

# PRELIMINARY WATER BALANCE ASSESSMENT

6586 Beatty Line North, Township of Centre Wellington,  
County of Wellington, ON

Project #: 24-0837

Prepared for: Sorbara/Tribute Brubacher Holdings Inc.

Date: January 7, 2025

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January 7, 2025

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**SUBJECT: PRELIMINARY WATER BALANCE ASSESSMENT, 6586 BEATTY LINE NORTH, TOWNSHIP OF  
CENTRE WELLINGTON, COUNTY OF WELLINGTON, ON**

EnVision Consultants Ltd. is pleased to present the enclosed Preliminary Water Balance Assessment report for the above-noted property. The report describes the interpreted hydrogeological conditions based on our assessment and provides conclusions for your consideration.

We thank you for utilizing EnVision for this assignment. If there are any questions regarding the enclosed report, please do not hesitate to contact us.

Yours sincerely,

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## QUALITY MANAGEMENT

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## TABLE OF CONTENTS

<b>1. Introduction</b>	<b>4</b>
1.1. Objectives and Scope of Work	4
1.2. Previous Site Investigations	5
1.3. Site Description	6
1.4. Policy and Regulatory Overview	6
<b>2. Regional Setting</b>	<b>8</b>
2.1. Regional Physiography	8
2.2. Geology	8
2.3. Hydrogeological Setting	8
<b>3. Site Setting</b>	<b>10</b>
3.1. Soil Conditions	10
3.2. Surface Water Features	10
3.3. Groundwater Conditions	10
3.4. Hydraulic Conductivity and Infiltration Potential in Site Soils	13
<b>4. Preliminary Water Balance Assessment</b>	<b>15</b>
4.1. Climate-Based Water Budget	15
4.2. Pre-Development Water Budget	16
4.3. Post-Development Water Budget	17
4.4. Water Quality	19
<b>5. Closing</b>	<b>20</b>
5.1. Conclusions	20
5.2. Qualification of the Assessors	20
5.3. Certification and Signatures	21
5.4. Qualifier	21
<b>6. References</b>	<b>23</b>



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## **LIST OF TABLES** *(INCLUDED WITHIN THE REPORT)*

Table 1-1: Summary of Source Water Protection Policy Areas .....	6
Table 3-1: Soil Engineer Reported Groundwater Levels (Fall 2024).....	11
Table 3-2: Summary of Single Well Response Tests for Estimation of Hydraulic Conductivity (Soil Engineers).....	13

## **LIST OF FIGURES** *(ATTACHED TO THE REPORT)*

Figure 1	Site Location Plan
Figure 2	Site Instrumentation Plan
Figure 3	Wellhead Protection Area Map
Figure 4	Significant Groundwater Recharge Area Map
Figure 5	Stantec Conceptual Hydrogeological Model of the Study Area
Figure 6	Stantec Stratigraphic Cross-Section
Figure 7	MECP Water Well Location Map
Figure 8	Site Specific Cross Section A-A'
Figure 9	Site Specific Cross Section B-B'
Figure 10	Pre-Development Site Plan
Figure 11	Post-Development Site Plan

## **LIST OF APPENDICES**

**APPENDIX A:** Borehole Logs (Soil Engineers, 2024)

**APPENDIX B:** Infiltration Potential Assessment

**APPENDIX C:** Preliminary Water Balance Assessment



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## 1. INTRODUCTION

EnVision Consultants Ltd. (EnVision) was retained by Sorbara/Tribute Brubacher Holdings Inc. (the 'Client') to complete a preliminary water balance assessment of the property comprised of municipal addresses 6586 Beatty Line North, Township of Centre Wellington, County of Wellington, ON (the 'Site'). It is our understanding that this assessment has been requested to support ongoing site planning activities, including an Official Plan Amendment (OPA) for the Subject Lands. The effects of the OPA are to redesignate the Site and to expand the boundaries of the North West Fergus Secondary Plan. Please refer to the draft OPA and available planning report for a description of the proposed Official Plan land use designations for the property.

The Subject Lands are comprised of open field agricultural land with some woodlot coverage along the north, northeastern, central, and western portions of the property. New development, consisting of residential homes, bounds the property along the southeastern boundary. Additional agricultural lands are present north and west of the Site. **Figure 1** highlights the Site location and natural heritage features as described in the Preliminary Environmental Impact Study (EIS), prepared by GeoProcess Research Associates for the Subject Property (GeoProcess Research Associates, 2024). A buffer of 500-m extending out from the property boundary has been applied to **Figure 1**, and represents the 'Study Area' for the following Study.

Based on information provided by the client, the proposed development of the Site includes residential subdivision, associated private roads, underground infrastructure (municipal water and sewer connections), and stormwater management (SWM) features including a SWM pond. The future homes will be serviced through the municipal system, with no plans for private water wells or septic systems. Several identified natural heritage features are being maintained and protected during development.

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### 1.1. OBJECTIVES AND SCOPE OF WORK

The key objectives for the preliminary water balance assessment are to:

1. Characterize the regional and site-specific geology and hydrogeology;
2. Review the groundwater conditions and constraints as they relate to the proposed development;
3. Provide preliminary water balance calculations to provide input to the stormwater management plans, which are being developed by SCS Consulting Group;
4. Provide recommendations for Low Impact Development (LID) measures to maintain, where possible, inputs for the key hydrogeological functions across the Site.

In order to satisfy the stated objectives above, EnVision has completed the following scope of work, which is summarized in the assessment:



1. Review of published geological/hydrogeological resources, including existing soil mapping, natural heritage information, environmental databases, and groundwater records (MECP Water Well Records);
2. Review background reports from the ongoing development work, including geotechnical, hydrogeological, environmental, and stormwater management briefs;
3. Complete analysis of the pre-development land use using GIS, with preparation of pre-development catchment delineation and existing surface water flow and recharge conditions;
4. Provide an annual water balance calculation for the existing conditions at the Site as a baseline;
5. Develop the post-development water balance for the Site, with input from the preliminary conceptual design work, provided by the client.

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## 1.2. PREVIOUS SITE INVESTIGATIONS

EnVision was not retained to complete hydrogeological investigation at the Site, but has been provided background reports prepared by others, to aid in developing a hydrogeological conceptual model of the Site. Previous field level investigations have been completed for the development property by others, including environmental, geotechnical, and hydrogeological. The following summary is provided as some of the historical information and data has been incorporated into this report to provide additional Site context.

### 1.2.1. *Preliminary Geotechnical Investigation by Soil Engineers, November 2024*

A field program was conducted in the summer of 2024 which included the advancement of thirteen (13) boreholes ranging in depth from 6.2 to 10.9 meters below ground (m BGS). Geotechnical soil testing and lab analysis was completed on the collected samples. A total of ten (10) monitoring wells, were installed across the Site as shown on **Figure 2**.

### 1.2.2. *Hydrogeological Assessment by Soil Engineers, 2024-ongoing*

In coordination with a geotechnical program, Soil Engineers also completed a preliminary hydrogeological assessment report for the Site, which utilized the existing geotechnical boreholes and monitoring wells. In addition, a total of six (6) piezometers were installed within the Site boundaries in close proximity to the identified wetland areas, as shown in **Figure 2**.

A groundwater monitoring program, including the piezometer locations, has been implemented for the Site, with readings provided from September, October, and November of 2024. Ongoing monitoring is being proposed for the Spring of 2025 to identify the seasonal high levels. Additional information from the hydrogeological report will be summarised throughout the remaining sections of this assessment.



### 1.3. SITE DESCRIPTION

The Site has an area of 43.2 ha (432,000 m<sup>2</sup>) and is rectangular in shape. The Site lies along the southern side of Beatty Line North, approximately 600 m east of Sideroad 15, in the western portion of the community of Fergus. The property is described as Prime Agricultural Lands with three areas designated as Core Greenlands, based on the Schedule B1 Centre Wellington Official Plan. These core areas are considered as Provincially Significant Wetlands (PSWs). A small watercourse runs along the eastern side of the Site and is mapped as a Grand River Conservation Authority (GRCA) regulated area; draining the PSW areas along the western property area. A former raised rail corridor bisects the Site from west to east, which serves as a local hiking trail.

The Site is currently operated as agricultural, with large tracts of tilled field area, a farmhouse and gravel driveway.

### 1.4. POLICY AND REGULATORY OVERVIEW

A review of the Source Water Protection Policy areas indicates that the Site is located within, or intersects, several protection areas, including Wellhead Protection Area (WHPA), significant groundwater recharge area (SGRA), as highlighted in *Table 1-1* below.

*Table 1-1: Summary of Source Water Protection Policy Areas*

#### SOURCE POLICY PROTECTION DETAIL

SOURCE PROTECTION AREA:	Grand River Source Protection Area (GRSPA)
WELLHEAD PROTECTION AREA	B, score 6 (eastern half of Site) C, score 2 (western half of Site) (as shown on <b>Figure 3</b> )
ISSUE CONTRIBUTING AREA	No
HIGHLY VULNERABLE AQUIFER	No
SIGNIFICANT GROUNDWATER RECHARGE AREA	Small portions of the eastern wetland area and along the southern property boundary southwest of the rail corridor ( <b>Figure 4</b> )

The wellhead protection area is associated with the nearby municipal well Fergus #7 (F7), which is located at 6538 Beatty Line North, and supplies water to the Elora-Fergus distribution system for



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consumption by local residents. The well is permitted to supply up to 1,964 cubic meters of water per day with water extracted from the bedrock aquifer (Matrix Solutions Inc., 2020).



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## 2. REGIONAL SETTING

The physical setting across the Study Area is characterized by overburden sediments of Quaternary age, which were deposited as glacial ice lobes advanced and retreated across much of the area. The following section summarizes the work of others, including a summary of the physiography, and regional geology.

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### 2.1. REGIONAL PHYSIOGRAPHY

The Site and Study Area is located within the physiographic regions identified as the Guelph Drumlin Field (Chapman, 2007), with much of the Site situated on till plains, with some northern elements mapped within spillway physiographic features.

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### 2.2. GEOLOGY

#### 2.2.1. *Overburden Geology*

Based on a review of the public geological mapping (Ontario Geological Survey, 1997) of the Study area, the surficial material is classified as Halton Till and Glaciolacustrine deposits. The boundary between Halton Till and Glaciolacustrine deposits is identified in intersection area of Humber Station Drive, Mayfield Drive and Clarkway Drive. The northern portion of the Site is characterized to be Halton Till, which is predominantly silt to silty clay matrix, high in matrix carbonate content and is clast poor. The southern portion of the Site along Clarkway Drive has been classified as Glaciolacustrine deposits, comprised of silt and clay, with minor sand, deposited in basin and quiet water deposits.

#### 2.2.2. *Bedrock Geology*

Based on the bedrock mapping conducted by the Ontario Geological Survey, the uppermost bedrock within the Study Area is Guelph Formation, which consists of a combination of dolostone and limestone (Sharpe, 1980). Based on local well records and work completed by Stantec, bedrock is expected at a depth of more than 20 meters below the existing ground surface at the Site scale.

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### 2.3. HYDROGEOLOGICAL SETTING

Geological and hydrogeological conditions throughout the Study Area and surrounding region have been documented in previous studies, including in work completed by Stantec for the New Well Exploration Feasibility Assessment Report, published in February of 2024 (Stantec, 2024). A copy of Stantec's conceptual hydrogeological model that includes portions of the Study Area, has been attached as **Figure 5**, and an interpretation of the stratigraphy beneath the Site and Study Area as **Figure 6**.

The groundwater system has been interpreted to be made up of a shallow water-table overburden aquifer, which recharges the bedrock (Guelph Formation) aquifer, with some shallow flow directed



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towards local creeks (Irvine Creek) as discharge. Beneath the Guelph Formation, the Ancaster Member acts as a regional aquitard, with some leakage serving to recharge the deep groundwater flow system (Niagara Falls/Gasport/Cabot Head Formations).

The stratigraphic sequence highlighted on **Figure 6** further subdivides the overburden into Elmira Moraine Sand, situated otop of Maryhill Till. The overburden rests on the Guelph Formation at approximately 395-400 meters above sea level at the Study Area locale.

Groundwater use across the Study Area shows a history of private use, including typical agricultural-livestock use, domestic wells, residential supply, and municipal supply use (Soil Engineers Ltd., 2024).

Municipal supply well F7 is located approximately 400 m southeast of the property at 6538 Beatty Line North, Fergus, and pumps water from the Guelph Formation at depths starting from 47.2 m BGS. This well supplies water to the nearby municipalities.

**Figure 7** provides a summary of the MECP water well record database for locations within the Study Area, with well records categorized by final use, and the type of well (overburden/bedrock).



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### 3. SITE SETTING

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#### 3.1. SOIL CONDITIONS

Based on the borehole records prepared by Soil Engineer, and appended as **Appendix A**, the following subsurface conditions were noted at the property:

- Topsoil in all boreholes, with the exception of BH1, ranging in thickness from 15 to 23 cm.
- Earthen fill at the BH1 location along the driveway near an abandoned house extending to about 2.3 m in depth and consisting of sand and gravel, some peat, and grey silty clay.
- Silty clay near the ground surface at BH2, BH3, BH8, BH12, and BH13, with reported weathering zone in the upper 1.2 m.
- Silt was contacted at various depths in BH1, BH3, BH4, BH7, BH9, BH10, BH13, which contained some sand to being sandy, trace of clay.
- Sand at all boreholes, with exception of BH1, BH5, BH9, and BH13 overlying the sandy silt till.
- Sandy silt till predominates the soil stratigraphy at all boreholes at various depths

EnVision has prepared two cross sections from west to east, across the Site, which present a stratigraphic interpretation of the hydrogeological/geological conditions based off of the Soil Engineer borehole records. Cross Section A-A', which presents a profile along the southern half of the Site is included as **Figure 8**. Cross Section B-B', which presents a profile along the northern half of the Site is included as **Figure 9**.

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#### 3.2. SURFACE WATER FEATURES

As described in section 1.3, the Site contains three wetland areas, as highlighted in Figure 1. The wetland area along the northernmost portions of the Site are part of the larger Irvine Creek Wetland Complex. A tributary of Irvine Creek is located in the northeastern corner of the Site that outlets part of this wetland area. A second wetland area is in the central portion of the Site, that does not have a visible outlet. The western most wetland area intersects the Site along the southwestern corner of the property, which features a surface water outlet that is directed towards the south.

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#### 3.3. GROUNDWATER CONDITIONS

Soil Engineer's installed monitoring wells at ten locations, with two locations (BH1, BH8) being selected for a two-nest well configuration, for a total of twelve (12) monitoring wells. Wells were all installed within the overburden material, with the depth of well screens ranging from 6.1 m to 10.1 m BGS. Groundwater levels reported at the well network are provided below in *Table 3-1*.



Table 3-1: Soil Engineer Reported Groundwater Levels (Fall 2024)

WELL ID		SEP 24, 2024	OCT. 7, 2024	OCT. 21, 2024	NOV. 28, 2024
BH/MW 1D	mbgs	0.9	0.9	0.9	0.6
	masl	417.8	417.8	417.8	418.1
BH/MW 1S	mbgs	0.8	0.8	0.9	0.5
	masl	418.0	418.0	417.9	418.0
BH/MW 2	mbgs	2.2	2.1	2.1	2.1
	masl	417.5	417.6	417.6	417.6
BH/MW 3	mbgs	1.5	1.5	1.6	1.5
	masl	417.5	417.5	417.4	417.5
BH/MW 4	mbgs	2.1	2.2	2.2	2.1
	masl	417.6	417.5	417.5	417.6
BH/MW 5	mbgs	1.3	1.4	1.5	1.1
	masl	415.9	415.8	415.7	416.1
BH/MW 6	mbgs	4.2	4.7	5.0	4.8
	masl	412.5	412.0	411.7	411.9
BH/MW 7	mbgs	0.7	0.8	0.9	0.6
	masl	416.0	415.9	415.8	416.1
BH/MW 8D	mbgs	1.6	2.7	2.7	1.6
	masl	413.9	412.8	412.8	413.9
BH/MW 8S	mbgs	0.8	0.9	0.9	0.4
	masl	414.7	414.6	414.6	415.1
BH/MW 10	mbgs	1.9	2.0	2.1	1.6
	masl	414.3	414.2	414.1	414.6



WELL ID		SEP 24, 2024	OCT. 7, 2024	OCT. 21, 2024	NOV. 28, 2024
BH/MW 13	mbgs	Dry	Dry	Dry	Dry
	masl	<405.2	<405.2	<405.2	<405.2

Notes:

*mbgs* – meters below ground surface

*masl* – meters above sea level

Vertical and horizontal hydraulic gradients have not been assessed for the Site, however EnVision has provided estimates for the vertical gradients at the nested well locations, BH/MW 1s/d and BH/MW 8s/d below. Note that these represent the gradient condition at the time of the data observation.

	VERTICAL DISTANCE (m)	CHANGE IN HYDRAULIC HEAD (m)	VERTICAL GRADIENT (unitless)	DIRECTION
BH/MW 1S BH/MW 1D	1.5	0.0	0.0	NA
BH/MW 8S BH/MW 8D	1.5	1.8	1.2	Downward

Notes:

Vertical distance is the reported difference in meters between the two center points of the well screen assembly, as indicated on the well log.

Hydraulic head as measured on Oct. 21, 2024 and reported by Soil Engineers.

Except for BH/MW 6, and the piezometer locations, the monitoring wells have not clearly established the water table condition across the Site. The wells are screened at depth with potentiometric pressure readings that are all above the top of the screen opening. Developing an understanding of the shallow water table position and alignment is difficult based on the existing data. Horizontal groundwater flow direction is difficult to assess, however based on the potentiometric pressure readings, the flow direction appears to be directed towards the south.



### 3.4. HYDRAULIC CONDUCTIVITY AND INFILTRATION POTENTIAL IN SITE SOILS

#### 3.4.1. Saturated Hydraulic Conductivity Assessment Summary

Soil Engineering conducted a series of hydraulic tests in the onsite monitoring wells to estimate the saturated hydraulic conductivity of screened formations. Based on the analysis, the hydraulic conductivity ranges are summarized in *Table 3-2*, below.

*Table 3-2: Summary of Single Well Response Tests for Estimation of Hydraulic Conductivity (Soil Engineers)*

SCREENED FORMATION	MONITORING WELL LOCATION	HYDRAULIC CONDUCTIVITY	
		Min (m/sec)	Max (m/sec)
SANDY SILT TILL	BH/MW 1d, BH/MW 3, BH/MW 5, BH/MW 6, BH/MW 8d	1.6X10 <sup>-8</sup>	2.6X10 <sup>-7</sup>
SILT/SANDY SILT TILL	BH/MW 1s, BH/MW 10	1.3X10 <sup>-6</sup>	2.3X10 <sup>-6</sup>
SAND/SANDY SILT TILL	BH/MW 2, BH/MW 7, BH/MW 8s	1.2X10 <sup>-7</sup>	2.9X10 <sup>-6</sup>
SAND	*BH/MW4 (one test only)	1.2X10 <sup>-5</sup>	1.2X10 <sup>-5</sup>

#### 3.4.2. Infiltration Rate Estimation

Infiltration assessment of in-situ soils was not completed by Soil Engineers due to preliminary nature of the current development stage. EnVision has prepared a preliminary assessment of the infiltration potential at the Site based on select grain size data and the hydraulic conductivity assessment. All data provided for this assessment are sourced from the Soil Engineers hydrogeological and geotechnical report, no reliance on this data has been obtained, the following information is only intended to provide a preliminary estimation for potential infiltration at the location and depths at which the testing data was obtained. In-situ testing is generally recommended to support future LID design.

EnVision has reviewed grain size approximations from the borehole sampling to develop hydraulic conductivity in the horizontal direction for select samples (selected as the split spoon samples collected above 3.5 m BGS. These have been converted to a vertical hydraulic conductivity by applying a decrease of one order of magnitude (Todd 1980, Freeze Cherry 1979) to each approximated horizontal conductivity. These values have been reviewed using the established relationship between vertical hydraulic conductivity and infiltration rates presented in the Credit Valley Conservation and Toronto Regional Conservation Low Impact Stormwater Management Planning and Design Guide (LID SMPDG). The approximate infiltration rate for each of the soil distribution profiles are included in **Table B-1, Appendix B**. The range of infiltration based on this method is between 6 and 25 mm/hr.



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EnVision also reviewed the saturated hydraulic conductivity values from the well testing, which was completed at the Site to provide additional estimates for infiltration rates at the screen depth. Based on similar approximation of the vertical hydraulic conductivity ranges determined from the single well response tests, the range of infiltration is estimated between 2 and 9 mm/hr. as shown in **Table B-1**.

Across all sources, the ranges for infiltration are highlighted in the summary shown in **Table B-1**, with an average of 10 mm/hr.

During detailed design stage, LID functionality should be confirmed by in-situ infiltration testing at the planned facility location and base elevation. In addition, the LID features should be designed to maintain separation from the seasonally high groundwater elevations by 0.5 m. Additional groundwater monitoring to determine the high levels is underway by others.



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## 4. PRELIMINARY WATER BALANCE ASSESSMENT

The Water Budget Analysis is presented in the following sections. Section 4.1 describes the analysis of historical climate data to estimate annual average precipitation and potential evapotranspiration. Section 4.2 describes the Pre- Development Water Budget. Section 4.3 Describes the Post-Development Water Budget. Section 4.4 revisits the Post-Development Water Budget to consider the potential benefits of identified mitigation opportunities.

The Water Budget is a simple accounting of the water inputs and outputs within a defined area, in this case, it is defined as areas that contribute water to the three major features and the onsite areas, as highlighted in **Figure 10**. The following assessment is considered a preliminary water balance calculation without applying any mitigation measures, which are understood to be under development.

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### 4.1. CLIMATE-BASED WATER BUDGET

The climate-based water budget calculations are included in *Tables C-1 to C-5 (Appendix C)*. The average annual precipitation for the thirty-year normal data between 1981 and 2010 is about 769.6 mm/m<sup>2</sup>/year (mm/year). The annual potential evapotranspiration is calculated in *Table C-1* at 610.2 mm/year. This equates to a potential water surplus of 159.4 mm/year and a soil moisture deficit of 120.7 mm/year. Thus, the net annual water surplus based on potential evapotranspiration is 280.1 mm/year.

The calculations were expanded to include the water holding capacity of the soil as presented in *Tables C-2 to C-5*. This will produce a total moisture surplus based on the calculated actual evapotranspiration. Three (3) combinations of soil type and vegetation type were identified on the Site for the Pre-Development and Post-Development scenarios. Most of the surficial soil at the site is considered to be fine silty clay. The land use classifications and the corresponding water holding capacities are:

- Silty Clay, Residential Lawn (75 mm/year);
- Silty Clay, Cultivated (150 mm/year);
- Silty Clay, Uncultivated (200 mm/year); and
- Silty Clay, Woodland (350 mm/year).

Consideration of these factors produces a range of net annual moisture surplus between 178.1 and 219.1 mm/year as summarized in *Table C-2, C-3, and C-4*. The soils with higher water holding capacity effectively increase the water removed as evapotranspiration.

The calculated moisture surplus occurs during the winter, spring and fall months, and a water deficit occurs during the summer months. Much of the water surplus in the winter accumulates as snow. Snowmelt during the spring results in the runoff or infiltration of precipitation that is effectively equivalent to the winter and spring water surplus.



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## 4.2. PRE-DEVELOPMENT WATER BUDGET

The Pre-Development Water Budget was developed based on topographic information provided on the grading plans prepared by SCS Consulting Group Ltd.

### 4.2.1. *Pre-Development Catchment Areas*

Figure 10 illustrates the delineation of drainage catchments and sub-catchments for the Site. The Site is represented by one (1) (on site) catchment area that is considered to receive run-on from adjacent properties situated to the northwest. The Existing Storm Drainage Plan, prepared by SCS (SCS Consulting Group Ltd., 2024) includes an external catchment area along the northern/northwestern boundary of the Site. The water generated in the off-site catchment is considered to be conveyed on to the Site and to the three wetland features, or as by-pass to the southern storm sewer. The preliminary water balance incorporates this run on water into the model for the pre-development condition. It is further understood that the design intent is to maintain this run on water in the pre-development condition, with some minor modifications. The water balance calculation also includes this design intent.

The on-Site catchment areas have been further subdivided. The drainage sub-catchments are based on similar slopes, soils, and vegetation/land use. The drainage sub-catchments also include consideration of post-development drainage boundaries so that changes to drainage areas can be evaluated for the post-development conditions. The outlets for drainage of the identified Pre-Development catchments are as follows:

#### *On-Site Catchments:*

- Pre-Development On-Site Catchment A: Drains off-site through the eastern property boundary through the existing wetland and headwater drainage feature.
- Pre-Development On-Site Catchment B: Drains off-site through the southeastern property boundary through the existing concrete box bypass sewer.
- Pre-Development On-Site Catchment C: Drains off-site through the southwestern property boundary through the existing wetland feature.
- Pre-Development On-Site Catchment D: Drains off-site through the southern property boundary through overland flow.

### 4.2.2. *PRE-DEVELOPMENT ANALYSIS*

Properties associated with area, slope, soil type, and land cover were analyzed and assigned to each Pre-Development sub-catchment. The values assigned to each Pre-Development sub-catchment were used to estimate an Infiltration Factor. The Infiltration Factors were reviewed to confirm that they are appropriate and adjusted if necessary. Existing building areas were assumed to be impervious and to generate runoff equivalent to the precipitation volume minus a 10% evaporative loss. Gravel areas were assumed to have a surplus equivalent to that of urban lawn areas.



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A summary of the preliminary Pre-Development water budget calculations is provided in *Table C-6*. These values will be used to assess the changes that proposed development will create relative to the pre-development conditions.

#### 4.2.3. *PRE-DEVELOPMENT INFILTRATION*

The estimated total infiltration for the Site is 64,503 m<sup>3</sup>/yr or an equivalent of 148 mm/year (mm/m<sup>2</sup>/yr). The calculated infiltration represents approximately 19% of the annual precipitation (798 mm/yr) and 53% of the estimated annual water surplus (280.1 mm/yr).

#### 4.2.4. *PRE-DEVELOPMENT RUNOFF*

The total runoff for the Site is 26,648 m<sup>3</sup>/yr or an equivalent of 61 mm/year. The calculated runoff represents approximately 8% of the annual precipitation (798 mm/yr) and 21% of the estimated annual water surplus (280.1 mm/yr).

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### 4.3. POST-DEVELOPMENT WATER BUDGET

#### 4.3.1. *Post-Development Catchments Areas*

**Figure 11** illustrates the delineation of drainage catchments and sub-catchments for the Site under post-development conditions. The Site has been subdivided into six (6) on-site catchments. Sub-catchment delineations in Pre- Development conditions were maintained for the Post-Development analysis. The post-development catchments were prepared based on a preliminary grading plan and drainage area plan provided by SCS.

Runoff from within the developed areas of the Site drains offsite to the south through the existing storm sewer, or to the existing wetland features for infiltration. EnVision has assumed that the runoff from the upgradient properties (to the north) will be conveyed through the wetland areas. The outlets for each Catchment are summarized below:

##### *On-Site Catchments:*

- Post-Development On-Site Catchment PA1 and PA2: Drains off-site to the wetland complex or to the tributary east of the property.
- Post-Development On-Site Catchment PB: Infiltration through the central wetland feature.
- Post-Development On-Site Catchment PC: Drains to the south storm sewer via overland flow through the stormwater management feature (PD).
- Post-Development On-Site Catchment PD: Drains to the south storm sewer.
- Post-Development On-Site Catchment PE: Drains to the western wetland feature.



#### 4.3.2. WATER BUDGET- POST-DEVELOPMENT CONDITIONS

The Post-Development Water Budget was based on the proposed concept plan presented in Figure 11. The post-development scenario introduces 569 new homes and townhome blocks, new roadways, driveways, parks and stormwater management areas.

The Post-Development scenario presented by SCS in the Functional Servicing and Stormwater Management Report (SCS, 2024) includes the off-site catchment to the north as was included in Pre-Development. Some of this run-on will be directed towards the wetland areas, as indicated in Figure 11. This results in a slight difference in run-on calculations between the pre- and post-conditions.

#### 4.3.3. POST-DEVELOPMENT ANALYSIS

Properties associated with area, slope, soil type, and land cover were analyzed and assigned to each Post-Development sub-catchment. The values assigned to each Post-Development sub-catchment were used to estimate an Infiltration Factor. The Infiltration Factors were reviewed to confirm that they are appropriate and adjusted if necessary.

Assumptions incorporated into the water budget for the Post-Development scenario included:

1. Impervious surfaces (roads, driveways and buildings) are assumed to have a 10% evaporative loss.
2. Runoff is assumed to be conveyed directly to the outlets and not infiltrated.
3. Runoff from external sub-catchments is conveyed through the Site.
4. Infiltration through the naturalized drainage features is included in the Water Budget Summary in Table C-6.
5. There are no mitigation measures developed at this stage for the Site and therefore are not taken into account in the preliminary water balance calculations.

A summary of the Post-Development water budget calculations is provided in Table C-6.

#### 4.3.4. POST-DEVELOPMENT INFILTRATION

In the post-development condition, the Site will contain approximately 182,000 m<sup>2</sup> of impervious surfaces. This would result in a net infiltration of 31,559 m<sup>3</sup>/year or 73 mm/yr through natural pervious areas, including infiltration in the naturalized drainage areas. The net infiltration would reflect approximately 10% of the precipitation (798 mm/yr).

#### 4.3.5. POST-DEVELOPMENT RUNOFF

The construction of impervious land cover will increase the total runoff from the developed area. The total runoff generated by the proposed development area is 149,786 m<sup>3</sup>/yr or 344 mm/year. The total calculated net Post-Development runoff represents approximately 43 % of the annual precipitation.



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#### 4.3.6. COMPARISON WITH PRE-DEVELOPMENT

Table C-6 provides a comparison of the preliminary water budget estimates for the Pre-Development and Post-Development cases. The Post-Development scenario does not incorporate any mitigation measures currently. The total on-site infiltration is reduced by approximately 51% or 32,943 m<sup>3</sup>/yr when compared to the Pre-Development Scenario. It is further noted that the introduction of building areas introduces a runoff component of 40,670 m<sup>3</sup>/yr, which could be utilized as a source for infiltration to reduce the deficit.

The increase in total impervious areas increases the total runoff to 149,786 m<sup>3</sup>/yr, which represents a 462% increase over the pre-development condition. The increased runoff will be managed by the stormwater management system or can be selectively directed to the natural wetland features.

Consideration for downspout disconnection and building roof runoff to infiltration facilities is recommended to reduce the infiltration deficit.

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### 4.4. WATER QUALITY

The water budget analysis must also consider potential changes to water quality that could be experienced in relation to the proposed development. The following sections describe the typical contaminants associated with the current and future land uses.

#### 4.4.1. EXISTING CONDITIONS

The Site is currently vacant. As such, there are no activities present that could potentially impact groundwater quality at this time.

#### 4.4.2. FUTURE CONDITIONS

The proposed Post-Development conditions include new driveway and roadway areas. These areas may be a future source of contamination to groundwater infiltration or surface water runoff by winter road de-icing agents. The most effective method of reducing potential impacts from salt or other winter road de-icing agents is to minimize the mass/volume of material applied through the use of Best Management Practices (BMPs). Any pervious areas used for winter snow storage may also become potential sources of contamination from winter road de-icing agents. BMPs recommend storing snow on impervious surfaces.

The driveway and roadway areas may also be potential sources of petroleum hydrocarbons. These are typically contained in vehicles. These potential releases could result in impairment of water quality by infiltrating into the groundwater. The risk of significant impact from spills at the Site is low considering the only traffic will be the residents who occupy the building.

In pervious areas, soil-enrichment agents (i.e. fertilizers) and/or herbicides may also be a source of contamination. Application of these products should be minimized to reduce potential contamination.



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## 5. CLOSING

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### 5.1. CONCLUSIONS

Based on the information prepared in the Preliminary Water Balance Assessment, EnVision presents the following conclusions and recommendations:

- The climate based water budget indicates that the average annual precipitation over the past thirty-years is about 769.6 mm/yr;
- The pre-development water balance reflects infiltration for the Site of approximately 64,503 m<sup>3</sup>/year, and runoff of 26,648 m<sup>3</sup>/year;
- For the post-development condition without consideration of any mitigation measures, the infiltration will decrease to 31,559 m<sup>3</sup>/year, which represents a 51% overall decrease to net infiltration;
- For the post-development condition without consideration of any mitigation measures, the net runoff will increase to 149,786 m<sup>3</sup>/year, which represents a 462% increase over pre-development condition;
- Construction of new building surfaces will result in a net runoff from roofs of up to 40,670 m<sup>3</sup>/year, which is greater than the infiltration decrease.

Based on the above conclusions, the following recommendations are provided:

- 1) Mitigation measures should be reviewed that consider roof runoff of clean water for potential infiltration through LID initiatives to reduce the infiltration deficit for post-development conditions.
- 2) Feature based water budget analysis at the detailed design stage is recommended to confirm that the wetland features are maintained in post-development;
- 3) The water balance assessment will need to be revised during detailed design to incorporate mitigation (Low Impact Development) measures, and to ensure infiltration deficits are reduced/eliminated.

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### 5.2. QUALIFICATION OF THE ASSESSORS

**Robin Byers, P.Geo., B.Sc.** is a Senior Hydrogeologist and is a practicing member of the Professional Geoscientists of Ontario with over 12 years of hydrogeological experience working in the Greater Toronto Area and Southern Ontario. He has experience in physical and chemical hydrogeology with foundational knowledge of well construction and design, groundwater modeling, pumping test analysis, and construction dewatering. Rob is also a qualified person as defined by O.Reg 63/16 for purposes of preparing water taking and discharge plans.

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### 5.3. CERTIFICATION AND SIGNATURES

EnVision confirms the findings and conclusions and findings of the Hydrogeological Investigation.

Prepared by

Sam Harding, B.Sc.,  
Hydrogeologist

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Reviewed by

Rob Byers, B.Sc., P.Geo.,  
Senior Hydrogeologist

[rbyers@envisionconsultants.ca](mailto:rbyers@envisionconsultants.ca)



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### 5.4. QUALIFIER

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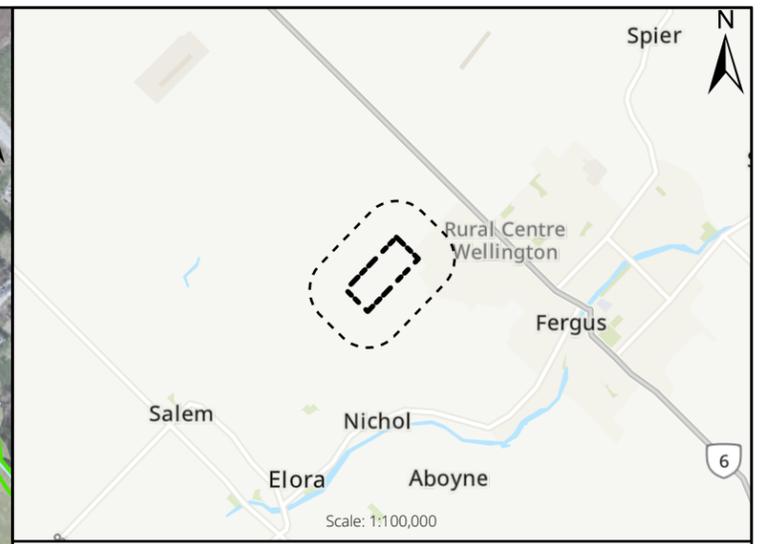
## 6. REFERENCES

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# FIGURES



**LEGEND**

- SITE BOUNDARY
- 500 m STUDY AREA
- WATERCOURSE
- WATERBODY
- WOODED AREAS
- UNEVALUATED WETLAND
- PROVINCIALY SIGNIFICANT WETLAND
- CORE GREENLANDS (COUNTY OF WELLINGTON / TOWNSHIP OF CENTRE WELLINGTON)

TITLE				
SITE LOCATION AND NATURAL HERITAGE FEATURES				
PROJECT				
PRELIMINARY WATER BALANCE ASSESSMENT 6586 BEATTY LINE TOWNSHIP OF CENTRE WELLINGTON, ONTARIO				
CLIENT				
SORBARA/TRIBUTE BRUBACHER HOLDINGS INC.				
PROJECT NO.	DATE	PREPARED BY	APPROVED BY	FIGURE
24-0837	DECEMBER 2024	TP	RB	1



Prepared By: Tanya Peterson  
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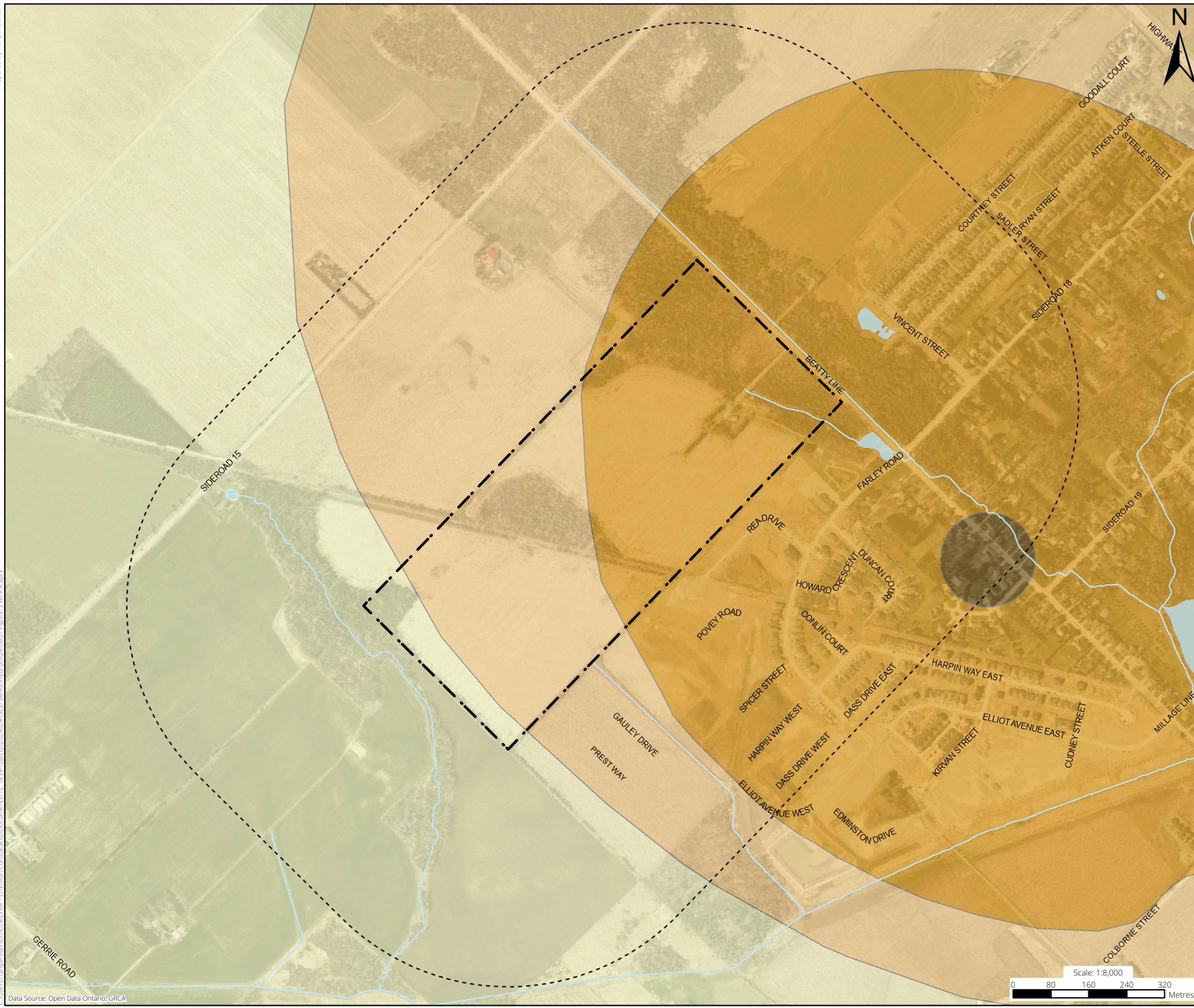


**LEGEND**

- SITE BOUNDARY
- WATERCOURSE
- WATERBODY
- MONITORING WELL (STANTEC 2024)
- BOREHOLE LOCATION (STANTEC, 2024)
- PIEZOMETER (STANTEC 2024)

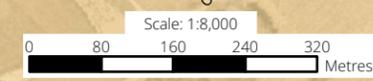
TITLE SITE INSTRUMENTATION BY OTHERS				
PROJECT PRELIMINARY WATER BALANCE ASSESSMENT 6586 BEATTY LINE TOWNSHIP OF CENTRE WELLINGTON, ONTARIO				
CLIENT SORBARA/TRIBUTE BRUBACHER HOLDINGS INC.				
PROJECT NO. 24-0837	DATE DECEMBER 2024	PREPARED BY TP	APPROVED BY RB	FIGURE 2





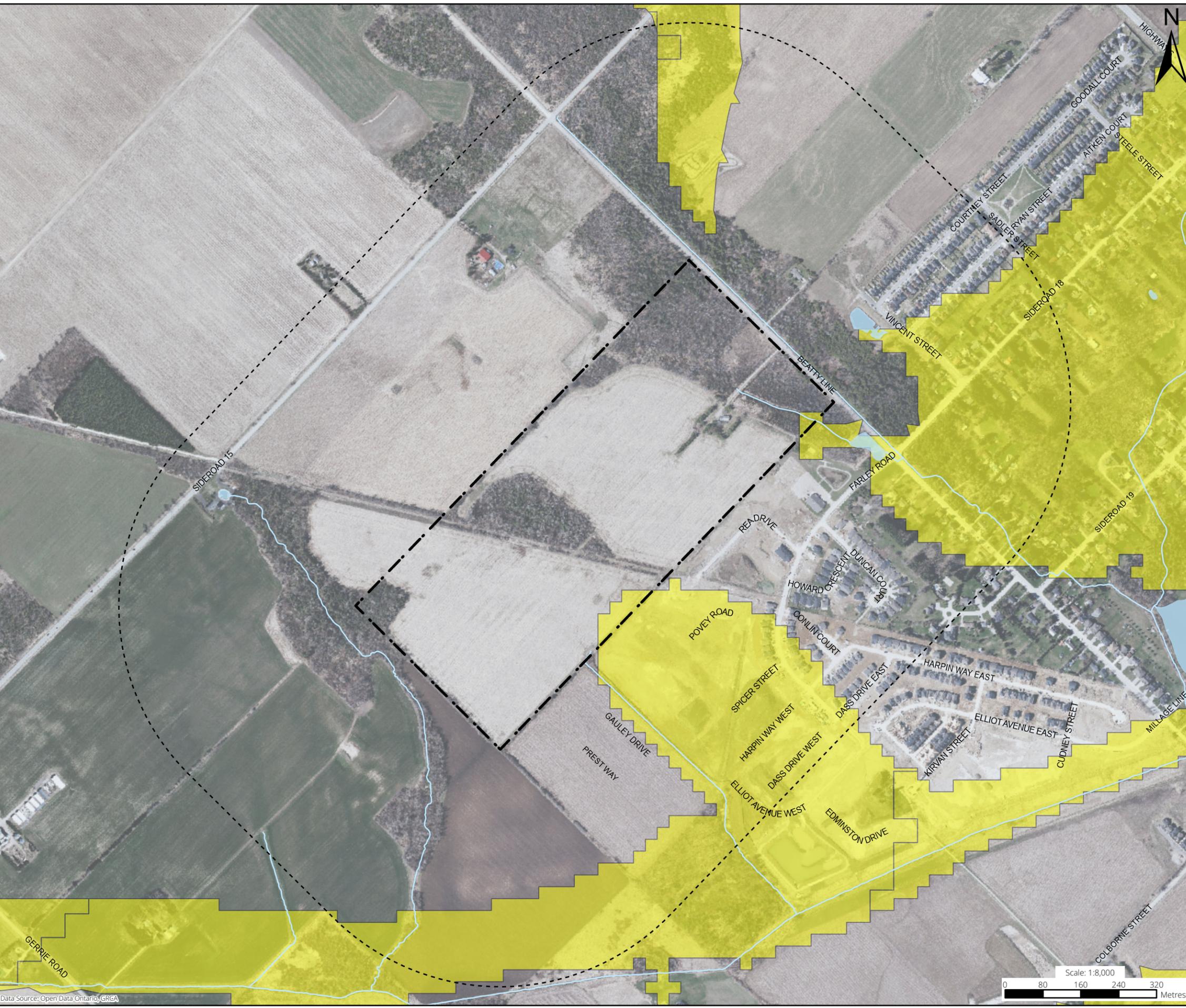
**LEGEND**

- SITE BOUNDARY
- 500 m BUFFER
- WATERBODY
- WATERCOURSE
- WHPA A
- WHPA B
- WHPA C
- WHPA D



TITLE				
WELLHEAD PROTECTION AREAS				
PROJECT				
PRELIMINARY WATER BALANCE ASSESSMENT 6586 BEATTY LINE TOWNSHIP OF CENTRE WELLINGTON, ONTARIO				
CLIENT				
SORBARA/TRIBUTE BRUBACHER HOLDINGS INC.				
PROJECT NO.	DATE	PREPARED BY	APPROVED BY	FIGURE
24-0837	DECEMBER 2024	TP	RB	3

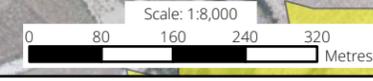
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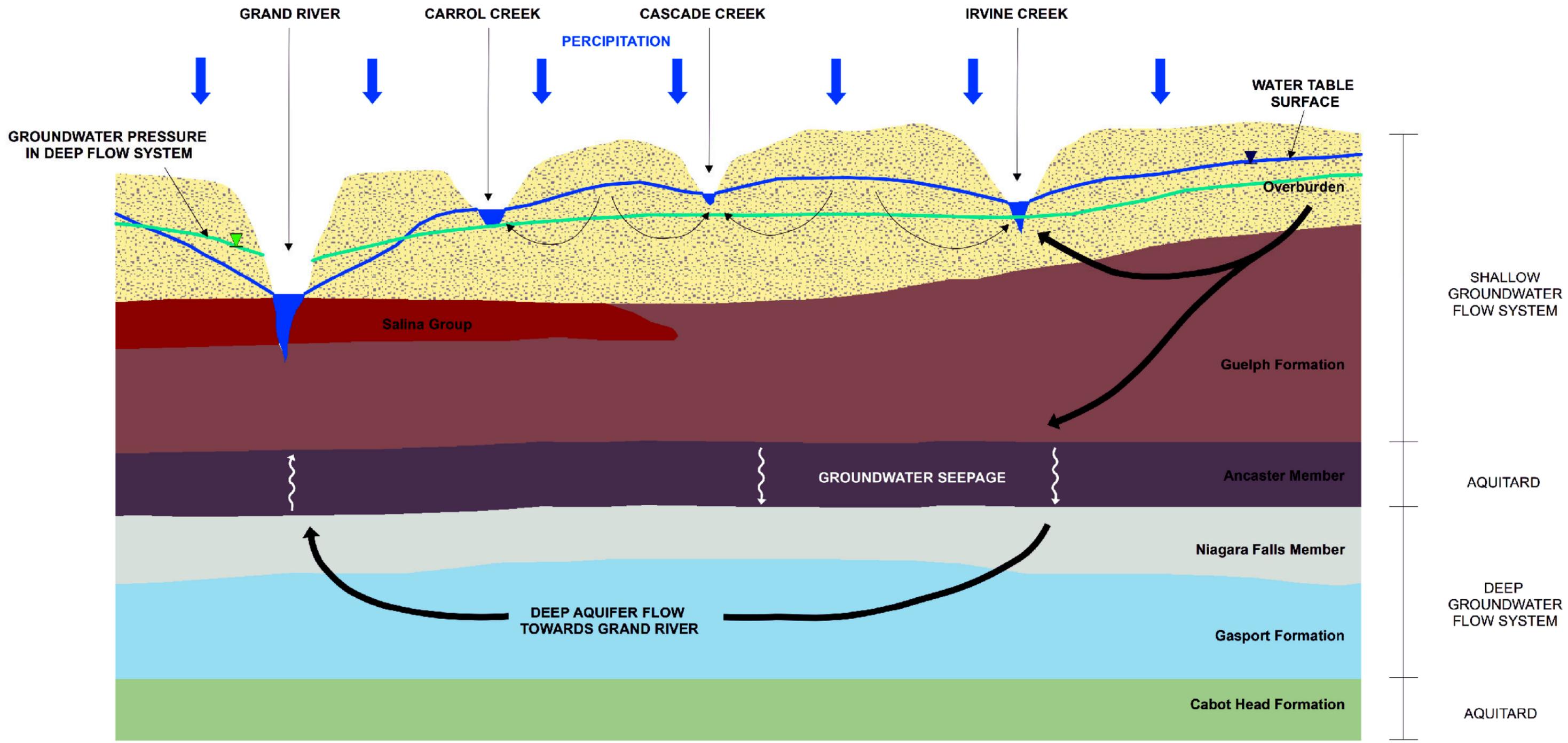


**LEGEND**

- SITE BOUNDARY
- 500 m BUFFER
- WATERBODY
- WATERCOURSE
- SIGNIFICANT GROUNDWATER RECHARGE AREA (SGRA)

TITLE				
SIGNIFICANT GROUNDWATER RECHARGE AREA				
PROJECT				
PRELIMINARY WATER BALANCE ASSESSMENT 6586 BEATTY LINE TOWNSHIP OF CENTRE WELLINGTON, ONTARIO				
CLIENT				
SORBARA/TRIBUTE BRUBACHER HOLDINGS INC.				
PROJECT NO.	DATE	PREPARED BY	APPROVED BY	FIGURE
24-0837	DECEMBER 2024	TP	RB	4





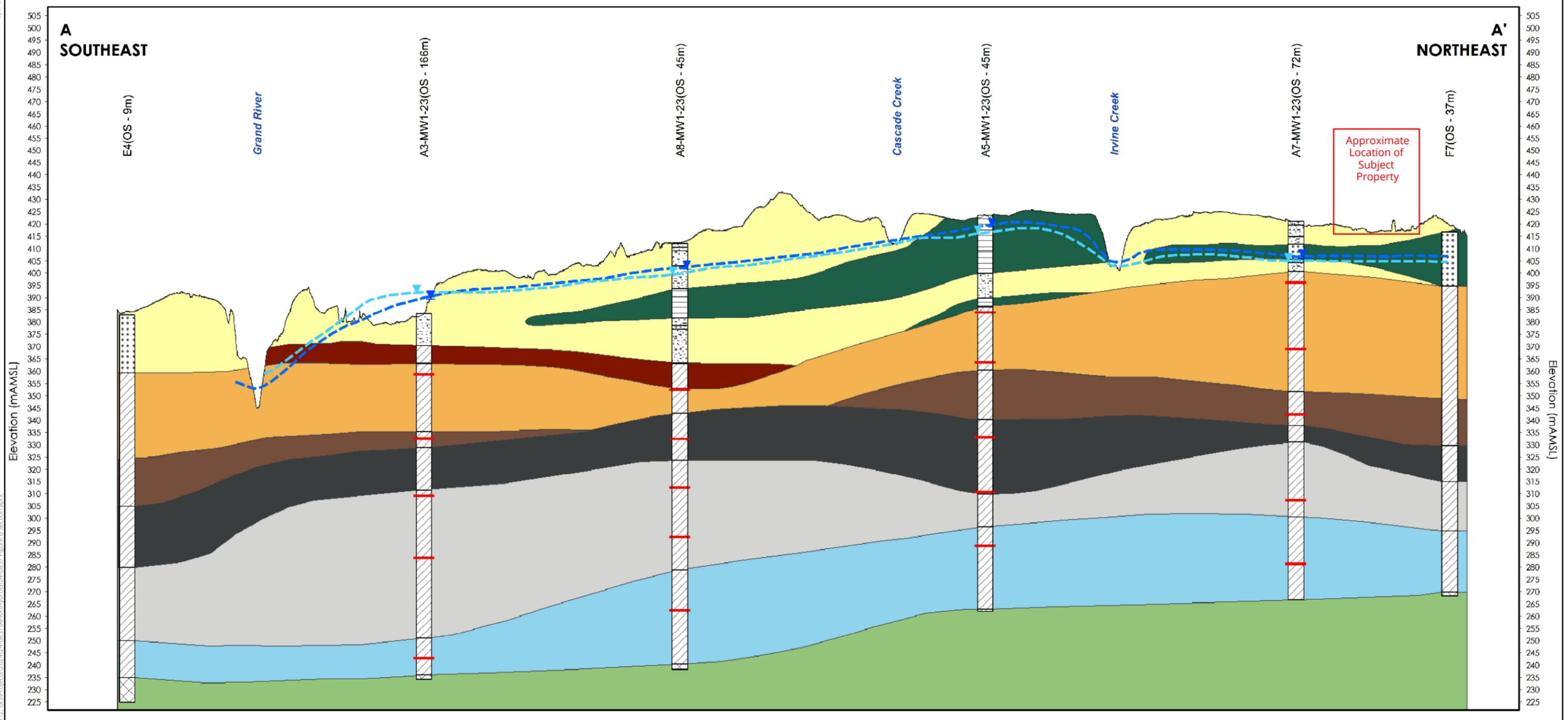
**Legend**

- Existing Groundwater Pressure/Elevation in Deep Aquifer
- Water Table Surface in Shallow Aquifer

CLIENT SORBARA/TRIBUTE BRUBACHER HOLDINGS INC.		TITLE STANTEC CONCEPTUAL HYDROGEOLOGICAL MODEL		
PROJECT PRELIMINARY WATER BALANCE ASSESSMENT 6586 BEATTY LINE TOWNSHIP OF CENTRE WELLINGTON, ONTARIO		PROJECT NO. 24-0837	DATE DECEMBER 2024	PREPARED BY TP
		APPROVED BY RB	FIGURE 5	



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Legend		Stratigraphic Nomenclature		Borehole Material	
	Interpreted Deep Bedrock Groundwater Elevation		Elmira Moraine Sand		Sand and Gravel
	Interpreted Shallow Bedrock Groundwater Elevation		Maryhill Till		Silt Till
	Shallow Bedrock Groundwater Level		Salina		Clayey Silt Till
	Deep Bedrock Groundwater Level		Guelph (Hanlon)		Dolostone
	Vibrating Wire Piezometer		Guelph (Wellington)		Shale
			Goat Island (Ancaster)		
			Goat Island (Niagara Falls)		
			Gasport		
			Cabot Head		

**CLIENT**  
 SORBARA/TRIBUTE BRUBACHER HOLDINGS INC.

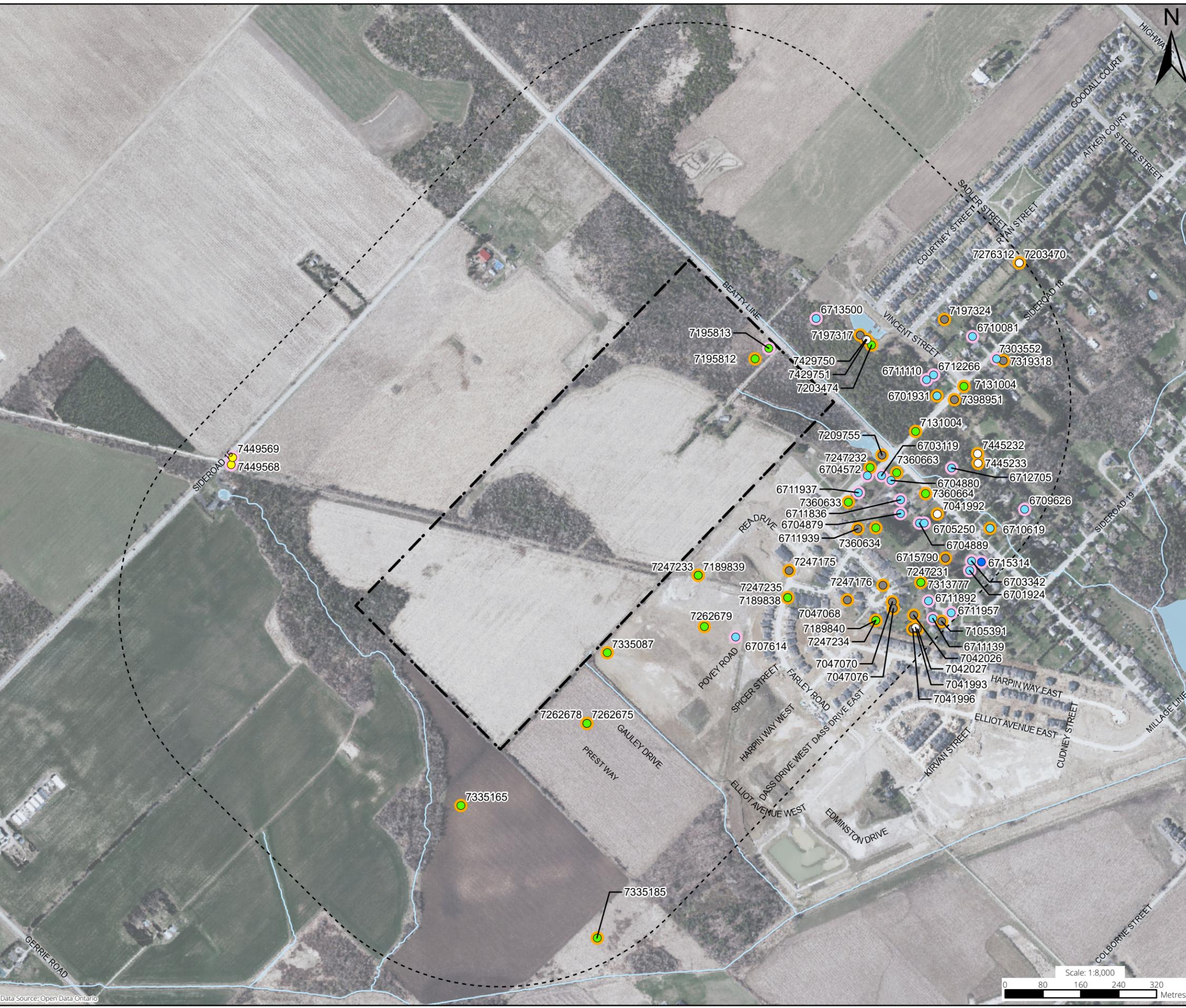
**PROJECT**  
 PRELIMINARY WATER BALANCE ASSESSMENT  
 6586 BEATTY LINE  
 TOWNSHIP OF CENTRE WELLINGTON, ONTARIO

**TITLE**  
 STANTEC STRATIGRAPHIC CROSS SECTION



<b>PROJECT NO.</b> 24-0837	<b>DATE</b> DECEMBER 2024	<b>PREPARED BY</b> TP	<b>APPROVED BY</b> RB	<b>FIGURE</b> 6
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Prepared By: Tanya Peterson  
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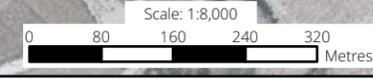
**LEGEND**

- SITE BOUNDARY
- 500 m BUFFER
- WATERBODY
- WATERCOURSE

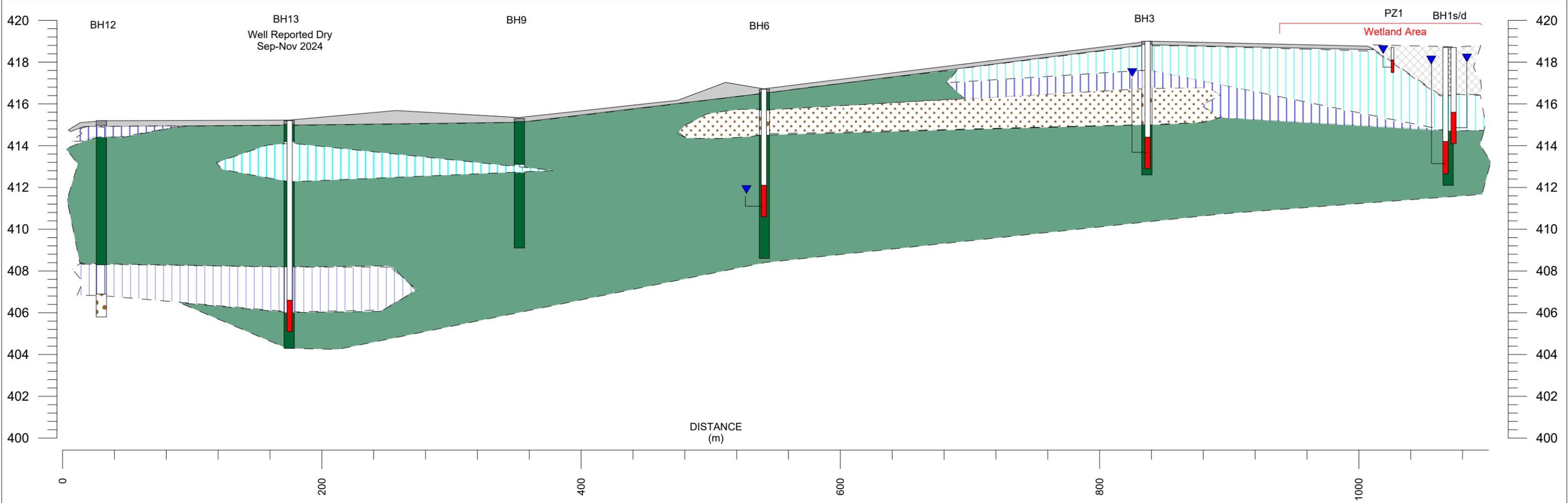
**MECP WATER WELL LOCATION:**

- ABANDONED
- OTHER STATUS
- OBSERVATION WELLS
- WATER SUPPLY
- WATER SUPPLY - MUNICIPAL
- UNKNOWN
- BEDROCK WELL
- OVERBURDEN WELL

TITLE				
MECP WATER WELL LOCATIONS				
PROJECT				
PRELIMINARY WATER BALANCE ASSESSMENT 6586 BEATTY LINE TOWNSHIP OF CENTRE WELLINGTON, ONTARIO				
CLIENT				
SORBARA/TRIBUTE BRUBACHER HOLDINGS INC.				
PROJECT NO.	DATE	PREPARED BY	APPROVED BY	FIGURE
24-0837	DECEMBER 2024	TP	RB	7



Elev. (m) A A' Elev. (m)



**LEGEND**

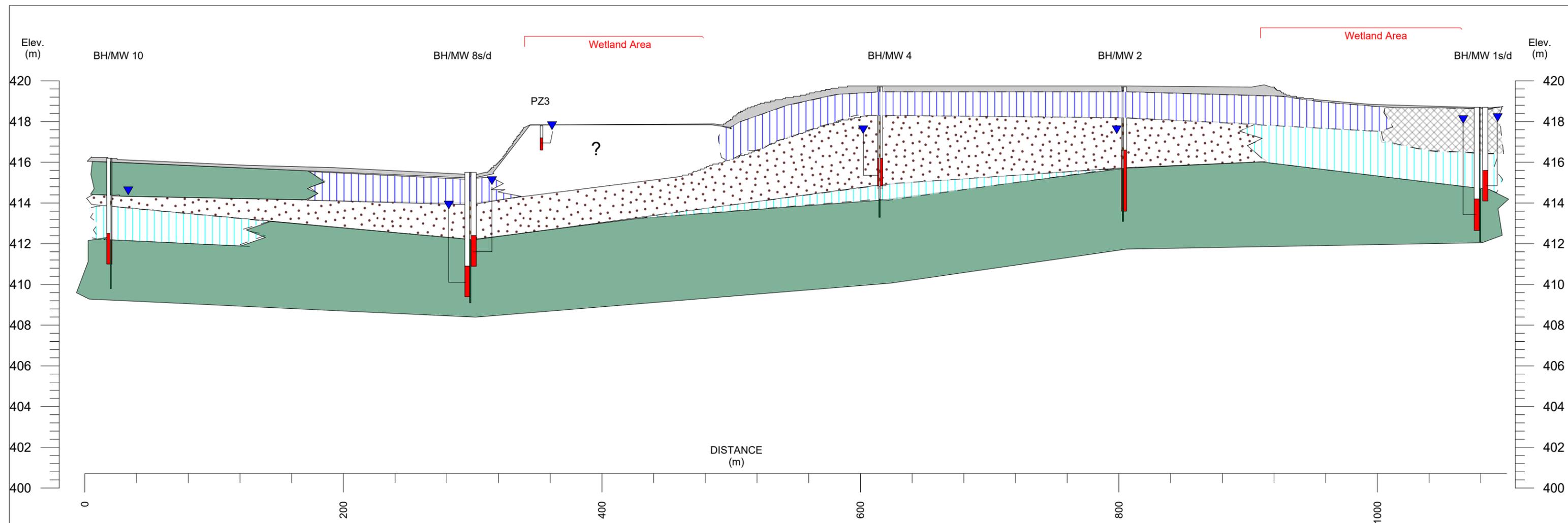
- Topsoil
- Earth fill
- Silt
- Silty clay
- Sand
- Sandy silt till
- Casing
- Screen
- Water Level (Sep. 2024, taken by Soil Engineers)



<p>CLIENT</p> <p>SORBARA/TRIBUTE BRUBACHER HOLDINGS INC.</p>	<p>TITLE</p> <p>SITE SPECIFIC CROSS SECTION (A-A')</p>	
<p>PROJECT</p> <p>PRELIMINARY WATER BALANCE ASSESSMENT 6586 BEATTY LINE NORTH TOWNSHIP OF CENTRE WELLINGTON, ON</p>	<p>FIGURE 8</p> <p>PROJECT NO. 24-0837</p>	<p>DATE:</p> <p>December 5, 2024</p>

B

B'



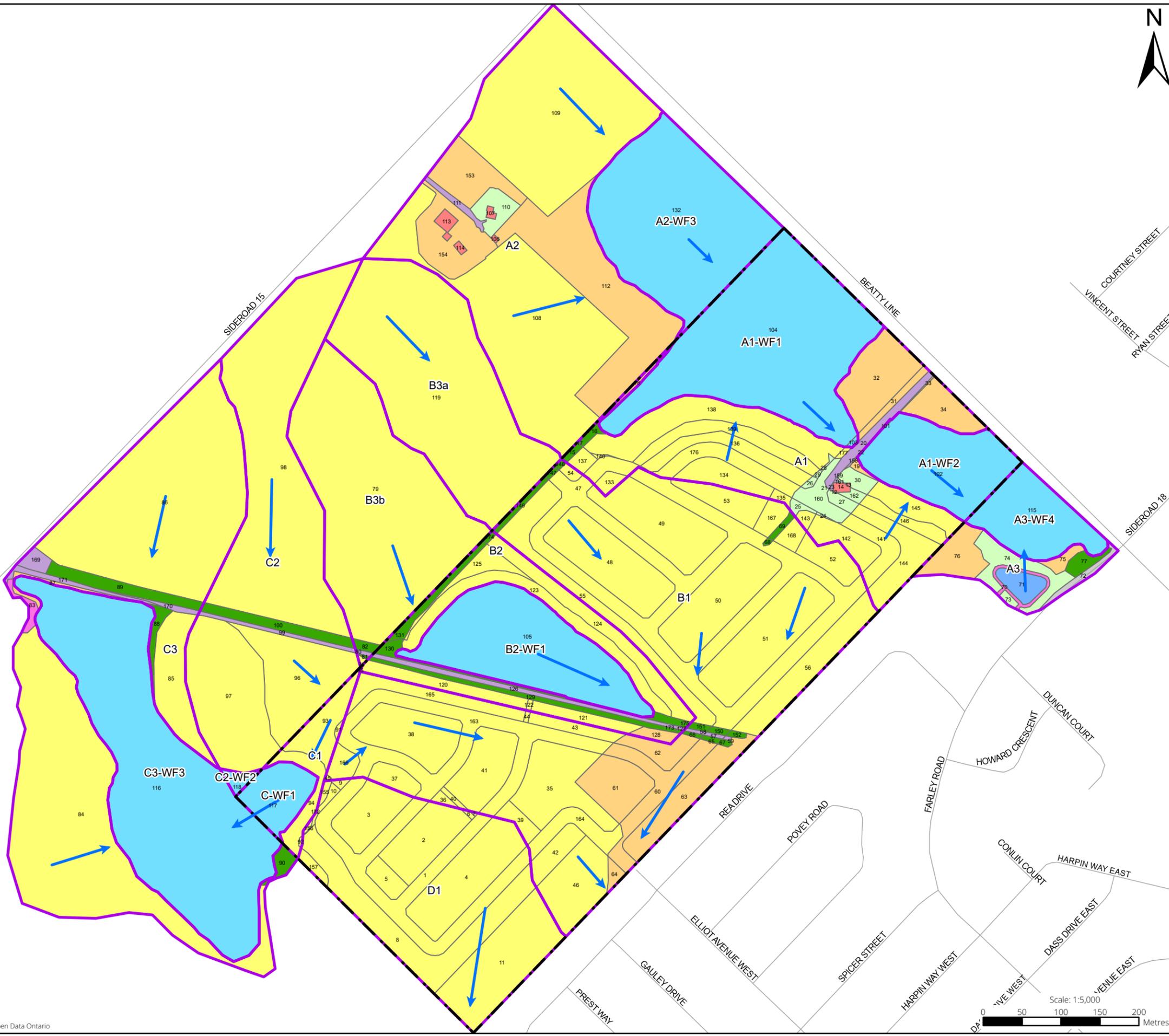
LEGEND

- Topsoil
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- Sandy silt till
- Silty clay
- Sand
- Casing
- Screen
- Water Level (Sep. 2024, taken by Soil Engineers)



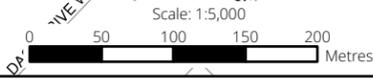
CLIENT SORBAR/TRIBUTE BRUBACHER HOLDINGS INC.	TITLE SITE SPECIFIC CROSS SECTION (B-B')	
PROJECT PRELIMINARY WATER BALANCE ASSESSMENT 6586 BEATTY LINE NORTH TOWNSHIP OF CENTRE WELLINGTON, ON	FIGURE 9  PROJECT NO. 24-0837	DATE: December 5, 2024

Prepared By: Tanya Peterson  
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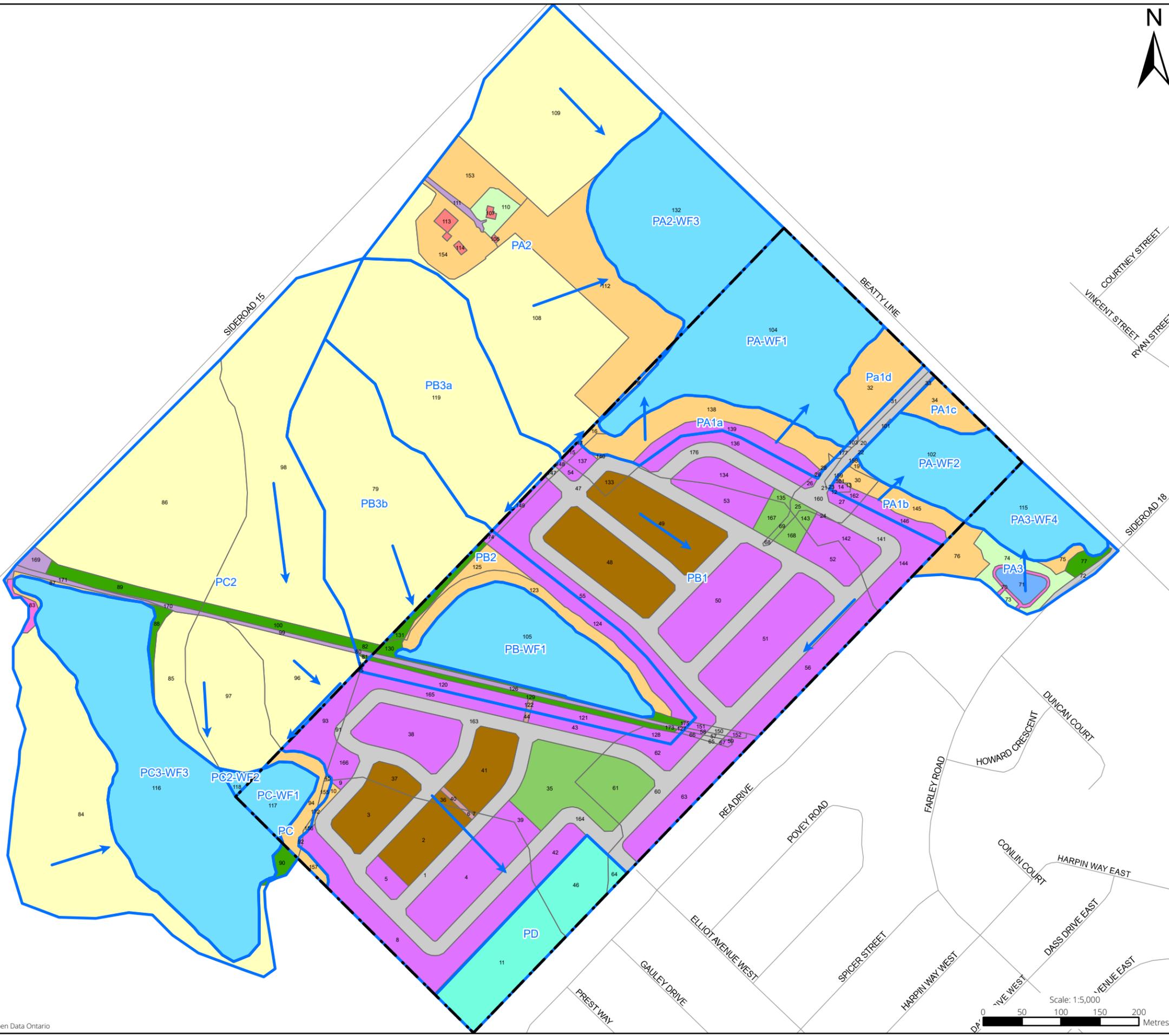


- LEGEND**
- SITE BOUNDARY
  - PRE DEVELOPMENT CATCHMENTS
  - BUILDING
  - CULTIVATED
  - GRAVEL
  - LAWN
  - PAVEMENT / CONCRETE
  - POND
  - ROAD
  - UNCULTIVATED
  - WETLAND
  - WOODLAND
  - PRE DEVELOPMENT FLOW DIRECTION

TITLE PRE DEVELOPMENT CATCHMENT AREAS				
PROJECT PRELIMINARY WATER BALANCE ASSESSMENT 6586 BETTY LINE TOWNSHIP OF CENTRE WELLINGTON, ONTARIO				
CLIENT SORBARA/TRIBUTE BRUBACHER HOLDINGS INC.				
PROJECT NO. 24-0837	DATE DECEMBER 2024	PREPARED BY TP	APPROVED BY RB	FIGURE 10

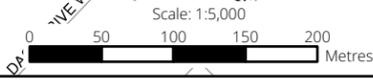


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 Data Source: Open Data Ontario



LEGEND	
	SITE BOUNDARY
	POST DEVELOPMENT CATCHMENTS
	BUILDING
	CULTIVATED
	DETACHED
	PARK
	GRAVEL
	LAWN
	PAVEMENT / CONCRETE
	POND
	ROAD
	SWMP
	TOWNHOUSE
	UNCULTIVATED
	WALKWAY
	WETLAND
	WOODLAND
	POST DEVELOPMENT FLOW DIRECTION

TITLE POST DEVELOPMENT CATCHMENT AREAS				
PROJECT PRELIMINARY WATER BALANCE ASSESSMENT 6586 BEATTY LINE TOWNSHIP OF CENTRE WELLINGTON, ONTARIO				
CLIENT SORBARA/TRIBUTE BRUBACHER HOLDINGS INC.				
PROJECT NO. 24-0837	DATE DECEMBER 2024	PREPARED BY TP	APPROVED BY RB	FIGURE 11





# APPENDIX A:

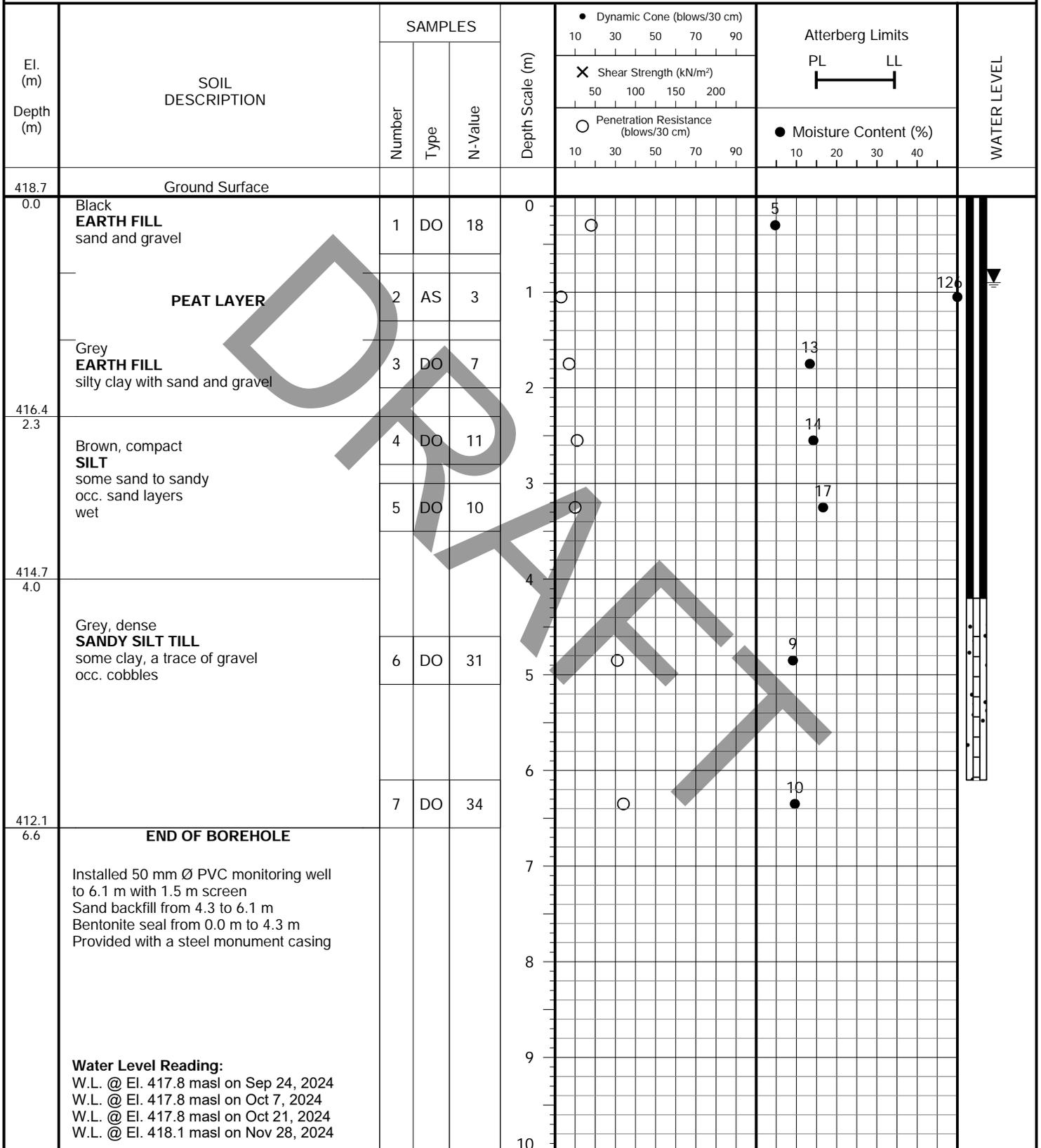
*Borehole Logs (Soil Engineers, 2024)*

**PROJECT DESCRIPTION:** Proposed Residential Development

**METHOD OF BORING:** Solid Stem Augers

**PROJECT LOCATION:** 6586 Beatty Line North,  
Township of Centre Wellington (Fergus)

**DRILLING DATE:** September 5, 2024



JOB NO.: 2311-S044

# LOG OF BOREHOLE: BH/MW 1S

FIGURE NO.: 2

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: 6586 Beatty Line North,  
Township of Centre Wellington (Fergus)

DRILLING DATE: September 5, 2024

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES			Depth Scale (m)	Dynamic Cone (blows/30 cm)		Atterberg Limits		WATER LEVEL
		Number	Type	N-Value		10	30	50	70	
418.7	Ground Surface									
0.0	Black <b>EARTH FILL</b> sand and gravel				0					
	<b>PEAT LAYER</b>				1					
	Grey <b>EARTH FILL</b> silty clay with sand and gravel				2					
416.4 2.3	Brown, compact <b>SILT</b> some sand to sandy occ. sand layers wet				3					
414.7 4.0	Grey, dense <b>SANDY SILT TILL</b> some clay, a trace of gravel				4					
414.1 4.6	occ. cobbles				5					
	<b>END OF BOREHOLE</b>				6					
	(Shallow Well) Installed 50 mm Ø PVC monitoring well to 4.6 m with 1.5 m screen Sand backfill from 2.7 to 4.6 m Bentonite seal from 0.0 m to 2.7 m Provided with a steel monument casing				7					
	<b>Water Level Reading:</b> W.L. @ El. 417.9 masl on Sep 24, 2024 W.L. @ El. 417.9 masl on Oct 7, 2024 W.L. @ El. 417.8 masl on Oct 21, 2024 W.L. @ El. 417.9 masl on Nov 28, 2024				8					
					9					
					10					

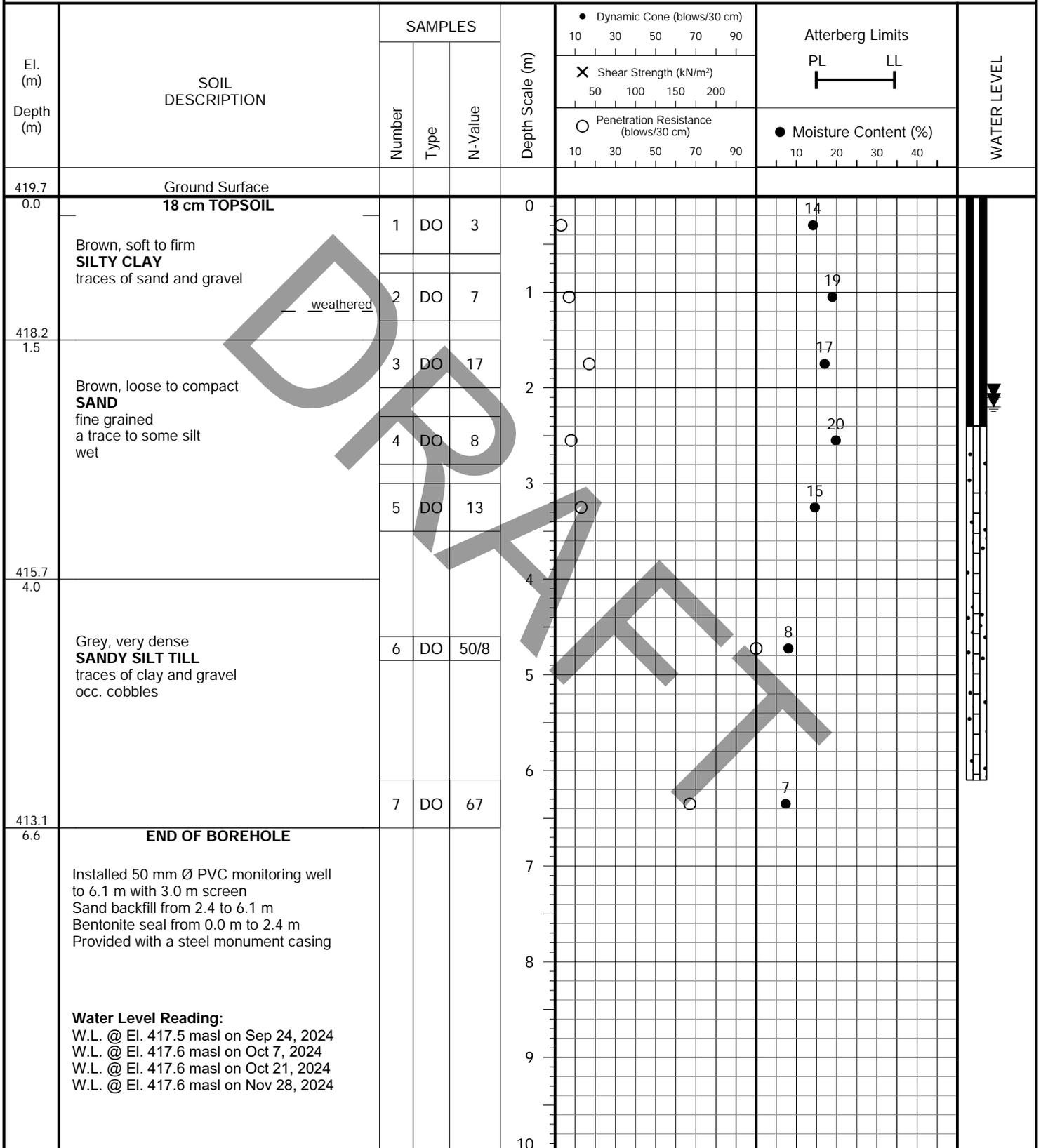


**PROJECT DESCRIPTION:** Proposed Residential Development

**METHOD OF BORING:** Solid Stem Augers

**PROJECT LOCATION:** 6586 Beatty Line North,  
Township of Centre Wellington (Fergus)

**DRILLING DATE:** August 29, 2024



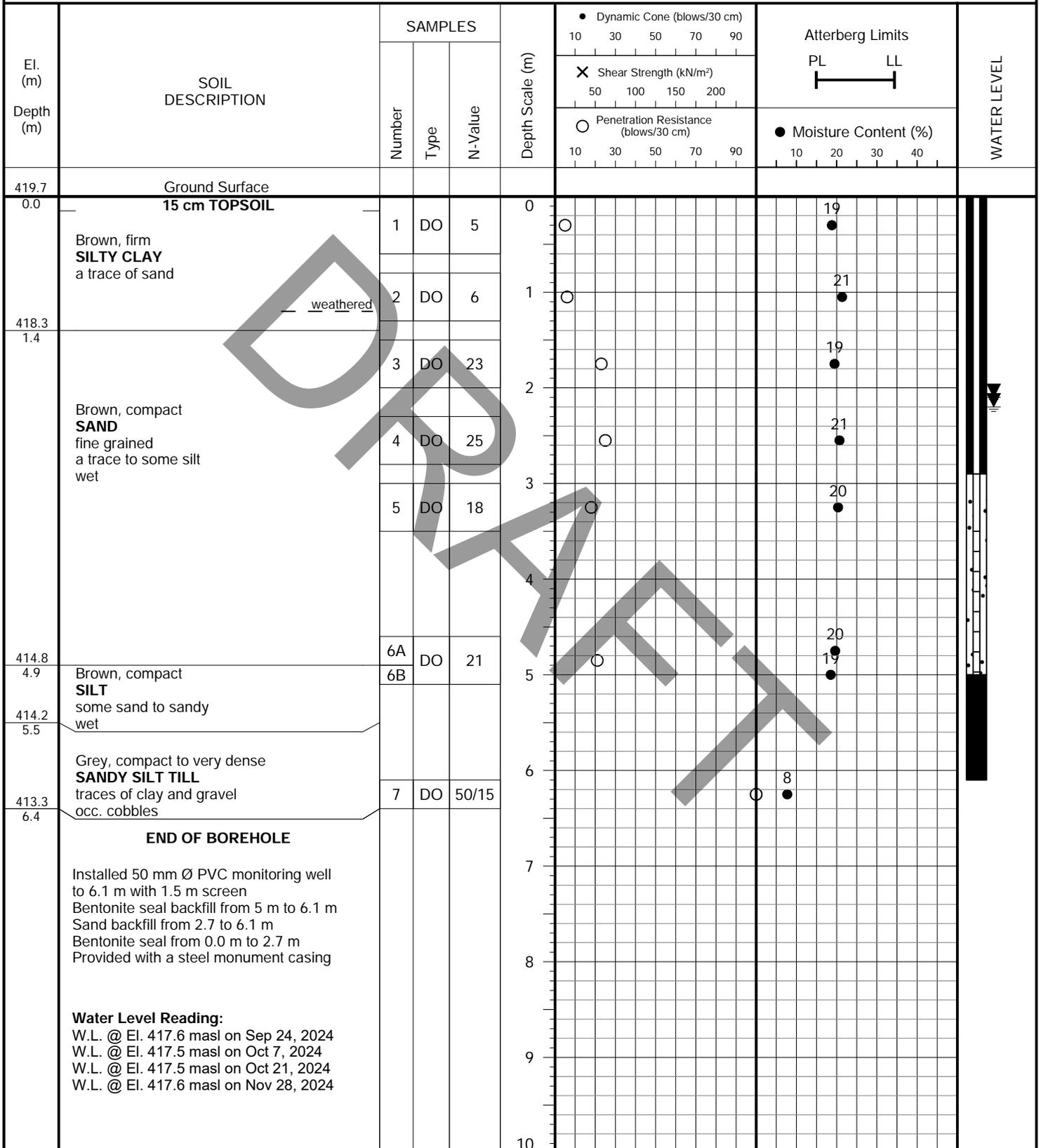


**PROJECT DESCRIPTION:** Proposed Residential Development

**METHOD OF BORING:** Solid Stem Augers

**PROJECT LOCATION:** 6586 Beatty Line North,  
Township of Centre Wellington (Fergus)

**DRILLING DATE:** August 29, 2024

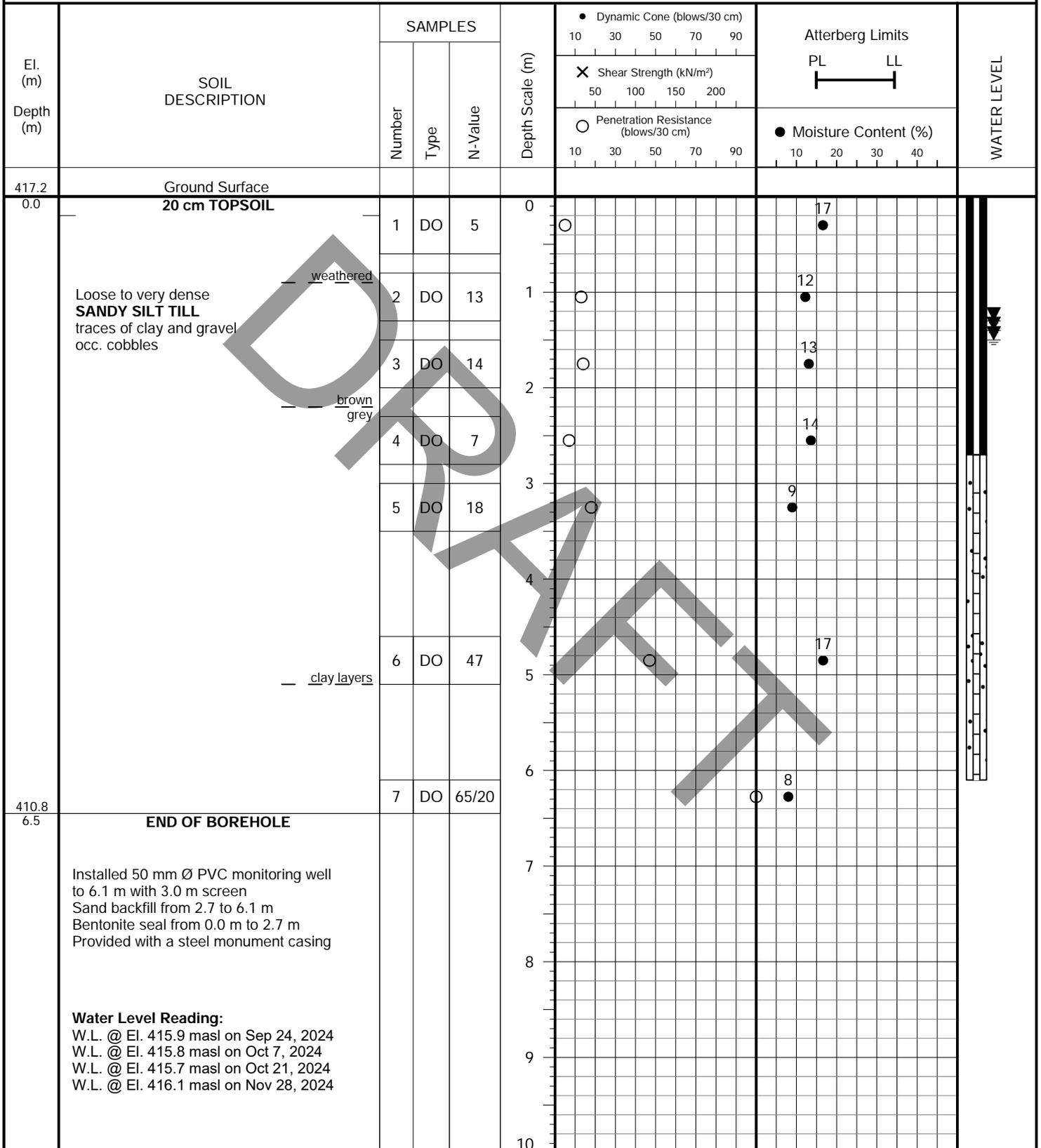


**PROJECT DESCRIPTION:** Proposed Residential Development

**METHOD OF BORING:** Solid Stem Augers

**PROJECT LOCATION:** 6586 Beatty Line North,  
Township of Centre Wellington (Fergus)

**DRILLING DATE:** September 4, 2024

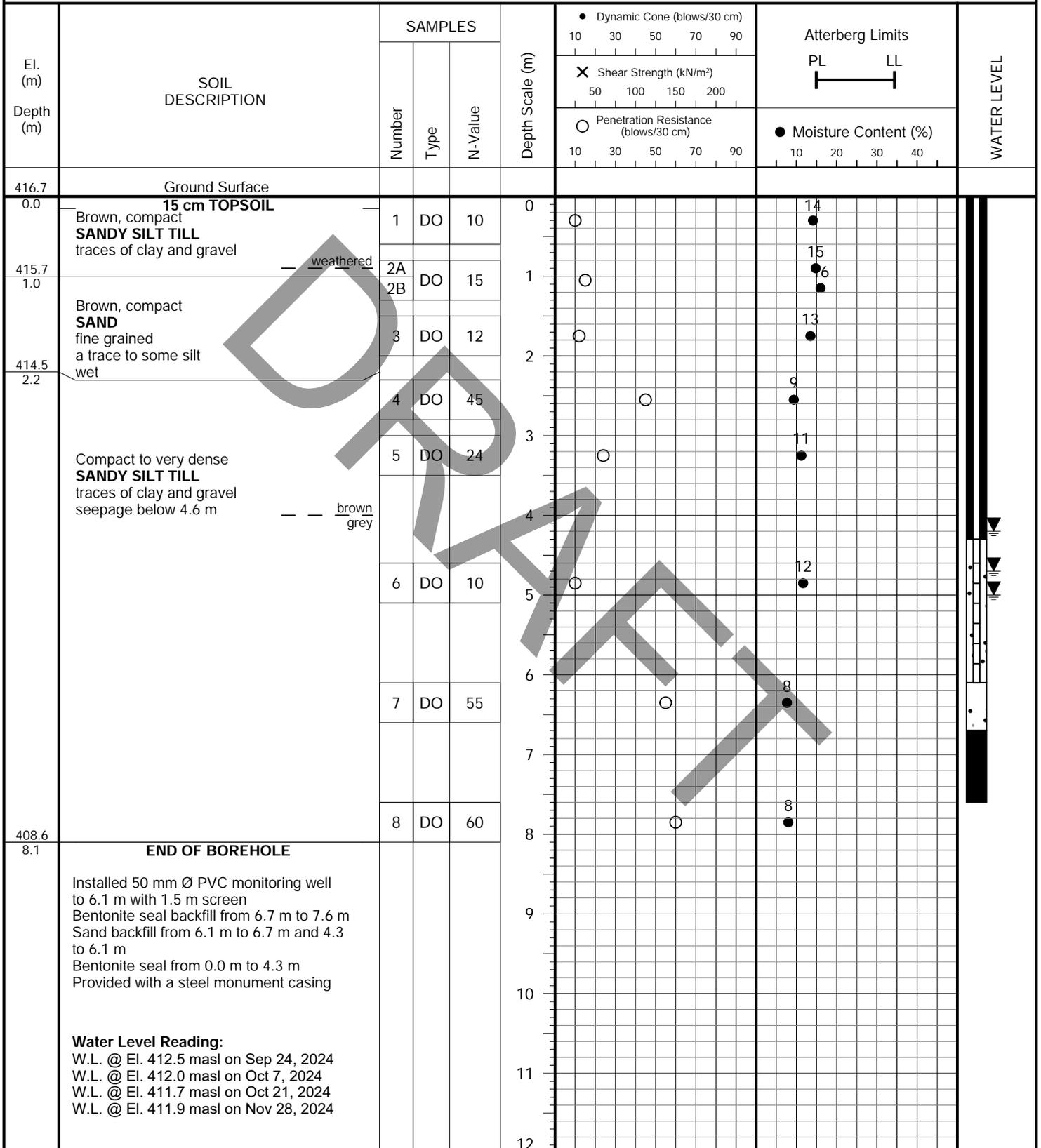


**PROJECT DESCRIPTION:** Proposed Residential Development

**METHOD OF BORING:** Solid Stem Augers

**PROJECT LOCATION:** 6586 Beatty Line North,  
Township of Centre Wellington (Fergus)

**DRILLING DATE:** September 4, 2024

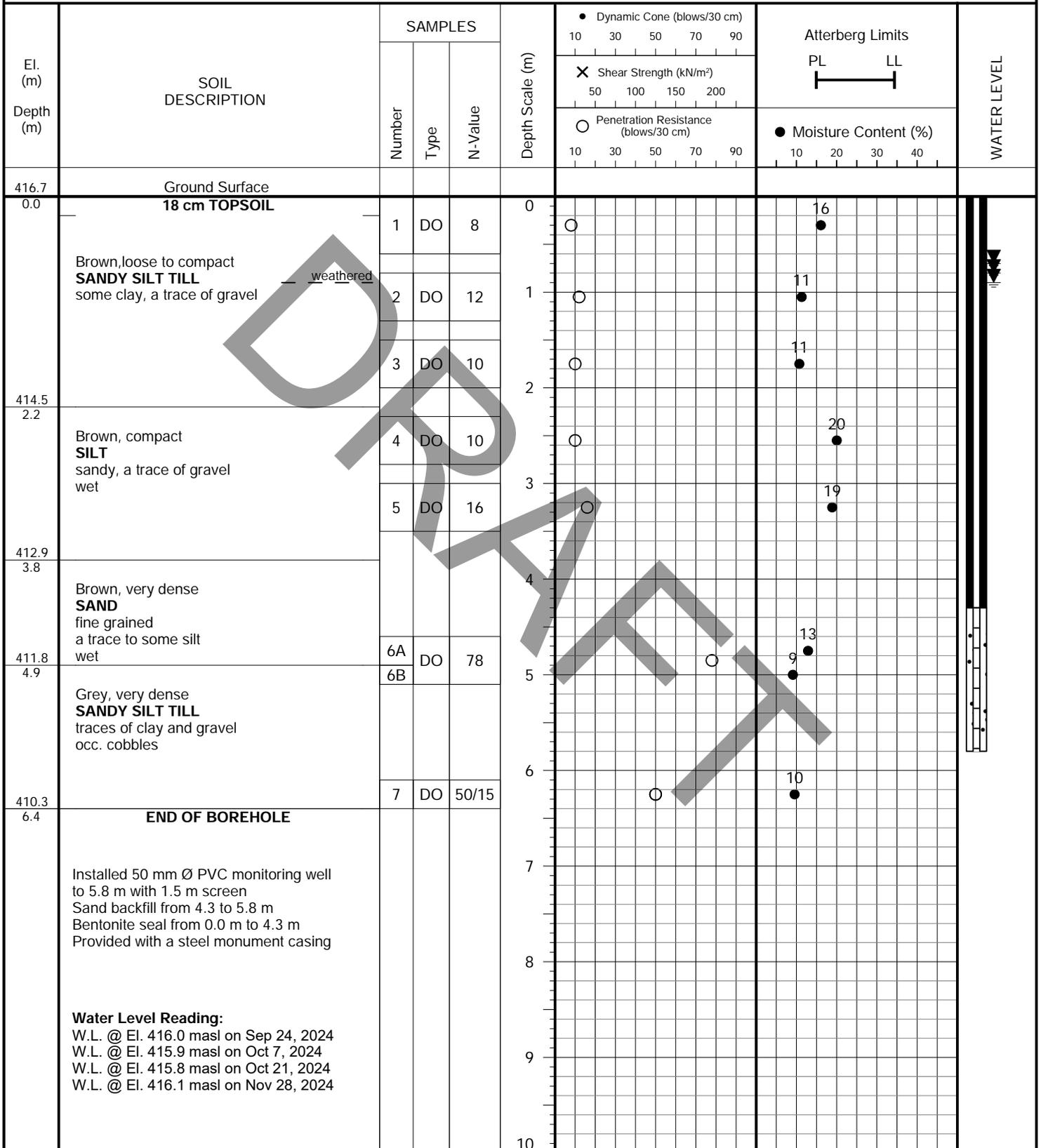


**PROJECT DESCRIPTION:** Proposed Residential Development

**METHOD OF BORING:** Solid Stem Augers

**PROJECT LOCATION:** 6586 Beatty Line North,  
Township of Centre Wellington (Fergus)

**DRILLING DATE:** August 30, 2024

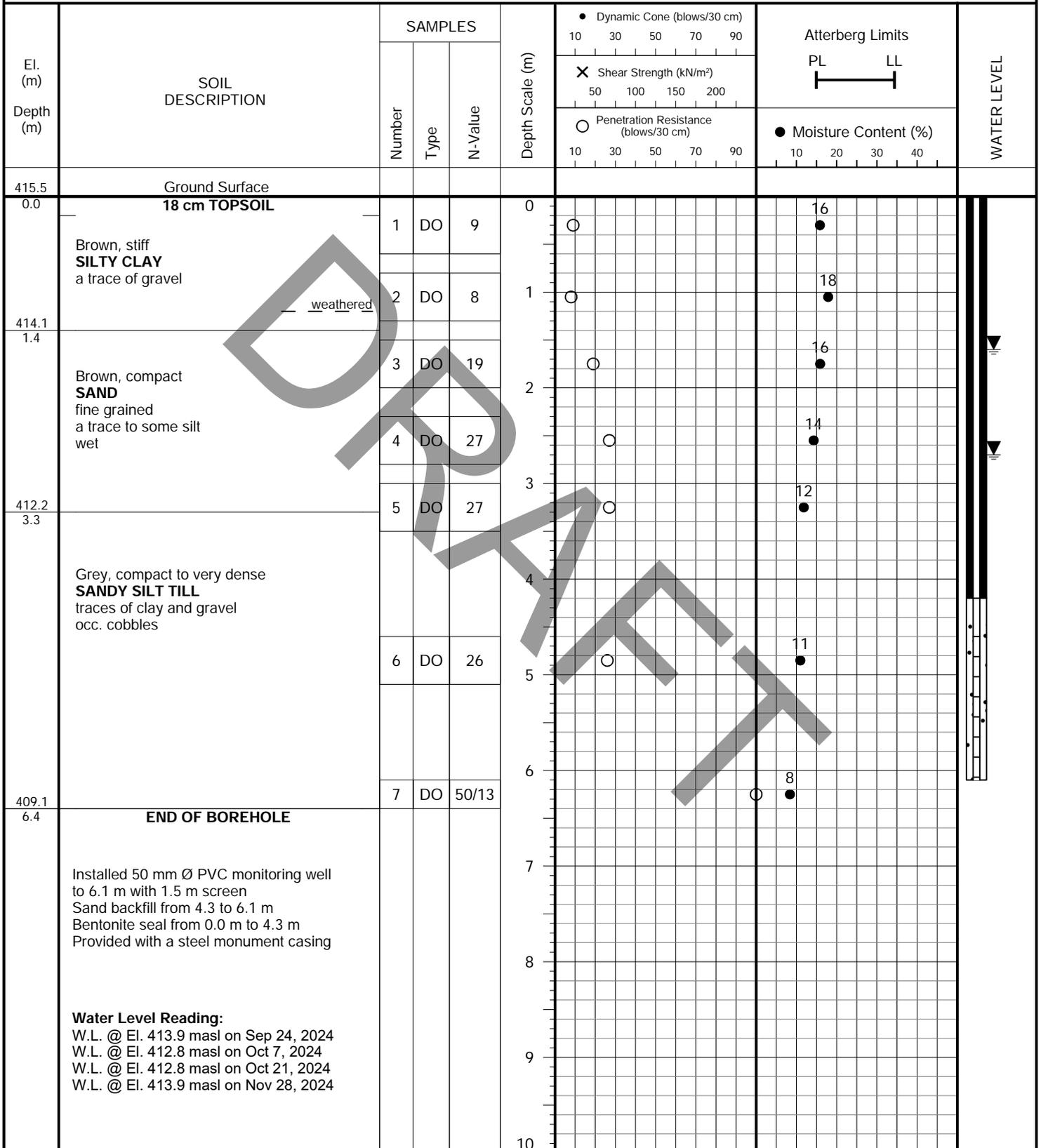


**PROJECT DESCRIPTION:** Proposed Residential Development

**METHOD OF BORING:** Solid Stem Augers

**PROJECT LOCATION:** 6586 Beatty Line North,  
Township of Centre Wellington (Fergus)

**DRILLING DATE:** September 3, 2024



**PROJECT DESCRIPTION:** Proposed Residential Development

**METHOD OF BORING:** Solid Stem Augers

**PROJECT LOCATION:** 6586 Beatty Line North,  
Township of Centre Wellington (Fergus)

**DRILLING DATE:** September 3, 2024

El. (m)	SOIL DESCRIPTION	SAMPLES			Depth Scale (m)	Dynamic Cone (blows/30 cm)		Atterberg Limits		WATER LEVEL
		Number	Type	N-Value		10	30	50	70	
415.5	Ground Surface									
0.0	<b>18 cm TOPSOIL</b>				0					
	Brown, stiff <b>SILTY CLAY</b> a trace of gravel  weathered				1					
414.1					1.4					
	Brown, compact <b>SAND</b> fine grained a trace to some silt wet				2					
412.2					3					
	Grey, compact to very dense <b>SANDY SILT TILL</b> traces of clay and gravel occ. cobbles				4					
410.9					4.6					
	<b>END OF BOREHOLE</b>  (Shallow Well) Installed 50 mm Ø PVC monitoring well to 4.6 m with 1.5 m screen Sand backfill from 2.4 to 4.6 m Bentonite seal from 0.0 m to 2.4 m Provided with a steel monument casing  <b>Water Level Reading:</b> W.L. @ El. 414.7 masl on Sep 24, 2024 W.L. @ El. 414.6 masl on Oct 7, 2024 W.L. @ El. 414.6 masl on Oct 21, 2024 W.L. @ El. 415.1 masl on Nov 28, 2024				5					
					6					
					7					
					8					
					9					
					10					

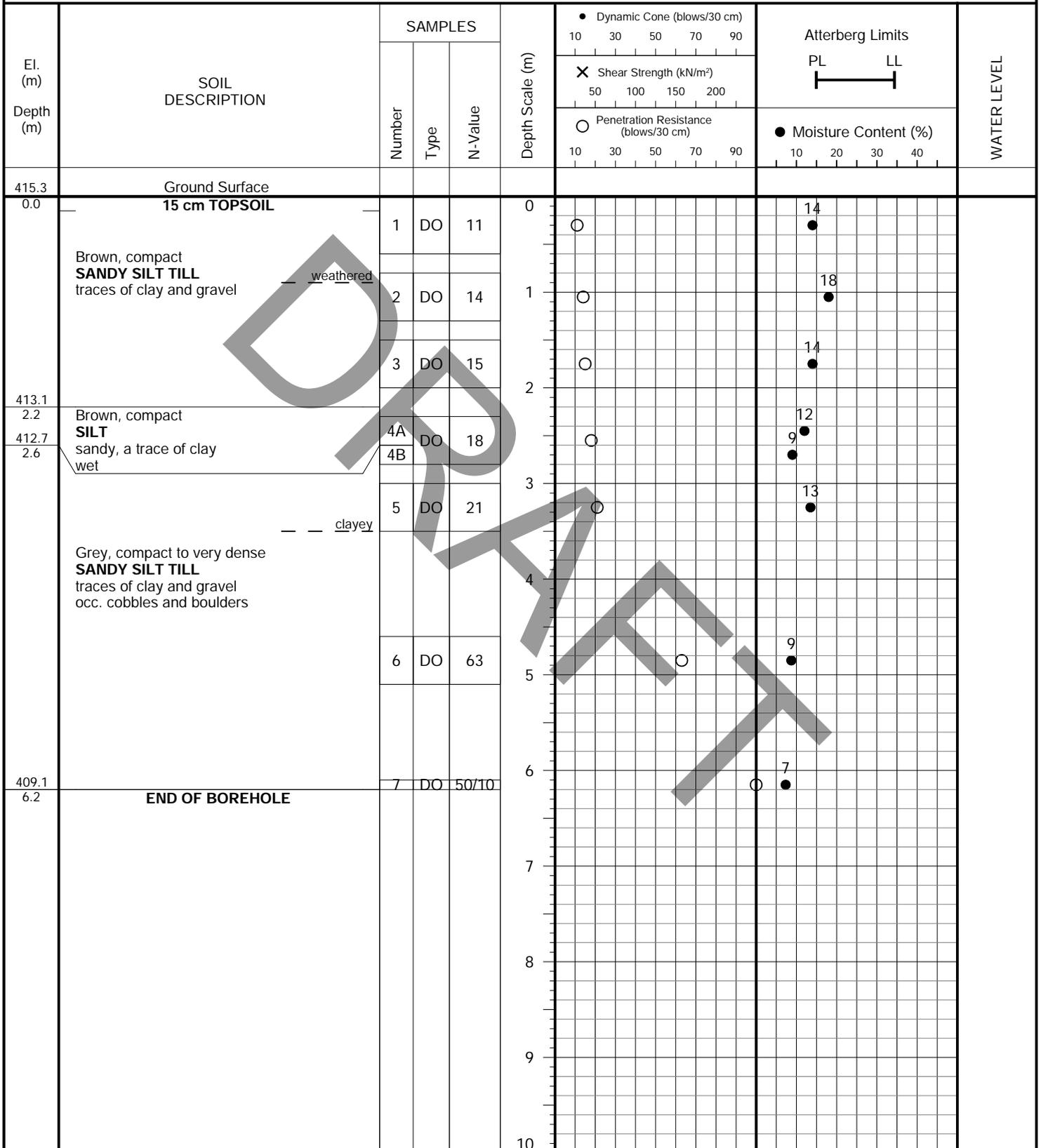


**PROJECT DESCRIPTION:** Proposed Residential Development

**METHOD OF BORING:** Solid Stem Augers

**PROJECT LOCATION:** 6586 Beatty Line North,  
Township of Centre Wellington (Fergus)

**DRILLING DATE:** September 4, 2024

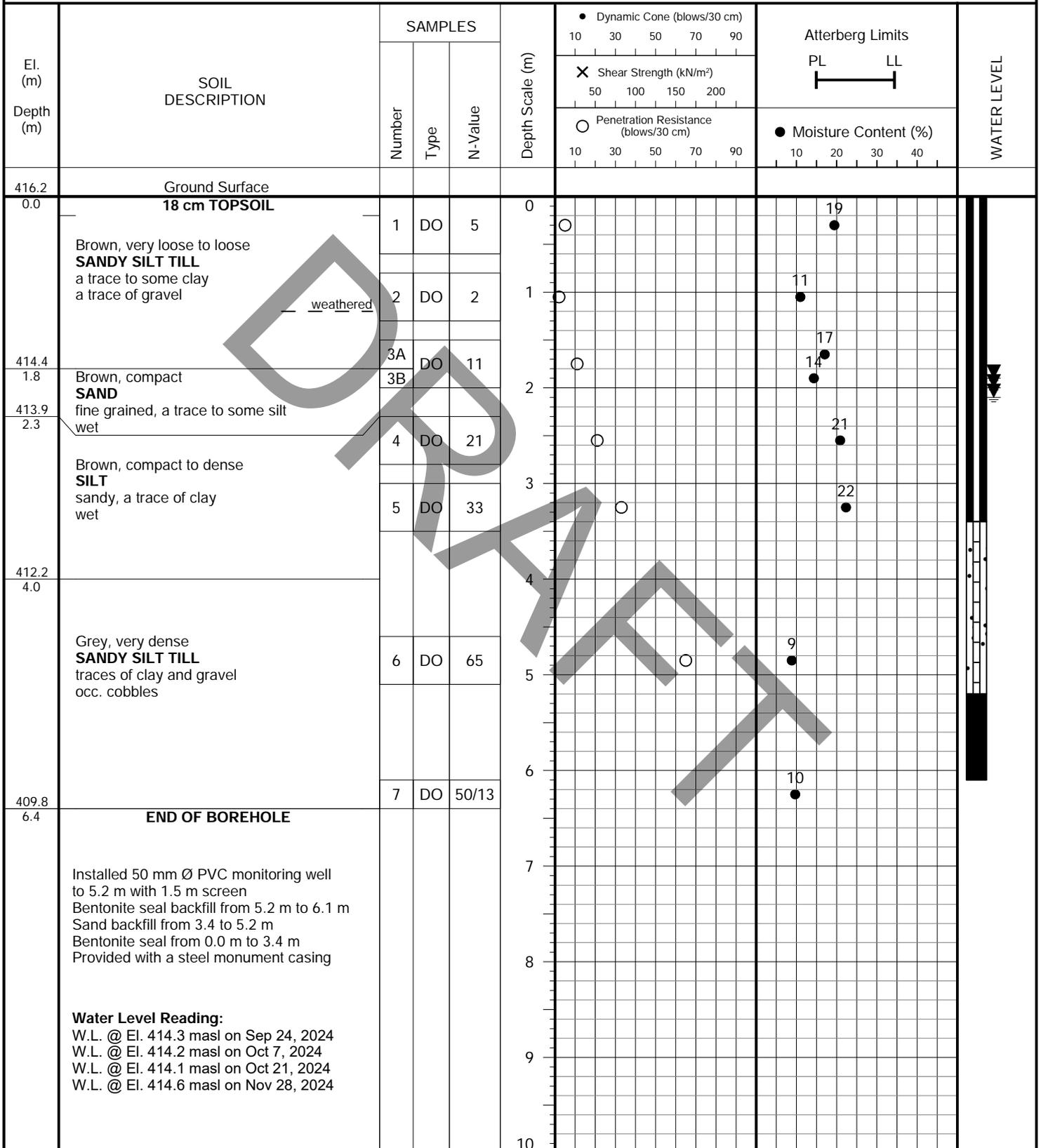


**PROJECT DESCRIPTION:** Proposed Residential Development

**METHOD OF BORING:** Solid Stem Augers

**PROJECT LOCATION:** 6586 Beatty Line North,  
Township of Centre Wellington (Fergus)

**DRILLING DATE:** August 30, 2024

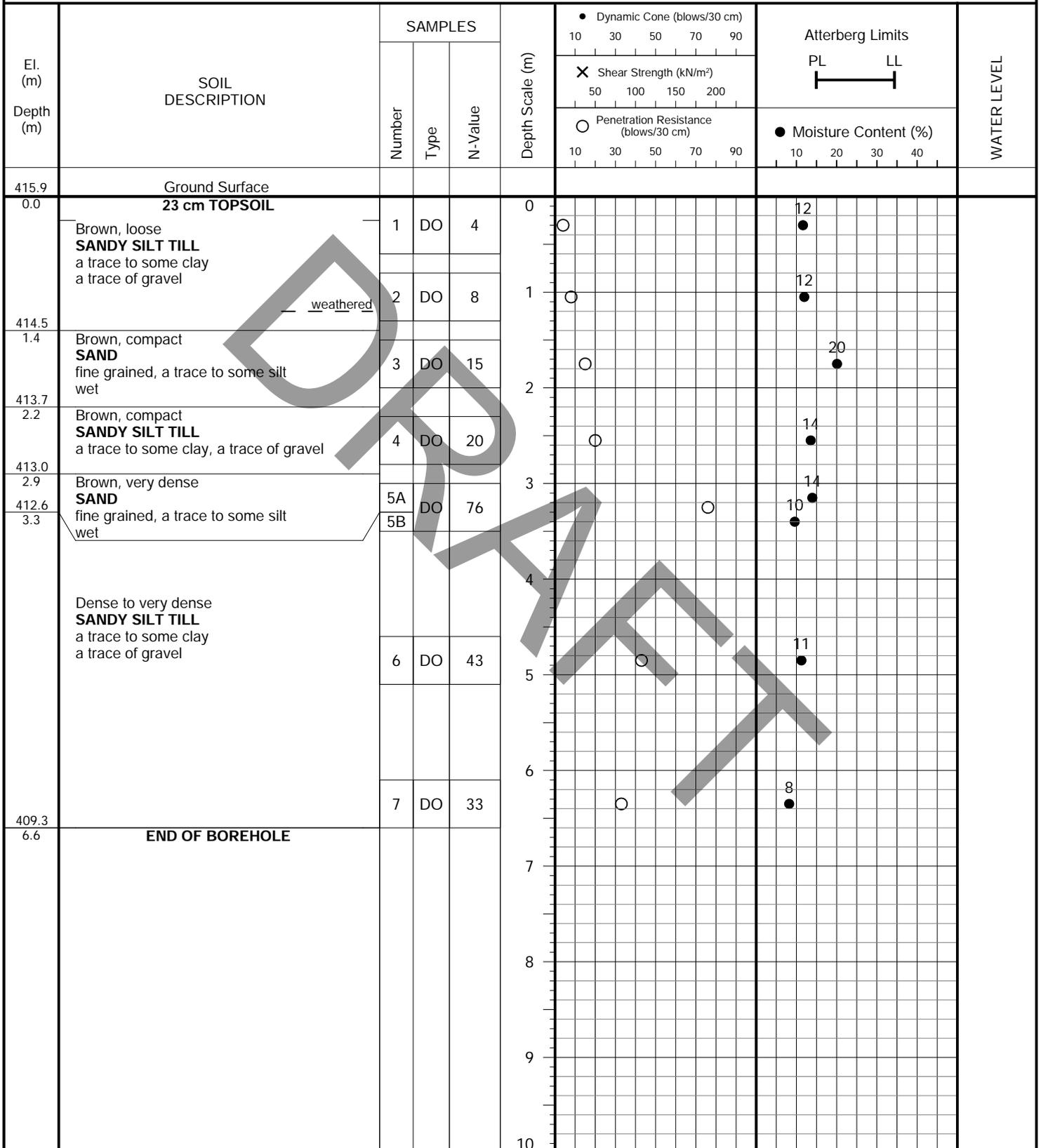


**PROJECT DESCRIPTION:** Proposed Residential Development

**METHOD OF BORING:** Solid Stem Augers

**PROJECT LOCATION:** 6586 Beatty Line North,  
Township of Centre Wellington (Fergus)

**DRILLING DATE:** August 29, 2024

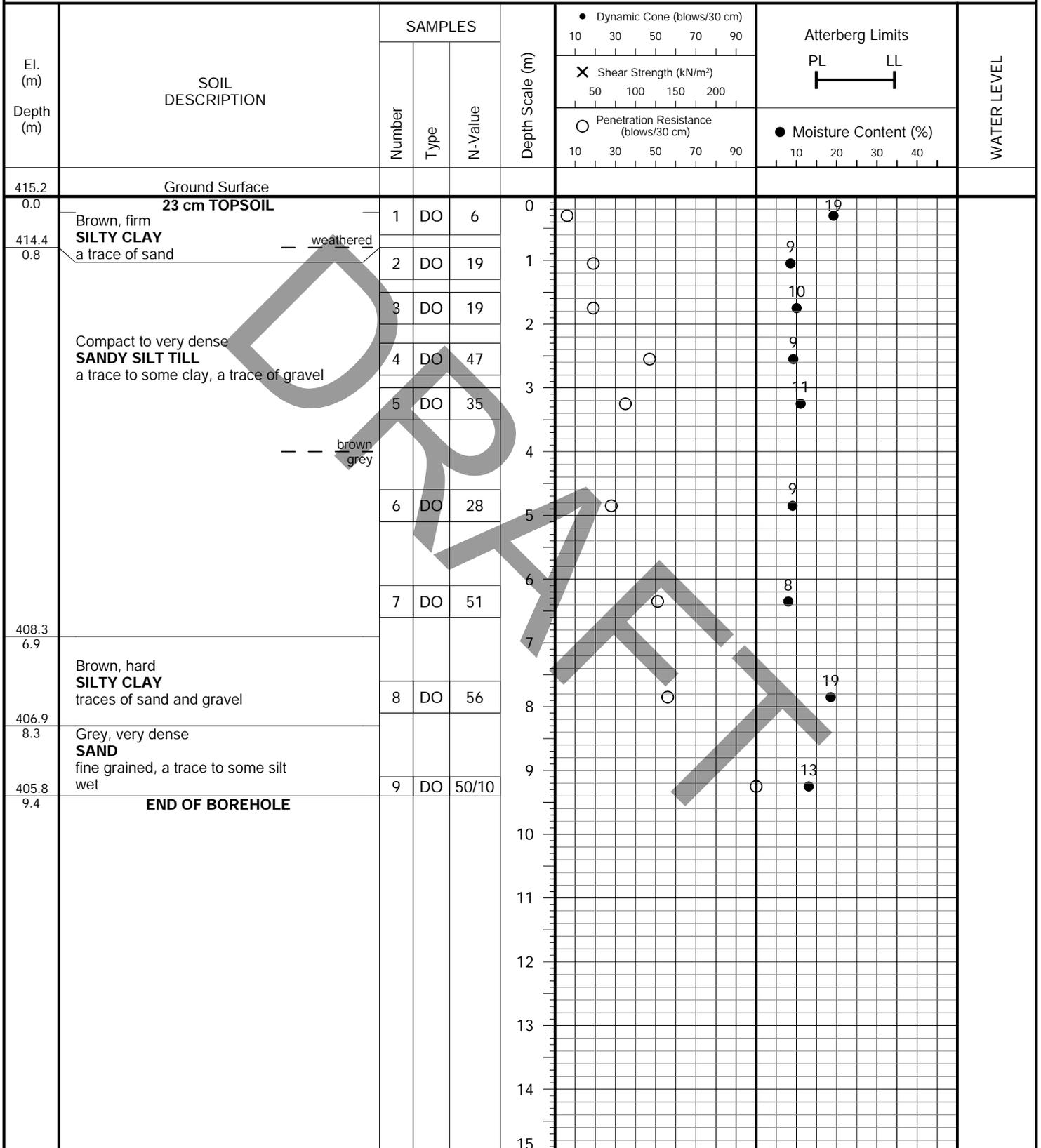


**PROJECT DESCRIPTION:** Proposed Residential Development

**METHOD OF BORING:** Solid Stem Augers

**PROJECT LOCATION:** 6586 Beatty Line North,  
Township of Centre Wellington (Fergus)

**DRILLING DATE:** August 29, 2024

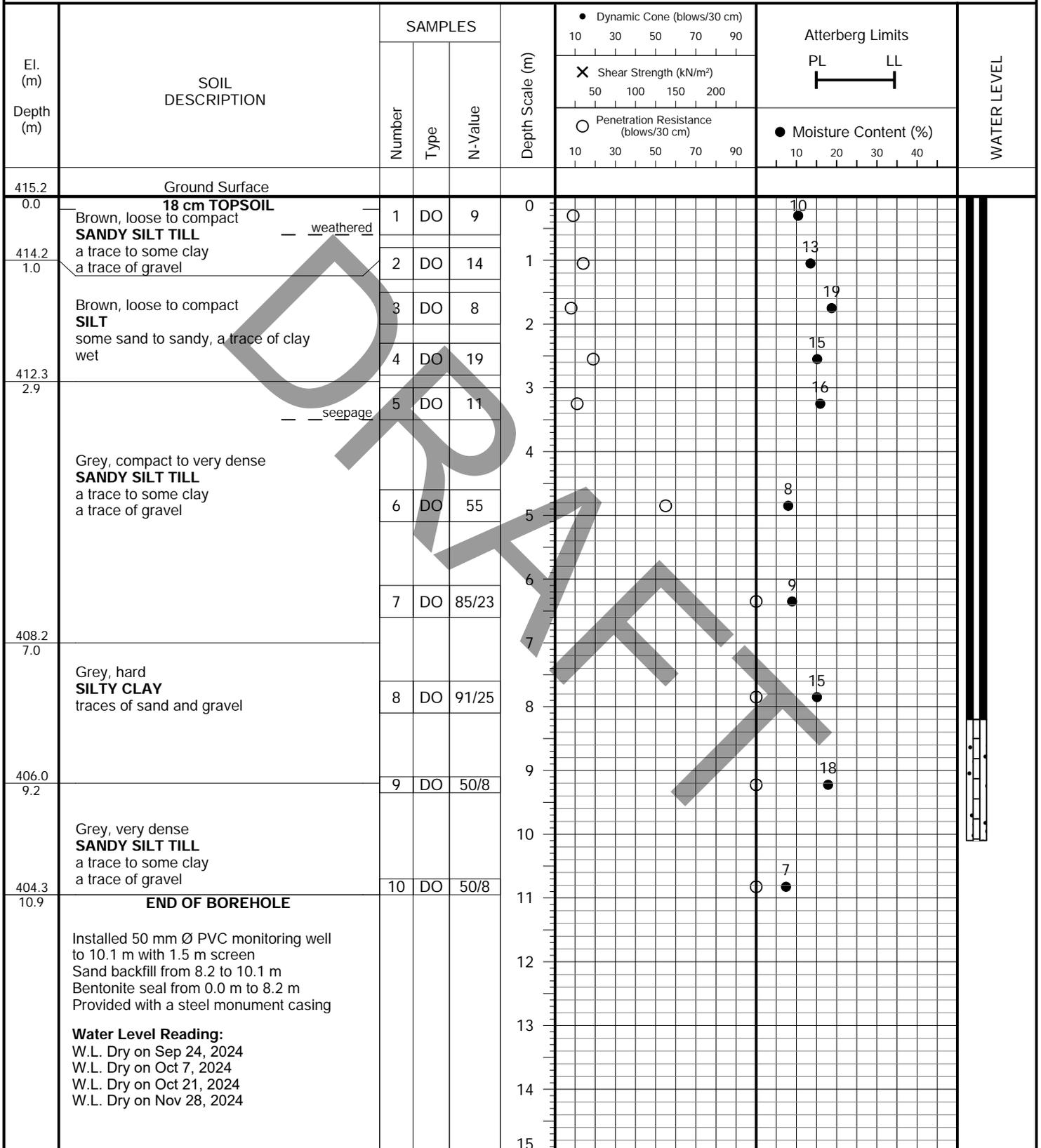


**PROJECT DESCRIPTION:** Proposed Residential Development

**METHOD OF BORING:** Solid Stem Augers

**PROJECT LOCATION:** 6586 Beatty Line North,  
Township of Centre Wellington (Fergus)

**DRILLING DATE:** August 29, 2024





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# **APPENDIX B:**

## *Infiltration Potential Assessment*



Table B-1 - Infiltration Potential Assessment and Summary

Testing Location	Ground Surface Elevation (m ASL)	Horizontal Hydraulic Conductivity (cm/s)	Vertical Hydraulic Gradient (cm/s)	Estimated Infiltration Rate (mm/hr)	In Situ Infiltration Rate (mm/hr)	Testing Depth		Screen Interval (m BGS)	Soil Description	Grain Size Proportions (%)			
						(m BGS)	(m ASL)			Gravel	Sand	Silt	Clay
BH24-2 (SS5)	419.7	1.05E-04	1.05E-05	25	NA	3	416.7	NA	Fine sand: a trace to some silt		90	8	2
BH24-4 (SS5)	417.2	3.66E-05	3.66E-06	19	NA	3	414.2	NA	Fine sand: a trace to some silt		85	4	1
BH24-1D (SS5)	418.7	3.80E-07	3.80E-08	6	NA	3	415.7	NA	Sandy silt, a trace of clay		48	50	2
BH24-10 (SS5)	416.2	1.57E-06	1.57E-07	8	NA	3	413.2	NA	Silt		21	76	3

Single Well Response Testing

BH/MW1s	418.7	2.30E-06	2.30E-07	9	NA	3.1	415.6	3.1-4.6	Silty to sandy silt till	-	-	-	-
BH/MW1d	418.7	1.60E-08	1.60E-09	2	NA	4.4	414.3	4.4-6.1	Sandy silt till	-	-	-	-
BH/MW2	419.7	1.20E-07	1.20E-08	4	NA	3.1	416.6	3.1-4.6	Sand to sandy silt till	-	-	-	-
BH/MW4	419.7	1.20E-05	1.20E-06	14	NA	3.1	416.6	3.1-4.6	Sand	-	-	-	-

Summary

Range	In-Situ Percolation Testing (mm/hr)	Grain Size Approximation (mm/hr)	Single Well Response Testing (mm/hr)
High	NA	25	9
Low	NA	6	2
Average	NA	15	5

All Sources	Estimated Infiltration Rate (mm/hr)	Safety Factor Application (Design Infiltration Rate) (mm/hr)	Safety Factor
High	25	10	2.5
Low	2	1	
Average	10	4	



# **APPENDIX C:**

*Preliminary Water Balance Assessment*

TABLE C-1  
 CLIMATIC WATER BUDGET: CLIMATE NORMAL 1981-2010 (BRANTFORD MOE CLIMATE STATION)  
 WATER BALANCE STUDY  
 6586 Beatty Line, Fergus  
 Township of Centre Wellington, Ontario

Month	Thornthwaite (1948)							
	Mean Temperature (°C)	Heat Index	Potential Evapo-transpiration (mm)	Daylight Correction Value	Adjusted Potential Evapo-transpiration (mm)	Total Precipitation (mm)	Surplus (mm)	Deficit (mm)
January	-6	0.0	0.0	0.7839	0.00	27.6	27.6	0.0
February	-4.3	0.0	0.0	0.8679	0.00	30.4	30.4	0.0
March	0.3	0.0	0.9	0.9871	0.89	43.5	42.6	0.0
April	7	1.7	30.4	1.1200	34.09	65.3	31.2	0.0
May	13.5	4.5	63.5	1.2290	78.01	81.1	3.1	0.0
June	18.7	7.4	91.4	1.2900	117.90	75.9	0.0	42.0
July	21.3	9.0	105.7	1.2581	133.01	95	0.0	38.0
August	20.2	8.3	99.6	1.1613	115.71	75	0.0	40.7
September	16	5.8	76.8	1.0400	79.83	86.6	6.8	0.0
October	9.3	2.6	41.8	0.9194	38.46	70.1	31.6	0.0
November	3.8	0.7	15.4	0.8000	12.29	78.3	66.0	0.0
December	-2.5	0.0	0.0	0.7355	0.00	40.8	40.8	0.0
<b>TOTALS</b>		<b>39.8</b>			<b>610.2</b>	<b>769.6</b>	<b>280.1</b>	<b>120.7</b>

TOTAL WATER SURPLUS 159.4 mm

NOTES:

- 1) Water budget adjusted for latitude and daylight.
- 2) (°C) - Represents calculated mean of daily temperatures for the month.
- 3) Precipitation and Temperature data from the Brantford MOE Station located at latitude 44°01'00.000" N, longitude 79°31'00.000" W, elevation 352.00.
- 4) Total Water Surplus (Thornthwaite, 1948) is calculated as total precipitation minus adjusted potential evapotranspiration.
- 5) Total Moisture Surplus (Thornthwaite and Mather, 1957) is calculated as total precipitation minus actual evapotranspiration.

TABLE C-2  
 CLIMATIC WATER BUDGET: CLIMATE NORMAL 1981-2010 (BRANTFORD MOE CLIMATE STATION)  
 Silt Clay, Residential Lawn (75 mm HOLDING CAPACITY)  
 WATER BALANCE STUDY  
 6586 Beatty Line, Fergus  
 Township of Centre Wellington, Ontario

Month	Thornthwaite (1948)									Thornthwaite and Mather (1957)					
	Mean Temperature (°C)	Heat Index	Potential Evapo-transpiration (mm)	Daylight Correction Value	Adjusted Potential Evapo-transpiration (mm)	Total Precipitation (mm)	Surplus (mm)	Deficit (mm)	TP - PET (mm)	Accumulated Potential Water Loss (mm)	Soil Moisture (mm)	Change in Soil Moisture (mm) (delta S)	Actual Evapo-transpiration (mm)	Moisture Deficit (mm)	Unadjusted Moisture Surplus (mm)
January	-6.0	0.0	0.0	0.7839	0.00	27.6	27.6	0.0	27.6	0.0	75.0	0.0	0.0	0.0	27.6
February	-4.3	0.0	0.0	0.8679	0.00	30.4	30.4	0.0	30.4	0.0	75.0	0.0	0.0	0.0	30.4
March	0.3	0.0	0.9	0.9871	0.89	43.5	42.6	0.0	42.6	0.0	75.0	0.0	0.9	0.0	42.6
April	7.0	1.7	30.4	1.1200	34.09	65.3	31.2	0.0	31.2	0.0	75.0	0.0	34.1	0.0	31.2
May	13.5	4.5	63.5	1.2290	78.01	81.1	3.1	0.0	3.1	0.0	75.0	0.0	78.0	0.0	3.1
June	18.7	7.4	91.4	1.2900	117.90	75.9	0.0	42.0	-42.0	-42.0	54.0	-21.0	96.9	21.0	0.0
July	21.3	9.0	105.7	1.2581	133.01	95.0	0.0	38.0	-38.0	-80.0	23.0	-31.0	126.0	7.0	0.0
August	20.2	8.3	99.6	1.1613	115.71	75.0	0.0	40.7	-40.7	-120.7	14.0	-9.0	84.0	31.7	0.0
September	16.0	5.8	76.8	1.0400	79.83	86.6	6.8	0.0	6.8	0.0	20.8	6.8	79.8	0.0	0.0
October	9.3	2.6	41.8	0.9194	38.46	70.1	31.6	0.0	31.6	0.0	75.0	54.2	38.5	0.0	-22.6
November	3.8	0.7	15.4	0.8000	12.29	78.3	66.0	0.0	66.0	0.0	75.0	0.0	12.3	0.0	66.0
December	-2.5	0.0	0.0	0.7355	0.00	40.8	40.8	0.0	40.8	0.0	75.0	0.0	0.0	0.0	40.8
<b>TOTALS</b>		<b>39.8</b>			<b>610.2</b>	<b>769.6</b>	<b>280.1</b>	<b>120.7</b>	<b>159.4</b>	<b>-120.7</b>	<b>711.8</b>	<b>0.0</b>	<b>550.5</b>	<b>59.7</b>	<b>219.1</b>

TOTAL WATER SURPLUS 159.4 mm

TOTAL MOISTURE SURPLUS 219.1 mm

NOTES:

- 1) Water budget adjusted for latitude and daylight.
- 2) (°C) - Represents calculated mean of daily temperatures for the month.
- 3) Precipitation and Temperature data from the Brantford MOE Station located at latitude 44°01'00.000" N, longitude 79°31'00.000" W, elevation 352.00.
- 4) Total Water Surplus (Thornthwaite, 1948) is calculated as total precipitation minus adjusted potential evapotranspiration.
- 5) Total Moisture Surplus (Thornthwaite and Mather, 1957) is calculated as total precipitation minus actual evapotranspiration.

TABLE C-3  
 CLIMATIC WATER BUDGET: CLIMATE NORMAL 1981-2010 (BRANTFORD MOE CLIMATE STATION)  
 Silt Clay, Cultivated (150 mm HOLDING CAPACITY)  
 WATER BALANCE STUDY  
 6586 Beatty Line, Fergus  
 Township of Centre Wellington, Ontario

Month	Thornthwaite (1948)									Thornthwaite and Mather (1957)					
	Mean Temperature (°C)	Heat Index	Potential Evapo-transpiration (mm)	Daylight Correction Value	Adjusted Potential Evapo-transpiration (mm)	Total Precipitation (mm)	Surplus (mm)	Deficit (mm)	TP - PET (mm)	Accumulated Potential Water Loss (mm)	Soil Moisture (mm)	Change in Soil Moisture (mm) (delta S)	Actual Evapo-transpiration (mm)	Moisture Deficit (mm)	Unadjusted Moisture Surplus (mm)
January	-6.0	0.0	0.0	0.7839	0.00	27.6	27.6	0.0	27.6	0.0	150.0	0.0	0.0	0.0	27.6
February	-4.3	0.0	0.0	0.8679	0.00	30.4	30.4	0.0	30.4	0.0	150.0	0.0	0.0	0.0	30.4
March	0.3	0.0	0.9	0.9871	0.89	43.5	42.6	0.0	42.6	0.0	150.0	0.0	0.9	0.0	42.6
April	7.0	1.7	30.4	1.1200	34.09	65.3	31.2	0.0	31.2	0.0	150.0	0.0	34.1	0.0	31.2
May	13.5	4.5	63.5	1.2290	78.01	81.1	3.1	0.0	3.1	0.0	150.0	0.0	78.0	0.0	3.1
June	18.7	7.4	91.4	1.2900	117.90	75.9	0.0	42.0	-42.0	-42.0	128.0	-22.0	97.9	20.0	0.0
July	21.3	9.0	105.7	1.2581	133.01	95.0	0.0	38.0	-38.0	-80.0	84.0	-44.0	139.0	-6.0	0.0
August	20.2	8.3	99.6	1.1613	115.71	75.0	0.0	40.7	-40.7	-120.7	67.0	-17.0	92.0	23.7	0.0
September	16.0	5.8	76.8	1.0400	79.83	86.6	6.8	0.0	6.8	0.0	73.8	6.8	79.8	0.0	0.0
October	9.3	2.6	41.8	0.9194	38.46	70.1	31.6	0.0	31.6	0.0	105.4	31.6	38.5	0.0	0.0
November	3.8	0.7	15.4	0.8000	12.29	78.3	66.0	0.0	66.0	0.0	150.0	44.6	12.3	0.0	21.4
December	-2.5	0.0	0.0	0.7355	0.00	40.8	40.8	0.0	40.8	0.0	150.0	0.0	0.0	0.0	40.8
<b>TOTALS</b>		<b>39.8</b>			<b>610.2</b>	<b>769.6</b>	<b>280.1</b>	<b>120.7</b>	<b>159.4</b>	<b>-120.7</b>	<b>1508.2</b>	<b>0.0</b>	<b>572.5</b>	<b>37.7</b>	<b>197.1</b>

TOTAL WATER SURPLUS 159.4 mm

TOTAL MOISTURE SURPLUS 197.1 mm

NOTES:

- 1) Water budget adjusted for latitude and daylight.
- 2) (°C) - Represents calculated mean of daily temperatures for the month.
- 3) Precipitation and Temperature data from the Brantford MOE Station located at latitude 44°01'00.000" N, longitude 79°31'00.000" W, elevation 352.00.
- 4) Total Water Surplus (Thornthwaite, 1948) is calculated as total precipitation minus adjusted potential evapotranspiration.
- 5) Total Moisture Surplus (Thornthwaite and Mather, 1957) is calculated as total precipitation minus actual evapotranspiration.

TABLE C-4  
 CLIMATIC WATER BUDGET: CLIMATE NORMAL 1981-2010 (BRANTFORD MOE CLIMATE STATION)  
 Silt Clay, Uncultivated (200 mm HOLDING CAPACITY)  
 WATER BALANCE STUDY  
 6586 Beatty Line, Fergus  
 Township of Centre Wellington, Ontario

Month	Thornthwaite (1948)									Thornthwaite and Mather (1957)					
	Mean Temperature (°C)	Heat Index	Potential Evapo-transpiration (mm)	Daylight Correction Value	Adjusted Potential Evapo-transpiration (mm)	Total Precipitation (mm)	Surplus (mm)	Deficit (mm)	TP - PET (mm)	Accumulated Potential Water Loss (mm)	Soil Moisture (mm)	Change in Soil Moisture (mm) (delta S)	Actual Evapo-transpiration (mm)	Moisture Deficit (mm)	Unadjusted Moisture Surplus (mm)
January	-6.0	0.0	0.0	0.7839	0.00	27.6	27.6	0.0	27.6	0.0	200.0	0.0	0.0	0.0	27.6
February	-4.3	0.0	0.0	0.8679	0.00	30.4	30.4	0.0	30.4	0.0	200.0	0.0	0.0	0.0	30.4
March	0.3	0.0	0.9	0.9871	0.89	43.5	42.6	0.0	42.6	0.0	200.0	0.0	0.9	0.0	42.6
April	7.0	1.7	30.4	1.1200	34.09	65.3	31.2	0.0	31.2	0.0	200.0	0.0	34.1	0.0	31.2
May	13.5	4.5	63.5	1.2290	78.01	81.1	3.1	0.0	3.1	0.0	200.0	0.0	78.0	0.0	3.1
June	18.7	7.4	91.4	1.2900	117.90	75.9	0.0	42.0	-42.0	-42.0	178.0	-22.0	97.9	20.0	0.0
July	21.3	9.0	105.7	1.2581	133.01	95.0	0.0	38.0	-38.0	-80.0	131.0	-47.0	142.0	-9.0	0.0
August	20.2	8.3	99.6	1.1613	115.71	75.0	0.0	40.7	-40.7	-120.7	109.0	-22.0	97.0	18.7	0.0
September	16.0	5.8	76.8	1.0400	79.83	86.6	6.8	0.0	6.8	0.0	115.8	6.8	79.8	0.0	0.0
October	9.3	2.6	41.8	0.9194	38.46	70.1	31.6	0.0	31.6	0.0	147.4	31.6	38.5	0.0	0.0
November	3.8	0.7	15.4	0.8000	12.29	78.3	66.0	0.0	66.0	0.0	200.0	52.6	12.3	0.0	13.4
December	-2.5	0.0	0.0	0.7355	0.00	40.8	40.8	0.0	40.8	0.0	200.0	0.0	0.0	0.0	40.8
<b>TOTALS</b>		<b>39.8</b>			<b>610.2</b>	<b>769.6</b>	<b>280.1</b>	<b>120.7</b>	<b>159.4</b>	<b>-120.7</b>	<b>2081.2</b>	<b>0.0</b>	<b>580.5</b>	<b>29.7</b>	<b>189.1</b>

TOTAL WATER SURPLUS 159.4 mm

TOTAL MOISTURE SURPLUS 189.1 mm

**NOTES:**

- 1) Water budget adjusted for latitude and daylight.
- 2) Precipitation and Temperature data from the Welland Climate Station located at latitude 42°59'33.096" N, longitude 79°15'40.098" W, elevation 175.30 m.
- 3) Precipitation and Temperature data from the Brantford MOE Station located at latitude 44°01'00.000" N, longitude 79°31'00.000" W, elevation 352.00.
- 4) Total Water Surplus (Thornthwaite, 1948) is calculated as total precipitation minus adjusted potential evapotranspiration.
- 5) Total Moisture Surplus (Thornthwaite and Mather, 1957) is calculated as total precipitation minus actual evapotranspiration.

TABLE C-5  
 CLIMATIC WATER BUDGET: CLIMATE NORMAL 1981-2010 (BRANTFORD MOE CLIMATE STATION)  
 Silt Clay, Woodland (350 mm HOLDING CAPACITY)  
 WATER BALANCE STUDY  
 6586 Beatty Line, Fergus  
 Township of Centre Wellington, Ontario

Month	Thornthwaite (1948)								TP - PET (mm)	Thornthwaite and Mather (1957)					
	Mean Temperature (°C)	Heat Index	Potential Evapo-transpiration (mm)	Daylight Correction Value	Adjusted Potential Evapo-transpiration (mm)	Total Precipitation (mm)	Surplus (mm)	Deficit (mm)		Accumulated Potential Water Loss (mm)	Soil Moisture (mm)	Change in Soil Moisture (mm) (delta S)	Actual Evapo-transpiration (mm)	Moisture Deficit (mm)	Unadjusted Moisture Surplus (mm)
January	-6.0	0.0	0.0	0.7839	0.00	27.6	27.6	0.0	27.6	0.0	350.0	0.0	0.0	0.0	27.6
February	-4.3	0.0	0.0	0.8679	0.00	30.4	30.4	0.0	30.4	0.0	350.0	0.0	0.0	0.0	30.4
March	0.3	0.0	0.9	0.9871	0.89	43.5	42.6	0.0	42.6	0.0	350.0	0.0	0.9	0.0	42.6
April	7.0	1.7	30.4	1.1200	34.09	65.3	31.2	0.0	31.2	0.0	350.0	0.0	34.1	0.0	31.2
May	13.5	4.5	63.5	1.2290	78.01	81.1	3.1	0.0	3.1	0.0	350.0	0.0	78.0	0.0	3.1
June	18.7	7.4	91.4	1.2900	117.90	75.9	0.0	42.0	-42.0	-42.0	327.0	-23.0	98.9	19.0	0.0
July	21.3	9.0	105.7	1.2581	133.01	95.0	0.0	38.0	-38.0	-80.0	274.0	-53.0	148.0	-15.0	0.0
August	20.2	8.3	99.6	1.1613	115.71	75.0	0.0	40.7	-40.7	-120.7	248.0	-26.0	101.0	14.7	0.0
September	16.0	5.8	76.8	1.0400	79.83	86.6	6.8	0.0	6.8	0.0	254.8	6.8	79.8	0.0	0.0
October	9.3	2.6	41.8	0.9194	38.46	70.1	31.6	0.0	31.6	0.0	286.4	31.6	38.5	0.0	0.0
November	3.8	0.7	15.4	0.8000	12.29	78.3	66.0	0.0	66.0	0.0	350.0	63.6	12.3	0.0	2.4
December	-2.5	0.0	0.0	0.7355	0.00	40.8	40.8	0.0	40.8	0.0	350.0	0.0	0.0	0.0	40.8
<b>TOTALS</b>		<b>39.8</b>			<b>610.2</b>	<b>769.6</b>	<b>280.1</b>	<b>120.7</b>	<b>159.4</b>	<b>-120.7</b>	<b>3840.2</b>	<b>0.0</b>	<b>591.5</b>	<b>18.7</b>	<b>178.1</b>

TOTAL WATER SURPLUS 159.4 mm

TOTAL MOISTURE SURPLUS 178.1 mm

NOTES:

- 1) Water budget adjusted for latitude and daylight.
- 2) Precipitation and Temperature data from the Welland Climate Station located at latitude 42°59'33.096" N, longitude 79°15'40.098" W, elevation 175.30 m.
- 3) Precipitation and Temperature data from the Brantford MOE Station located at latitude 44°01'00.000" N, longitude 79°31'00.000" W, elevation 352.00.
- 4) Total Water Surplus (Thornthwaite, 1948) is calculated as total precipitation minus adjusted potential evapotranspiration.
- 5) Total Moisture Surplus (Thornthwaite and Mather, 1957) is calculated as total precipitation minus actual evapotranspiration.

TABLE C-6: WATER BALANCE SUMMARY  
 WATER BALANCE STUDY  
 6586 Beatty Line, Fergus  
 Township of Centre Wellington, Ontario

A. OVERALL WATER BALANCE

Characteristics		Pre-development		Post-development (No Recharge mitigation)		Change	
		Volume (m <sup>3</sup> /yr)	mm/yr	Volume (m <sup>3</sup> /yr)	mm/yr	Volume (m <sup>3</sup> /yr)	%
Input	Precipitation	334,793	770	334,793	770	0	0%
	Runon (from offsite catchments only)	12,494	29	13,813	32	1,319	11%
	<b>Total In</b>	<b>347,288</b>	<b>798</b>	<b>348,607</b>	<b>801</b>	<b>1,319</b>	<b>0.38%</b>
Output	Infiltration via Pervious Areas	64,503	148	31,559	73	-32,943	-51%
	Infiltration via Infiltration Trench	0	0	0	0	0	0%
	<b>Total Infiltration</b>	<b>64,503</b>	<b>148</b>	<b>31,559</b>	<b>73</b>	<b>-32,943</b>	<b>-51%</b>
	Run-off (Net)	26,648	61	149,786	344	123,138	462.1%
	Evapotranspiration	256,136	589	167,261	384	-88,875	-34.7%
	<b>Total Out</b>	<b>347,288</b>	<b>798</b>	<b>348,607</b>	<b>801</b>	<b>1,319</b>	<b>0.38%</b>

B. Breakdown of Post-Development Run-Off by Land Use

Land Use	Description	Post-Development		Runoff	% of Total Runoff
		Area	Volume		
		m <sup>2</sup>	m <sup>3</sup>	m <sup>3</sup>	%
Buildings	Includes buildings	58,718	40,670	40,670	23%
Paved Areas	Includes roads, sidewalks and driveways	123,268	85,380	85,380	48%
SWMP	Includes SWMP	20,129	2,488	2,488	1%
<b>Impervious Areas</b>		<b>181,985</b>	<b>128,538</b>	<b>128,538</b>	<b>72%</b>
Pervious Areas	Includes residential lawns, parks, uncultivated areas and woodland	753,836	50,481	50,481	28%
<b>Total Run-Off</b>		<b>935,821</b>	<b>179,019</b>	<b>179,019</b>	<b>100%</b>