HYDROGEOLOGICAL ASSESSMENT
In Support of a Major Site Plan Amendment to the License of

STANLEY PIT (MNRF ID 2191)

Part Lot 13, Concession 14, Municipality of Middlesex Centre
(Formerly London Township), Middlesex County, Ontario

Prepared for:
McCann Redi-Mix Inc.
69478 Bronson Line
Dashwood, Ontario
N0M 1N0

July 16, 2024

Prepared by:
Novaterra Environmental Ltd.
39 Winship Close,
London, ON   N6C 5M8

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Cover photo: Aerial photograph showing the Site and surrounding area, obtained from Google Earth imagery dated October 2020.

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1.0 INTRODUCTION

1.1 Background

McCann Redi-Mix Inc. possesses Aggregate License Number 2191 issued by the Ministry of Natural Resources and Forestry (MNRF) to extract aggregate material from their sand and gravel pit known as Stanley Pit. The License is classified as Category 1, Class "A" which authorizes the extraction of aggregate material from above and below the water table.

The licensed property occupies the north half of Lot 13, Concession 14, in the Geographic Township of London, now Municipality of Middlesex Centre, County of Middlesex (Figure 1). The 911 address of the site is 14693 Fifteen Mile Road. It is bound to the north by Fifteen Mile Road and to the east by Adelaide Street North.

The site was originally licensed in the late 1980s. The pit was later purchased by the Municipality of Middlesex Centre, and it is now owned and operated by McCann Redi-Mix Inc. Although the site is officially designated as Stanley Pit, it is also known as McCann Pit #10. In this report the officially designated name is used.

The site is bisected by Medway Creek which flows from the northeastern corner of the site and exits along the southern-central limit of the site. McCann Redi-Mix Inc. intends to realign a significant portion of the Creek in order to access aggregate deposits from the centre of the site which are otherwise inaccessible due to the current location of the Creek.

With the above in mind, McCann Redi-Mix Inc. engaged Novaterra Environmental Ltd. (hereafter Novaterra) to prepare this report and assesses the potential impacts of the proposed Creek realignment on the existing hydrogeological characteristics of the site and surrounding area.

1.2 Scope

Groundwater and surface water monitoring program at the site, in compliance with the Operational Plan for Stanley Pit, has been conducted by Novaterra since 2010. Reporting of groundwater and surface water conditions have been prepared on an annual basis since that time. This has afforded a detailed understanding of groundwater conditions at the site and the interaction between Medway Creek and adjacent groundwater which has been documented over the past decade.

The purpose of this report is to assess the potential adverse effects, if any, of the channel realignment on the existing hydrogeological framework at the site. Specifically, the effect of the channel realignment on the following:

- Groundwater table configuration
- Groundwater-surface water interaction
- Baseflow to Medway Creek

The proposed Medway Creek channel realignment is shown and described in detail in the Medway Creek Realignment Design Brief and accompanying engineering drawings prepared by Greck (2024). Updated Site Plans were provided by Harrington McAvan Ltd. (2024) and are based on the original site plans prepared by Huron-Middlesex Engineering Ltd. (1988).

The information contained in this report has been prepared in accordance with accepted professional standards. Portions of this report have been adapted from the previous site investigations and monitoring reports prepared by Novaterra which are listed in the References section of this report.

1.3 Historical and Current use of the Site

Prior to issuance of the aggregate license in the late 1980s, the majority of the site was used for agriculture, with a small northern portion which was disturbed by previous aggregate extraction (Huron-Middlesex Engineering Ltd., 1988).

Since issuance of the original license, approximately one third of the site has been mined out, resulting in the creation of an irregularly shaped pit pond (Figure 1).

Current aggregate extraction is taking place in the northwest area of the site, which can be seen on the aerial photograph on Figure 2. The stockpiles of aggregate materials and aggregate processing area are located in the western bank of the northern portion of the pit pond.

1.4 Past and Current Field Investigations

In May 2005, a detailed investigation of aggregate presence at the subject site was done by Atkinson, Davies Inc. (2005). A total of 11 boreholes were drilled, varying in depths between 8.8 m and 15.8 m. None of those boreholes were completed as monitoring wells.

In order to meet the operational plan stipulated under Item 13 (Sheet No. 2 of 4, Huron–Middlesex Engineering, 1988), four boreholes were drilled at the site and completed as monitoring wells (MW1, MW2, MW3, and MW4) on June 9, 2010. On the same day, the monitoring wells were developed by removing several well casing volumes of water. On June 14, 2010, three staff gauges were installed in Medway Creek and one in the pit pond. Most of the original staff gauges have since been destroyed: SG1 was destroyed in late 2012, SG3 in summer 2020, and SG4 in January 2018.

Monitoring at the site was initially conducted on a monthly basis from June 2010 to December 2011. Minor gap in measurement occurred January 2012 to August 2012 due to transfer in ownership from Municipality of Middlesex Centre to McCann Redi-mix. It was then reduced to a quarterly basis from August 2012 to October 2021.

On November 12 and 15, 2021, three additional monitoring wells (MW5, MW6, MW7) were constructed in other to establish geological/hydrogeological conditions along the new route of the proposed re-alignment of Medway Creek. The wells were situated in strategic locations along the east side of the proposed channel.

Locations of the boreholes, monitoring wells, and staff gauges are identified on Figure 2. Borehole logs are provided in Appendix A.

From January 2022 to January 2023, groundwater measurements at all seven monitoring wells and at SG2 were taken on a nearly monthly basis. In 2023, monitoring was reduced to a quarterly basis and is ongoing.

2.0 SITE PHYSICAL FEATURES

2.1 Topography and Drainage

The site occupies the bottom of the valley of Medway Creek and includes portions of the eastern and western valley slopes of Medway Creek. The highest ground surface elevation is 299 metres above mean sea level (m amsl) and is found in the northwestern and the southeastern sections of the site (Figure 2). The topographic contour of 289 m amsl defines the top of Medway Creek banks from where the valley bottom gently rises to the east and west. If we assume that the topographic contour of 291 m amsl defines the valley bottom, then the valley width varies between 150 and 280 m.

Medway Creek enters the site near the northeastern corner of the property and exits at the middle of the southern boundary, dividing the site into two almost equal parts. The channel of Medway Creek is approximately 5.4 m wide and an average depth of 0.65 m (Greck, 2021).

2.2 Natural Heritage Features and Adjacent Land Use

There are no notable natural environment features within the immediate vicinity of the site. The nearest woodlot is 350 m southwest of the license boundary and is approximately 2.5 hectares in size. A second woodlot is located 450 m east of the license boundary and is approximately 13.5 hectares in size. Both woodlots appear to consist of mature deciduous threes.

There is no Provincially Significant Wetlands (PSW) within at least a 500 m radius from the subject site. A small northwestern section of the site falls within the Elginfield Area Moraine Area of Natural and Scientific Interest (ANSI). This ANSI feature carries provincial significance in the Earth Science field and is classifies as non-sensitive.

Most of the surrounding land is cultivated for agricultural use. A few residences exist across the roads along the northeastern and northwestern boundaries of the site. Immediately north of the site, and on the west side of Medway Creek, is a former gravel pit which is now used as a concrete ready-mix batch plant operated by Dufferin Concrete.

2.3 Surface Water Bodies

2.3.1 Open Water Bodies

A large system of ponds exists north of the site on the opposite side of Fifteen Mile Road. These ponds are the result of aggregate extraction at two former licensed pits and one active pit. They are inline with Medway Creek.

The large onsite pit pond was created by the removal of the solid phase of the water table aquifer. By its definition it is a surface water body, but it is part of the groundwater system. In the north, the pond is almost square in shape, measuring 4.5 ha in size (220 m by 210 m). The pond then becomes elongated for a distance of 440 m and width of 60 m, encompassing an area of 2.0 hectares. The pond is separated from Medway Creek by a 30 m buffer zone (Huron-Middlesex Engineering Ltd. 1988). The pond varies in depth from approximately 6 to 8 metres.

The northern portion of the pond is also separated from Medway Creek by a 30 m buffer zone to the east and to the south (Figure 2). During high water level stage in the Creek, water from the Creek occasionally overflows the 30 m buffer area and enters the northern part of the pond and then flows out of the pond on the west side of MW2 where it re-enters Medway Creek.

2.3.2 Medway Creek

The description of Medway Creek at the subject site is given in considerable detail by Greck and Associates Limited in their technical memorandum on the proposed concept plan (Greck, 2021).

Medway Creek flows in a general north to south direction through the Stanley Pit site. The contributing watershed area is 62.4 km^2 (Greck, 2021). Flows enter the property at a bridge located on Fifteen Mile Road and exit the property onto the adjacent neighbouring agricultural lands at the southern boundary. Under the current operating license, the watercourse is to be unaltered and protected with a 30 m buffer zone from the top of each channel bank.

The Medway Creek's channel is carved into aggregated deposits consisting of sand and gravel with some cobbles. There are two main hydrologic cycles in the Medway Creek flow: wet cycle when there is variable flow with mostly effluent conditions, and dry condition when there is no flow in the Creek which may last for a few months. These cycles are illustrated in Photos 1, 2 and 3 on page 9. This wet and dry cycle limits its ability to support or maintain permanent natural aquatic habitats. This results in periodic die-offs of non motile or semi-motile organisms (e.g., mussels, some benthic invertebrates, etc.) or exposure of such organisms to predation on an annual basis (Greck, 2021).

The gradient of the stream bed of Medway Creek was calculated by:

- using the elevation of streambed at SG4 and SG2 which resulted in a hydraulic gradient of 0.00079 m/m (0.08%) over a distance of 392 m.
- streambed elevation between SG2 and SG3 (shown on Figure 1) which resulted in streambed hydraulic gradient of 0.00108 m/m (0.11%) over a distance of 329 m.
- over the entire length of stream bed between SG4 and SG3, the hydraulic gradient was calculated to be 0.00093 m/m (0.09%).

3.0 GEOLOGY

3.1 Geology

According to Chapman and Putnam (1984) the surficial deposits on both sides of Medway Creek consist of spillway physiographic units which are surrounded by till plain (undrumlinized).

The Quaternary Geology map for Lucan Area (Preliminary Map P. 1048) describes the Quaternary deposit on both sides of Medway Creek as lacustrine deposits overlaying gravelly outwash (Sado, E.V. and Wagners, U. J. 1975). This relatively narrow area of sand and gravel deposits is surrounded by sandy silt loam till.

In the southeastern corner of the site is a small terrace feature oriented in the northeast-to-southwest direction towards Medway Creek. It is presumed to be filled with the more recent gravel and gravelly sand outwash.

Quaternary deposits at the site are underlain by limestone of the Dundee Formation (Freeman, 1979).

3.2 Subsurface Condition at the Site

Of the total 11 boreholes (BH101 through BH111) drilled by Atkinson, Davies Inc. in 2005, nine of them penetrated the entire thickness of aggregate deposits and were terminated into grey clayey silt till which underlies sand and gravel deposits. The reported thickness of sand and gravel varied between 6.7 and 15.5 m below ground surface (bgs). Two of the boreholes (BH108 and BH111) were terminated into sand and gravel with cobbles at depths of 14.3 and 15.8 m bgs. The unconsolidated deposits at the site are described as sand and gravel, and some cobbles with occasional boulders (Atkinson, Davies Inc. 2005).

Drilling in 2010 of monitoring wells MW1, MW2, MW3, and MW4 confirmed the presence of near-surface sand and gravel. At MW1 and MW2, gravel, sand, and silty sand were found to depths of 6.6 and 4.6 m, respectively, but the clayey silt till was not reached. At MW3, silty sand and gravel was found to a depth of 3.0 m bgs followed by grey silt. At MW4, the silty sand and gravel was found to depths of 4.5 m but was underlain by angular gravel.

More recent drilling in 2021 of monitoring wells MW5, MW6, and MW7 showed slightly different geology due to their location on the higher elevations of the Medway Creek valley. At MW5, nearly the entire thickness consisted of dry clayey silt with one layer of saturated silty sand and gravel at a depth of 8 to 9.3 m bgs. Monitoring well MW6 is located in a low-lying area within the geologic terrace where the deposits are silty sand with some gravel to 4.0 m bgs followed by grey clayey silt till. At MW7, which is located within the Creek valley, brown clayey silt was found to a depth of 5.8 m bgs followed by sand and gravel to 7.8 m bgs and then clayey silt till,

The geologic setting is visualized on the local cross-section shown on Figure 3. We can see from this figure that the deeper portions of the Medway Creek valley are comprised of outwash sands and gravels which were deposited into a deep valley which was carved into the clayey silt till by glaciofluvial erosion. The clayey silt till surface rises sharply from the valley centre and is found at ground surface on the table land surrounding the Medway Creek valley.

The near-surface brown clayey silt shows more prevalence in the southern margin of the site near MW7. It is surmised that the Medway Creek channel bottom consists of clayey silt beyond the site limits and further southward.

4.0 HYDROGEOLOGY

The coarse granular deposits at the subject site, which consist of sand and gravel, and some cobbles are saturated and thus constitute a water table aquifer.

Monitoring wells MW1 to MW4 are screened into the water table aquifer with 30-mm diameter, 0.010-inch slot size schedule 40 PVC screens. Top of screen interval ranges from 2.30 to 3.90 m bgs. The wells were placed at strategic locations to observe the interaction between onsite groundwater and the surface water in Medway Creek. Monitoring well MW1 is in an upgradient area outside the extraction limit, MW2 and MW4 are situated along the banks of Medway Creek, and MW3 is located approximately 100 m distance northeast of the Creek.

In 2021, locations of monitoring wells MW5, MW6, and MW7 were determined based on the proposed location of the re-aligned Medway Creek Channel. They were placed along the east side of the proposed channel in order to remain outside of the extraction area and be preserved for future monitoring. The wells are screened into the same aquifer as the original four wells and are equipped with 3-m long, 50-mm diameter, 0.010-inch slot size schedule 40 PVC screens. The depth to top of screen is 7.6 m bgs at MW5, 2.1 m bgs at MW6, and 7.6 m bgs at MW7.

4.1 Site Hydrogeology and Water Table Aquifer

Depths to water levels at three of the four original monitoring wells (MW2, MW3, and MW4) range from 0.18 to 2.85 m bgs. Because MW2, MW3, and MW4 are located within the exaction limits, they are reflective of the depth to water level expected during aggregate extraction. At MW1, which is located outside of the proposed sand and gravel extraction area, water levels range from 2.76 to 5.10 m bgs. At the more recent monitoring wells MW5 and MW7, depths to water level range from 4.53 to 5.85 m bgs, while at MW6 they range from 0.48 to 2.49 m bgs.

The hypsometric position of water level in relation to surface water can also be observed on cross-section A-A' shown on Figure 3. This figure shows that there is a very gentle groundwater gradient towards Medway Creek from both sides on March 9, 2022. This date was selected because it represents the highest water level elevation measured during the last two monitoring years.

Three short cross-sections across Medway Creek are shown on Figure 4. They illustrate the relationship between Medway Creek and local groundwater for the highest and lowest recorded water level over the past two years. At MW5 and MW6, conditions are effluent during the hydrologic high, but are influent during the hydrologic low. At MW7 groundwater levels are approximately 2 m lower than the channel bottom for both dates. If unsaturated zone found at MW7 reaches beneath the Creek, some water from the watercourse might be exfiltrating into the unsaturated zone so we might have influent stream condition.

4.2 Water level fluctuations

Water level fluctuations at the site are presented as water level elevation hydrographs on Figure 5. The data are also provided in tabular form on Table 1. From Figure 5 we can see that historically the highest measured water level elevations in groundwater and Medway Creek occur in April of each year but have on occasion occurred in June (e.g. 2018) and in January (e.g. 2020). The lowest elevations typically occur in October or November. The highest groundwater level was primarily in MW1, followed by MW3, then MW2, and the lowest in MW4. The difference between water level elevations at these four monitors is very small, typically 0.5 m between them, but may reach up to 1.0 m.

The magnitude and timing of the hydrologic high and hydrologic low at the site are heavily dependent on two main factors: the amount of precipitation and the timing of water level measurement in relation to precipitation events. Although Medway Creek is typically dry during the late summer, a significant rainfall event may cause water to flow through the Creek and create mounding conditions in its vicinity. If a water level measurement is taken shortly after such an even, the hydrologic low would appear to have higher elevation.

The monitoring program was enhanced with the addition of MW5, MW6, and MW7 which began monitoring in January 2022. The water levels from those well are plotted alongside the original four on Figure 6 for the time period of January 2018 to December 2023.

We can see from Figure 6 that MW6 has the highest groundwater level elevation while MW5 is closely grouped with the original four monitoring wells. Monitoring well MW7 has a considerably lower water level elevation, approximately 3 m lower than all of the other monitoring wells. It is theorized that the Medway Creek channel bottom is comprised of clayey silt southward beyond the site limits and does not infiltrate to groundwater as effectively as the upstream areas.

In 2022, water level elevations reach their peak in March 2022, following the spring freshet, and they gradually declined through the spring and summer months, reaching an apparent minimum in August 2022. Water level recovery then began in September/October 2022 and lasted until April 2023. At this point, water levels receded until July 2023 when above-average precipitation caused a sharp rise in water levels. This was followed by gradual recession into October 2023. The pattern and magnitude of fluctuations is generally consistent with that of previous years.

4.3 Groundwater Hydraulic Gradients

The groundwater flow configuration at the site was evaluated for the 2022 monitoring year which had both the highest and lowest water level elevations of the past two years. The hydrologic high which occurred in March 2022 is shown on Figure 7. The hydrologic low which occurred in August 2022 is shown on Figure 8.

Creation of the groundwater flow configuration is assisted by the existence of the pit pond which abuts the entire western buffer surrounding Medway Creek all the way to the southern boundary of the site (see Figure 2). The pit pond is part of the groundwater system and has a constant head over its entire area which acts as a boundary for delineating the groundwater flow.

During the hydrologic high (Figure 7), groundwater flow direction is primarily in the westerly direction towards Medway Creek with a smaller southerly component parallel to the creek flow. In the central area of the site, which occupies the flood plain roughly between MW5 and MW4, hydraulic gradient is quite flat with a gentle hydraulic gradient towards Medway Creek. On this date, groundwater is discharging into Medway Creek, creating effluent stream conditions. Notably, a component of groundwater arrives from the east beyond MW6 where sand deposits occupy the low-lying area around that well. This topographic low is saturated by overland runoff originating from agricultural field further northeast of the site which may be tiled.

During the hydrologic low (Figure 8), groundwater flow direction is very similar, but with a smaller hydraulic gradient. Primary, groundwater flow is in the southerly direction with a small westward component towards Medway Creek. On this date, Medway Creek was dry and water levels in the groundwater are below the channel bottom.

As noted earlier, water level elevation in MW7 is close to 3 m lower than the other monitoring wells. This condition has caused steep groundwater gradient from the north-to-south direction (Figures 7 and 8). It is significant to note that water level response in MW7 has a similar pattern to the other wells, albeit slightly smaller magnitude, which suggests that this may be a local groundwater recharge area.

4.4 Groundwater and Surface Water Interaction

The relationship between groundwater and Medway Creek has been well documented over the past decade. There are three stages of the relationship:

1. Effluent conditions
   Groundwater flow direction is towards Medway Creek during periods after hydrologic high that typically follow the spring freshet. During these periods, groundwater levels are above Creek levels which creates effluent stream conditions where a baseflow of groundwater feeds the Creek.

   This can be seen on Figure 7 where there is a very gentle groundwater gradient from MW1 across the pond to MW2, and westward from MW6 towards MW3, MW4 and then Medway Creek. The condition continues through the late spring and summer months providing input of groundwater to the Creek. Typical condition can be seen on Photo 1 on page 9.

2. No-flow in the Creek
   As groundwater level recession continues through the late spring and summer months, and runoff inputs decrease, Medway Creek may completely dry up. Groundwater levels also decline gradually to levels below the channel bottom. In this case, there is no flow in the Creek and no baseflow contribution from groundwater. It is uncertain how long such periods last, but they have occurred in the past for over one month at a time, typically in August, September, and October. This situation can be seen on Figure 8 and on Photo 2. During periods when the Creek is dry, an underflow likely exists beneath the Creek channel.

   Considering that Medway Creek is completely dry for at least one month, the presence of any biotic life in the Creek is excluded.

3. Influent conditions
   Influent conditions exist when adjacent groundwater levels are below Creek levels and the stream water infiltrates into the groundwater.

   This situation occurs during spring freshet and is compounded by precipitation which causes Creek levels to rise rapidly in relation to the adjacent groundwater. During such periods, a bank storage is created along the sides of the Creek. If a water level measurement is taken shortly after bankfull flow it can incorrectly lead to the conclusion that nearby groundwater is feeding the Creek when the opposite is actually the case. This condition is seen on Photo 3.

Photo 1. Looking downstream at Medway Creek on May 22, 2022, monitoring well MW2 is in front and staff gauge SG2 is to the left of MW2.

Photo 2. Looking south and downstream from the same location as Photo 2, Medway Creek channel is completely dry on October 17, 2022.

Photo 3. Looking south and downstream, bankfull Medway Creek is seen flowing away from camera on October 26, 2021. Top of SG2 is few centimeters above top of Creek water and is left of MW2.

Despite the drying of the Creek during short periods, groundwater hydraulic gradients are typically towards Medway Creek where the baseflow afforded by groundwater continues to feed Medway Creek through most of the year. Typical effluent condition in Medway Creek is depicted by Photo 1.

Interaction between groundwater and Medway Creek water during historical monitoring periods can be observed on Table 4.1. The table shows a comparison between groundwater elevation at monitoring wells adjacent to the Creek and the Creek channel bottom at those locations. Although groundwater gradients in the broader area are always towards Medway Creek, in its the immediate vicinity groundwater gradients are variable, partly due to the phenomenon of bank storage and decline of groundwater levels.

Table 4.1. Difference in elevation between Medway Creek bottom and adjacent groundwater level.

Date	Difference at MW2	Difference at MW4		Date	Difference at MW2	Difference at MW4
17-Aug-10	-0.11	0.00		10-Oct-19	-0.05	0.26
14-Sep-10	-0.51	-0.36		20-Jul-20	-0.38	-0.03
06-Oct-10	-0.70	-0.68		09-Oct-20	-0.71	-0.36
10-Nov-10	-0.18	0.30		16-Jul-21	-0.07	0.27
17-Aug-11	-0.12	0.01		25-May-22	-0.03	0.26
07-Aug-12	-0.53	-0.40		12-Jul-22	-0.39	-0.04
31-Oct-12	-0.88	-0.52		31-Aug-22	-0.61	-0.25
16-Oct-15	-0.54	-0.58		30-Sep-22	-0.30	-0.15
19-Jul-16	-0.11	0.02		17-Oct-22	-0.44	-0.08
08-Sep-16	-0.17	0.00		25-Nov-22	0.06	0.39
19-Oct-16	-0.68	-0.52		10-Jan-23	0.65	0.83
22-Jul-17	-0.04	0.09		11-Apr-23	0.67	0.80
21-Oct-17	-0.94	-0.73		22-Jun-23	n/m	0.12
24-Oct-18	-0.02	0.23		11-Jul-23	0.91	1.04
08-Jul-19	-0.12	0.09		25-Oct-23	0.36	0.59

Negative values indicate groundwater elevation is lower than Medway Creek bottom.
NOTES: Distance to Medway Creek is 6.4 m at MW2 and 8.0 m at MW4
Channel bottom elevation is 228.53 m at MW2 and 288.17 m at MW4

Flow in Medway Creek has not been affected by aggregate extraction activities at the subject site. Rather, the interdependence between Medway Creek and groundwater in the water table aquifer adjacent to the Creek is a result of precipitation and from the Creek flow reaching the site from the upper reaches of the Creek watershed.

4.5 Groundwater and Surface Water Use

Water well records on file with the Ministry of the Environment, Conservation, and Parks (MECP) are plotted on Figure 2. Five water well records were plotted on Figure 2 and fall within 120 m distance of the site licensed boundary. Relevant information from the water well records are provided in Table 4.2, below.

Table 4.2 Summary of information from local water well records on file with MECP.

Water well record number	Date; Type	Diameter (cm)	Total depth (m bgs)	Screen interval (m bgs)	Depth (m), Lithology
7150519	2010; Drilled	0.3	-	-	Onsite monitoring wells MW1, MW2, MW3, and MW4.
4108882	1979; Drilled	12.7	11.0	9.8 – 10.0	0.3 Topsoil 11.0 Gravel
4104590	1968; Bored/Dug	0.91	6.7	4.0 – 6.7	4.0 Coarse gravel 6.7 Coarse gravel
4105906	1972; Drilled	12.7	74.4	44.5 – 74.4 (open hole)	2.4 Yellow clay, 9.8 Blue clay, 31.4 Blue clay, stones, 43.3 Hardpan, 60.4 Med. grey limestone, 66.1 Light brown limestone, 73.2 Med. brown limestone, 74.4 Med. grey limestone
4102427	1955; Drilled	10.2	57.0	44.2 – 57.0 (open hole)	4.6 Clay, stones, 6.1 Gravel, 30.5 Stones, clay, 36.6 Medium sand, 39.6 Clay, 44.2 Medium sand, 57.0 Limestone

Of the five water well records shown above, one is for the construction of the original onsite monitoring wells MW1, MW2, MW3, and MW4. Water well record 4108882 is a former onsite drilled well which is presumed to have been destroyed. The remaining three water well records are domestic wells. Water well record 4104590 is north and across Fifteen Mile Road from Stanley Pit and is sourced from the water table aquifer. Water well records 4105906 and 4102427 are for residences located east of the site and are sourced from the deep confined bedrock aquifer.

Water takings from well 4104590 are authorized by Permit to Take Water Number 2212-AFDP3V for a rate of 69 L/min and maximum daily volume of 100,000 litres. The purpose of the water taking is industrial manufacturing, which is presumed to be associated with the concrete plant operated by Dufferin Concrete. There are no other PTTWs or surface water uses within one kilometer from the subject site.

Local wells would not be impacted by the proposed channel re-alignment because the nearest are sourced from the bedrock aquifer. The third is used for commercial purposes and is located a significant distance north of the site.

5.0 PROPOSED OPERATION AND POTENTIAL IMPACT

5.1 Channel Re-alignment

The proposed Medway Creek channel realignment is shown and described in detail in the Medway Creek Realignment Design Brief and accompanying engineering drawings prepared by Greck (2024). The location of the realigned channel is also shown on Figures 1, 2, 7, and 8. Approximately the entire southern half of the Creek channel would be moved eastward, making it possible to access aggregate material from the centre of the site which is otherwise inaccessible due to the current location of the Creek.

Monitoring wells MW5, MW6, and MW7 were constructed along the east side of the proposed channel within the 30 m buffer zone. Split spoon samples were collected by Novaterra staff during borehole drilling at specific depths which roughly corresponded to the bottom of the proposed channel. Collected samples were submitted to LDS Consultants Inc. for sieve and hydrometer analysis. The results are provided in Appendix B and discussed below.

The northern portion of the new channel would cut into the eastern valley slope by approximately 4 metres. In this area, the geologic profile is represented by borehole MW5 and illustrated on cross-section B-B' (see Figure 4). Soil samples were collected from 4.0 m and 6.0 m bgs which roughly correspond to 1 m above and below the channel bottom, respectively. The sample from 4.0 m depth is classified as clayey silt with some sand, while the sample from 6.0 m depth is classified as dense sandy clayey silt.

As the new channel progresses southward, the amount of cut required to achieve original channel slope gradually decreases. Along cross-section C-C' (Figure 4), ground topography is slightly lower, and approximately 2.7 m of overburden material will require removal. Soil samples collected at MW6 from 3.0 m bgs at are classified as medium to coarse sand.

In the southern portion of the new channel, near MW7, approximately 2 m of cut is required. Soil samples collected at 3.7 m bgs in MW7 are classified as silty sand with some gravel. This is shown on cross-section D-D' (Figure 4)

So, the upper portion of the new channel will be incised into the valley slope which is comprised of dense fine-grained clayey silt which has very low permeability. But as the channel meanders southward, it intercepts gradually coarser material before reaching centre of the Medway Creek valley and exiting the site.

5.2 Potential Impacts to Groundwater and the Natural Environment

The new channel of Medway Creek will be cut into similar but less pervious geological deposits from the current Medway Creek channel. This particularly applies to the area around MW5 where dry clayey silt is present below the proposed depth of the new channel. Although water level in MW5 rises to a height above the new channel bottom, it is expected that there would be little to no groundwater seepage from the easterly direction due to the low permeability of the clayey silt.

In the central segment of the re-aligned channel, near MW6, the new channel would cut into more porous deposits consisting of silty sand with some gravel. In this area, groundwater levels range from 288.95 to 290.96 m amsl which is 1 to 3 m above the new channel bottom. This suggests that there would be a steady baseflow towards the new channel in that area. The primary source of baseflow in this narrow segment of the new channel is the low-lying area east of the drain which may collect tiled drainage from the adjacent farm field. Of course, once the new channel has been established, groundwater levels in the upgradient area east of MW6 would lower slightly, but a small and steady baseflow would continue to contribute to the drain in that area.

Available data shows that the southern section of the realigned channel will have bottom elevation a few metres above water table in the area of MW7. If this case is persistent, some stream water would be infiltrate into the unsaturated present beneath the stream channel in that area. As a result, we expect groundwater levels in MW7 to rise due to their proximity to the realigned channel.

The most significant change that would occur post realignment, is the enlargement of the pit pond which will be the result of aggregate removal. From a hydrogeological perspective, this results in two major changes: flattening of water levels across the pond area, and minor change of baseflow to the Creek.

A pit pond has already been established, and its water elevation in 2022 and 2023 ranged from 288.2 to 289.5 m amsl. As the pit pond is enlarged eastward, the pond levels would rise slightly, due to the higher groundwater elevation at MW3. We anticipate that pond levels would eventually achieve an elevation midway between the current pit pond levels and groundwater levels at MW3. In 2022 and 2023, groundwater levels at MW3 ranged from 288.36 to 289.67 m amsl. So, future pond levels are expected to range from 288.3 to 289.6 m amsl seasonally, or +/- 288.9 m amsl.

Because the small area of the flood plain which contributes to the baseflow would become a pond, it can be argued that this represents a loss of baseflow to the Creek. In reality it is not the case because the enlarged pond will have slightly higher elevation than the realigned bottom of the Creek and will continue to afford baseflow to Medway Creek. This area of approximately 4.75 hectares is very small in comparison to the watershed area of Medway Creek of 6,241 hectares (Greck, 2024). Therefore, any potential change of baseflow is too diminutive in size to negatively influence flow in the Creek. Baseflow would still continue to enter the new channel from the enlarged pond and the reduction in baseflow post-realignment is considered negligible.

The hydrologic regime of Medway Creek would still be maintained as before by having three existing stages: effluent conditions, no-flow, and influent conditions. Having this in mind, there is no ability of the Creek to support permanent natural habitat in the realigned Creek as it was not in the existing Medway Creek. So, the natural condition would be maintained as before realignment of Medway Creek.

5.3 Other Considerations

In portions of the realigned Creek, the channel bottom would be excavated deeper into water table than at the current location. This would give potential for the larger groundwater seepage into the excavation which might lead to the need for temporary dewatering of the excavation. If dewatering of the channel is required, then a Permit to Take Water (PTTW) should be obtained from the MECP. If this condition develops then a suitable discharge location should be found and measured should be taken to prevent silt-laden water from entering Medway Creek.

Another important consideration is stability of the eastern slope of the new channel, particularly near MW5 where topographic relief is quite high. In this area, soil consists of relatively dense clayey silt which would require suitable grading and vegetation to ensure it is stable.

6.0 MONITORING PROGRAM

An existing monitoring program is in place which consists of four monitoring wells and one staff gauge and was enhanced by the addition of three new wells along the east side of the re-aligned channel. Water levels in these seven wells continue to be monitored on a quarterly basis.

Once earthworks commence, monitoring frequency would be changed to a monthly basis to more accurately observe potential changes to water levels during construction. Once the realigned channel is completed, temporary staff gauges shall be installed in the new channel and incorporated into the monitoring program. Thereafter, monitoring would continue on a monthly basis for one full year after the realigned channel has been completed. A summary report will then be prepared by a qualified professional to establish new baseline conditions of the channel and assess whether major changes have occurred. Thereafter, monitoring would be reduced to a quarterly basis, and annual monitoring reports will continue to be prepared, as required by the Site Plans.

Monitoring wells MW2, MW3, and MW4 will eventually be destroyed by aggregate extraction below the water table which will result in the enlargement of the pit pond. The wells will continue to be monitored until they are decommissioned. Monitoring wells MW5, MW6, and MW7 have been strategically placed along the east side of the proposed channel and outside the active extraction area. They will be preserved and monitored in place of MW2, MW3, and MW4.

A staff gauge should be established in the pit pond to monitor water levels. The pit pond would abut the entire western length of Medway Creek and acts a boundary condition that will assist in determining baseflow contribution arriving to the Creek from the westerly direction.

7.0 CONCLUSIONS

Based on the information collected in the field, and analysis of available data, the following conclusions are made:

1. Geological investigation at Stanley Pit established that there are substantial aggregate deposits comprised of outwash sand and gravel which were deposits in a valley incised in the underlying clayey silt till. These sand and gravel deposits are saturated and constitute a water table aquifer.

2. Along the proposed Medway Creek realignment, near-surface deposits of moderate hydraulic conductivities are found and consist of clayey silt with minor sand and gravel.

3. The channel bottom of the Medway Creek realignment would intercept the saturated clayey silt at MW5 and silty sand at MW6, while at MW7 the channel bottom would be constructed into unsaturated brown silt.

4. Approximately 4.75 ha of valley land which now contributes to baseflow of Medway Creek will eventually become a pond. No reduction of baseflow to the Creek would occur because the groundwater system east of the realigned channel and the pond would continue to contribute baseflow to the Creek in the same amount as before realignment.

5. Hydrologic regime in the Medway Creek and groundwater system adjacent to it will continue to function in the same manner as it was before channel realignment. It will still maintain three stages of flow: effluent, no-flow, and influent conditions.

6. The proposed Medway Creek Channel realignment will not have a negative effect on hydrologic/hydrogeologic regime or natural environment in the area.

8.0 RECOMMENDATIONS

Based on the conclusions drawn from the work described herein, the following recommendations are made and shall be incorporated into the site plans:

1. Water levels shall be measured in seven onsite monitoring wells (MW1 to MW7, inclusive) on a quarterly basis.

2. Upon commencement of earthworks for the channel realignment, monitoring frequency shall change to a monthly basis. Once the realigned channel is established, temporary staff gauges shall be installed in the new channel opposite MW5, MW6, and MW7. Monthly monitoring shall then continue for one full year and then be reduced to a quarterly basis.

3. After one year of monthly monitoring post-realignment, a report shall be prepared by a qualified professional to present baseline conditions of the realigned channel. The report shall provide recommendations for future monitoring and shall act as a baseline for future comparison.

4. Annual monitoring reports shall be prepared by a qualified professional to assess whether pit operations have adversely affected groundwater conditions at the site. The reports shall be submitted to the MNRF in Aylmer and to the MECP in London.

5. If any water well is encountered onsite during aggregate extraction, such well shall be decommissioned in accordance with O.Reg. 903. Monitoring wells MW2, MW3, and MW4 are planned to be decommissioned as aggregate extraction encroaches upon them.

6. The remaining onsite monitoring wells shall be preserved for the life of the licence and may be decommissioned in accordance with O.Reg. 903 once final rehabilitation is completed and approved.

Respectfully Submitted,

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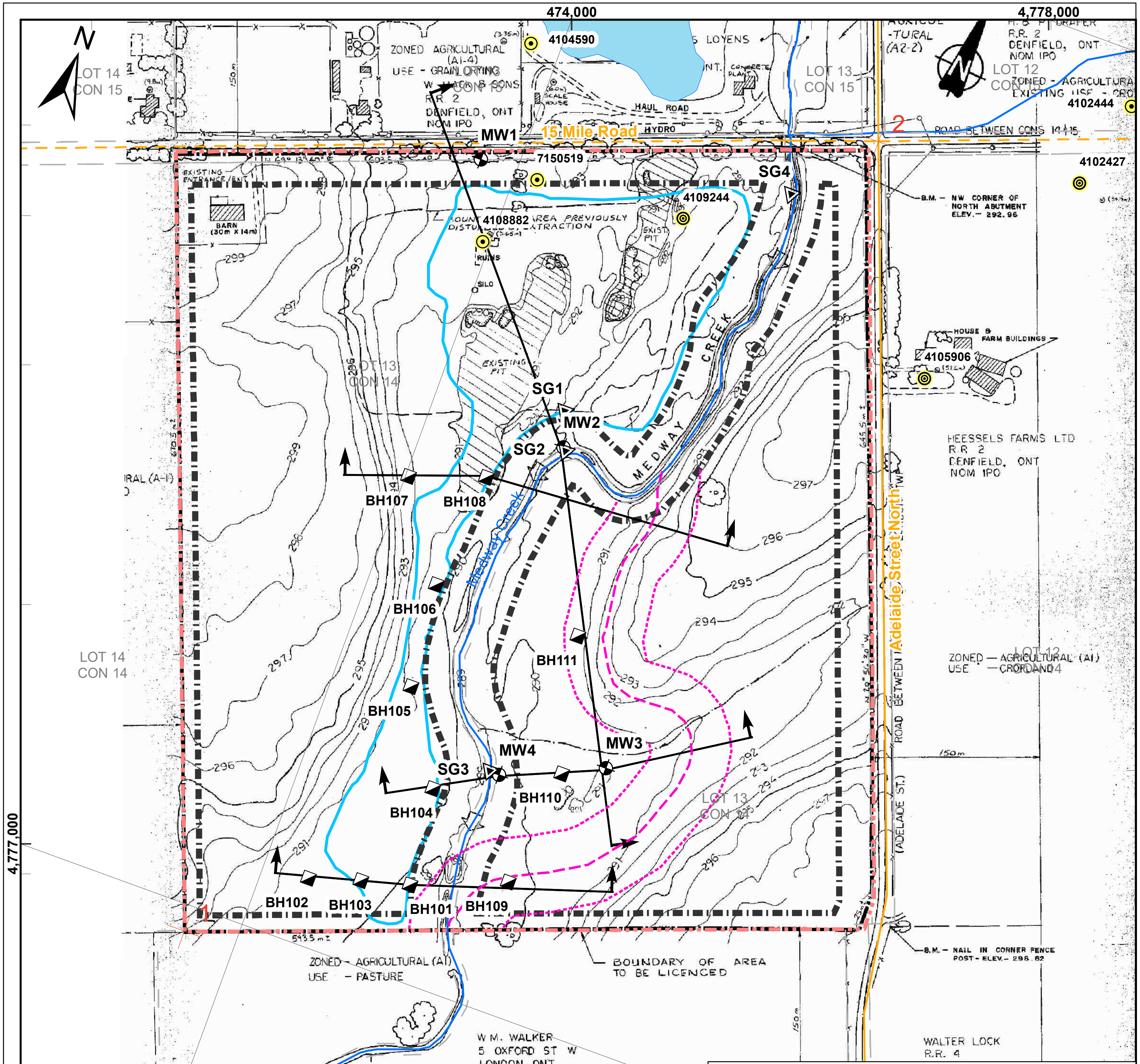
10.0 LIMITATIONS

This report was prepared by Novaterra Environmental Ltd. (Novaterra) for the exclusive use of McCann Redi-Mix Inc. The material in it reflects Novaterra's best judgement considering the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Novaterra accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

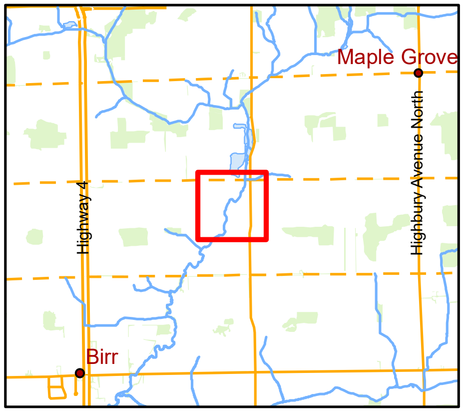
The report was prepared based, in part, on information and data for the site provided to Novaterra Environmental Ltd., by other parties. It is assumed that the information provided is factual and accurate. We accept no responsibility for any deficiencies, misstatements or inaccuracies contained in this report as a result of omissions, misinterpretations or fraudulent acts of these other parties.

FIGURES

Figures 1 to 9



Adapted from Existing Features Site Plan
(Drawing 1 of 4; Huron-Middlesex Engineering Ltd., 1988)



INDEX MAP

LEGEND

- Monitoring well
- Borehole
- Staff gauge
- Extraction Limit
- License Boundary
- Existing Pit Pond
- Proposed re-aligned channel
- 30 m channel buffer
- Cross-section

MECP Water Well Records

- 4505352 Overburden well
- 4506025 Bedrock well

Figure 1. Location map

STANLEY PIT
Re-alignment of Medway Creek

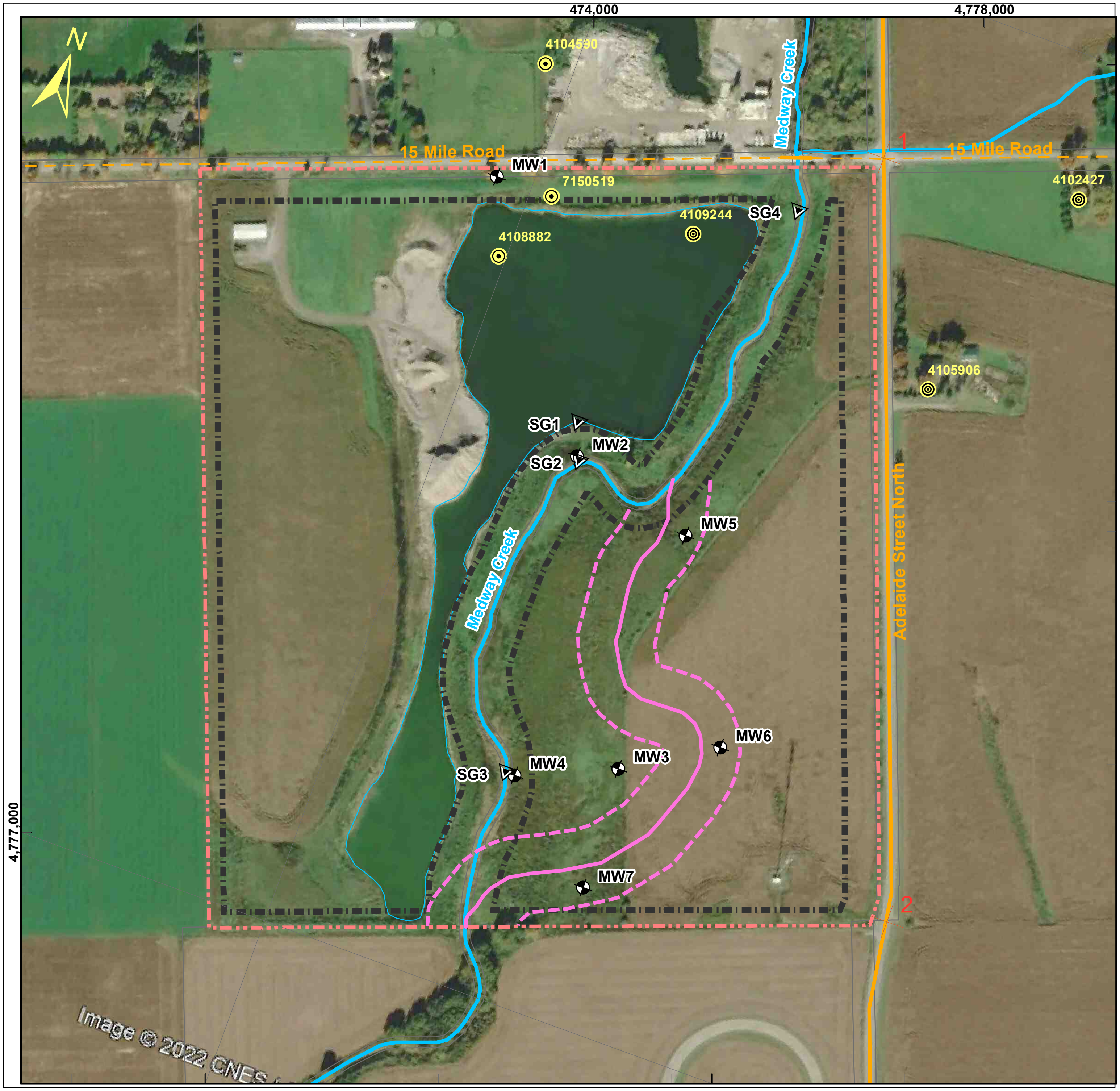
Part Lot 13, Concession 14, Municipality of Middlesex Centre (formerly London Township), Middlesex County

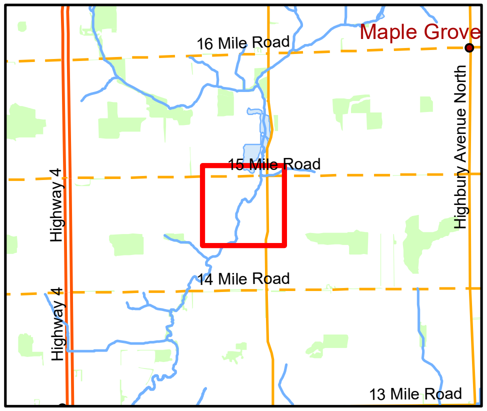
January 4, 2024

Novaterra ENVIRONMENTAL

1:5,000
0 25 50 100 150 Meters

Map based on MNRF data
Contour Interval - 5 metres
NAD 1983, UTM Zone 17 N





INDEX MAP

LEGEND

⌖	Monitoring well
▽	Staff gauge
▭	Extraction Limit
▭	License Boundary
▭	Existing Pit Pond
—	Proposed re-aligned channel
- - -	30 m channel buffer

MECP Water Well Records

⊙ 4505352	Overburden Well
◎ 4503689	Bedrock Well

Figure 2. Aerial photo showing detailed view subject site.

STANLEY PIT
Re-alignment of Medway Creek

Part Lot 13, Concession 14, Municipality of Middlesex Centre (formerly London Township), Middlesex County

January 4, 2024

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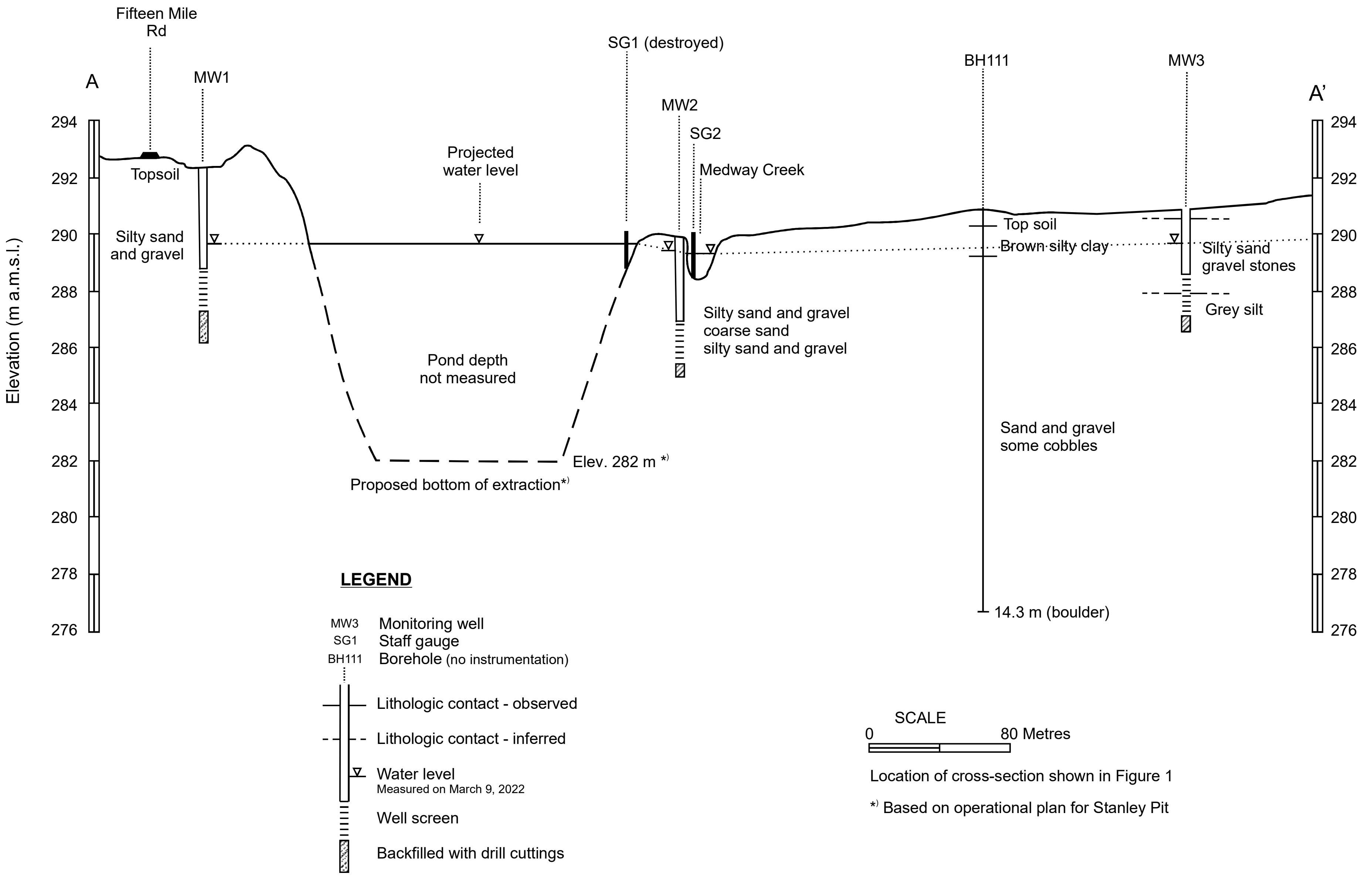
1:5,000

0 25 50 100 150 Meters

Map based on MNRF data
Contour Interval - 5 metres
NAD 1983, UTM Zone 17 N



Location of cross-section shown in Figure 1

*) Based on operational plan for Stanley Pit

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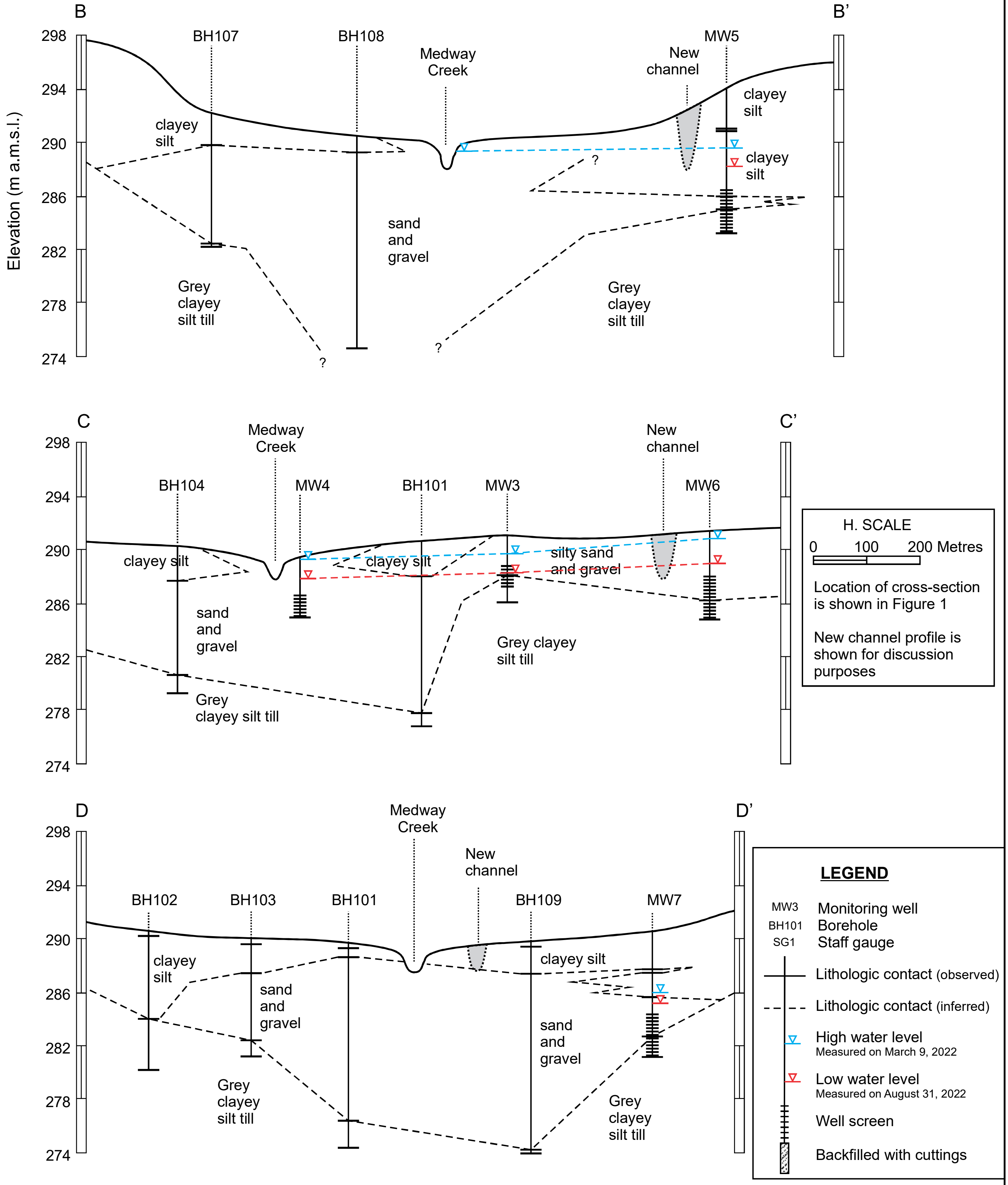
CROSS-SECTION A-A’ SHOWING GEOLOGY AND HYDROGEOLOGY

Part of Lot 13, Concession 14, Municipality of Middlesex Centre
(Formerly London Township) Country of Middlesex

Figure 3

McCANN PIT #10
Re-alignment of Medway Creek

December 5, 2023



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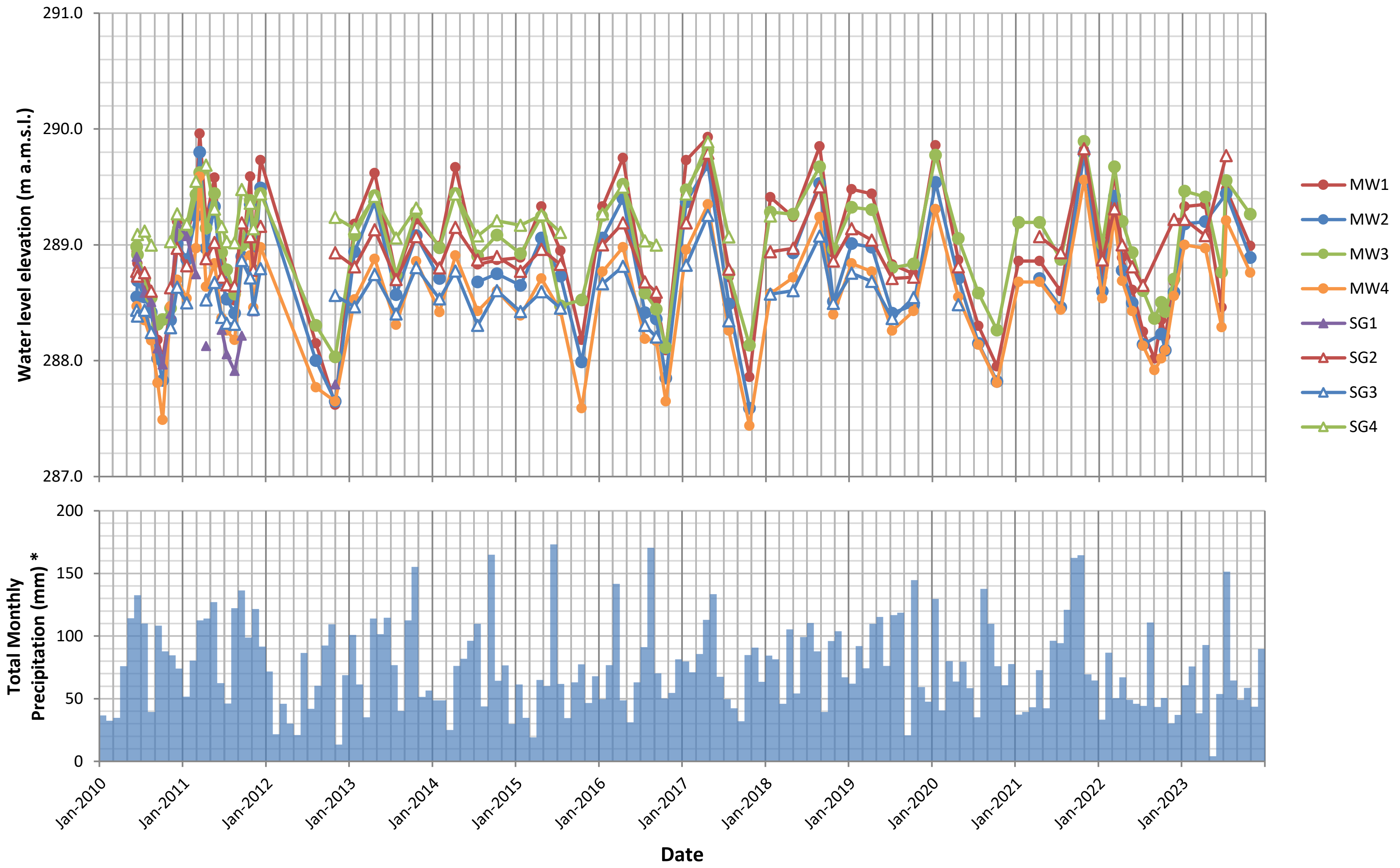
CROSS-SECTIONS B-B’, C-C’ AND D-D’ ACROSS MEDWAY CREEK

Part of Lot 13, Concession 14, Municipality of Middlesex Centre
(Formerly London Township) Country of Middlesex

Figure 4

STANLEY PIT
Re-alignment of Medway Creek

December 5, 2023



* Precipitation measured at London Climate Station (http://www.climate.weatheroffice.ec.gc.ca) up to October 31, 2022

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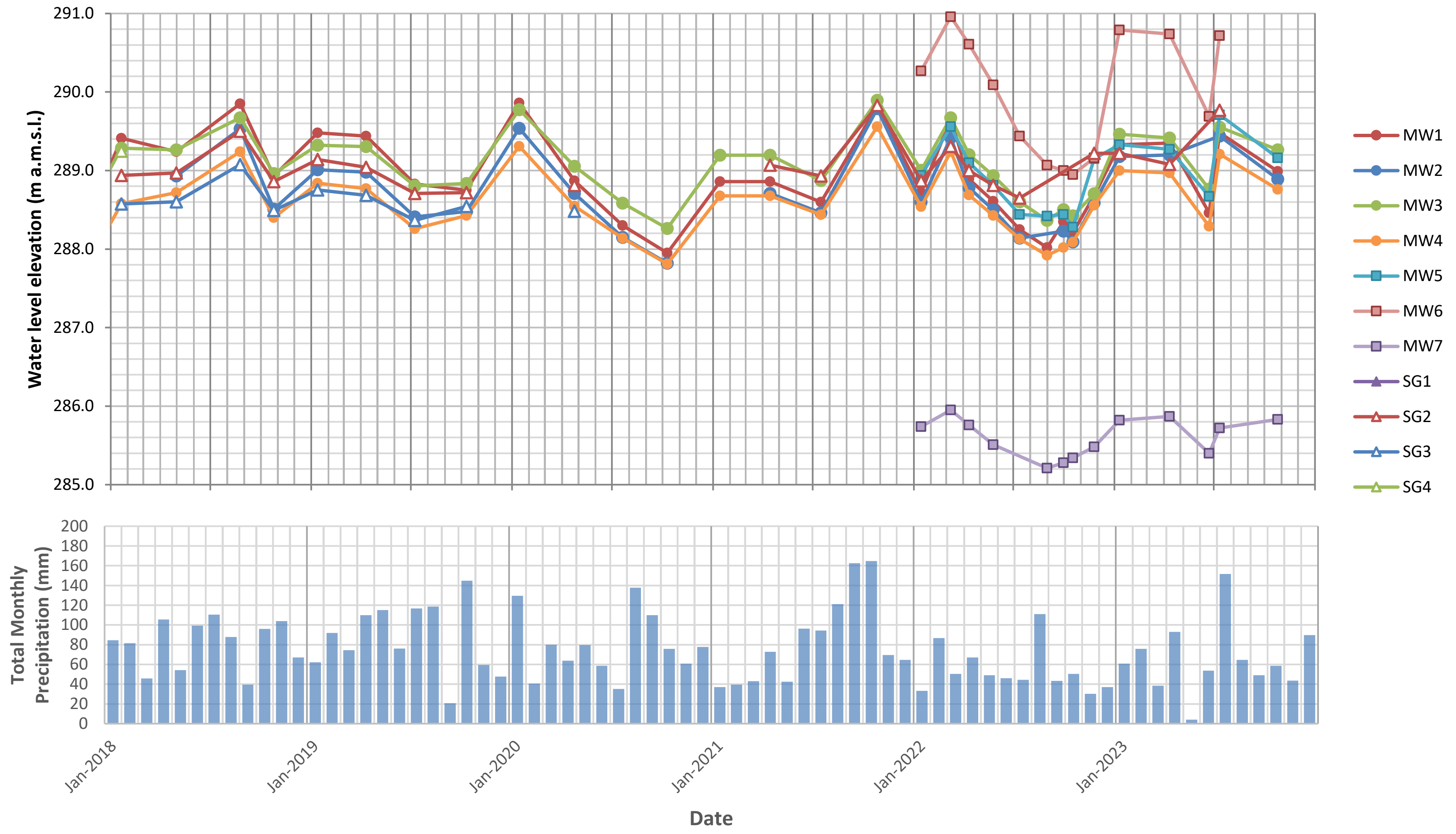
HISTORICAL WATER LEVEL ELEVATION HYDROGRAPHS AND PRECIPITATION

Part of Lot 13, Concession 14, Municipality of Middlesex Centre
(Formerly London Township), County of Middlesex

Figure 5

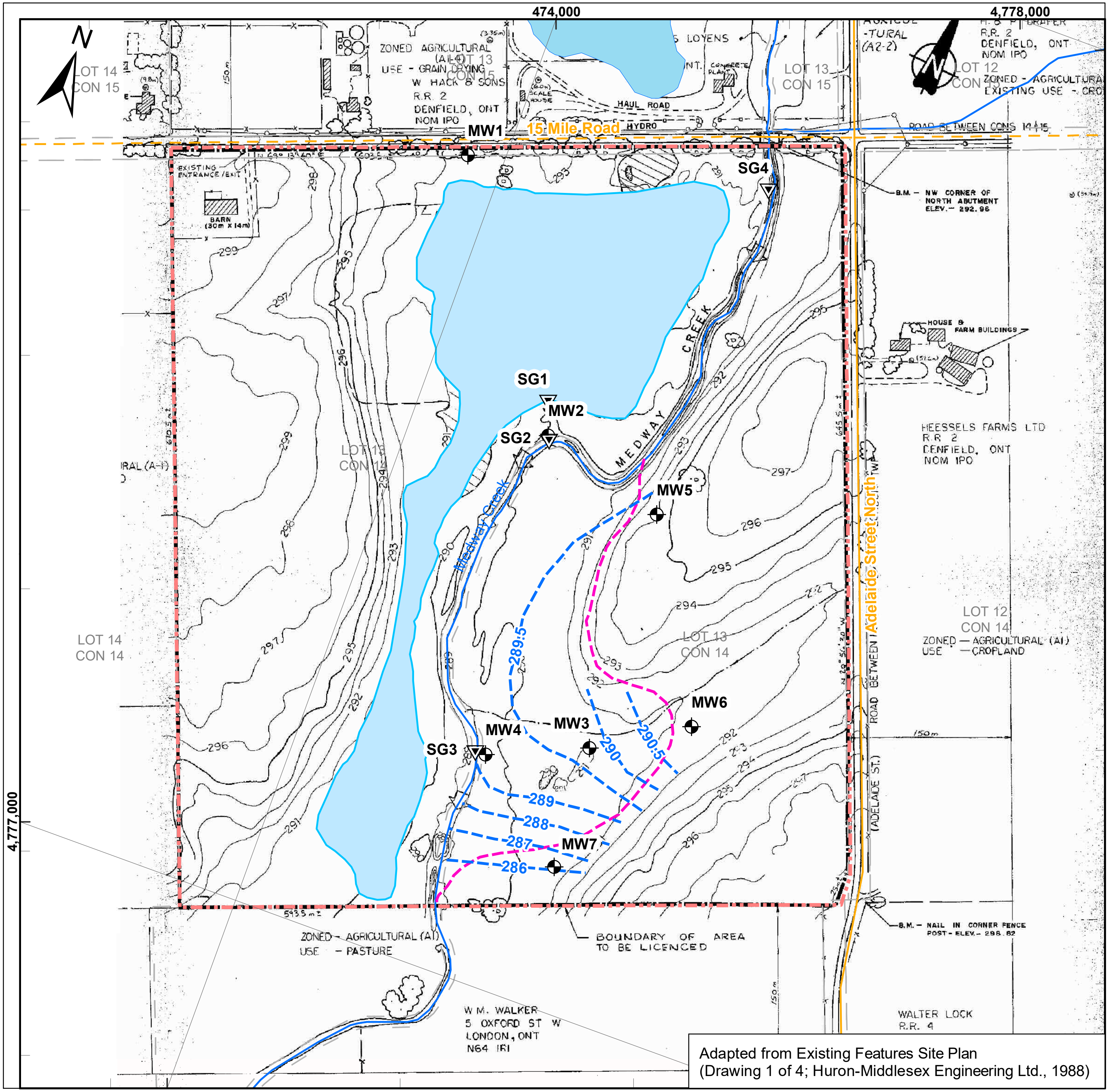
STANLEY PIT
Re-alignment of Medway Creek

January 5, 2024



* Precipitation measured at London Climate Station (http://www.climate.weatheroffice.ec.gc.ca) up to October 31, 2022

Novaterra ENVIRONMENTAL	WATER LEVEL ELEVATION HYDROGRAPHS AND PRECIPITATION FOR 2018 TO 2023	Figure 6
	Part of Lot 13, Concession 14, Municipality of Middlesex Centre (Formerly London Township), County of Middlesex	STANLEY PIT Re-alignment of Medway Creek
		January 5, 2024



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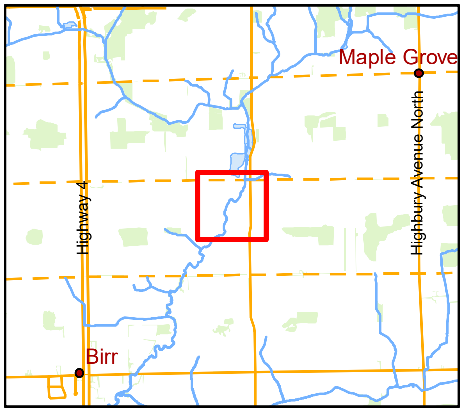
(Drawing 1 of 4; Huron-Middlesex Engineering Ltd., 1988)



INDEX MAP

LEGEND

⊕ Monitoring well

▽ Staff gauge

License Boundary

🟦 Existing Pit Pond

Proposed re-aligned channel

Water table in Mar. 2022

Figure 7. High groundwater table configuration (Mar. 2022).

STANLEY PIT
Re-alignment of Medway Creek

Part Lot 13, Concession 14, Municipality of Middlesex Centre (formerly London Township), Middlesex County

December 5, 2023

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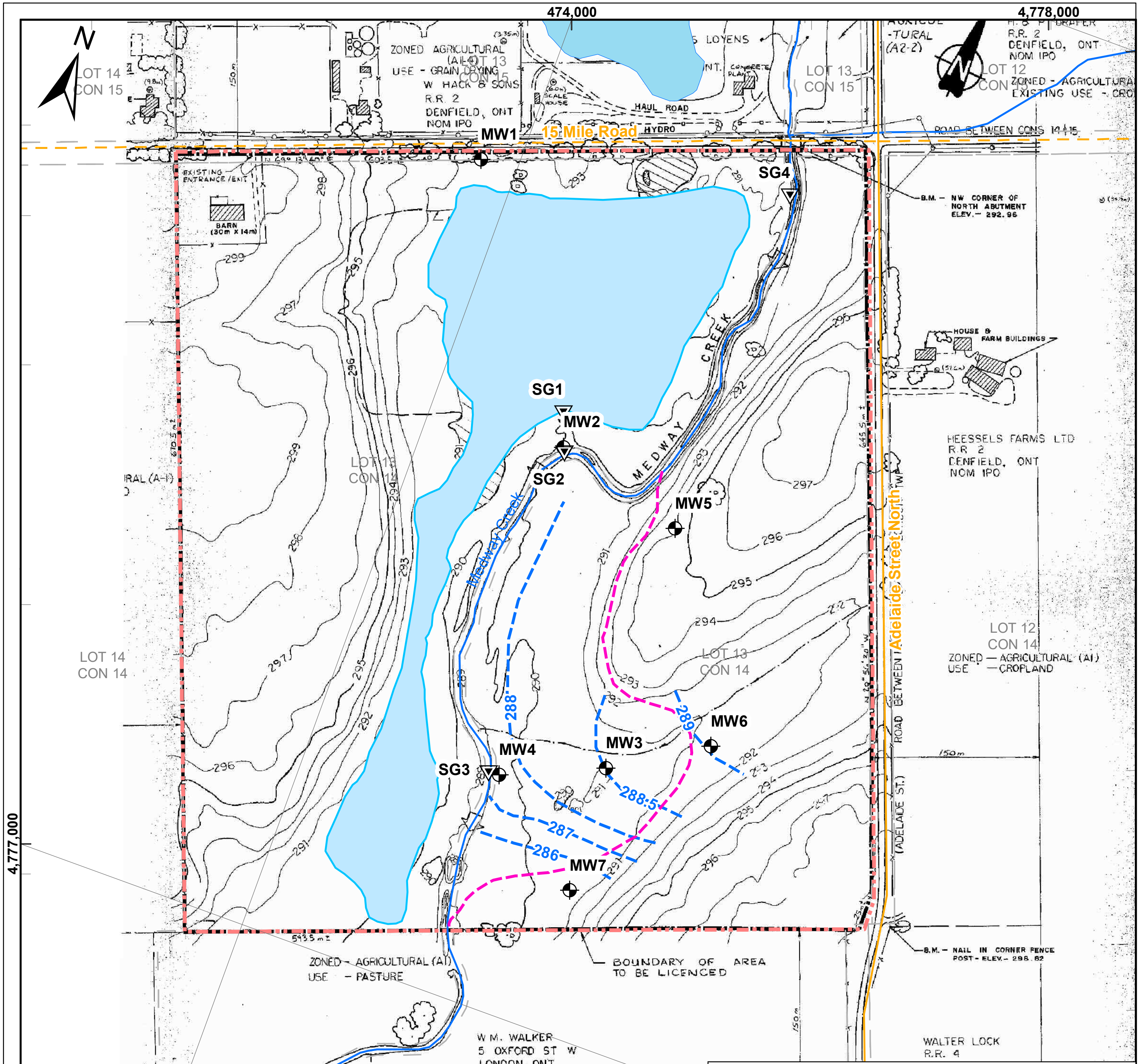
1:5,000
0 25 50 100 150
Meters

Map based on MNRF data
Contour Interval - 5 metres
NAD 1983, UTM Zone 17 N



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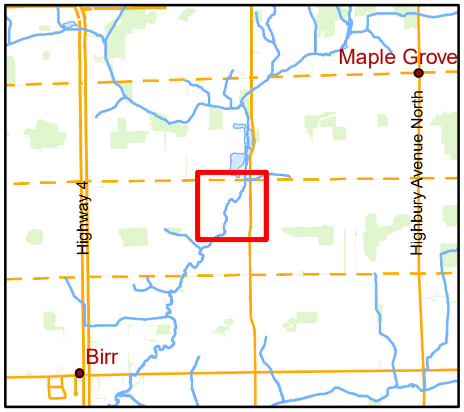


INDEX MAP

LEGEND

- ⊕ Monitoring well
- ▽ Staff gauge
- ▭ License Boundary
- 🟦 Existing Pit Pond
- ╌ Proposed realigned channel
- ╌ Water table in Aug. 2022

Figure 8. Low groundwater table configuration (Aug. 2022).

STANLEY PIT
Re-alignment of Medway Creek

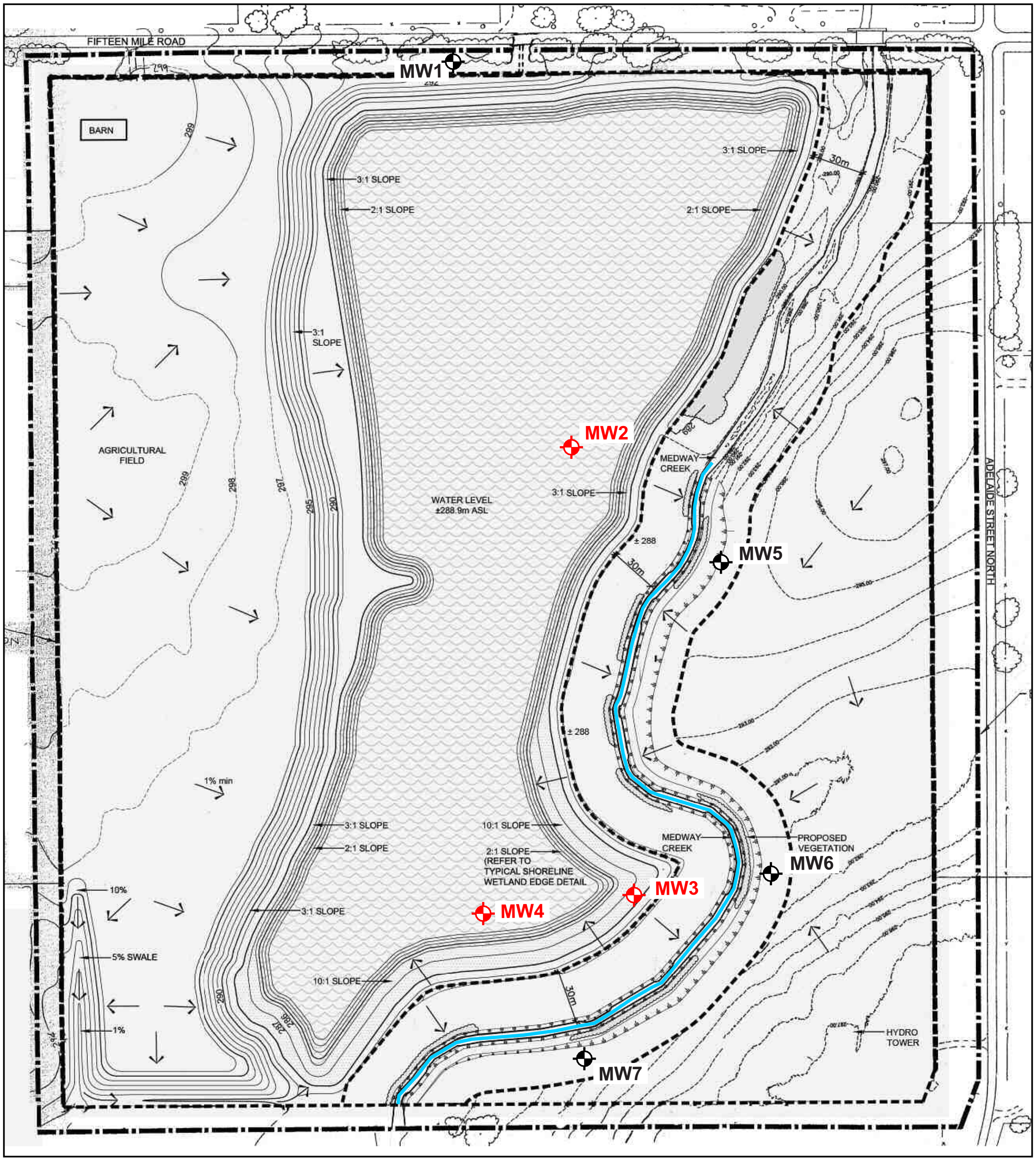
Part Lot 13, Concession 14, Municipality of Middlesex Centre (formerly London Township), Middlesex County

December 5, 2023

Novaterra ENVIRONMENTAL

1:5,000
0 25 50 100 150 Meters

Map based on MNRF data
Contour Interval - 5 metres
NAD 1983, UTM Zone 17 N



LEGEND

—·—·—	Licensed boundary
—	Re-aligned channel of Medway Creek
- - - - -	30 m buffer surrounding re-aligned channel
⊕ MW7	Monitoring well
⊕ MW4	Monitoring well to be decommissioned as extraction encroaches upon it

SCALE
0 100 m

N

Adapted from Engineering Drawing 3 of 4
Harrington McAvan Ltd. (July 15, 2024)

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FINAL REHABILITATION PLAN

Part of Lot 13, Concession 14, Municipality of Middlesex Centre
(Formerly London Township), County of Middlesex

Figure 9

McCANN PIT #10
Re-alignment of Medway Creek

July 15, 2024

TABLES

Table 1

Table 1. Water level elevations and construction information for monitoring stations at Stanley Pit.

Monitoring station	Elevation, m amsl		Casing stickup (m)	Well diameter (mm)	Screen Interval (m)	Water level elevations, m amsl								
	Ground	Top of casing				14-Jun-10	18-Jun-10	19-Jul-10	17-Aug-10	14-Sep-10	06-Oct-10	10-Nov-10	09-Dec-10	19-Jan-11
MW1	292.70	293.57	0.85	30	3.9 - 5.4	288.94	288.84	288.63	288.54	288.18	288.02	288.46	289.20	289.08
MW2	289.98	290.85	0.87	30	2.9 - 4.4	288.55	288.69	288.55	288.42	288.02	287.83	288.35	289.01	288.88
MW3	290.88	291.58	0.70	30	2.3 - 3.8	288.98	288.91	288.70	288.54	288.31	288.35	288.45	289.08	289.11
MW4	290.04	290.87	0.83	30	3.0 - 4.5	288.47	288.40	288.35	288.17	287.81	287.49	288.47	288.70	288.54
MW5	294.13	295.00	0.87	50	7.6 - 10.6	Installed Nov. 2021								
MW6	291.44	292.20	0.76	50	6.1 - 9.1	Installed Nov. 2021								
MW7	290.48	291.34	0.76	50	2.1 - 5.1	Installed Nov. 2021								
SG1	288.45	289.90	1.41^{+}	N/A	N/A	288.90	288.82	288.59	288.51	288.11	287.97	288.41	289.19	289.08
SG2	288.53$^{1)}$	290.03+	1.50^{+}	N/A	N/A	288.77	288.73	288.76	288.60	dry	dry	288.63	288.97	288.82
SG3	288.17$^{1)}$	289.58+	1.41^{+}	N/A	N/A	288.43	288.38	288.43	288.24	dry	dry	288.28	288.63	288.50
SG4	288.84$^{1)}$	290.17+	1.33^{+}	N/A	N/A	N/I	289.09	289.12	289.00	dry	dry	289.03	289.27	289.18

amsl – above mean sea level; N/A – Not Applicable; N/I- Not Installed; N/Ac – Not Accessible; Ob – Obstruction.

$^{+)}$ Height of staff gauge above stream bed; $^{1)}$ Elevation of Medway Creek bottom.

Table 1. Cont'd.

Monitoring station	Water level elevations, m amsl														
	1-Mar-11	17-Mar-11	14-Apr-11	21-May-11	22-Jun-11	13-Jul-11	17-Aug-11	18-Sept-11	25-Oct-11	08-Nov-11	09-Dec-11	7-Aug-12	31-Oct-12	24-Jan-13	22-Apr-13
MW1	289.39	289.96	289.21	289.58	288.87	288.67	288.52	288.87	289.59	289.02	289.73	288.15	287.62	289.18	289.62
MW2	289.25	289.8	288.97	289.33	288.69	288.53	288.41	288.9	289.35	288.78	289.49	288.00	287.65	288.94	289.37
MW3	289.43	290.62	289.14	289.44	288.93	288.78	288.57	288.99	289.38	289.00	289.44	288.30	288.03	289.08	289.42
MW4	288.97	289.59	288.64	288.84	288.37	288.26	288.18	288.87	288.91	288.46	288.98	287.77	287.65	288.53	288.88
MW5	Installed Nov. 2021														
MW6	Installed Nov. 2021														
MW8	Installed Nov. 2021														
SG1	288.75	N/Ac	288.13	N/Ac	288.27	288.06	287.915	288.22	dry	288.43	dry	Destroyed			
SG2	N/Ac	N/Ac	288.88	289.02	288.72	288.66	288.645	289.19	289.07	288.78	289.16	dry	288.93	288.81	289.13
SG3	N/Ac	N/Ac	288.52	288.67	288.37	288.32	288.31	288.86	288.71	288.44	288.79	dry	288.56	288.46	287.33
SG4	289.55	N/Ac	289.69	289.31	289.16	289.03	289.02	289.48	289.36	289.14	289.44	dry	289.24	289.14	289.42

amsl – above mean sea level; N/A – Not Applicable; N/I- Not Installed; N/Ac – Not Accessible; Ob – Obstruction.

Table 1. Cont'd.

Monitoring station	**Water level elevation, m amsl**														
	25-Jul-13	21-Oct-13	31-Jan-14	11-Apr-14	17-Jul-14	10-Oct-14	21-Jan-15	23-Apr-15	16-Jul-15	16-Oct-15	16-Jan-16	14-Apr-16	19-Jul-16	08-Sep-16	19-Oct-16
MW1	288.73	289.22	288.99	289.67	288.83	288.87	288.89	289.33	288.95	288.18	289.33	289.75	288.59	288.52	288.09
MW2	288.57	289.08	288.71	Ob	288.68	288.75	288.65	289.06	288.73	287.99	289.06	289.40	288.42	288.36	287.85
MW3	288.74	289.28	288.97	289.44	288.90	289.08	288.92	289.24	288.47	288.52	289.25	289.52	288.58	288.44	288.11
MW4	288.31	288.86	288.42	288.91	288.43	288.60	288.39	288.71	288.43	287.59	288.77	288.98	288.19	288.17	287.65
MW5	Installed Nov. 2021														
MW6	Installed Nov. 2021														
MW7	Installed Nov. 2021														
SG1	Destroyed														
SG2	288.70	289.07	288.80	289.15	288.87	288.90	288.77	288.96	288.83	dry	289.00	289.19	288.68	288.59	dry
SG3	288.40	288.80	288.53	288.77	288.30	288.60	288.42	288.59	288.45	dry	288.66	288.81	288.30	288.20	dry
SG4	289.06	289.32	N/A	289.44	289.08	289.21	289.17	289.26	289.11	dry	289.27	289.50	289.03	289.00	dry

amsl – above mean sea level; N/A – Not Applicable; N/I- Not Installed.
N/Ac – Not Accessible; Ob – Obstruction.

Table 1. Cont'd.

Monitoring station	**Water level elevation, m amsl**															
	16-Jan-17	22-Apr-17	22-Jul-17	21-Oct-17	20-Jan-18	30-Apr-18	24-Aug-18	24-Oct-18	12-Jan-19	10-Apr-19	08-Jul-19	10-Oct-19	14-Jan-20	23-Apr-20	20-Jul-20	09-Oct-20
MW1	289.73	289.93	288.72	287.86	289.41	289.24	289.85	288.93	289.48	289.44	288.83	288.75	289.86	288.87	288.30	287.95
MW2	289.37	289.69	288.49	287.59	n/m	288.93	289.53	288.51	289.01	288.98	288.41	288.48	289.54	288.71	288.15	287.82
MW3	289.47	289.81	288.75	288.13	289.28	289.26	289.67	288.96	289.32	289.30	288.80	288.83	289.77	289.05	288.58	288.26
MW4	288.96	289.35	288.26	287.44	288.58	288.72	289.24	288.40	288.84	288.77	288.26	288.43	289.31	288.55	288.14	287.81
MW5	Installed Nov. 2021															
MW6	Installed Nov. 2021															
MW7	Installed Nov. 2021															
SG1	Destroyed															
SG2	289.19	289.79	288.79	dry	288.94	288.97	289.50	288.86	289.14	289.04	288.71	288.72	dry	288.81	dry	dry
SG3	288.82	289.25	288.34	dry	288.57	288.60	289.07	288.49	288.75	288.68	288.36	288.54	dry	288.48	Destroyed	
SG4	289.44	289.89	289.07	dry	289.25	Destroyed										

amsl – above mean sea level; N/A – Not Applicable; N/I – Not Installed.
N/Ac – Not Accessible; Ob – Obstruction. n/m – Not measured.

Table 1. Cont'd.

Monitoring station	Water level elevation, m amsl														
	13-Jan-21	14-Apr-21	16-Jul-21	26-Oct-21	14-Jan-22	09-Mar-22	11-Apr-22	25-May-22	12-Jul-22	31-Aug-22	30-Sep-22	17-Oct-22	25-Nov-22	10-Jan-23	11-Apr-23
MW1	288.86	288.86	288.60	289.82	288.72	289.66	288.89	288.61	288.25	288.02	288.35	288.35	288.68	289.33	289.35
MW2	n/m	288.71	288.46	289.79	288.60	289.42	288.78	288.50	288.14	n/m	288.23	288.23	288.59	289.18	289.20
MW3	289.19	289.19	288.87	289.89	289.00	289.67	289.20	288.93	288.60	288.36	288.50	288.50	288.70	289.46	289.41
MW4	288.68	288.68	288.44	289.56	288.54	289.24	288.69	288.43	288.13	287.92	288.02	288.02	288.56	289.00	288.97
MW5	Installed Nov. 2021				288.94	289.56	289.10	288.81	288.44	288.42	288.44	288.44	289.15	289.33	289.27
MW6	Installed Nov. 2021				289.05	289.74	289.39	288.87	288.22	287.85	287.78	287.78	289.16	290.79	290.74
MW7	Installed Nov. 2021				285.74	285.95	285.76	285.51	n/m	285.21	285.28	285.28	285.48	285.82	285.87
SG1	Destroyed														
SG2	n/m	289.07	288.93	289.83	288.87	289.31	289.00	288.81	288.65	n/m	dry	dry	289.22	289.22	289.08
SG3	Destroyed														
SG4	Destroyed														

amsl – above mean sea level; N/A – Not Applicable; N/I – Not Installed.
N/Ac – Not Accessible; Ob – Obstruction. n/m – Not measured.

Table 1. Cont'd.

Monitoring station	Water level elevation, m amsl		
	22-Jun-23	11-Jul-23	25-Oct-23
MW1	288.46	289.48	288.99
MW2	n/m	289.44	288.89
MW3	288.76	289.55	289.26
MW4	288.29	289.21	288.76
MW5	288.67	289.71	289.16
MW6	289.69	290.72	n/m
MW7	285.40	285.72	285.83
SG1	Destroyed		
SG2	n/m	289.77	n/m
SG3	Destroyed		
SG4	Destroyed		

amsl – above mean sea level; N/A – Not Applicable; N/I – Not Installed.
N/Ac – Not Accessible; Ob – Obstruction. n/m – Not measured.

APPENDIX A

Borehole Logs

Summary of Borehole data from Atkinson, Davies Inc. (2005).

Borehole Summary			
Borehole	**Depth (m bgs)**	**Description**	**Water Level (m bgs)**
BH101	0.00 – 0.375	Topsoil	1.5
	0.375 – 1.0	Brown silty clay	
	1.0 – 13.2	Sand and gravel, occasional cobbles and boulders	
	13.2 – 15.2	Hard grey clayey silt till, embedded boulders	
BH102	0.00 – 0.275	Topsoil	3.2
	0.275 – 6.7	Brown sandy clayey silt, occasional cobles	
	6.7 – 10.4	Grey sandy clayey silt till	
BH103	0.00 – 0.275	Topsoil	3.0
	0.275 – 2.6	Brown clayey silt, some cobbles	
	2.6 – 7.6	Sand and gravel, occasional cobbles	
	7.6 – 8.8	Grey clayey silt till, embedded boulders	
BH104	0.00 – 0.35	Topsoil	2.7
	0.35 – 2.7	Clayey silt, some cobbles	
	2.7 – 9.5	Sand and gravel, occasional cobbles and boulders	
	9.5 – 11.0	Grey clayey silt till, embedded boulders	
BH105	0.0 – 0.3	Topsoil	2.7
	0.3 – 3.7	Clayey silt, some cobbles	
	3.7 – 6.9	Sand and gravel, some cobbles	
	6.9 – 9.1	Grey clayey silt till, embedded boulders	
BH106	0.0 – 0.3	Topsoil	2.7
	0.3 – 3.0	Brown silty clay	
	3.0 – 10.4	Sand and gravel, some cobbles	
	10.4 – 11.0	Grey clayey silt till, embedded boulders	
BH107	0.0 – 0.15	Topsoil	2.4
	0.15 – 2.4	Brown clayey silt, some cobbles	
	2.4 – 9.8	Sand and gravel	
	9.8 – 10.0	Grey clayey silt till, embedded boulders	
BH108	0.0 – 0.425	Topsoil	2.1
	0.425 – 1.1	Brown clayey silt	
	1.1 – 15.8	Sand and gravel, some cobbles and boulders	
BH109	0.0 – 0.425	Topsoil	2.4
	0.425 – 2.4	Brown sandy clayey silt, some cobbles	
	2.4 – 15.5	Sand and gravel and cobbles	
	15.5 – 15.8	Grey clayey silt till, embedded boulders	
BH110	0.0 – 0.20	Topsoil	2.3
	0.20 – 2.7	Brown clayey silt, some cobbles and boulders	
	2.7 – 12.8	Sand and gravel, cobbles, occasional boulders	
	12.8 – 13.7	Grey clayey silt till, embedded boulders	
BH111	0.0 – 0.30	Topsoil	2.1
	0.30 – 1.5	Brown silty clay	
	1.5 – 14.3	Sand and gravel, some cobbles (boulder at 14.3 m)	

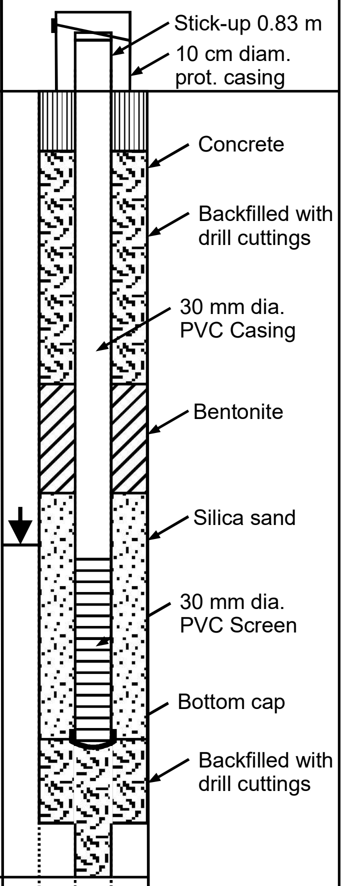
BOREHOLE LOG FOR MW1

LOCATION: N½ of Lot 13, Conc. 14, London Twp.
CLIENT: Middlesex Centre
BORE TYPE: Hollow stem auger
GROUND ELEVATION: 292.70 m a.m.s.l.
TOP OF CASING ELEVATION: 293.57 m a.m.s.l.

DRILLING CO.: London Soil Test Ltd.
DATE: 9 June 2010
GEOLOGIST: Blagy Novakovic
ASSEMBLED BY: Blagy Novakovic
PROJECT NAME: Stanley Pit

DEPTH (m)	STRATIGRAPHIC DESCRIPTION	SAMPLE SS	CONE PENETRATION
0.4	Fill, silt, some sand		Number of blows
	Medium sand, sand and gravel	☒	9 13 19
2			
	Sand and gravel stones (core recovery 0.2 m)	☒	9 25 36
4			
	Sand, grave, silty medium to coarse sand (core recovery 0.3 m)	☒	16 9 8
6			
6.55	Uniform coarse sand, silty sand and gravel	☒	17 24 19
8			

MONITORING INSTALLATION



Novaterra Environmental Ltd.

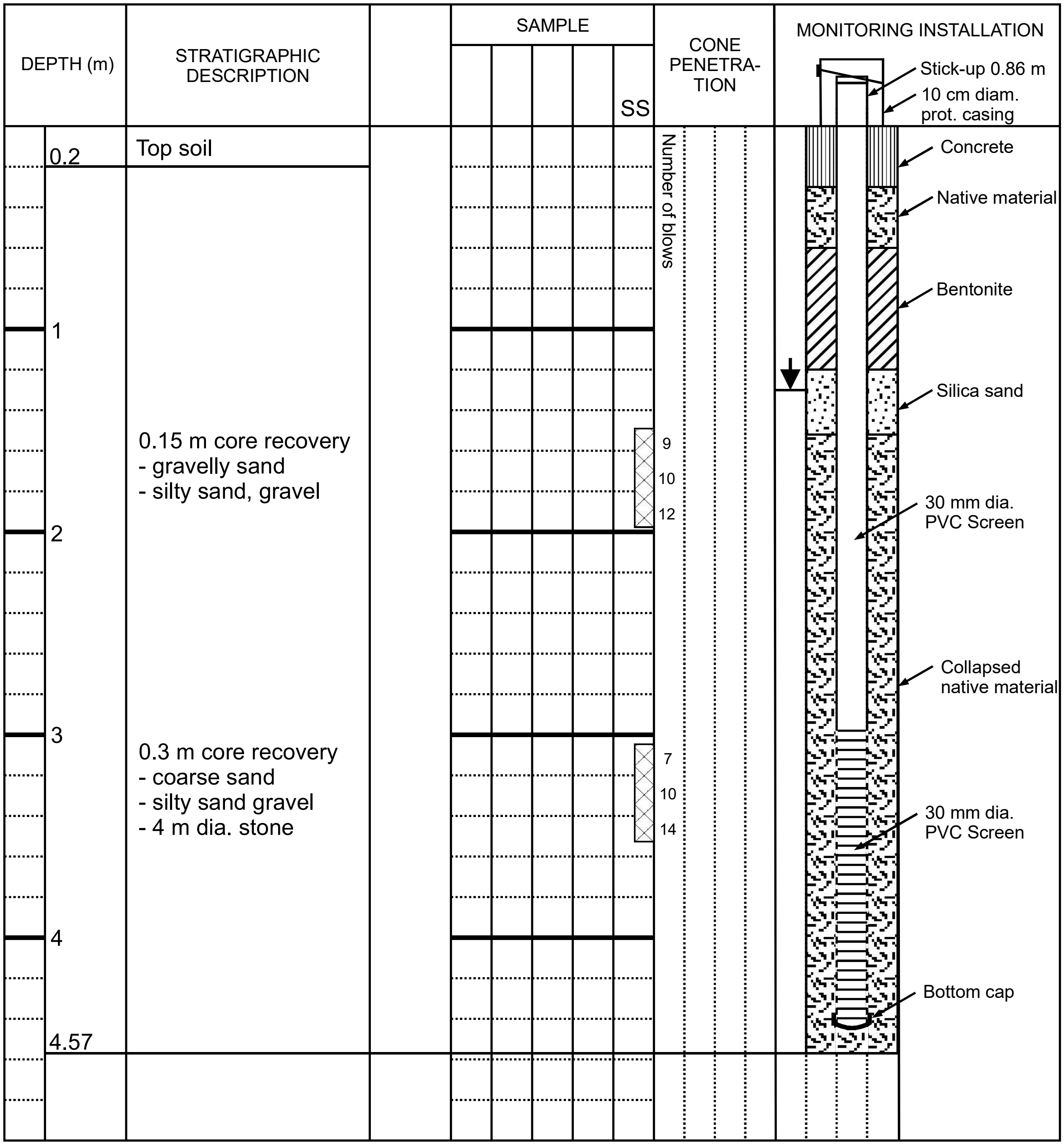
☒ Split spoon sample

↓ Water level on June 18, 2010

BOREHOLE LOG FOR MW2

LOCATION: N½ of Lot 13, Conc. 14, London Twp.
CLIENT: Middlesex Centre
BORE TYPE: Hollow stem auger
GROUND ELEVATION: 289.98 m a.m.s.l.
TOP OF CASING ELEVATION: 290.85 m a.m.sl.

DRILLING CO.: London Soil Test Ltd.
DATE: 9 June 2010
GEOLOGIST: Blagy Novakovic
ASSEMBLED BY: Blagy Novakovic
PROJECT NAME: Stanley Pit

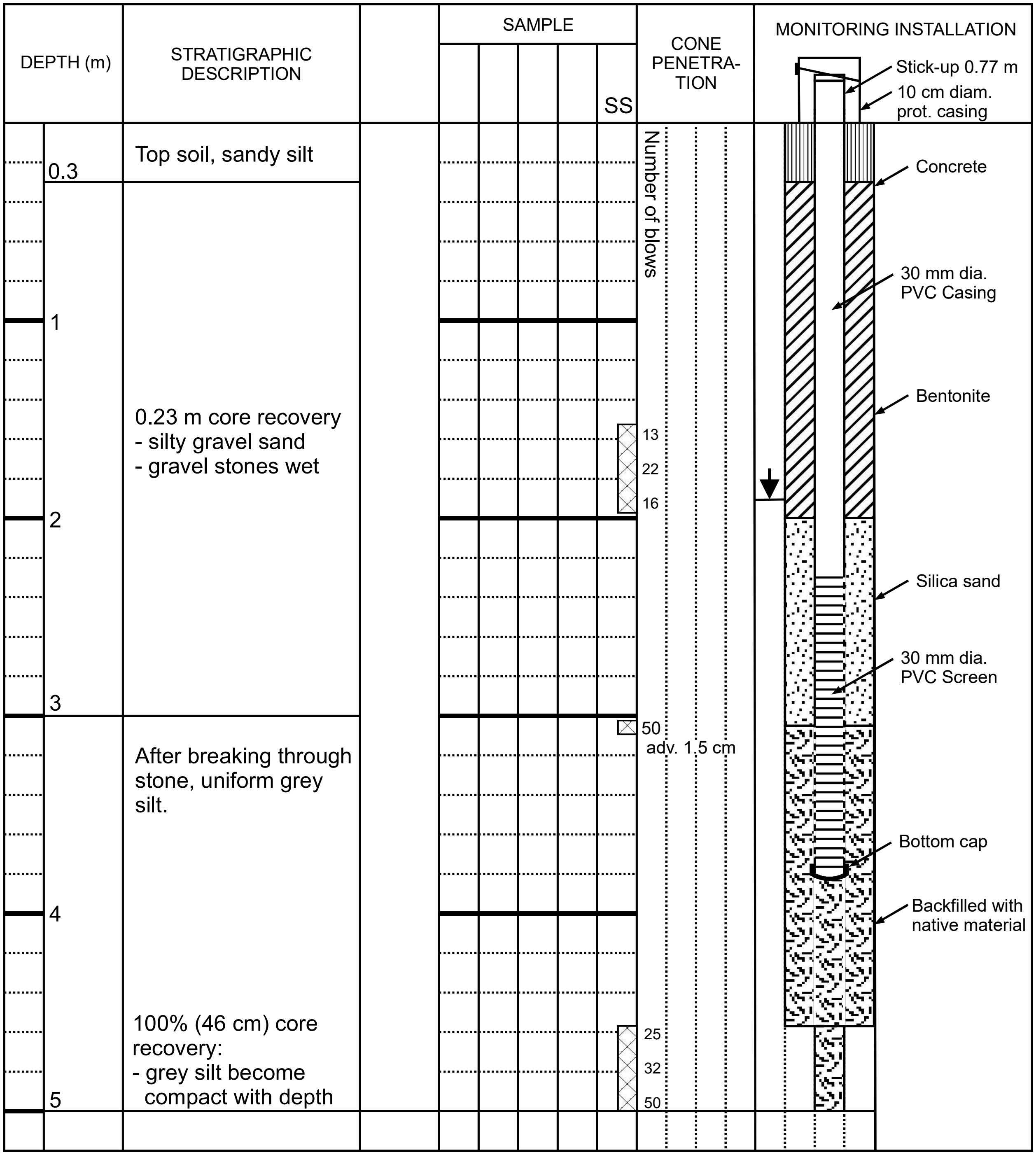


Novaterra Environmental Ltd. ▨ Split spoon sample ↓ Water level on June 18, 2010

BOREHOLE LOG FOR MW3

LOCATION: N½ of Lot 13, Conc. 14, London Twp.
CLIENT: Middlesex Centre
BORE TYPE: Hollow stem auger
GROUND ELEVATION: 290.88 m a.m.s.l.
TOP OF CASING ELEVATION: 291.54 m a.m.s.l.

DRILLING CO.: London Soil Test Ltd.
DATE: 9 June 2010
GEOLOGIST: Blagy Novakovic
ASSEMBLED BY: Blagy Novakovic
PROJECT NAME: Stanley Pit



Top soil, sandy silt

0.23 m core recovery
- silty gravel sand
- gravel stones wet

After breaking through stone, uniform grey silt.

100% (46 cm) core recovery:
- grey silt become compact with depth

Novaterra Environmental Ltd. ▨ Split spoon sample ↓ Water level on June 18, 2010

BOREHOLE LOG FOR MW4

LOCATION: N½ of Lot 13, Conc. 14, London Twp.

CLIENT: Middlesex Centre

BORE TYPE: Hollow stem auger

GROUND ELEVATION: 290.04 m a.m.s.l.

TOP OF CASING ELEVATION: 290.87 m a.m.s.l.

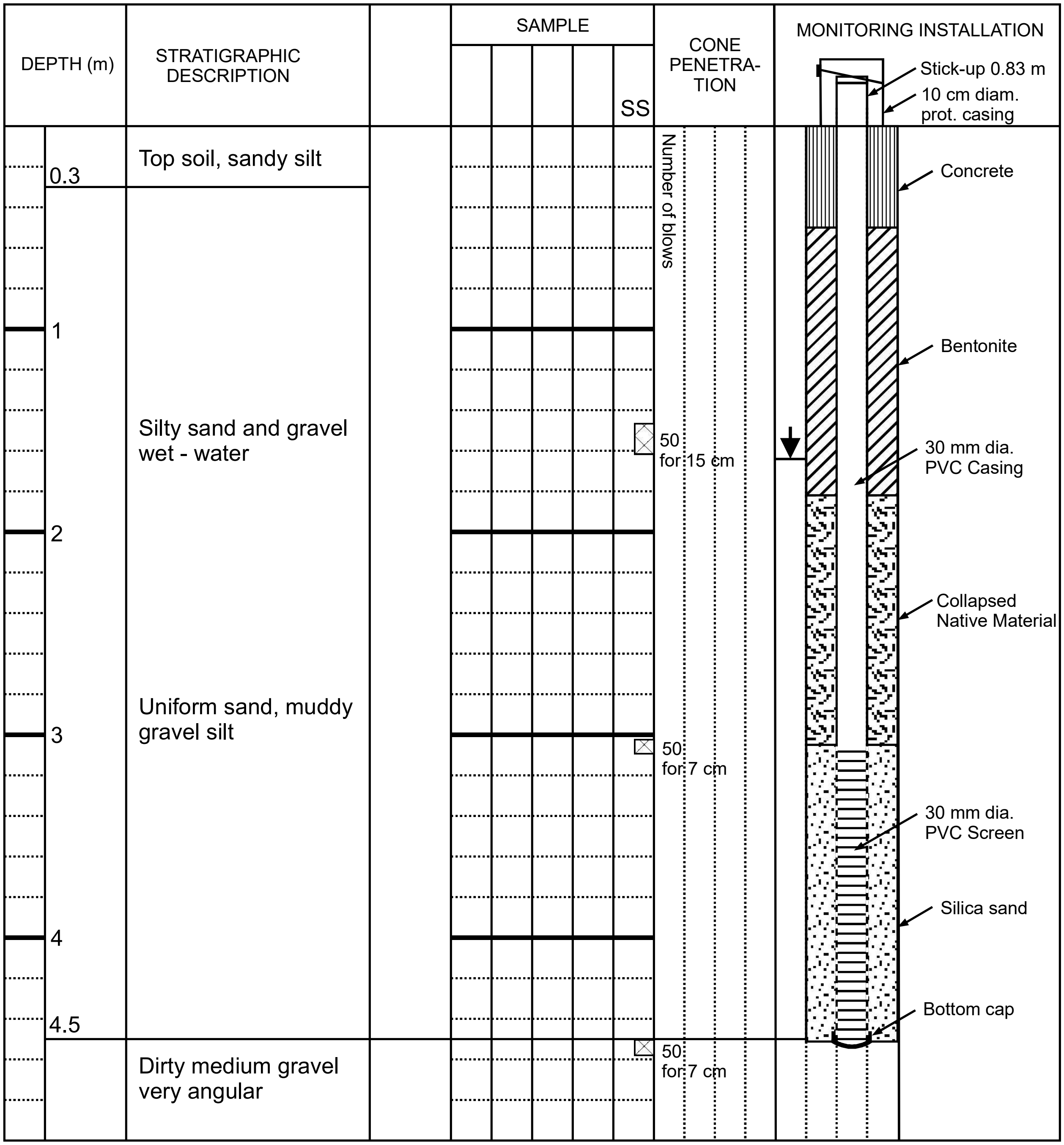
DRILLING CO.: London Soil Test Ltd.

DATE: 9 June 2010

GEOLOGIST: Blagy Novakovic

ASSEMBLED BY: Blagy Novakovic

PROJECT NAME: Stanley Pit



Novaterra Environmental Ltd. ☒ Split spoon sample ↓ Water level on June 18, 2010

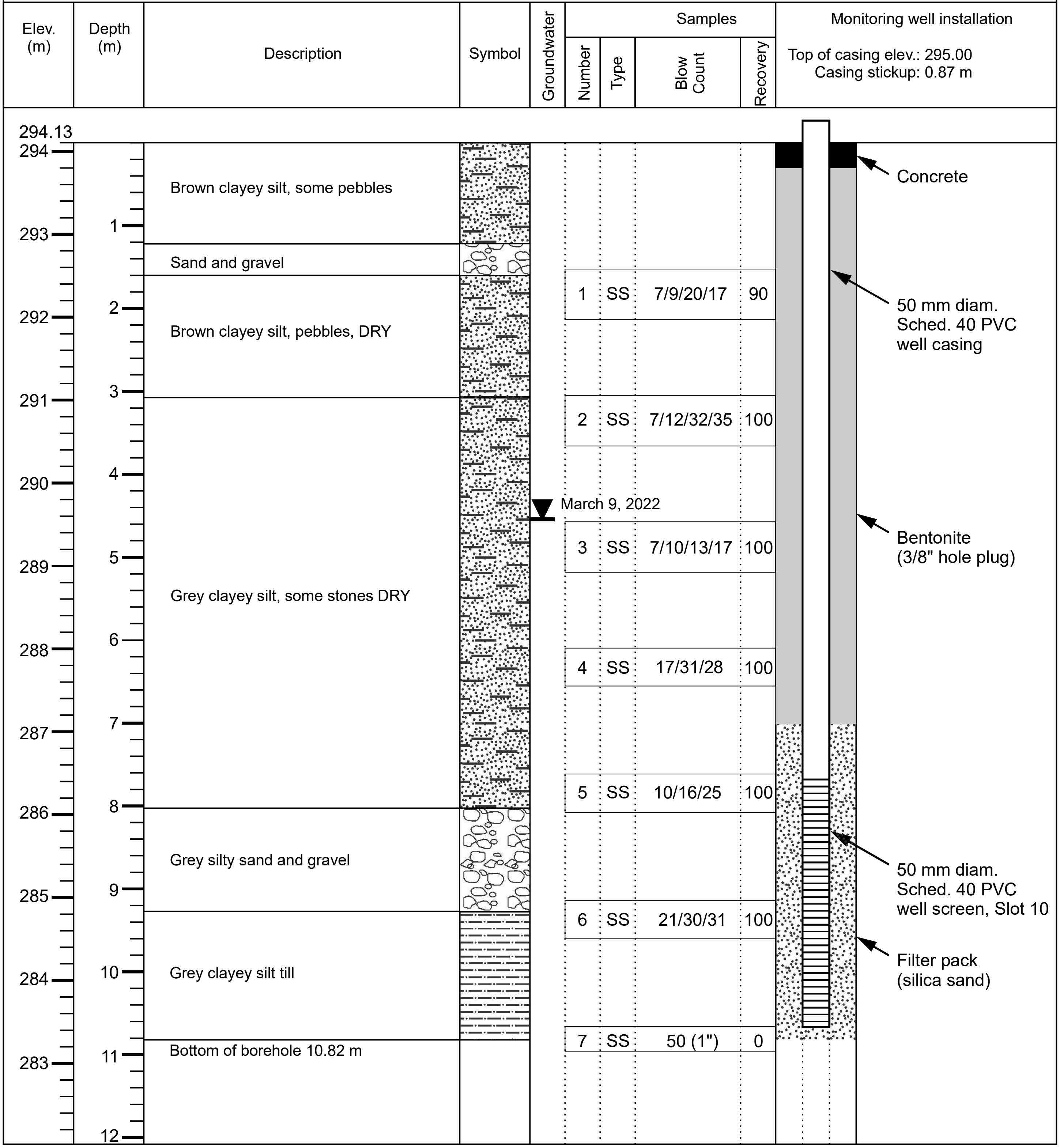
Novaterra Environmental Ltd.
39 Winship Close London, ON N6C 5M8

Client: McCann Redi-Mix Inc.
Project: Stanley Pit - Realignment of Medway Creek
Site Location: Lot 13, Concession 14, Municipality of Middlesex Centre, Middlesex County

BOREHOLE LOG for MW5

Date: November 12, 2021
Driller: London Soil Test
Drill Type: Hollow Stem Auger; D50-T
Hole Diameter: 200 mm
Geologist: Sasha Novakovic (Novaterra)

Monitoring well installation
Top of casing elev.: 295.00
Casing stickup: 0.87 m



Description
Brown clayey silt, some pebbles
Sand and gravel
Brown clayey silt, pebbles, DRY
Grey clayey silt, some stones DRY
Grey silty sand and gravel
Grey clayey silt till
Bottom of borehole 10.82 m

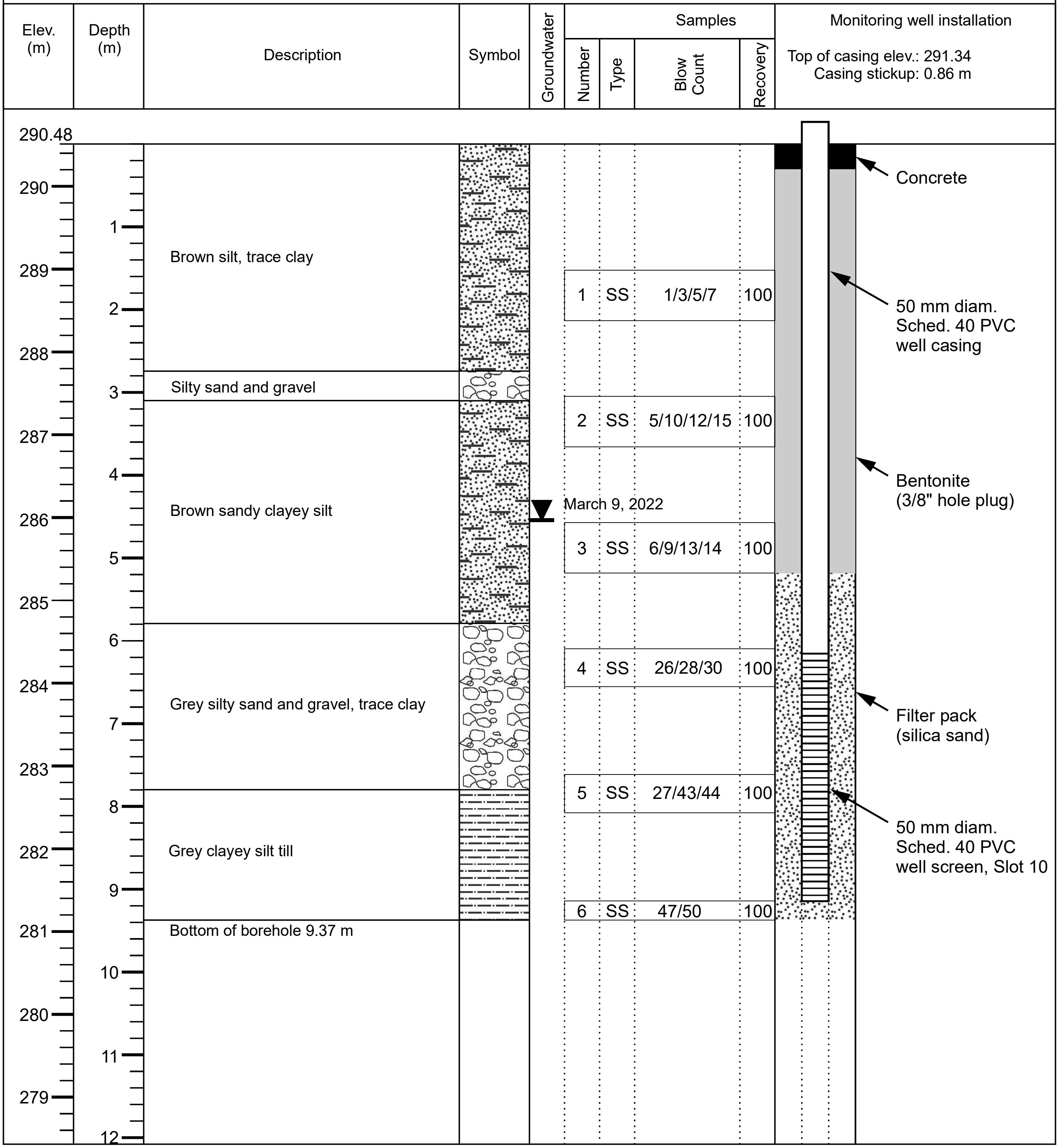
Samples			
Number	Type	Blow Count	Recovery
1	SS	7/9/20/17	90
2	SS	7/12/32/35	100
3	SS	7/10/13/17	100
4	SS	17/31/28	100
5	SS	10/16/25	100
6	SS	21/30/31	100
7	SS	50 (1")	0

Novaterra Environmental Ltd.
39 Winship Close London, ON N6C 5M8

BOREHOLE LOG for MW7

Client: McCann Redi-Mix Inc.
Project: Stanley Pit - Realignment of Medway Creek
Site Location: Lot 13, Concession 14, Municipality of Middlesex Centre, Middlesex County

Date: November 15, 2021
Driller: London Soil Test
Drill Type: Hollow Stem Auger; D50-T
Hole Diameter: 200 mm
Geologist: Sasha Novakovic (Novaterra)



Monitoring well installation
Top of casing elev.: 291.34
Casing stickup: 0.86 m

Description
Brown silt, trace clay
Silty sand and gravel
Brown sandy clayey silt
Grey silty sand and gravel, trace clay
Grey clayey silt till
Bottom of borehole 9.37 m

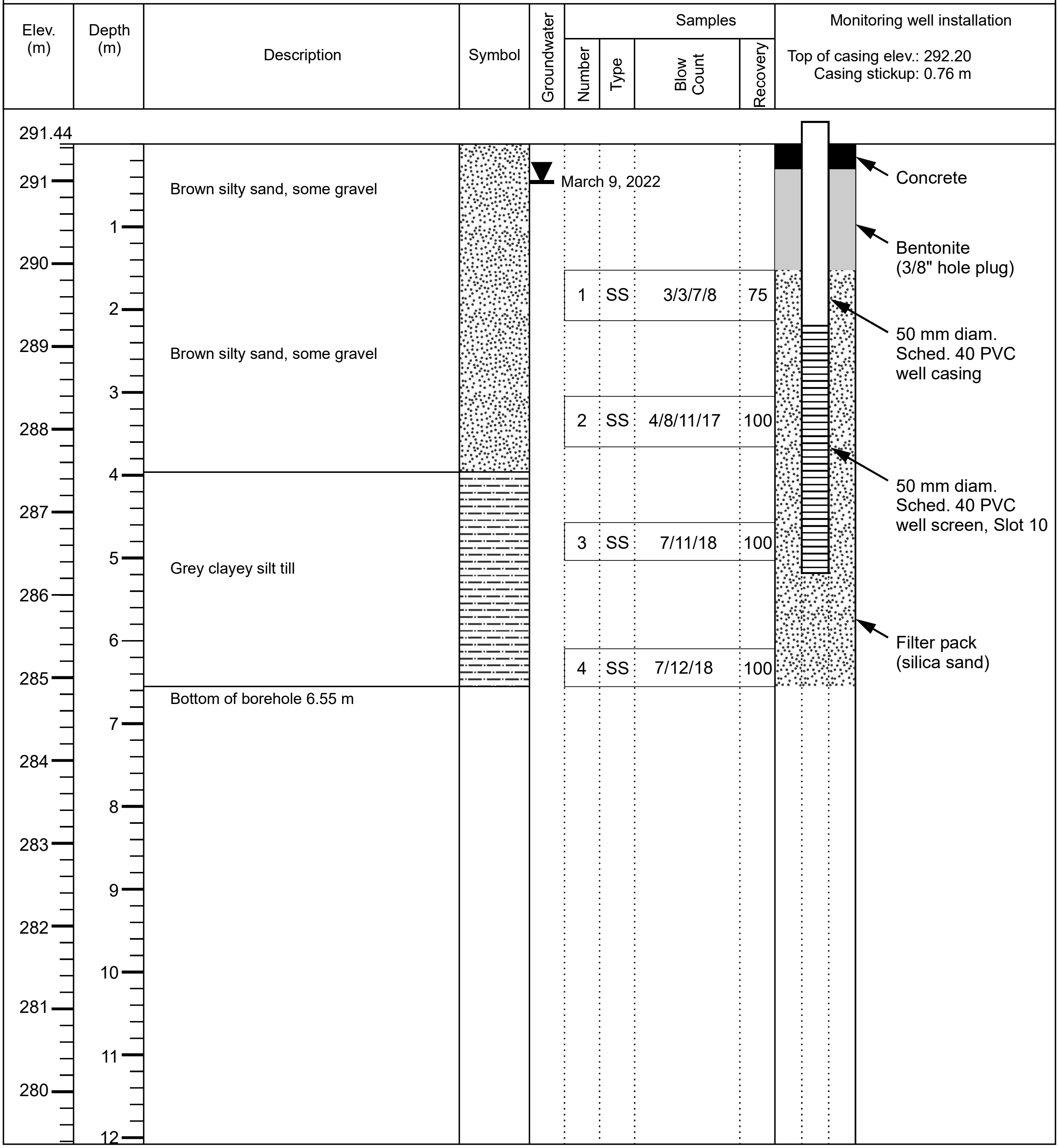
Samples			
Number	Type	Blow Count	Recovery
1	SS	1/3/5/7	100
2	SS	5/10/12/15	100
3	SS	6/9/13/14	100
4	SS	26/28/30	100
5	SS	27/43/44	100
6	SS	47/50	100

Novaterra Environmental Ltd.
39 Winship Close London, ON   N6C 5M8

BOREHOLE LOG for MW6

Client: McCann Redi-Mix Inc.
Project: Stanley Pit - Realignment of Medway Creek
Site Location: Lot 13, Concession 14, Municipality of Middlesex Centre, Middlesex County

Date: November 15, 2021
Driller: London Soil Test
Drill Type: Hollow Stem Auger; D50-T
Hole Diameter: 200 mm
Geologist: Sasha Novakovic (Novaterra)



Brown silty sand, some gravel

Brown silty sand, some gravel

Grey clayey silt till

Bottom of borehole 6.55 m

Number	Type	Blow Count	Recovery
1	SS	3/3/7/8	75
2	SS	4/8/11/17	100
3	SS	7/11/18	100
4	SS	7/12/18	100

APPENDIX B

Grain Size Analyses

Particle Size Distribution
Results of Sieve Analysis

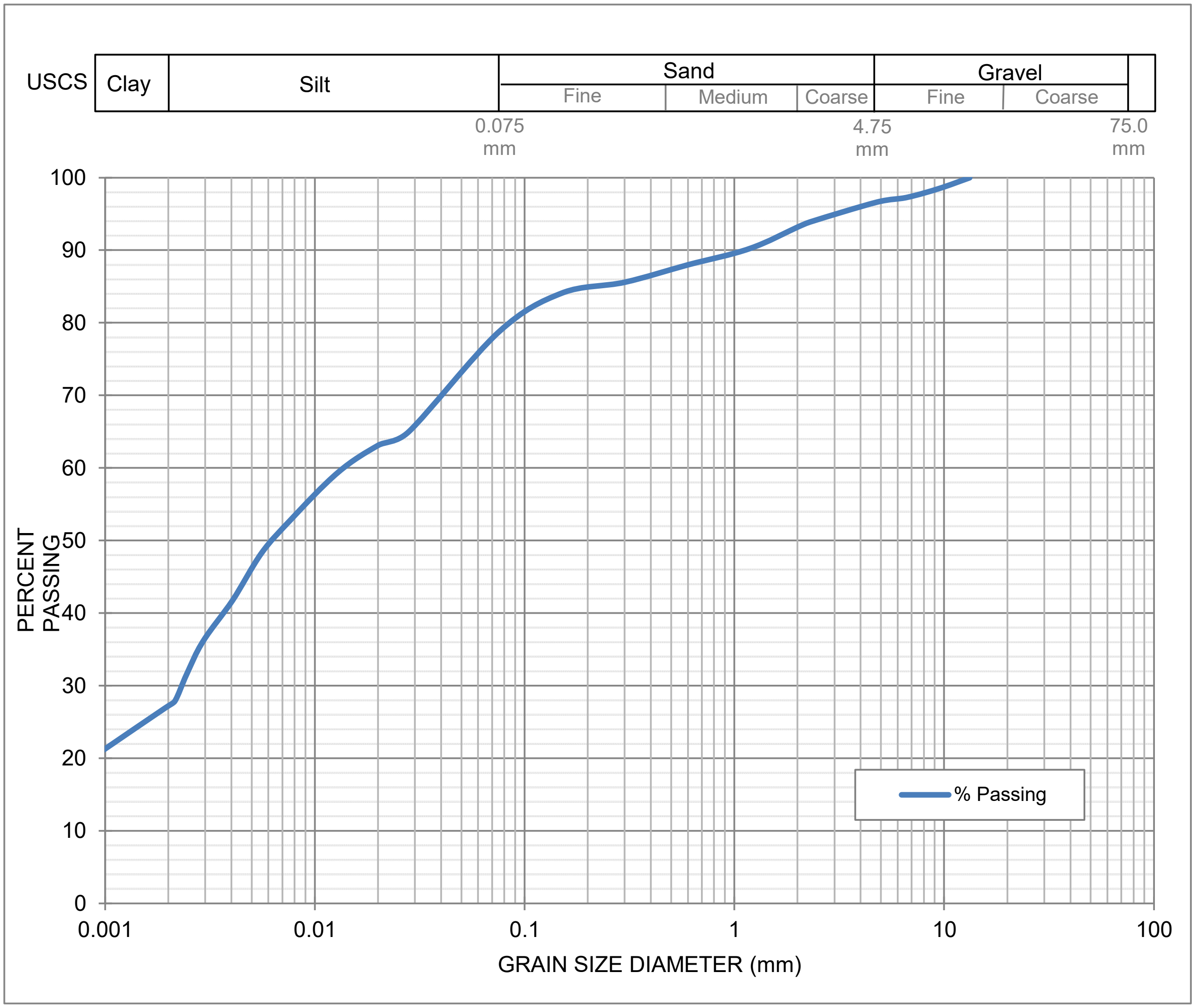
Project Name: Laboratory Testing for Novaterra Environmental Ltd.

Date: 22-Jun-22

Project Location: 14693 Fifteen Mile Road, London, ON

Project No.: GE-00744

Sample ID	Unified Soil Classification				Moisture Content (%)
	% Clay	% Silt	% Sand	% Gravel	
MW5- 12ft	29.1	49.6	17.9	3.4	9.5



Particle Size Distribution
Results of Sieve Analysis

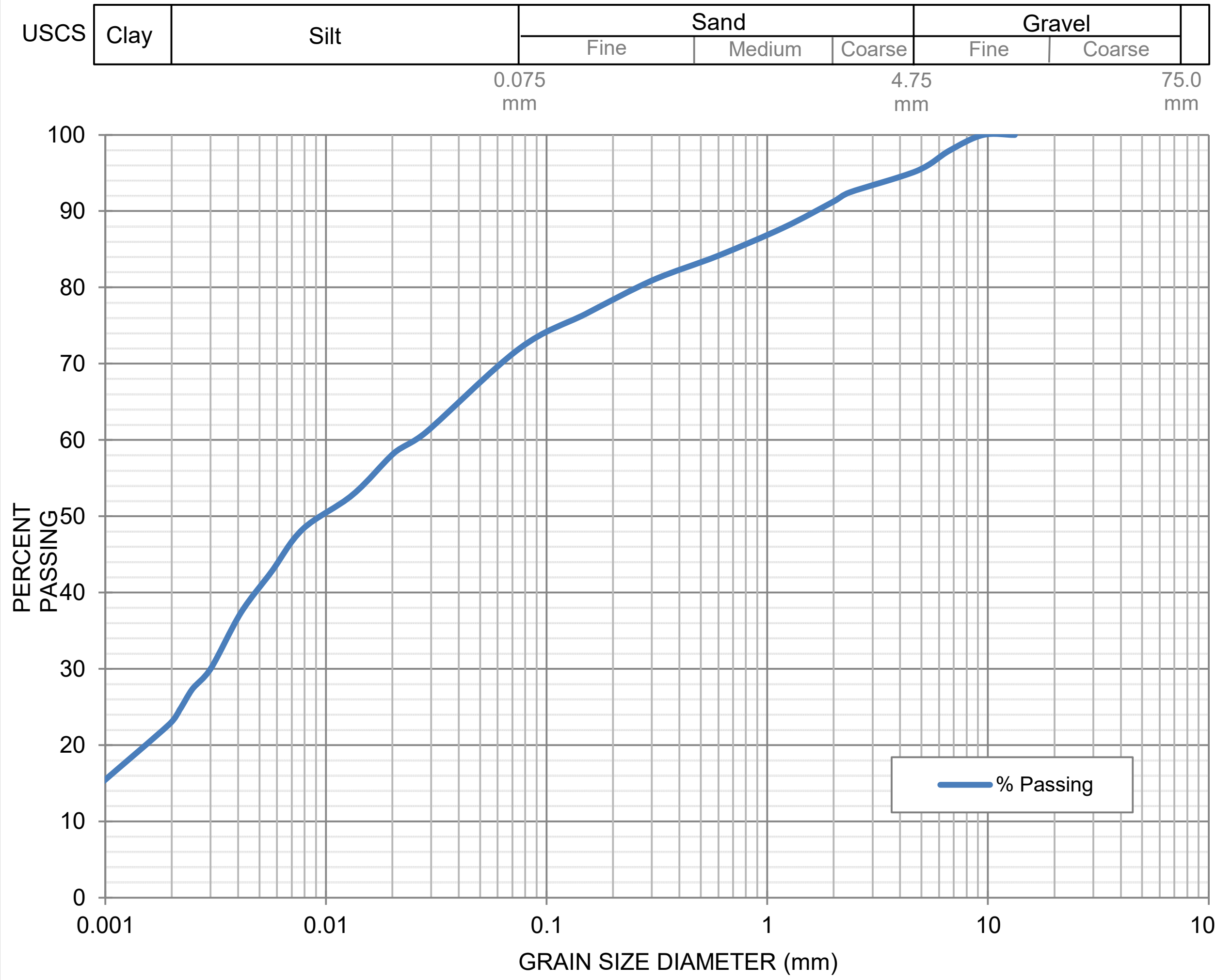
Project Name: Laboratory Testing for Novaterra Environmental Ltd.

Date: 22-Jun-22

Project Location: 14693 Fifteen Mile Road, London, ON

Project No.: GE-00744

Sample ID	Unified Soil Classification				Moisture Content (%)
	% Clay	% Silt	% Sand	% Gravel	
MW5- 22ft	22.8	49.2	23.3	4.7	9.5

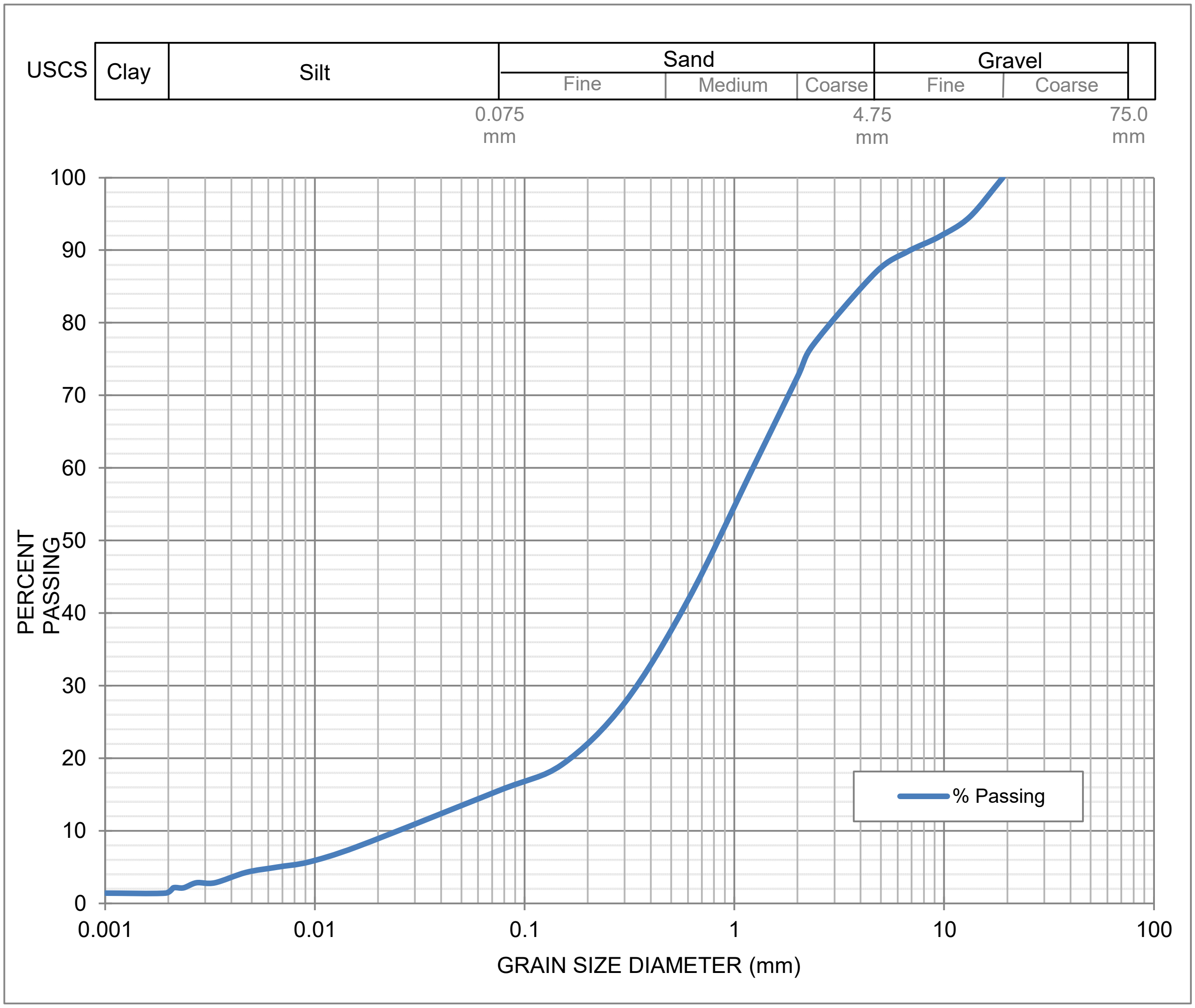


Particle Size Distribution
Results of Sieve Analysis

Project Name: Laboratory Testing for Novaterra Environmental Ltd. **Date:** 28-Jun-22

Project Location: 14693 Fifteen Mile Road, London, ON **Project No.:** GE-00744

Sample ID	Unified Soil Classification				Moisture Content (%)
	% Clay	% Silt	% Sand	% Gravel	
MW6- 10ft	1.4	14.1	71.5	12.9	5.6

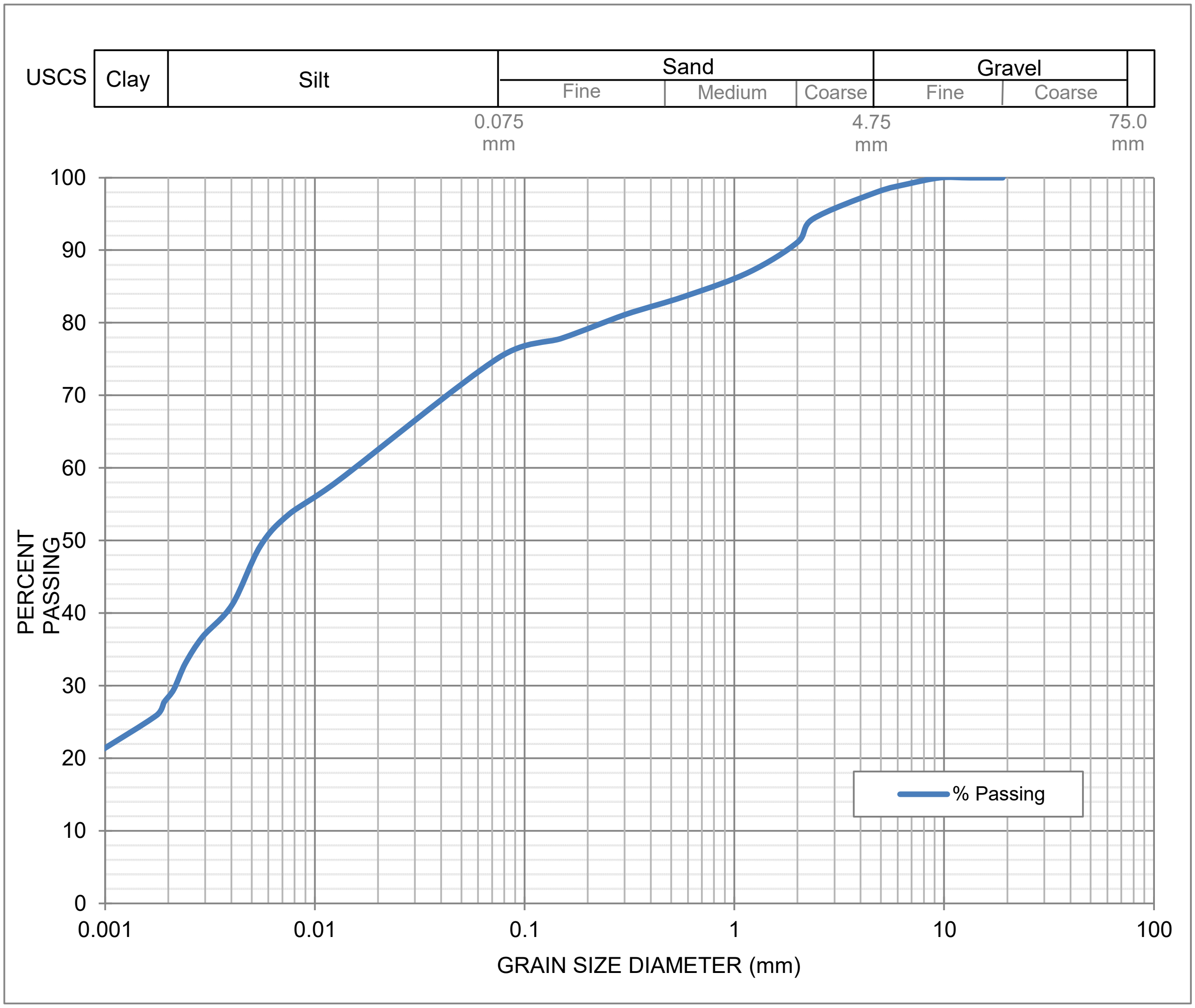


Particle Size Distribution
Results of Sieve Analysis

Project Name: Laboratory Testing for Novaterra Environmental Ltd. **Date:** 28-Jun-22

Project Location: 14693 Fifteen Mile Road, London, ON **Project No.:** GE-00744

Sample ID	**Unified Soil Classification**				**Moisture Content (%)**
	% Clay	**% Silt**	**% Sand**	**% Gravel**	
MW7- 12ft	26.0	49.2	22.8	2.0	25.4

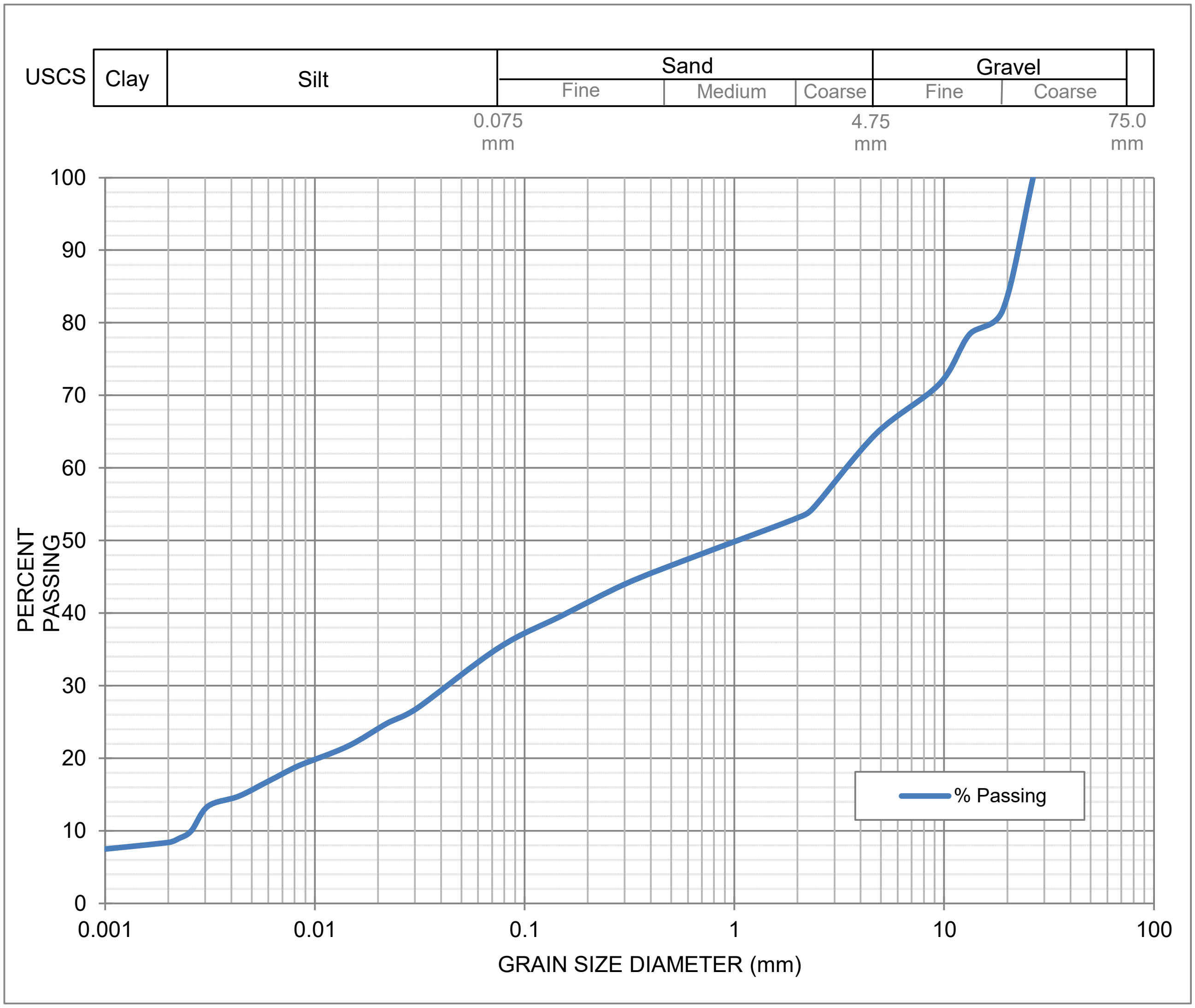


Particle Size Distribution
Results of Sieve Analysis

Project Name: Laboratory Testing for Novaterra Environmental Ltd. **Date:** 22-Jun-22

Project Location: 14693 Fifteen Mile Road, London, ON **Project No.:** GE-00744

Sample ID	Unified Soil Classification				Moisture Content (%)
	% Clay	% Silt	% Sand	% Gravel	
MW7- 30ft	8.4	26.8	29.5	17.0	11.0



APPENDIX C

Resumes

Curriculum Vitae
Mr. Blagy (Blagoje) Novakovic, M. Sc. P. Eng.

email: novaterra@sympatico.ca Tel.:(519) 690-1796

Principal and Senior Hydrogeologist of Novaterra Environmental Ltd.

- Retired on December 31, 2001 from the Ontario Ministry of the Environment after 27 years of service
- Established consulting firm Novaterra Environmental Ltd. which was incorporated on January 9, 2002.
- Mr. B. Novakovic is the President of Novaterra Environmental Ltd. The firm carries out consulting work in the fields of hydrogeology and geological engineering.

EDUCATION

University of Waterloo, Waterloo, Ontario, Canada
Master of Sciences in Hydrogeology, 1973
Department of Earth Sciences

University of Belgrade, Belgrade, Yugoslavia
Bachelor of Science in Geological Engineering, 1963
Faculty of Mining and Geological Engineering

WORK EXPERIENCE

NOVATERRA ENVIRONMENTAL LTD., London, Ontario

Principal and Senior Hydrogeologist, January 2002 - Present

Member of Peer Review Committee, 2006 to 2014

- Upper Thames River Conservative Authority.
- Essex and Region Conservation Authority.
- The Committee provides critical technical review of the different stages of the technical reports prepared according to Provincial “Source Water Protection” program.

Ontario Municipal Board Hearing as an expert witness, 2008

- Relating to the proposed commercial plaza development and the protection of municipal wells in the Police Village of Dorchester, Middlesex County.

Hydrogeological Site Assessment and Technical Report Preparation Relating to Applications for Pits and Quarry License

- Preparation of hydrogeological assessment reports (Hydrogeological Level 1 and Level 2 Study) in support of the application for pits and quarries licence to be approved under Aggregate Resources Act by Ontario Ministry of Natural Resources and Forestry (MNRF).
- Preparation of over 25 hydrogeological reports

Hydrogeological Site Assessment and Technical Report Preparation Relating to Permit to Take Water and Water Resources

- Preparation of Hydrogeological Assessment Report involving aquifer pumping tests in support of for Category 3 application for Permit to Take Water. Permit to be issued by the Ontario Ministry of the Environment and Climate Change (MOECC) under Ontario Water Resources Act (OWRA).
- Over 40 hydrogeological reports were prepared.

Hydrogeological Site Assessment and Technical Report Preparation Relating to Environmental Site Assessment and Remediation

- Hydrogeological Site Assessment and Technical Report preparation relating to Environmental Site Assessment and Remediation under the Ontario Regulation 153/04 Environmental Protection Act (EPA).
- Phase I, Phase II and Phase III were involved, and in several cases actual remediation was implemented.

- 11 reports were prepared.

Provincial and Regional Groundwater Study Reports

- Peer Review of Provincial and Regional Groundwater Study report prepared by various consultants for the Ministry of the Environment. Four geographical area reports were involved and reviewed for the Ontario Ministry of the Environment.

Groundwater Under the Direct Influence of Surface Water (GUDI) reports

- Peer Review of Groundwater Under the Direct Influence of Surface Water (GUDI) reports prepared by various consultants for the Ministry of the Environment. At least 17 hydrogeological reports of this nature were reviewed for the Ontario Ministry of the Environment.

ONTARIO MINISTRY OF THE ENVIRONMENT, Southwest Region, London, Ontario

Regional Hydrogeologist, June 1975 – December 2001

Carried out numerous and variety of *investigations* relating to groundwater quality and quantity problems caused by human activities. Besides writing numerous Ministry of the Environment (MOE) interim reports relating to the variety of projects described below, Mr. B. Novakovic wrote up to10 technical papers published in referenced journals or conferences proceedings.

Main duties and responsibilities:

- *Groundwater contamination* including communal and domestic wells caused by the operation of waste disposal sites, former coal tar sites, deep injection wells of industrial liquid waste, operation of municipal sewage treatment facilities (sewage lagoon system), farming operations, operation of industrial plants, application of road salt, etc.
- *Groundwater quantity interference* mainly caused by the operation of communal/municipal wells and well fields, irrigation wells, dewatering relating to the construction of highways, roads, municipal sewage systems, communal water supply systems, dewatering of pit and quarries, etc. Many of these investigations resulted in the production of comprehensive technical reports written and produced in order to defend MOE's position at court proceedings, at the meetings of technical experts regarding a particular subject matter, and to support corrective remedial measures to be undertaken.
- *Undertaken pioneering work* in municipal and communal well fields protection in Ontario (Dorchester, Strathroy, Otterville, etc.), and municipal sewage effluent treatment by rapid infiltration into the subsurface (i.e. Markdale, Lucknow, etc.).
- *Review and assess* the comprehensive technical reports prepared by the consultants (hydrogeologists, professional engineers, etc.) dealing with suitability assessment, proposed design and the operation of landfill sites, the proposed communal water well systems, municipal sewage effluent disposal by way of spray irrigation, rapid infiltration into the subsurface, operation and dewatering of pits and quarries, proposed deep injection wells, etc. Many of these reports included mathematical model simulation of contaminants transport, groundwater flow, pumping tests analyses. These facilities proposed to be established under the OWRA, EPA, Environmental Assessment Act (EAA).
- *Critical review* of the comprehensive technical reports of the former coal and oil tar sites, to ensure that the proposed remediation measures were adequate and furthermore that the cleanup measures were implemented according to the prescribed Ontario regulations and standards.
- *Review and comments* on the proposed municipal official plans, amendments to such plans-aspects of such documents relating to groundwater and soils.
- *Testified* as an expert witness for the MOE in Court Proceedings, Public Hearings held under the OWRA, EPA, Consolidated Hearing Act, Environmental Review Tribunal, etc.
- *Interpretation and implementation* of the relevant Ontario Regulations made under OWRA, EPA and provide advice with such interpretation to municipalities, consulting communities, general public. Worked closely on such matters with legal profession representing the Crown.

NEW BRUNSWICK DEPARTMENT OF THE ENVIRONMENT, Fredericton, New Brunswick

Resource Manager, 1973 – 1975

Main duties included:

- Carrying out groundwater contamination investigations relating to leaks from gasoline service stations, accidental spills from transport trucks, utilities vehicles, from unloading petroleum hydrocarbons from ships, etc.
- Supervised pumping tests to assess hydraulic capacities of communal water supply wells and groundwater

availability, potential and extent of saltwater intrusion into freshwater aquifer.
- Overseeing the establishment of the Provincial groundwater monitoring network.
- Provide advice and assisted municipalities and general public with the establishment and improvement of adequate and better-quality groundwater supplies.

CANADA DEPARMENT OF THE ENVIRONMENT, Ottawa-Hull, Ontario, and Quebec

Project Hydrogeologist, 1973

Worked on Joint project sponsored by the Canada Department of the Environment and the Ontario Ministry of the Environment. Work involved an assessment of deep well injection of industrial liquid waste and cavern washing brines into the subsurface formation in Lambton County, Ontario. Available data were analyzed with an aim of assessing the direction of groundwater flow and subsequently the direction and the extent of injected fluid movement in the deep subsurface formations. Reservoir capacity and the potential for trans-boundary contaminants movement were assessed. This work resulted in the publication of Technical Bulletin published by Environment Canada, of which B. Novakovic is coauthor.

DEPARTMENT OF EARTH SCIENCES, University of Waterloo, Waterloo, Ontario

Research Assistant and Graduate Student, 1970 – 1972

- Obtained M. Sc. Degree in Hydrogeology. Thesis title: The Scale of Groundwater Flow Systems in Big Creek and Big Otter Creeks Drainage Basins, Ontario.
- During the summer of 1971 worked for the Ontario Water Resources Commission
- This work resulted in the publication of: Groundwater Probability Map for Elgin County, Ontario.

FALCONBRIDGE NICKEL MINES COMPANY, Toronto, Ontario

Geological Engineer, 1968 – 1970

Carried out mineral exploration including geophysical surveys at various mining properties located at Temagami Lake, Ontario, southwestern Quebec, northern Manitoba, and at La Luz Mines, Nicaragua, a subsidiary of Falconbridge Nickel Mines.

GEOLOGICAL INSTITUTE, Sarajevo, Yugoslavia

Research Assistant, 1964 – 1968

Carried out regional water resources studies and then hydrogeological mapping of various areas of that Province with the aim of complete assessment of groundwater resources, availability and producing hydrogeological maps at the scale of 1:25,000. Such maps included a complete assessment of water resources, regime and balance of groundwater, quality, and vulnerability of groundwater to contamination for the area covered by these maps. Works also included performing long term pumping tests to define the hydraulic capacity of the identified aquifer systems in the consolidated-hard rocks and unconsolidated deposits. Groundwater outcrops such as huge karst springs were also mapped and the flow monitored by the construction of weirs, staff gauges and associated water quality monitoring were also carried out. These works resulted in publishing a comprehensive reports and associated maps depicting the finding results of such studies. Carried out geotechnical studies, including test drilling and mapping for the locations of small irrigation dams.

ASSOCIATIONS MEMBERSHIP

- Association of Professional Engineers of Ontario,
- National Water Well Association (Groundwater Scientists and Engineers Division).

PUBLICATIONS

Mellary, A. A., Novakovic B. 1972.
Groundwater Probability Map, County of Elgin. Map 3106-1, Ontario Ministry of the Environment

Novakovic, B., Farvolden R.N., 1974.
Investigations of groundwater flow systems in Big Creek and Big Otter Creek Drainage Basins, Ontario. Canadian Earth Sci. Journal, Vol II, PP. 964-975.

Vandenberg A., Lawson, D. W. Charron, J.E. and Novakovic, B. 1977.
Subsurface Waste Disposal in Lambton County, Ontario – Piezometric Head in the Disposal Formation and Groundwater Chemistry of the Shallow Aquifer. Inland Waters Directorate, Water Resources Branch, Fisheries and Environment Canada, Technical Bulletin No. 90. Ottawa.

Novakovic B. 1984a.
Impact and Recovery of Chromium Waste Leaked Beneath an Industrial Plant. Proceedings of the Fourth National Symposium on Aquifer Restoration and Ground Water Monitoring. National Water Well association, Worthington Ohio. The Fawcett Center, Columbus, Ohio. May 23-25, 1984

Novakovic, B., Longworth J. 1984b.
Well Field Protection and Management through a Municipal Official Plan. NWWA Conference on Groundwater Management, October 29-31, 1984 Orlando, Florida. National Water Well Association.

Novakovic B., Jagger, D. 1992.
Application of hydraulic confinement concept of landfill design and operation. 1992 Conference of the Canadian National Chapter, International Association of Hydrogeologists. Modern Trend in Hydrogeology. Hamilton, Ontario May 11-13, 1992. WCGR and Env. Canada

RESUME

SASHA NOVAKOVIC, B.A.Sc., P.Eng.

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Hydrogeologist – Novaterra Environmental Ltd.

- Initially involved with Phase I, II, and III ESAs, currently focusing on hydrogeological assessments of aggregate extraction pits and assessments supporting PTTW applications
- Involved in over 40 projects relating to Permit to Take Water applications for groundwater takings.

EDUCATION

University of Waterloo, Waterloo, Ontario Canada
Bachelor of Applied Sciences, 2013
Geological Engineering – Specialization in Water Resources

EMPLOYMENT HISTORY

Novaterra Environmental Ltd., Hydrogeologist, *London, ON* 2001 - Present

- Conducting elevation surveys, water level monitoring, soil and groundwater sampling, field reconnaissance and instrument installation.
- Performing pumping tests, analyzing results with AQTESOLV software, writing well assessment reports, and submitting Permit to Take Water applications to regulatory agencies.
- Creating groundwater contour maps and hydrographs, and analyzing data to assess hydrogeological and hydrological conditions at proposed gravel pits.
- Writing Environment Site Assessment report and Hydrogeological Site Assessment reports
- Drafting responses to comments by regulatory agencies regarding submitted reports.

Golder Associates Ltd., Geological Engineering Intern, *Mississauga, ON* Sept. - Dec. 2011

- Performed field compaction tests during construction of a tailings dam in Northern Manitoba for a 3-week period.
- Analyzed current and historical geologic data to generate geological cross-sections and contour maps.
- Conducted laboratory experiment to test settling, moisture and beach slope of mine tailings.
- Performed slope stability analysis using GeoSlope software.
- Limited water budget analysis, and field investigation of water reservoir in Niagara Falls used for power generation.

Matrix Solutions Inc., Environmental Engineering Intern, *Calgary, AB* Jan. - Apr. 2011

- Authored Phase II ESA reports and proposals for both the Alberta and B.C. regulatory jurisdictions relating to upstream oil and gas well sites, facilities, and spills.
- Ensured site compliance with Alberta and B.C. soil and groundwater guidelines and standards.
- Created contour maps and site diagrams, while ensuring quality control of figures and data tables included in reports.

MEMBERSHIPS AND CERTIFICATIONS

- Licensed Engineer with the Association of Professional Engineers of Ontario
- Member of the International Association of Hydrogeologists and National Ground Water Association
- Certified with Class 5 Ontario Well Technicians License