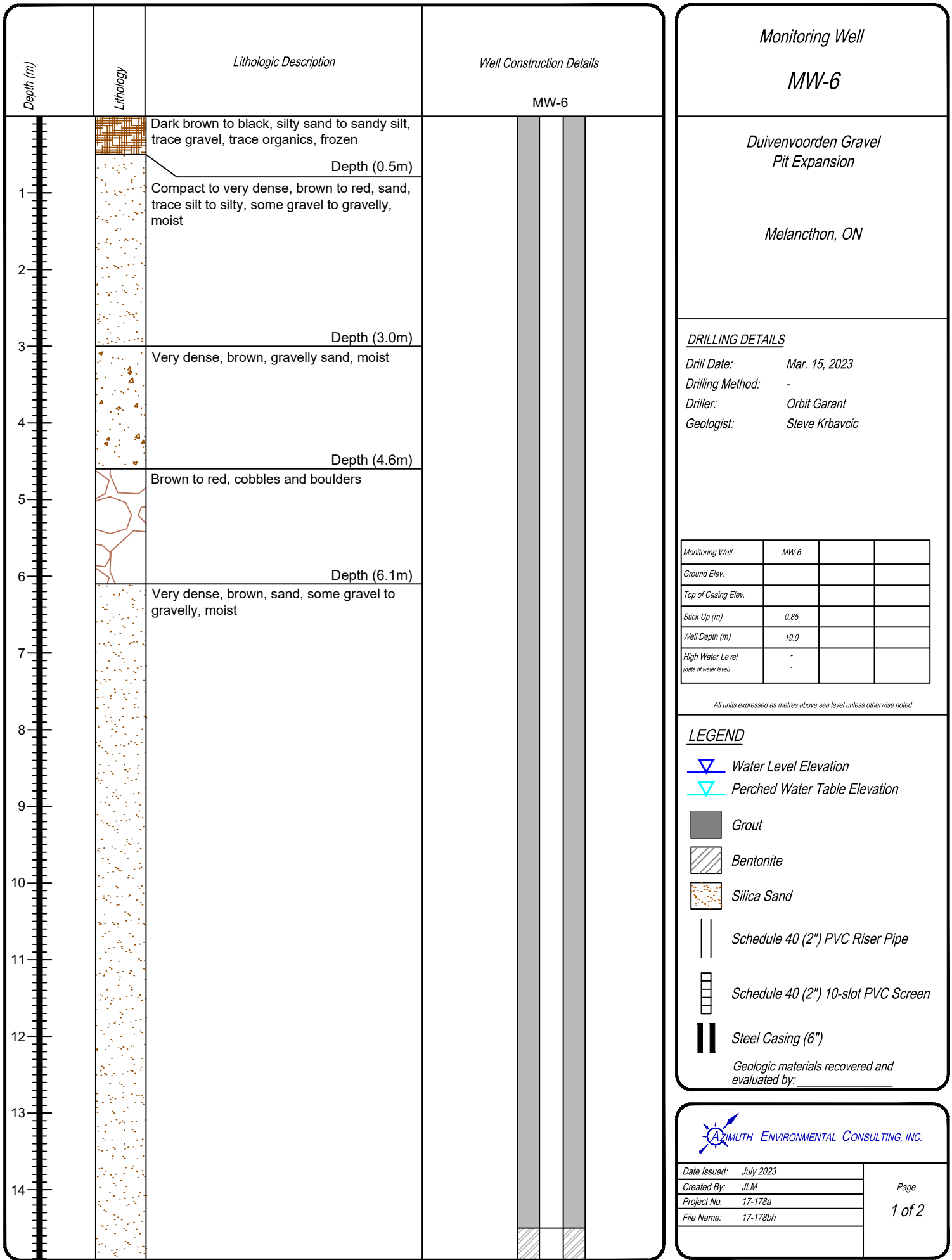
#### LEGEND

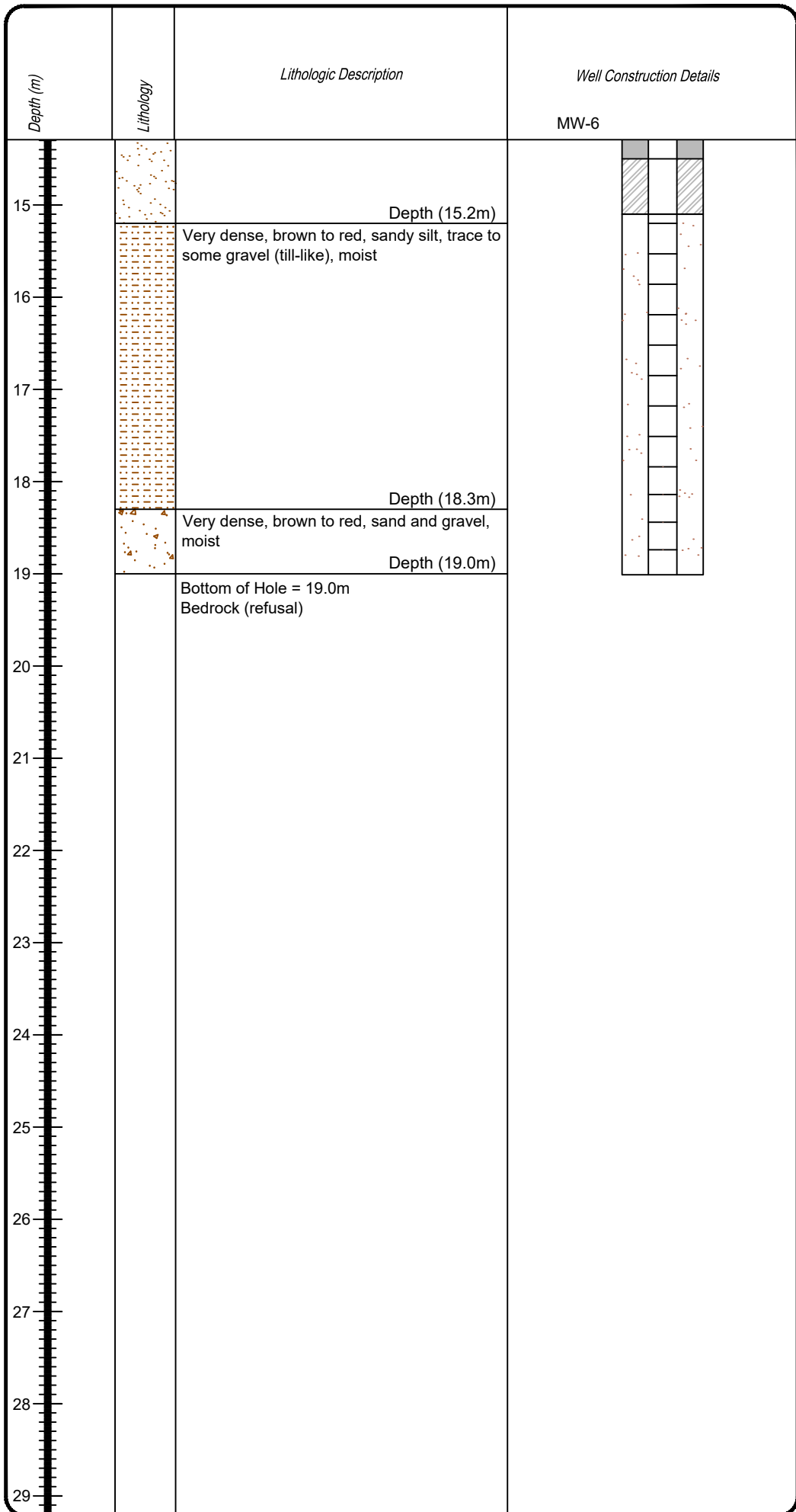
- Water Level Elevation
- Perched Water Table Elevation
- Grout
- Bentonite
- Silica Sand
- Schedule 40 (2") PVC Riser Pipe
- Schedule 40 (2") 10-slot PVC Screen
- Steel Casing (6")

Geologic materials recovered and evaluated by: \_\_\_\_\_

AZIMUTH ENVIRONMENTAL CONSULTING, INC.

|              |           |                       |
|--------------|-----------|-----------------------|
| Date Issued: | July 2023 | Page<br><b>2 of 2</b> |
| Created By:  | JLM       |                       |
| Project No.  | 17-178a   |                       |
| File Name:   | 17-178bh  |                       |





### Monitoring Well

## MW-6

Duivenvoorden Gravel Pit Expansion

Melancthon, ON

#### DRILLING DETAILS

Drill Date: Mar. 15, 2023

Drilling Method: -

Driller: Orbit Garant

Geologist: Steve Krbavcic

|                                           |      |  |  |
|-------------------------------------------|------|--|--|
| Monitoring Well                           | MW-6 |  |  |
| Ground Elev.                              |      |  |  |
| Top of Casing Elev.                       |      |  |  |
| Stick Up (m)                              | 0.85 |  |  |
| Well Depth (m)                            | 19.0 |  |  |
| High Water Level<br>(date of water level) | -    |  |  |

All units expressed as metres above sea level unless otherwise noted

#### LEGEND

- Water Level Elevation
- Perched Water Table Elevation
- Grout
- Bentonite
- Silica Sand
- Schedule 40 (2") PVC Riser Pipe
- Schedule 40 (2") 10-slot PVC Screen
- Steel Casing (6")

Geologic materials recovered and evaluated by: \_\_\_\_\_

**AZIMUTH ENVIRONMENTAL CONSULTING, INC.**

|                        |                       |
|------------------------|-----------------------|
| Date Issued: July 2023 | Page<br><b>2 of 2</b> |
| Created By: JLM        |                       |
| Project No. 17-178a    |                       |
| File Name: 17-178bh    |                       |



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## **APPENDIX D**

### **Water Quality Results**

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**CLIENT NAME: AZIMUTH ENVIRONMENTAL CONSULTING,  
642 WELHAM ROAD  
BARRIE, ON L4N9A1  
(705) 721-8451**

**ATTENTION TO: Drew West**

**PROJECT: 17-178a**

**AGAT WORK ORDER: 18T364819**

**WATER ANALYSIS REVIEWED BY: Mike Muneswar, BSc (Chem), Senior Inorganic Analyst**

**DATE REPORTED: Jul 31, 2018**

**PAGES (INCLUDING COVER): 8**

**VERSION\*: 1**

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

**\*NOTES**

**All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.**



## Certificate of Analysis

AGAT WORK ORDER: 18T364819

PROJECT: 17-178a

5835 COOPERS AVENUE  
MISSISSAUGA, ONTARIO  
CANADA L4Z 1Y2  
TEL (905)712-5100  
FAX (905)712-5122  
<http://www.agatlabs.com>

CLIENT NAME: AZIMUTH ENVIRONMENTAL CONSULTING,

SAMPLING SITE:

ATTENTION TO: Drew West

SAMPLED BY:

### Water Quality Assessment (excl. Hg) - Surface & Ground Water Samples

DATE RECEIVED: 2018-07-20

DATE REPORTED: 2018-07-31

| Parameter               | Unit     | SAMPLE DESCRIPTION: |     | Pond       |       | MW2d       |         | MW4s       |         | MW5        |  |
|-------------------------|----------|---------------------|-----|------------|-------|------------|---------|------------|---------|------------|--|
|                         |          | SAMPLE TYPE:        |     | Water      |       | Water      |         | Water      |         | Water      |  |
|                         |          | DATE SAMPLED:       |     | 2018-07-19 |       | 2018-07-19 |         | 2018-07-19 |         | 2018-07-19 |  |
|                         |          | G / S               | RDL | 9416466    | RDL   | 9416471    | 9416472 | RDL        | 9416473 |            |  |
| pH, Saturation          |          |                     |     | 7.62       |       | 7.08       | 6.86    |            | 6.89    |            |  |
| pH                      | pH Units |                     | NA  | 7.90       | NA    | 8.03       | 7.65    | NA         | 7.63    |            |  |
| Langelier Index         |          |                     |     | 0.28       |       | 0.95       | 0.79    |            | 0.74    |            |  |
| Alkalinity (as CaCO3)   | mg/L     | 5                   |     | 115        | 5     | 237        | 307     | 5          | 273     |            |  |
| Bicarbonate (as CaCO3)  | mg/L     | 5                   |     | 115        | 5     | 237        | 307     | 5          | 273     |            |  |
| Carbonate (as CaCO3)    | mg/L     | 5                   |     | <5         | 5     | <5         | <5      | 5          | <5      |            |  |
| Hydroxide (as CaCO3)    | mg/L     | 5                   |     | <5         | 5     | <5         | <5      | 5          | <5      |            |  |
| Electrical Conductivity | uS/cm    | 2                   |     | 219        | 2     | 467        | 669     | 2          | 747     |            |  |
| Fluoride                | mg/L     | 0.05                |     | <0.05      | 0.05  | <0.05      | <0.05   | 0.10       | <0.10   |            |  |
| Chloride                | mg/L     | 0.10                |     | 1.53       | 0.10  | 8.66       | 4.03    | 0.20       | 20.6    |            |  |
| Nitrate as N            | mg/L     | 0.05                |     | <0.05      | 0.05  | 4.90       | 0.68    | 0.10       | 9.59    |            |  |
| Nitrite as N            | mg/L     | 0.05                |     | <0.05      | 0.05  | <0.05      | <0.05   | 0.10       | <0.10   |            |  |
| Bromide                 | mg/L     | 0.05                |     | <0.05      | 0.05  | <0.05      | <0.05   | 0.10       | <0.10   |            |  |
| Sulphate                | mg/L     | 0.10                |     | 0.20       | 0.10  | 8.62       | 3.83    | 0.20       | 25.9    |            |  |
| Calcium                 | mg/L     | 0.05                |     | 34.6       | 0.05  | 71.8       | 87.1    | 0.05       | 84.8    |            |  |
| Magnesium               | mg/L     | 0.05                |     | 9.07       | 0.05  | 18.8       | 25.8    | 0.05       | 32.0    |            |  |
| Sodium                  | mg/L     | 0.05                |     | 2.01       | 0.05  | 3.77       | 1.77    | 0.05       | 3.43    |            |  |
| Potassium               | mg/L     | 0.05                |     | 0.85       | 0.05  | 1.10       | 0.47    | 0.05       | 0.86    |            |  |
| Ammonia as N            | mg/L     | 0.02                |     | <0.02      | 0.02  | <0.02      | <0.02   | 0.10       | 3.82    |            |  |
| Phosphate as P          | mg/L     | 0.10                |     | <0.10      | 0.10  | <0.10      | <0.10   | 0.20       | <0.20   |            |  |
| Total Phosphorus        | mg/L     | 0.02                |     | 0.08       | 0.02  | <0.02      | 4.80    | 0.02       | 0.13    |            |  |
| Reactive Silica         | mg/L     | 0.05                |     | 1.23       | 0.05  | 7.38       | 9.89    | 0.05       | 10.7    |            |  |
| Total Organic Carbon    | mg/L     | 0.5                 |     | 15.6       | 0.5   | 41.1       | 31.4    | 0.5        | 30.8    |            |  |
| Colour                  | TCU      | 5                   |     | 17         | 5     | 6          | <5      | 5          | <5      |            |  |
| Turbidity               | NTU      | 0.5                 |     | 5.5        | 15    | 42500      | 13500   | 15         | 79700   |            |  |
| Aluminum                | mg/L     | 0.004               |     | 0.068      | 0.004 | 0.006      | <0.004  | 0.004      | 0.028   |            |  |
| Arsenic                 | mg/L     | 0.003               |     | <0.003     | 0.003 | <0.003     | <0.003  | 0.003      | <0.003  |            |  |
| Barium                  | mg/L     | 0.002               |     | 0.014      | 0.002 | 0.022      | 0.014   | 0.002      | 0.051   |            |  |
| Boron                   | mg/L     | 0.010               |     | 0.020      | 0.010 | 0.012      | <0.010  | 0.010      | <0.010  |            |  |
| Cadmium                 | mg/L     | 0.002               |     | <0.002     | 0.002 | <0.002     | <0.002  | 0.002      | <0.002  |            |  |

**Certified By:**



## Certificate of Analysis

AGAT WORK ORDER: 18T364819

PROJECT: 17-178a

5835 COOPERS AVENUE  
MISSISSAUGA, ONTARIO  
CANADA L4Z 1Y2  
TEL (905)712-5100  
FAX (905)712-5122  
<http://www.agatlabs.com>

CLIENT NAME: AZIMUTH ENVIRONMENTAL CONSULTING,

SAMPLING SITE:

ATTENTION TO: Drew West

SAMPLED BY:

### Water Quality Assessment (excl. Hg) - Surface & Ground Water Samples

DATE RECEIVED: 2018-07-20

DATE REPORTED: 2018-07-31

|                           |      | SAMPLE DESCRIPTION: |       | Pond       |       | MW2d       |         | MW4s       |         | MW5        |  |
|---------------------------|------|---------------------|-------|------------|-------|------------|---------|------------|---------|------------|--|
|                           |      | SAMPLE TYPE:        |       | Water      |       | Water      |         | Water      |         | Water      |  |
|                           |      | DATE SAMPLED:       |       | 2018-07-19 |       | 2018-07-19 |         | 2018-07-19 |         | 2018-07-19 |  |
| Parameter                 | Unit | G / S               | RDL   | 9416466    | RDL   | 9416471    | 9416472 | RDL        | 9416473 |            |  |
| Chromium                  | mg/L |                     | 0.003 | <0.003     | 0.003 | <0.003     | <0.003  | 0.003      | <0.003  |            |  |
| Copper                    | mg/L |                     | 0.003 | <0.003     | 0.003 | 0.006      | 0.003   | 0.003      | <0.003  |            |  |
| Iron                      | mg/L |                     | 0.010 | 2.39       | 0.010 | <0.010     | <0.010  | 0.010      | <0.010  |            |  |
| Lead                      | mg/L |                     | 0.001 | <0.001     | 0.001 | <0.001     | <0.001  | 0.001      | <0.001  |            |  |
| Manganese                 | mg/L |                     | 0.002 | 0.439      | 0.002 | <0.002     | <0.002  | 0.002      | <0.002  |            |  |
| Molybdenum                | mg/L |                     | 0.002 | <0.002     | 0.002 | <0.002     | <0.002  | 0.002      | <0.002  |            |  |
| Nickel                    | mg/L |                     | 0.003 | <0.003     | 0.003 | <0.003     | <0.003  | 0.003      | <0.003  |            |  |
| Selenium                  | mg/L |                     | 0.004 | <0.004     | 0.004 | <0.004     | <0.004  | 0.004      | <0.004  |            |  |
| Silver                    | mg/L |                     | 0.002 | <0.002     | 0.002 | <0.002     | <0.002  | 0.002      | <0.002  |            |  |
| Strontium                 | mg/L |                     | 0.005 | 0.044      | 0.005 | 0.109      | 0.104   | 0.005      | 0.148   |            |  |
| Thallium                  | mg/L |                     | 0.006 | <0.006     | 0.006 | <0.006     | <0.006  | 0.006      | <0.006  |            |  |
| Tin                       | mg/L |                     | 0.002 | <0.002     | 0.002 | <0.002     | <0.002  | 0.002      | <0.002  |            |  |
| Titanium                  | mg/L |                     | 0.002 | 0.003      | 0.002 | <0.002     | <0.002  | 0.002      | <0.002  |            |  |
| Uranium                   | mg/L |                     | 0.002 | <0.002     | 0.002 | <0.002     | <0.002  | 0.002      | <0.002  |            |  |
| Vanadium                  | mg/L |                     | 0.002 | <0.002     | 0.002 | <0.002     | <0.002  | 0.002      | <0.002  |            |  |
| Zinc                      | mg/L |                     | 0.005 | <0.005     | 0.005 | 0.011      | <0.005  | 0.005      | 0.006   |            |  |
| Total Dissolved Solids    | mg/L |                     | 20    | 148        | 20    | 308        | 314     | 20         | 396     |            |  |
| Total Hardness (as CaCO3) | mg/L |                     | 0.5   | 124        | 0.5   | 257        | 324     | 0.5        | 344     |            |  |
| % Difference/ Ion Balance | %    |                     | NA    | 4.77       | NA    | 1.76       | 1.37    | NA         | 0.287   |            |  |

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

9416466-9416473 Elevated RDLs indicate the degree of sample dilutions prior to analysis in order to keep the analytes within the calibration range of the instruments and to reduce matrix interferences.

**Certified By:**

## Quality Assurance

CLIENT NAME: AZIMUTH ENVIRONMENTAL CONSULTING,

AGAT WORK ORDER: 18T364819

PROJECT: 17-178a

ATTENTION TO: Drew West

SAMPLING SITE:

SAMPLED BY:

| Water Analysis         |       |           |           |        |     |              |                    |                   |       |                    |                   |       |              |                   |       |
|------------------------|-------|-----------|-----------|--------|-----|--------------|--------------------|-------------------|-------|--------------------|-------------------|-------|--------------|-------------------|-------|
| RPT Date: Jul 31, 2018 |       |           | DUPLICATE |        |     | Method Blank | REFERENCE MATERIAL |                   |       | METHOD BLANK SPIKE |                   |       | MATRIX SPIKE |                   |       |
| PARAMETER              | Batch | Sample Id | Dup #1    | Dup #2 | RPD |              | Measured Value     | Acceptable Limits |       | Recovery           | Acceptable Limits |       | Recovery     | Acceptable Limits |       |
|                        |       |           |           |        |     |              |                    | Lower             | Upper |                    | Lower             | Upper |              | Lower             | Upper |

### Water Quality Assessment (excl. Hg) - Surface & Ground Water Samples

|                                     |         |         |        |        |       |         |      |     |      |      |     |      |      |     |      |
|-------------------------------------|---------|---------|--------|--------|-------|---------|------|-----|------|------|-----|------|------|-----|------|
| pH                                  | 9414642 |         | 6.36   | 6.31   | 0.8%  | NA      | 100% | 90% | 110% |      |     |      |      |     |      |
| Alkalinity (as CaCO <sub>3</sub> )  | 9414642 |         | 149    | 143    | 4.1%  | < 5     | 83%  | 80% | 120% |      |     |      |      |     |      |
| Bicarbonate (as CaCO <sub>3</sub> ) | 9414642 |         | 149    | 143    | 4.1%  | < 5     | NA   | 80% | 120% |      |     |      |      |     |      |
| Carbonate (as CaCO <sub>3</sub> )   | 9414642 |         | <5     | <5     | NA    | < 5     | NA   | 80% | 120% |      |     |      |      |     |      |
| Hydroxide (as CaCO <sub>3</sub> )   | 9414642 |         | <5     | <5     | NA    | < 5     | NA   | 80% | 120% |      |     |      |      |     |      |
| Electrical Conductivity             | 9414642 |         | 947    | 948    | 0.1%  | < 2     | 112% | 80% | 120% |      |     |      |      |     |      |
| Fluoride                            | 9415370 |         | <0.25  | <0.25  | NA    | < 0.05  | 97%  | 90% | 110% | 97%  | 90% | 110% | 98%  | 80% | 120% |
| Chloride                            | 9415370 |         | 39.3   | 38.4   | 2.3%  | < 0.10  | 92%  | 90% | 110% | 103% | 90% | 110% | 108% | 80% | 120% |
| Nitrate as N                        | 9415370 |         | 0.31   | 0.32   | 3.2%  | < 0.05  | 91%  | 90% | 110% | 102% | 90% | 110% | 103% | 80% | 120% |
| Nitrite as N                        | 9415370 |         | <0.25  | <0.25  | NA    | < 0.05  | NA   | 90% | 110% | 106% | 90% | 110% | 112% | 80% | 120% |
| Bromide                             | 9415370 |         | <0.25  | <0.25  | NA    | < 0.05  | 106% | 90% | 110% | 104% | 90% | 110% | 104% | 80% | 120% |
| Sulphate                            | 9415370 |         | 309    | 301    | 2.6%  | < 0.10  | 91%  | 90% | 110% | 97%  | 90% | 110% | 99%  | 80% | 120% |
| Calcium                             | 9418955 |         | 46.7   | 47.6   | 1.9%  | < 0.05  | 101% | 90% | 110% | 102% | 90% | 110% | 105% | 70% | 130% |
| Magnesium                           | 9418955 |         | 8.65   | 8.75   | 1.1%  | < 0.05  | 99%  | 90% | 110% | 98%  | 90% | 110% | 101% | 70% | 130% |
| Sodium                              | 9418955 |         | 60.1   | 61.0   | 1.5%  | < 0.05  | 97%  | 90% | 110% | 97%  | 90% | 110% | 98%  | 70% | 130% |
| Potassium                           | 9418955 |         | 5.21   | 5.30   | 1.7%  | < 0.05  | 97%  | 90% | 110% | 97%  | 90% | 110% | 99%  | 70% | 130% |
| Ammonia as N                        | 9414614 |         | <0.02  | <0.02  | NA    | < 0.02  | 95%  | 90% | 110% | 102% | 90% | 110% | 108% | 80% | 120% |
| Phosphate as P                      | 9415370 |         | <0.50  | <0.50  | NA    | < 0.10  | 105% | 90% | 110% | 97%  | 90% | 110% | 100% | 80% | 120% |
| Total Phosphorus                    | 9416209 |         | 10.4   | 10.3   | 1.0%  | < 0.02  | 98%  | 80% | 120% | 101% | 90% | 110% | 91%  | 70% | 130% |
| Reactive Silica                     | 9421674 |         | 20.1   | 19.5   | 3.0%  | < 0.05  | 108% | 90% | 110% | 107% | 90% | 110% | 107% | 80% | 120% |
| Total Organic Carbon                | 9416466 | 9416466 | 15.6   | 15.8   | 1.3%  | < 0.5   | 96%  | 90% | 110% | 97%  | 90% | 110% | 85%  | 80% | 120% |
| Colour                              | 9415557 |         | 17     | 18     | NA    | < 5     | 106% | 90% | 110% |      |     |      |      |     |      |
| Turbidity                           | 9416466 | 9416466 | 5.5    | 5.5    | 0.0%  | < 0.5   | 101% | 90% | 110% |      |     |      |      |     |      |
| Aluminum                            | 9414614 |         | 0.071  | 0.072  | 1.4%  | < 0.004 | 100% | 90% | 110% | 96%  | 90% | 110% | 80%  | 70% | 130% |
| Arsenic                             | 9414614 |         | <0.003 | <0.003 | NA    | < 0.003 | 101% | 90% | 110% | 96%  | 90% | 110% | 102% | 70% | 130% |
| Barium                              | 9414614 |         | 0.075  | 0.072  | 4.1%  | < 0.002 | 107% | 90% | 110% | 100% | 90% | 110% | 97%  | 70% | 130% |
| Boron                               | 9414614 |         | 0.032  | 0.034  | NA    | < 0.010 | 102% | 90% | 110% | 105% | 90% | 110% | 85%  | 70% | 130% |
| Cadmium                             | 9414614 |         | <0.002 | <0.002 | NA    | < 0.002 | 104% | 90% | 110% | 103% | 90% | 110% | 106% | 70% | 130% |
| Chromium                            | 9414614 |         | <0.003 | <0.003 | NA    | < 0.003 | 104% | 90% | 110% | 101% | 90% | 110% | 96%  | 70% | 130% |
| Copper                              | 9414614 |         | <0.003 | <0.003 | NA    | < 0.003 | 103% | 90% | 110% | 103% | 90% | 110% | 90%  | 70% | 130% |
| Iron                                | 9414614 |         | 0.075  | 0.087  | 14.8% | < 0.010 | 98%  | 90% | 110% | 97%  | 90% | 110% | 114% | 70% | 130% |
| Lead                                | 9414614 |         | <0.001 | <0.001 | NA    | < 0.001 | 105% | 90% | 110% | 103% | 90% | 110% | 95%  | 70% | 130% |
| Manganese                           | 9414614 |         | 0.144  | 0.146  | 1.4%  | < 0.002 | 101% | 90% | 110% | 99%  | 90% | 110% | 88%  | 70% | 130% |
| Molybdenum                          | 9414614 |         | <0.002 | <0.002 | NA    | < 0.002 | 98%  | 90% | 110% | 98%  | 90% | 110% | 103% | 70% | 130% |
| Nickel                              | 9414614 |         | <0.003 | <0.003 | NA    | < 0.003 | 103% | 90% | 110% | 103% | 90% | 110% | 94%  | 70% | 130% |
| Selenium                            | 9414614 |         | <0.004 | <0.004 | NA    | < 0.004 | 100% | 90% | 110% | 101% | 90% | 110% | 113% | 70% | 130% |
| Silver                              | 9414614 |         | <0.002 | <0.002 | NA    | < 0.002 | 104% | 90% | 110% | 109% | 90% | 110% | 103% | 70% | 130% |
| Strontium                           | 9414614 |         | 0.284  | 0.303  | 6.5%  | < 0.005 | 98%  | 90% | 110% | 97%  | 90% | 110% | 98%  | 70% | 130% |
| Thallium                            | 9414614 |         | <0.006 | <0.006 | NA    | < 0.006 | 105% | 90% | 110% | 101% | 90% | 110% | 95%  | 70% | 130% |



## Quality Assurance

CLIENT NAME: AZIMUTH ENVIRONMENTAL CONSULTING,

PROJECT: 17-178a

SAMPLING SITE:

AGAT WORK ORDER: 18T364819

ATTENTION TO: Drew West

SAMPLED BY:

### Water Analysis (Continued)

| RPT Date: Jul 31, 2018 |         |           | DUPLICATE |        |     | Method Blank | REFERENCE MATERIAL |                   |       | METHOD BLANK SPIKE |                   |       | MATRIX SPIKE |                   |       |
|------------------------|---------|-----------|-----------|--------|-----|--------------|--------------------|-------------------|-------|--------------------|-------------------|-------|--------------|-------------------|-------|
| PARAMETER              | Batch   | Sample Id | Dup #1    | Dup #2 | RPD |              | Measured Value     | Acceptable Limits |       | Recovery           | Acceptable Limits |       | Recovery     | Acceptable Limits |       |
|                        |         |           |           |        |     |              |                    | Lower             | Upper |                    | Lower             | Upper |              | Lower             | Upper |
| Tin                    | 9414614 |           | <0.002    | <0.002 | NA  | < 0.002      | 106%               | 90%               | 110%  | 110%               | 90%               | 110%  | 109%         | 70%               | 130%  |
| Titanium               | 9414614 |           | 0.006     | 0.007  | NA  | < 0.002      | 100%               | 90%               | 110%  | 97%                | 90%               | 110%  | 97%          | 70%               | 130%  |
| Uranium                | 9414614 |           | <0.002    | <0.002 | NA  | < 0.002      | 104%               | 90%               | 110%  | 102%               | 90%               | 110%  | 103%         | 70%               | 130%  |
| Vanadium               | 9414614 |           | <0.002    | <0.002 | NA  | < 0.002      | 101%               | 90%               | 110%  | 94%                | 90%               | 110%  | 100%         | 70%               | 130%  |
| Zinc                   | 9414614 |           | <0.005    | <0.005 | NA  | < 0.005      | 103%               | 90%               | 110%  | 102%               | 90%               | 110%  | 93%          | 70%               | 130%  |
| Total Dissolved Solids | 9416323 |           | 60        | 62     | NA  | < 20         | 102%               | 80%               | 120%  |                    |                   |       |              |                   |       |

Comments: NA signifies Not Applicable.

Duplicate Qualifier: As the measured result approaches the Reporting Limit (RL), the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

**Certified By:**

## Method Summary

**CLIENT NAME:** AZIMUTH ENVIRONMENTAL CONSULTING,

**PROJECT:** 17-178a

**SAMPLING SITE:**
**AGAT WORK ORDER:** 18T364819

**ATTENTION TO:** Drew West

**SAMPLED BY:**

| PARAMETER                           | AGAT S.O.P   | LITERATURE REFERENCE                                | ANALYTICAL TECHNIQUE     |
|-------------------------------------|--------------|-----------------------------------------------------|--------------------------|
| <b>Water Analysis</b>               |              |                                                     |                          |
| pH, Saturation                      |              | SM 2320 B                                           | CALCULATION              |
| pH                                  | INOR-93-6000 | SM 4500-H+ B                                        | PC TITRATE               |
| Langelier Index                     |              | SM 2330B                                            | CALCULATION              |
| Alkalinity (as CaCO <sub>3</sub> )  | INOR-93-6000 | SM 2320 B                                           | PC TITRATE               |
| Bicarbonate (as CaCO <sub>3</sub> ) | INOR-93-6000 | SM 4500-H+ B                                        | PC TITRATE               |
| Carbonate (as CaCO <sub>3</sub> )   | INOR-93-6000 | SM 4500-H+ B                                        | PC TITRATE               |
| Hydroxide (as CaCO <sub>3</sub> )   | INOR-93-6000 | SM 4500-H+ B                                        | PC TITRATE               |
| Electrical Conductivity             | INOR-93-6000 | SM 2510 B                                           | PC TITRATE               |
| Fluoride                            | INOR-93-6004 | SM 4110 B                                           | ION CHROMATOGRAPH        |
| Chloride                            | INOR-93-6004 | SM 4110 B                                           | ION CHROMATOGRAPH        |
| Nitrate as N                        | INOR-93-6004 | SM 4110 B                                           | ION CHROMATOGRAPH        |
| Nitrite as N                        | INOR-93-6004 | SM 4110 B                                           | ION CHROMATOGRAPH        |
| Bromide                             | INOR-93-6004 | SM 4110 B                                           | ION CHROMATOGRAPH        |
| Sulphate                            | INOR-93-6004 | SM 4110 B                                           | ION CHROMATOGRAPH        |
| Calcium                             | MET-93-6105  | EPA SW-846 6010C & 200.7                            | ICP/OES                  |
| Magnesium                           | MET-93-6105  | EPA SW-846 6010C & 200.7                            | ICP/OES                  |
| Sodium                              | MET-93-6105  | EPA SW-846 6010C & 200.7                            | ICP/OES                  |
| Potassium                           | MET-93-6105  | EPA SW-846 6010C & 200.7                            | ICP/OES                  |
| Ammonia as N                        | INOR-93-6059 | QuikChem 10-107-06-1-J & SM 4500 NH <sub>3</sub> -F | LACHAT FIA               |
| Phosphate as P                      | INOR-93-6004 | SM 4110 B                                           | ION CHROMATOGRAPH        |
| Total Phosphorus                    | INOR-93-6057 | QuikChem 10-115-01-3-A & SM 4500-P I                | LACHAT FIA               |
| Reactive Silica                     | INOR-93-6047 | SmartChem Method SIL-001-A & SM 4500 Si-F 18 & 19th | DISCRETE ANALYZER        |
| Total Organic Carbon                | INOR-93-6049 | EPA 415.1 & SM 5310 B                               | SHIMADZU CARBON ANALYZER |
| Colour                              | INOR93-6046  | SM 2120 B                                           | SPECTROPHOTOMETER        |
| Turbidity                           | INOR-93-6044 | SM 2130 B                                           | NEPHELOMETER             |
| Aluminum                            | MET-93-6103  | EPA SW-846 6020A & 200.8                            | ICP-MS                   |
| Arsenic                             | MET-93-6103  | EPA SW-846 6020A & 200.8                            | ICP-MS                   |
| Barium                              | MET-93-6103  | EPA SW-846 6020A & 200.8                            | ICP-MS                   |
| Boron                               | MET-93-6103  | EPA SW-846 6020A & 200.8                            | ICP-MS                   |
| Cadmium                             | MET-93-6103  | EPA SW-846 6020A & 200.8                            | ICP-MS                   |
| Chromium                            | MET-93-6103  | EPA SW-846 6020A & 200.8                            | ICP-MS                   |
| Copper                              | MET-93-6103  | EPA SW-846 6020A & 200.8                            | ICP-MS                   |
| Iron                                | MET-93-6103  | EPA SW-846 6020A & 200.8                            | ICP-MS                   |
| Lead                                | MET-93-6103  | EPA SW-846 6020A & 200.8                            | ICP-MS                   |
| Manganese                           | MET-93-6103  | EPA SW-846 6020A & 200.8                            | ICP-MS                   |
| Molybdenum                          | MET-93-6103  | EPA SW-846 6020A & 200.8                            | ICP-MS                   |
| Nickel                              | MET-93-6103  | EPA SW-846 6020A & 200.8                            | ICP-MS                   |
| Selenium                            | MET-93-6103  | EPA SW-846 6020A & 200.8                            | ICP-MS                   |
| Silver                              | MET-93-6103  | EPA SW-846 6020A & 200.8                            | ICP-MS                   |
| Strontium                           | MET-93-6103  | EPA SW-846 6020A & 200.8                            | ICP-MS                   |
| Thallium                            | MET-93-6103  | EPA SW-846 6020A & 200.8                            | ICP-MS                   |
| Tin                                 | MET-93-6103  | EPA SW-846 6020A & 200.8                            | ICP-MS                   |
| Titanium                            | MET-93-6103  | EPA SW-846 6020A & 200.8                            | ICP-MS                   |
| Uranium                             | MET-93-6103  | EPA SW-846 6020A & 200.8                            | ICP-MS                   |
| Vanadium                            | MET-93-6103  | EPA SW-846 6020A & 200.8                            | ICP-MS                   |
| Zinc                                | MET-93-6103  | EPA SW-846 6020A & 200.8                            | ICP-MS                   |
| Total Dissolved Solids              | INOR-93-6028 | SM 2540 C                                           | BALANCE                  |

## Method Summary

CLIENT NAME: AZIMUTH ENVIRONMENTAL CONSULTING,

AGAT WORK ORDER: 18T364819

PROJECT: 17-178a

ATTENTION TO: Drew West

SAMPLING SITE:

SAMPLED BY:

| PARAMETER                              | AGAT S.O.P  | LITERATURE REFERENCE     | ANALYTICAL TECHNIQUE |
|----------------------------------------|-------------|--------------------------|----------------------|
| Total Hardness (as CaCO <sub>3</sub> ) | MET-93-6105 | EPA SW-846 6010C & 200.7 | CALCULATION          |
| % Difference/ Ion Balance              |             | SM 1030 E                | CALCULATION          |

