

**FINAL  
FOUNDATION INVESTIGATION REPORT  
OLD WOMAN RIVER BRIDGE  
HIGHWAY 17  
AGREEMENT NO. 5020-E-0025  
GWP 5207-18-00**



**THURBER ENGINEERING LTD.**

**FINAL  
FOUNDATION INVESTIGATION REPORT  
OLD WOMAN RIVER BRIDGE  
HIGHWAY 17  
AGREEMENT NO. 5020-E-0025  
GWP 5207-18-00**

**SITE NO. 38C-0009/B0  
GEOCRES NO.: 41N00-036**

**Report  
to  
AECOM Canada Ltd.**

Latitude: 47.790758°  
Longitude: -84.894241°

November 2023  
Thurber File No.: 31653



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**PART 1. FACTUAL INFORMATION**

**1. INTRODUCTION**

This section of the report presents the factual findings obtained from a foundation investigation completed at the Highway 17 crossing of Old Woman River in the Township of LaRonde within the District of Algoma, Ontario. Thurber Engineering Limited (Thurber) carried out the assignment as a sub-consultant to AECOM Canada Ltd. (AECOM) under Agreement No. 5020-E-0025 and as part of Change Order 1.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, a stratigraphic profile, laboratory test results, and a written description of the subsurface conditions. A model of the subsurface conditions influencing design and construction was developed in the course of the current investigation.

*It is a condition of this report that Thurber's performance of its professional services will be subject to the attached Statement of Limitations and Conditions.*

**2. SITE DESCRIPTION**

**2.1 General**

The existing Highway 17 bridge crosses Old Woman River approximately 24.3 km south of the junction of Highway 17 and Highway 101. The bridge site is situated within Lake Superior Provincial Park at approximate Sta. 15+250 LaRonde Township which is about 170 m south of the driveway entrance to the Old Woman Bay Scenic Lookout site. For project purposes, the bridge is herein described as oriented north-south, and the river's flow is described as oriented east to west. Passing lanes are present approximately 500 m north and south of the bridge.



The existing bridge is a two-lane, concrete deck on steel plate girders bridge, comprising one span built with a northeast to southwest skew to the river. Concrete parapet walls are placed along the east and west edges of the bridge deck. Steel guiderails supported with wood posts extend from both ends of the bridge. The existing roadway embankment side slopes at the site did not show any visible signs of global instability at the time of the investigation, but active surficial water erosion was observed at the side slopes near the approaches. The embankments near the approaches are sloped at 2.9H:1V to 2.0H:1V. Traffic volumes on this section of Highway 17 are understood to have been 2,300 AADT in 2019.

Drawings provided by AECOM indicate that the road surface is at approximate elevation 187.8 m. The river's water level was surveyed by Thurber at elev. 183.3 m on August 5, 2022. The depth of water at that time was 1.6 m. The river flows from east to west, toward Lake Superior which is approximately 300 m east of the site. The water flow was noted to be stronger near the north abutment where the water depth was observed to be deeper. Sand sediments, tree trunks and branches were observed near the south abutment. Beyond the bridge the river flows in a meandering manner. Frequent sand banks were noted, and rounded cobbles are present on the riverbed and on the riverbanks.

The site is in a rural setting and the area directly adjacent to the roadway is undeveloped and densely vegetated with coniferous and deciduous trees and shrubs. An entrance to a Scenic Lookout is located north of the bridge. The terrain is slightly undulating in the vicinity of the site. Overhead utility lines were not present.

Photographs showing the existing conditions in the project area at the time of the field investigation are included in Appendix D for reference.

## **2.2 Existing Structure Information**

The Terms of Reference (TOR) describe the bridge as constructed in 1958 (Contract 58-24) with a span length of 30 m. The structure is 10.4 m wide with a travelled width of 9.5 m and consists of a concrete deck on steel plate girders on conventional reinforced concrete abutments with expansion joints. Wingwalls are approximately 9.5 m long at each abutment and are at 54 deg from the abutment face. The abutment and wingwalls are founded on trapezoidal shaped spread footings which extend down to approximate elev. 181.6 m.

Historical construction drawings by Proctor & Redfern (W.P. 958-57) show that sheet piles were installed at each abutment to elev. 179.2 m to aid construction. Thurber observed the sheet piles in the water near the east side of the north abutment, see Photo 9 in Appendix D.



The bridge was rehabilitated in 1997 (Contract 1997-0240).

The 2019 OSIM report indicates that the existing structure is in fair condition overall but with some elements, such as girder ends and abutment walls, in poor condition. The OSIM report recommends structure rehabilitation in 1-5 years.

## **2.3 Existing Subsurface Information**

The following historical foundation investigation report was available for this site within the Online Geocres library:

- Geocres Report No. 41N00-008 (e. m. peto associates, 1957) presents the results of the foundation investigations carried out for the design and construction of the existing bridge structure. This investigation included 4 boreholes: 2 on the north side and 2 on the south side of the proposed Old Woman River bridge. All 4 boreholes indicated the presence of topsoil underlain by fine to coarse sand. Soils with organics were encountered 15.2 m below the ground surface in all the boreholes. The boreholes were terminated within the sand deposit at a depth of 30.7 m (approx. elev. 154.2 to 153.1 m).

The coordinates of the boreholes are not provided in the historical investigation and the boreholes were advanced prior to the bridge construction. For this reason, it is difficult to know the borehole locations. Nonetheless, the historical borehole plan and borehole records are included in the report for the reference in Appendix A.

## **2.4 Site Geology**

According to Crins et al. 2009<sup>1</sup> the project area is described as Ecoregion 4E (Lake Temagami Ecoregion) within the Ontario Shield Ecozone. According to Wester et al. 2018<sup>2</sup> the ecoregion is subdivided into Ecodistrict 4E-1 (Michipicoten Ecodistrict). The area is characterized by glaciofluvial, morainal material, and Precambrian bedrock. The main substrate type in the Ecodistrict is bedrock covered by a discontinuous thin layer of mineral material.

Regional Geology Map MRD126<sup>3</sup> indicates the site is on the boundary between a unit to the north consisting of granodiorite to granite and a unit consisting of gneiss to tonalite to granodiorite to the south.

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<sup>1</sup> <https://files.ontario.ca/mnrf-ecosystemspart1-accessible-july2018-en-2020-01-16.pdf>

<sup>2</sup> <https://files.ontario.ca/ecosystems-ontario-part2-03262019.pdf>

<sup>3</sup> <http://www.geologyontario.mndm.gov.on.ca/mines/data/google/mrd126/doc.kml>



### **3. SITE INVESTIGATION AND FIELD TESTING**

The site investigation and field-testing program was carried out between August 4 and 6, 2022 as part of the original scope, and between May 25 and June 11, 2023 as part of Change Order 1, and consisted of two on-road boreholes identified as 22-01 and 22-02, and two off-road boreholes identified as OW-23-01 and OW-23-02. Multiple attempts were required to drill at the off-road borehole OW-23-02 due to difficult drilling conditions which included cobbles and flowing sands. The borehole record included herein and the plotted borehole location, document the conditions for the deepest of these borehole attempts.

The on-road boreholes were advanced with a CME 75 truck mounted drill rig utilizing HW Casing and coring techniques. The off-road boreholes were advanced with portable drilling techniques and utilized a third-weight hammer for SPT advancement. A hammer weight correction has been applied to the reported N-Values for the SPT carried out with the portable equipment. Prior to commencement of drilling, utility clearances were obtained in the vicinity of the borehole locations.

A summary of the borehole coordinates, elevations, and termination depths is provided in Table 3-1, below. The as-drilled borehole elevations were surveyed by Thurber with an auto-level relative to BM HCP 150 (Elevation 186.656 m). The elevations and borehole coordinates were reviewed and referenced to the survey provided by AECOM. Horizontal locations were measured by Thurber relative to existing site features. The borehole coordinates and elevations are shown on the Borehole Location and Soil Strata drawing included in Appendix A and on the individual Record of Borehole sheets included in Appendix B. The borehole coordinates are referenced to MTM Zone 13.



**Table 3-1: Borehole Summary**

Borehole No.	Drilled Location	Northing (m)	Easting (m)	Ground Surface Elevation (m)	Termination Depth (m)
22-01	North Abutment/ Southbound Lane	5 295 028.9	237 784.3	187.6	15.8
22-02	South Abutment/ Northbound Lane	5 295 006.9	237 825.5	187.7	15.8 (DCPT 19.2)
OW-23-01	Embankment Toe/Northwest Quadrant	5 295 018.7	237 785.2	184.4	4.0 (DCPT 4.8)
OW-23-02	Embankment Toe/Southeast Quadrant	5 295 016.9	237 826.0	185.1	4.1

Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in general accordance with ASTM D 1586. The boreholes were advanced to sampled depths ranging from 4.0 m to 15.8 m below the existing ground surface (elev. 181.0 m to 171.8 m). A Dynamic Cone Penetration (DCPT) was completed below the sampled depth in Boreholes 22-02 and OW-23-01 to a tip elevation at 168.5 and 179.6 m (19.2 and 4.8 m below the ground surface), respectively. Bedrock was not encountered within the depth of investigation.

The drilling and sampling operations were supervised on a full-time basis by a member of Thurber's technical staff. The drilling supervisor logged the boreholes and processed the recovered soil samples for transport to the laboratory for further examination and testing.

A 32 mm diameter monitoring well was installed in each of Boreholes OW-23-01 and OW-23-02 to observe the groundwater level upon completion of drilling. The details for the well are illustrated on the respective Record of Borehole sheets provided in Appendix B. The wells were decommissioned in July 2023.

Following completion of the field investigation, the boreholes were decommissioned in general accordance with O.Reg. 903, as amended. Boreholes 22-01 and 22-02 were capped with asphalt patch to reinstate the pavement surface.



#### **4. LABORATORY TESTING**

Laboratory testing was selected in general accordance with the current MTO Guideline for Foundation Engineering Services, Section 5. Geotechnical laboratory testing consisted of natural moisture content determination and visual identification of all retained soil samples. Selected soil samples were chosen for grain size distribution and tested in accordance with MTO and ASTM standards. The results of these tests are summarized on the Record of Borehole sheets included in Appendix B.

Four soil samples were selected and submitted for analytical testing of corrosivity parameters and sulphate content.

All laboratory test results from the investigation are provided in Appendix C.

#### **5. DESCRIPTION OF SUBSURFACE CONDITIONS**

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix B and on the Borehole Location and Soil Strata Drawing included in Appendix A. A general description of the stratigraphy, based on the conditions encountered in the boreholes, is given in the following paragraphs. However, the factual data presented on the Record of Borehole sheets takes precedence over this general description for interpretation of the site conditions. It must be recognized that the soil and groundwater conditions will vary between and beyond borehole locations. Soil classification is in accordance with ASTM D 2487 as per current MTO Guidelines for Foundation Engineering Services.

In general terms, the encountered stratigraphy consisted of granular fill over native deposits of sand with varying amounts of silt and gravel.

##### **5.1 Asphalt**

Asphalt was encountered at the ground surface in both on-road boreholes with a recorded thickness of 110 and 140 mm.

##### **5.2 Fill - Silty Sand with Gravel to Sand with Silt and Gravel**

Silty sand with gravel to sand with silt and gravel fill was encountered beneath the asphalt in Boreholes 22-01 and 22-02. The granular fill layer was 2.5 to 4.3 m thick (base elevation 185.0 to 183.3 m). SPT N-values in the fill materials ranged from 10 to 70 blows, indicating a compact to very dense relative density. Borehole 22-01 had higher blow counts of 100 blows/125 mm which could represent a cobble within the fill. Coring was required to advance past a boulder.



The recorded moisture content of samples of the fill layer ranged from 4 to 16%. The results of three gradation analyses completed on samples of the fill are illustrated on Figure C1 of Appendix C. The results of the test are summarized below and on the Record of Borehole sheets in Appendix B.

Soil Particle	Percentage (%)	
Gravel	18 to 40	
Sand	52 to 78	
Silt	4 to 8	23
Clay		3

### 5.3 Sand (SP / SP-SM / SW-SM) to Gravel (GW) with Sand

A native layer of sand to gravel with sand was encountered below the granular fill. Varying amounts of gravel, silt, and cobbles were encountered within the sand, and wood fragments were encountered in Boreholes 22-01 and 22-02 approximately 15.2 m below the ground surface (elev. 172.5 m). In all the historical borehole logs, organic content was also encountered as high as elev. 174.2 m extending to the base of the investigation. The layer was not fully penetrated but was extended to depths ranging from 4.0 m to 15.8 m below the existing ground surface (base elev. 181.0 to 171.8 m) in the current investigation. SPT N-values ranged from 1 to 49 blows but were typically greater than 14 blows, indicating a compact to dense relative density. Borehole OW-23-02 had higher blow counts of 100 blows/150 mm which could infer cobbles within the layer. Coring was required to advance past the cobbles. Flowing sand was encountered near elev. 182.1 to 175.0 m in boreholes 22-01, 22-02, and OW-23-01.

The recorded moisture content ranged from 3 to 35% but was typically less than 23%. The results of gradation analyses completed on ten samples of the native sand illustrated on Figures C2 and C3 of Appendix C. The results of the tests are summarized below and on the Record of Borehole sheets in Appendix B.

Soil Particle	Percentage (%)	
Gravel	0 to 13	
Sand	78 to 96	
Silt	1 to 5	6 to 8
Clay		0 to 3



Three samples from the layer in Boreholes 22-01, 22-02, and OW-23-01 had a higher gravel content. The results of gradation analyses completed on those samples are summarized below and are illustrated on Figure C4 of Appendix C. The results tests are also summarized on the Record of Borehole sheets in Appendix B

Soil Particle	Percentage (%)
Gravel	35 to 72
Sand	27 to 59
Silt	1 to 6
Clay	

#### **5.4 Refusal**

Bedrock was not encountered within the depth of the borehole investigation. However, a Dynamic Cone Penetration Test (DCPT) was carried out below the sampled depth in Borehole 22-02, and a refusal blow count was encountered at a tip elevation of 168.5 m. A DCPT was also carried out below the sampled depth in Borehole OW-23-01 to a refusal blow count of 100 blows at a tip elevation of 179.6 m. However, this DCPT refusal is inferred to be refusal on a cobble or boulder within the layer.

Historical boreholes from Geocres 41N00-008 also did not encounter bedrock within a depth of investigation of 30.8 m (elev. 153.2 m). The historical boreholes did not carry out SPT testing below a depth of 18.3 m (elev. 165.7 m).

#### **5.5 Groundwater Level**

The measured groundwater levels within the wells installed in Borehole OW-23-01 and OW-23-02 are summarized in Table 5-1, below. An unstabilized groundwater level was recorded in Borehole 22-01 in the open borehole however, water was used during the drilling operations thus this reading may not be representative.

**Table 5-1 Measured Water Levels**

Borehole	Bottom of Screen Depth / Elevation (m)	Soil in Zone of Screen	Groundwater Level		Date of Measurement
			Depth (mbgs)	Elevation (m)	
OW-23-01	3.2 181.2	Sand with Silt	1.1	183.3	2023/06/02
			1.1	183.3	2023/06/09
			1.1	183.3	2023/06/15
			1.1	183.3	2023/07/06
			1.1	183.3	2023/07/14
OW-23-02	3.4 181.7	Sand with Silt	1.7	183.4	2023/07/08
			1.7	183.4	2023/07/11
			1.7	183.4	2023/07/13
			1.7	183.4	2023/07/14

The river water level was surveyed by Thurber at elev. 183.3 m on August 5, 2022.

These observations are considered short term, and it should be noted that the groundwater and river water level at the time of construction may be different. Seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater and river water level may be at a higher elevation after periods of significant and/or prolonged precipitation and spring snow melts.

A Single Well Response Test (SWRT), or “slug test”, was carried out on July 14, 2023 in the monitoring wells by lowering the water level within the monitoring well and recording the recovery of the water level over time with a data logger. The slug tests were completed and analyzed using the Hvorslev method and the plots of the slug test results are included in Appendix B. The hydraulic conductivity values calculated from the in-situ slug tests are summarized in Table 5-2, below.

**Table 5-2 Single Well Response Test Results**

Borehole /Monitoring Well	Bottom of Screen Depth /Elevation (m)	Soil in Zone of Screened	Estimated Hydraulic Conductivity (m/s)
OW-23-01	3.2 / 181.2	Sand with Silt	$4.2 \times 10^{-4}$
OW-23-02	3.4 / 181.7	Sand with Silt	$2.7 \times 10^{-4}$

It should be expected that variations in hydraulic conductivity will exist within the various soil deposits that were encountered.

Both wells were decommissioned following the completion of the testing on July 14, 2023.

## 5.6 Analytical Testing

Three soil samples were submitted for analytical testing. The analysis results are included in Appendix C and are summarized in Table 5-3.

**Table 5-3 Summary of Analytical Test results**

Borehole	22-01	22-02	22-02	OW-23-02
Sample	SS5	SS6	SS9	SS8
Depth (ft/m)	10 – 12 3.0 – 3.6	12.5 – 14.5 3.8 – 4.4	20 – 22 6.1 – 6.7	10 – 12 3.0 – 3.6
Elevation (m)	184.3	183.6	181.3	181.8
Soil Type	Sand	Sand with Silt and Gravel Fill	Sand with Silt	Sand with Silt
Conductivity ( $\mu\text{S}/\text{cm}$ )	86	158	45	18
pH	7.38	6.88	7.15	6.84
Resistivity (Ohm-cm)	11,600	6,340	22,000	54,700
Chloride ( $\mu\text{g}/\text{g}$ )	5	39	<5	<10
Sulphate ( $\mu\text{g}/\text{g}$ )	<5	29	6	<10
Sulphide (%)	<0.04	<0.04	-	<0.04



## **6. MISCELLANEOUS**

The borehole locations reflect existing site features and access constraints. The as-drilled locations and ground surface elevations were measured by Thurber. George Downing Estate Drilling Ltd. of Hawkesbury, Ontario, and Ohlmann Geotechnical Services Inc. of Almonte, Ontario, supplied and operated the drill rig used to drill, test, sample, and decommission the boreholes. Traffic control was performed in accordance with Ontario Book 7 and was provided by Leroy Construction of Blind River, Ontario, and J. Provost Contracting Ltd. of Wawa, Ontario. The field work was supervised on a full-time basis by Mr. I. Khan, EIT and Mr. A. de Oliveira, EIT, under the direction of Mr. S. Peters, P.Eng.

Geotechnical laboratory testing was carried out by Thurber's geotechnical laboratory in Ottawa, Ontario. Analytical laboratory testing was carried out by Paracel Laboratories Ltd. in Ottawa, Ontario.



Interpretation of the data and preparation of this report were carried out by A. de Oliveira, E.I.T., and S. Peters, P.Eng. The report was reviewed by F. Griffiths, P.Eng., and P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundation Projects.

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## STATEMENT OF LIMITATIONS AND CONDITIONS

### 1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

### 2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

### 3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

### 4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

### 5. INTERPRETATION OF THE REPORT

- a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.
- b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.
- c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.
- d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

### 6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

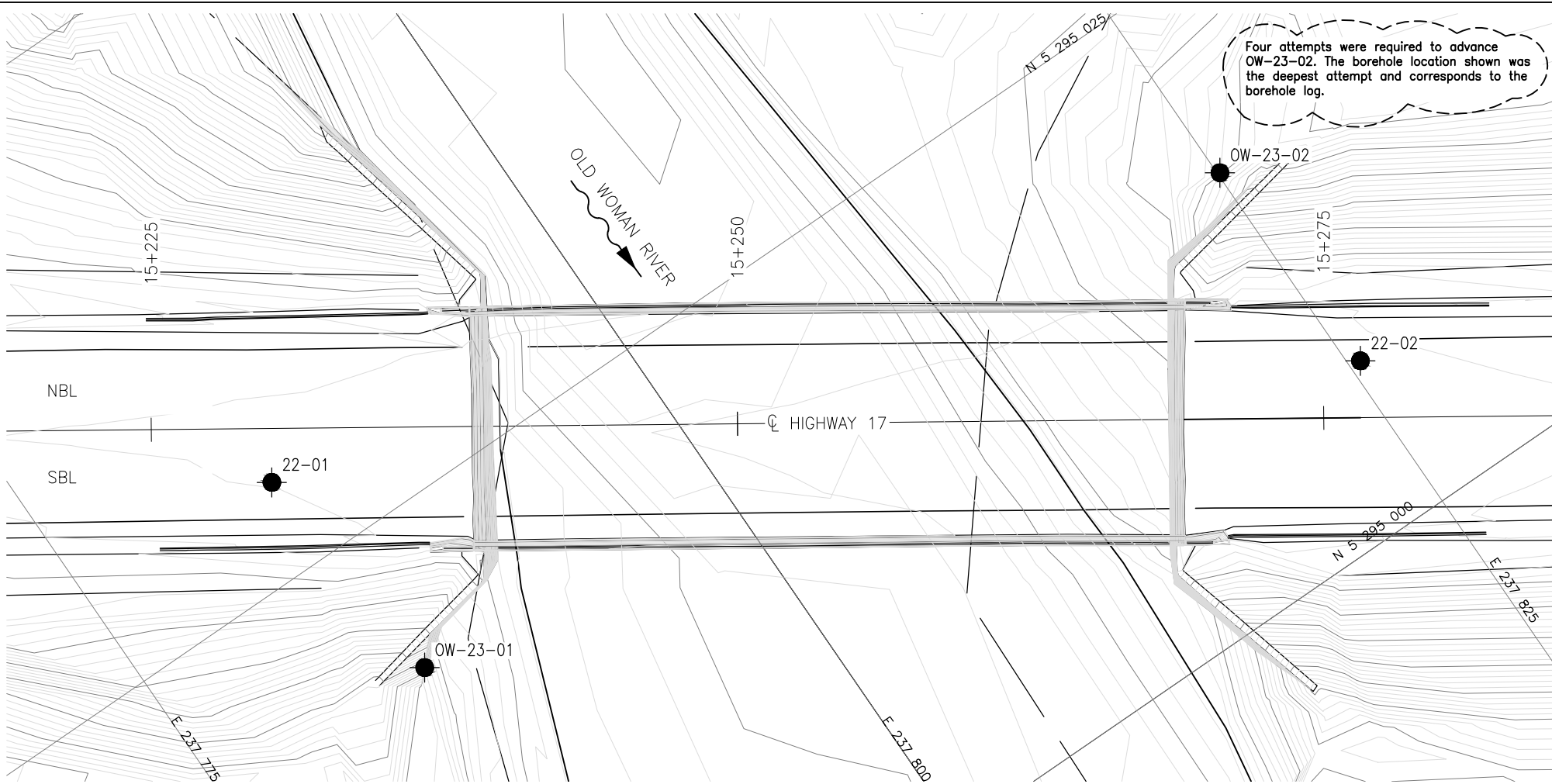
### 7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.



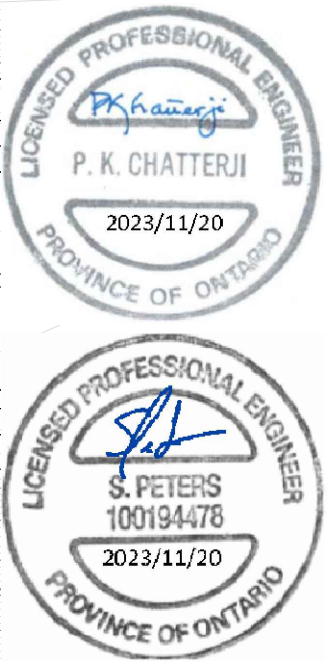
## **Appendix A Drawings**

Borehole Locations and Strata Drawing  
Historical Drawings and Borehole Records



Four attempts were required to advance OW-23-02. The borehole location shown was the deepest attempt and corresponds to the borehole log.

METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN



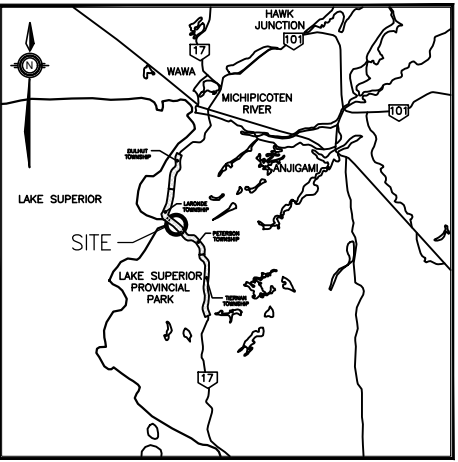
CONT No  
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HIGHWAY 17  
OLD WOMAN RIVER BRIDGE  
LARONDE TOWNSHIP  
BOREHOLE LOCATIONS AND SOIL STRATA

Ontario

THURBER ENGINEERING LTD.

SHEET



KEYPLAN

LEGEND

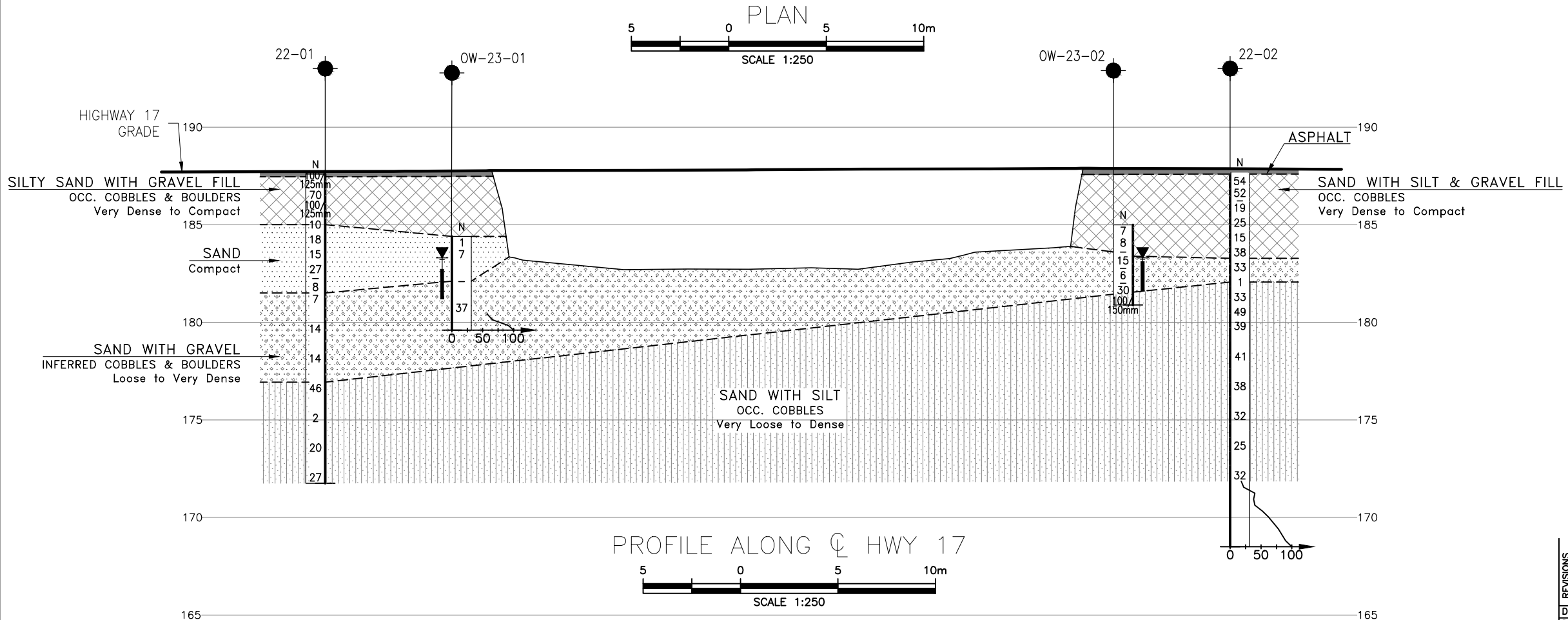
- Borehole
- Borehole (Previous Investigation)
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- Water Level
- Head Artesian Water
- Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
22-01	187.6	5 295 028.9	237 784.3
22-02	187.7	5 295 006.9	237 825.5
OW-23-01	184.4	5 295 018.7	237 785.2
OW-23-02	185.1	5 295 016.9	237 825.1

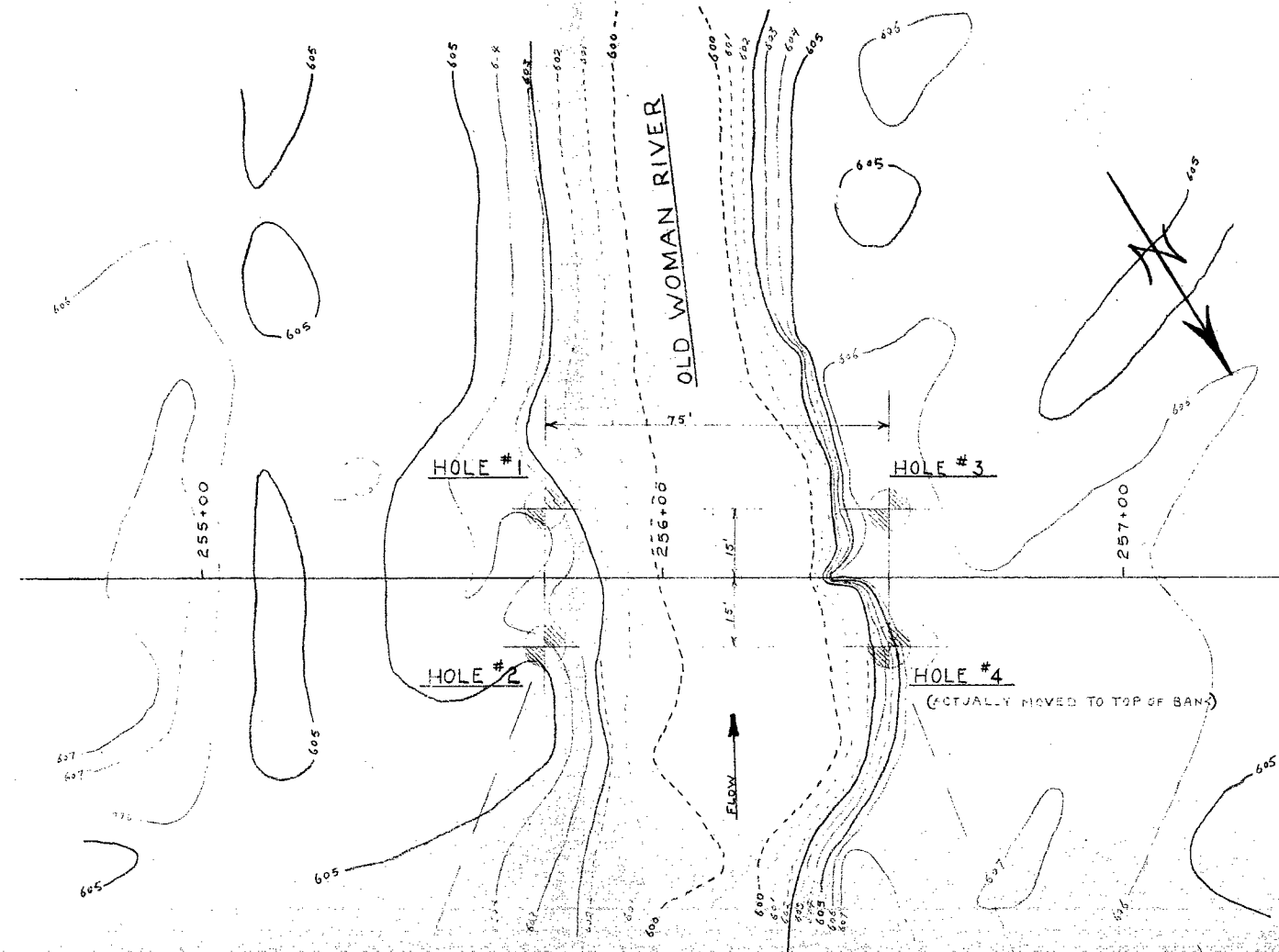
-NOTES-

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- Coordinate system is MTM NAD 83 Zone 13.

GEOCRES No. 41N00-036

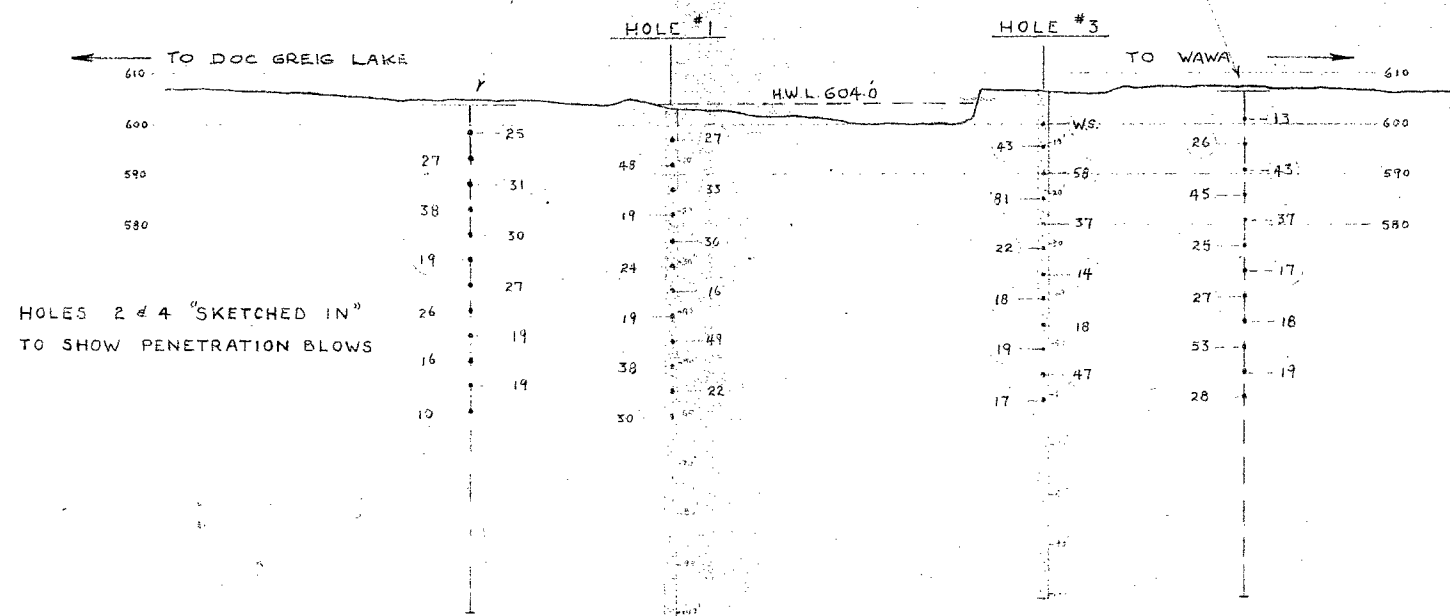


REVISIONS	DATE	BY	DESCRIPTION
DESIGN	AO	CHK	CODE
DRAWN	AN	CHK	SITE
			LOAD
			STRUCT
			DATE
			NOV 2023
			DWG F-1



# LEGEND

- 2" O.D. SPLIT BARREL SAMPLE
- 16 STD. PENETRATION TEST BLOWS
- 4200 IN. LBS. BLOWS PER FOOT



HOLES 2 & 4 "SKETCHED IN"  
TO SHOW PENETRATION BLOWS

SCALES: HOR. 1" = 20'  
VER. 1" = 20'



**e.m. peto & associates ltd.**

SOIL SITE INVESTIGATION  
AT  
OLD WOMAN RIVER--HWY.17 BRIDGE  
FOR  
DEPARTMENT OF HIGHWAYS OF ONTARIO

OUR JOB No. 5790 DATE AUG. 26/57  
CLIENTS PLAN No. E-3187 PER. *lu*



## **Appendix B Record of Borehole Sheets**

Symbols and Terms  
Record of Boreholes Sheets  
Single Well Response Test



## SYMBOLS, ABBREVIATIONS AND TERMS USED ON TEST HOLE RECORDS

### TERMINOLOGY DESCRIBING COMMON SOIL GENESIS

Topsoil	mixture of soil and humus capable of supporting vegetative growth
Peat	mixture of fragments of decayed organic matter
Till	unstratified glacial deposit which may include particles ranging in sizes from clay to boulder
Fill	material below the surface identified as placed by humans (excluding buried services)

### TERMINOLOGY DESCRIBING SOIL STRUCTURE:

Desiccated	having visible signs of weathering by oxidization of clay materials, shrinkage cracks, etc.
Fissured	having cracks, and hence a blocky structure
Varved	composed of alternating layers of silt and clay
Stratified	composed of alternating successions of different soil types, e.g. silt and sand
Layer	> 75 mm in thickness
Seam	2 mm to 75 mm in thickness
Parting	< 2 mm in thickness

### RECOVERY:

For soil samples, the recovery is recorded as the length of the soil sample recovered.

### N-VALUE:

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. For samples where insufficient penetration was achieved and N-value cannot be presented, the number of blows are reported over the sampler penetration in millimetres (e.g. 50/75).

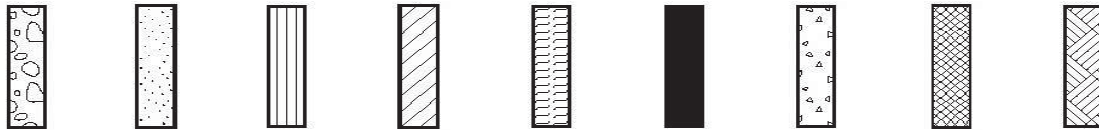
### DYNAMIC CONE PENETRATION TEST (DCPT):

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to an "A" size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone 0.3 m into the soil. The DCPT is used as a probe to assess soil variability.



### STRATA PLOT:

Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders  
Cobbles  
Gravel      Sand      Silt      Clay      Organics      Asphalt      Concrete      Fill      Bedrock

### TEXTURING CLASSIFICATION OF SOILS

Classification	Particle Size
Boulders	Greater than 200 mm
Cobbles	75 – 200 mm
Gravel	4.75 – 75 mm
Sand	0.075 – 4.75 mm
Silt	0.002 – 0.075 mm
Clay	Less than 0.002 mm

### TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

Descriptive Term	Undrained Shear Strength (kPa)
Very Soft	12 or less
Soft	12 – 25
Firm	25 – 50
Stiff	50 – 100
Very Stiff	100 – 200
Hard	Greater than 200

NOTE: Clay sensitivity is defined as the ratio of the undisturbed strength over the remolded strength.

### SAMPLE TYPES

SS	Split spoon samples
ST	Shelby tube or thin wall tube
DP	Direct push sample
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ etc.	Rock core sample obtained with the use of standard size diamond coring equipment

### TERMS DESCRIBING CONSISTENCY (COHESIONLESS SOILS ONLY)

Descriptive Term	SPT “N” Value
Very Loose	Less than 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very Dense	Greater than 50



### MODIFIED UNIFIED SOIL CLASSIFICATION

Major Divisions		Group Symbol	Typical Description
COARSE GRAINED SOIL	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILT AND CLAY SOILS $W_L < 35\%$	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		OL	Organic silts and organic silty-clays of low plasticity.
	SILT AND CLAY SOILS $35\% < W_L < 50\%$	MI	Inorganic compressible fine sandy silt with clay of medium plasticity, clayey silts.
		CI	Inorganic clays of medium plasticity, silty clays.
		OI	Organic silty clays of medium plasticity.
	SILT AND CLAY SOILS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy of silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other organic soils.

Note -  $W_L$  = Liquid Limit





## EXPLANATION OF ROCK LOGGING TERMS

### ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock materials.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structures are preserved.

### TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1 m in length or larger, as a percentage of total core length
Unconfined Compressive Strength: (UCS)	Axial stress required to break the specimen.
Fracture Index: (FI)	Frequency of natural fractures per 0.3 m of core run.

### DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 to 2 m
Medium bedded	0.2 to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 to 60 mm
Laminated	6 to 20 mm
Thinly laminated	Less than 6 mm

### STRENGTH CLASSIFICATION




Rock Strength	Approximate Uniaxial Compressive Strength (MPa)
Extremely Strong	Greater than 250
Very Strong	100 – 250
Strong	50 – 100
Medium Strong	25 – 50
Weak	5 – 25
Very Weak	1 – 5
Extremely Weak	0.25 – 1

# RECORD OF BOREHOLE No 22-01

1 OF 2

METRIC

GWP# 5207-18-00 LOCATION Lat: 47.790835°, Long: -84.894512° Old Woman River, Laronde Township, MTM z13: N 5 295 028.9 E 237 784.3 ORIGINATED BY AO/AH  
 HWY 17 BOREHOLE TYPE CME 75 Truck Mounted / HW Casing / NQ Coring COMPILED BY AO  
 DATUM Geodetic DATE 2022.08.04 - 2022.08.05 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)									
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa														
187.6	Asphalt Surface							20	40	60	80	100										
0.0	ASPHALT (140 mm)							20	40	60	80	100										
0.1	SILTY SAND with Gravel Occasional Cobbles and Boulders Very dense to compact Brownish grey FILL  - 240 mm Boulder at a depth of 2.0 m		1	SS	100/ 125mm		187															
			2	SS	70																	
			3	SS	100/ 125mm		186															
			1	NQ	-																	
			4	SS	10		185															
2.6	SAND (SP) Occasional Cobbles Compact Light brown		5	SS	18		184															
			6	SS	15																	
			7	SS	27		183															
			2	NQ	-		182															
			8	SS	8																	
181.5	GRAVEL (GW) with Sand to SAND (SP) with Gravel Inferred Cobbles and Boulders Loose to compact Light greyish brown		9	SS	7		181															
			10	SS	14		180															
			11	SS	14		179															
							178															

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 22-01

2 OF 2

METRIC

GWP# 5207-18-00 LOCATION Lat: 47.790835°, Long: -84.894512° Old Woman River, Laronde Township, MTM z13: N 5 295 028.9 E 237 784.3 ORIGINATED BY AO/AH  
 HWY 17 BOREHOLE TYPE CME 75 Truck Mounted / HW Casing / NQ Coring COMPILED BY AO  
 DATUM Geodetic DATE 2022.08.04 - 2022.08.05 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
	Continued From Previous Page													
176.9	GRAVEL (GW) with Sand to SAND (SP) with Gravel Inferred Cobbles and Boulders Loose to compact Light greyish brown						177							
10.7	SAND (SP-SM) with Silt Inferred Cobbles Very loose to dense Light grey		12	SS	46									0 92 8 0
							176							
			13	SS	2		175							
	- At a depth of 12.8 m, drilling method was switched from NW to HW casing as a result of flowing sands.						174							
			14	SS	20		173							
	- Wood fragments at a depth of 15.2 m		15	SS	27		172							0 91 8 1
171.8														
15.8	End of Borehole													
	Water was introduced into the borehole as part of the drilling procedure. An open-hole water level may not be representative of groundwater conditions.													

DOUBLE LINE 31653 HWY 17 OLD WOMAN RIVER.GPJ 2012TEMPLATE(MTO).GDT 11-20-23

# RECORD OF BOREHOLE No 22-02

1 OF 2

METRIC

GWP# 5207-18-00 LOCATION Lat: 47.790641°, Long: -84.893961° Old Woman River, Laronde Township, MTM z13: N 5 295 006.9 E 237 825.5 ORIGINATED BY AO/AH  
 HWY 17 BOREHOLE TYPE CME 75 Truck Mounted / HW Casing / NQ Coring COMPILED BY AO  
 DATUM Geodetic DATE 2022.08.05 - 2022.08.06 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				W P      W      W L				GR	SA	SI	CL
187.7	Asphalt Surface																		
0.0	ASPHALT (110 mm)																		
0.1	SAND with Silt and Gravel Occasional Cobbles Very dense to compact Brown to grey FILL		1	SS	54		187										40	52	8 (SH+CL)
			2	SS	52														
			1	NQ	-														
			3	SS	19		186												
			4	SS	25		185												
			5	SS	15		184										18	78	4 (SH+CL)
			6	SS	38														
183.3	SAND (SP) with Gravel Inferred Cobbles Dense to very loose Light grey		7	SS	33		183										45	51	4 (SH+CL)
4.4			8	SS	1		182												
182.1	SAND (SP to SP-SM) with Silt Inferred Cobbles Dense to Compact Light grey		9	SS	33		181												
5.6			10	SS	49		180										4	92	4 (SH+CL)
			11	SS	39		179												
			12	SS	41		178												

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
15  
10  
(%) STRAIN AT FAILURE

DOUBLE LINE 31653 HWY 17 OLD WOMAN RIVER.GPJ 2012TEMPLATE(MTO).GDT 11-20-23

## METRIC

[illegible]

DOUBLE LINE 31653 HWY 17 OLD WOMAN RIVER.GPJ 2012TEMPLATE(MTO).GDT 11-20-23


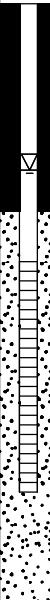
+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity

# RECORD OF BOREHOLE No OW-23-01

1 OF 1

METRIC

GWP# 5207-18-00 LOCATION Lat: 47.790743°, Long: -84.894498° Old Woman River, Laronde Township, MTM z13: N 5 295 018.7 E 237 785.2 ORIGINATED BY IK  
 HWY 17 BOREHOLE TYPE Portable / NW Casing / NQ Coring COMPILED BY RH  
 DATUM Geodetic DATE 2023.06.26 - 2023.06.27 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT  W P	NATURAL MOISTURE CONTENT  W	LIQUID LIMIT  W L	UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)	
184.4	Ground Surface																
0.0	SAND (SP-SM to SW-SM) with Silt trace to with Gravel contains cobbles very loose to dense light brown to greyish brown		1	SS	1										6 89 5 (SI+CL)		
			2	SS	7											35 59 6 (SI+CL)	
			3	NQ	-												
			4	SS	37												13 78 6 3
180.4	End of sampled borehole Borehole advanced with DCPT																
4.0																	
179.6																	
4.8	End of Borehole on DCPT refusal																
	Monitoring Well installed: Schedule 40 PVC standpipe with 32-mm diameter and 1.5-m slotted screen.  Water Level Readings: DATE DEPTH (m) ELEV. (m) 2023/06/02 1.1 183.3 2023/06/09 1.1 183.3 2023/06/15 1.1 183.3 2023/07/06 1.1 183.3 2023/07/14 1.1 183.3  Note 1: A third-weight hammer was used to advance the split-spoon sampler. The N values presented above have been adjusted to a standard hammer. Note 2: A full-weight hammer was used to advance the DCPT.																

# RECORD OF BOREHOLE No OW-23-02

1 OF 1

METRIC

GWP# 5207-18-00 LOCATION Lat: 47.790732°, Long: -84.893954° Old Woman River, Laronde Township, MTM z13: N 5 295 016.9 E 237 826.0 ORIGINATED BY IK  
 HWY 17 BOREHOLE TYPE Portable / NW Casing / NQ Coring COMPILED BY RH  
 DATUM Geodetic DATE 2023.05.25 - 2023.06.11 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)																			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)																		
185.1	Ground Surface							20	40	60	80	100					GR	SA	SI	CL															
0.0	<b>SAND (SP to SP-SM)</b> trace to with Silt, trace Gravel contains cobbles loose to dense light brown to greyish brown		1	SS	7		185										7	91	2	(SI+CL)															
			2	SS	8																														
			3	NQ	-		184																												
			4	SS	15																														
			5	NQ	-		183																												
			6	SS	6																														
			7	NQ	-		182																												
			8	SS	30												9	82	6	3															
			9	SS	100																														
181.0							181																												
4.1	<b>End of Borehole</b> - Practical Portable Refusal  <b>Monitoring Well installed:</b> Schedule 40 PVC standpipe with 32-mm diameter and 1.5-m slotted screen.  <b>Water Level Readings:</b> <table><tr><th>DATE</th><th>DEPTH (m)</th><th>ELEV. (m)</th></tr><tr><td>2023/07/08</td><td>1.7</td><td>183.4</td></tr><tr><td>2023/07/11</td><td>1.7</td><td>183.4</td></tr><tr><td>2023/07/13</td><td>1.7</td><td>183.4</td></tr><tr><td>2023/07/14</td><td>1.7</td><td>183.4</td></tr></table> <b>Note 1:</b> A third-weight hammer was used to advance the split-spoon sampler. The N values presented above have been adjusted to a standard hammer. <b>Note 2:</b> Three other attempts were made and could not advance the borehole deeper. 4.1 m.	DATE	DEPTH (m)	ELEV. (m)	2023/07/08	1.7	183.4	2023/07/11	1.7	183.4	2023/07/13	1.7	183.4	2023/07/14	1.7	183.4																			
DATE	DEPTH (m)	ELEV. (m)																																	
2023/07/08	1.7	183.4																																	
2023/07/11	1.7	183.4																																	
2023/07/13	1.7	183.4																																	
2023/07/14	1.7	183.4																																	

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE



**THURBER** ENGINEERING LTD.

**Slug Test Analysis Report**

Project: Highway 17 and Old Woman River Bridge

Number: 31653

Client: AECOM

Location: Laronde Township, Ontario

Slug Test: OW-23-01

Test Well: OW-23-01

Test Conducted by: SM & IK

Test Date: 2023-07-14

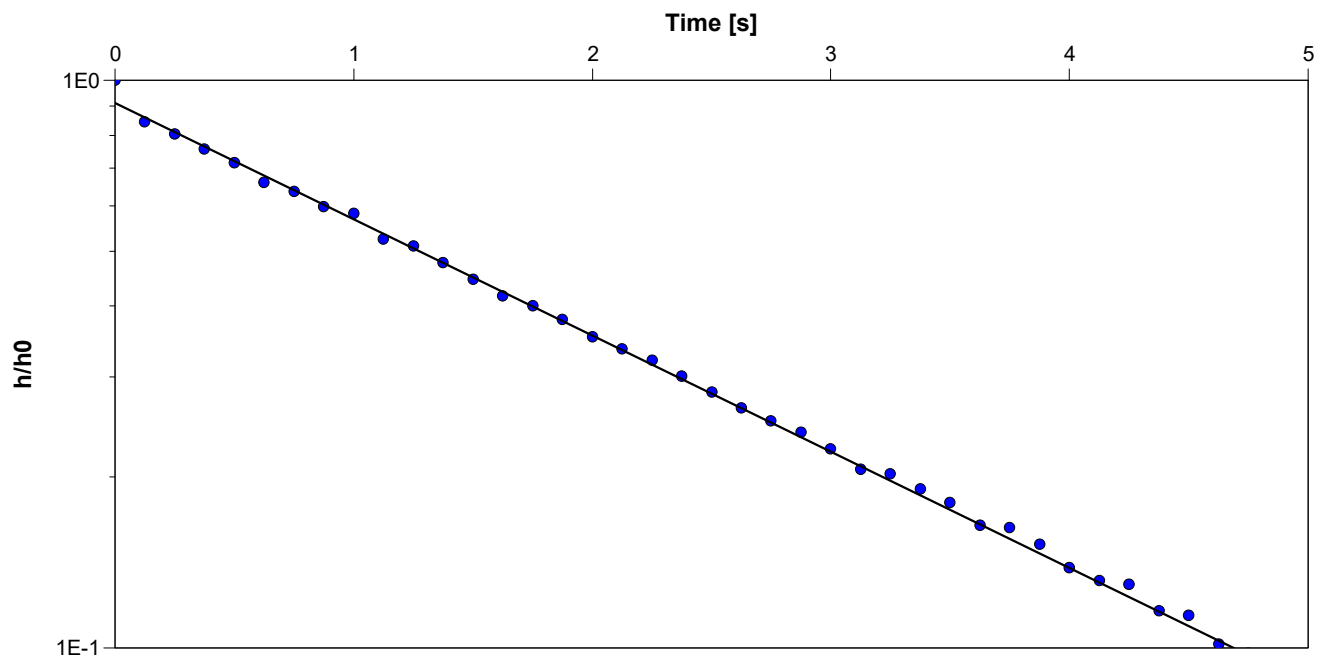
Analysis Performed by: SM

SWRT Analysis

Analysis Date: 2023-07-18

Aquifer Thickness:

Checked by: AH



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity  
[m/s]

OW-23-01

$4.2 \times 10^{-4}$





**THURBER** ENGINEERING LTD.

**Slug Test Analysis Report**

Project: Highway 17 and Old Woman River Bridge

Number: 31653

Client: AECOM

Location: Laronde Township, Ontario

Slug Test: OW-23-02

Test Well: OW-23-02

Test Conducted by: SM & IK

Test Date: 2023-07-14

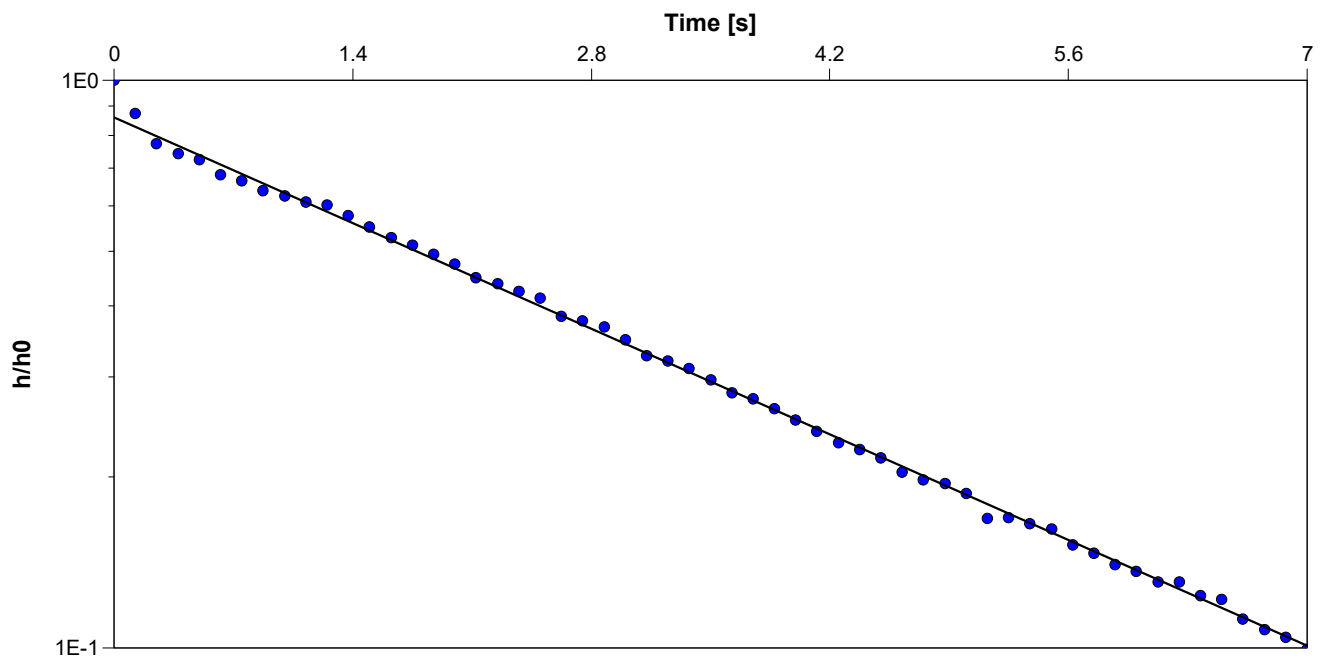
Analysis Performed by: SM

SWRT Analysis

Analysis Date: 2023-07-18

Aquifer Thickness:

Checked by: AH



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity  
[m/s]

OW-23-02

$2.7 \times 10^{-4}$



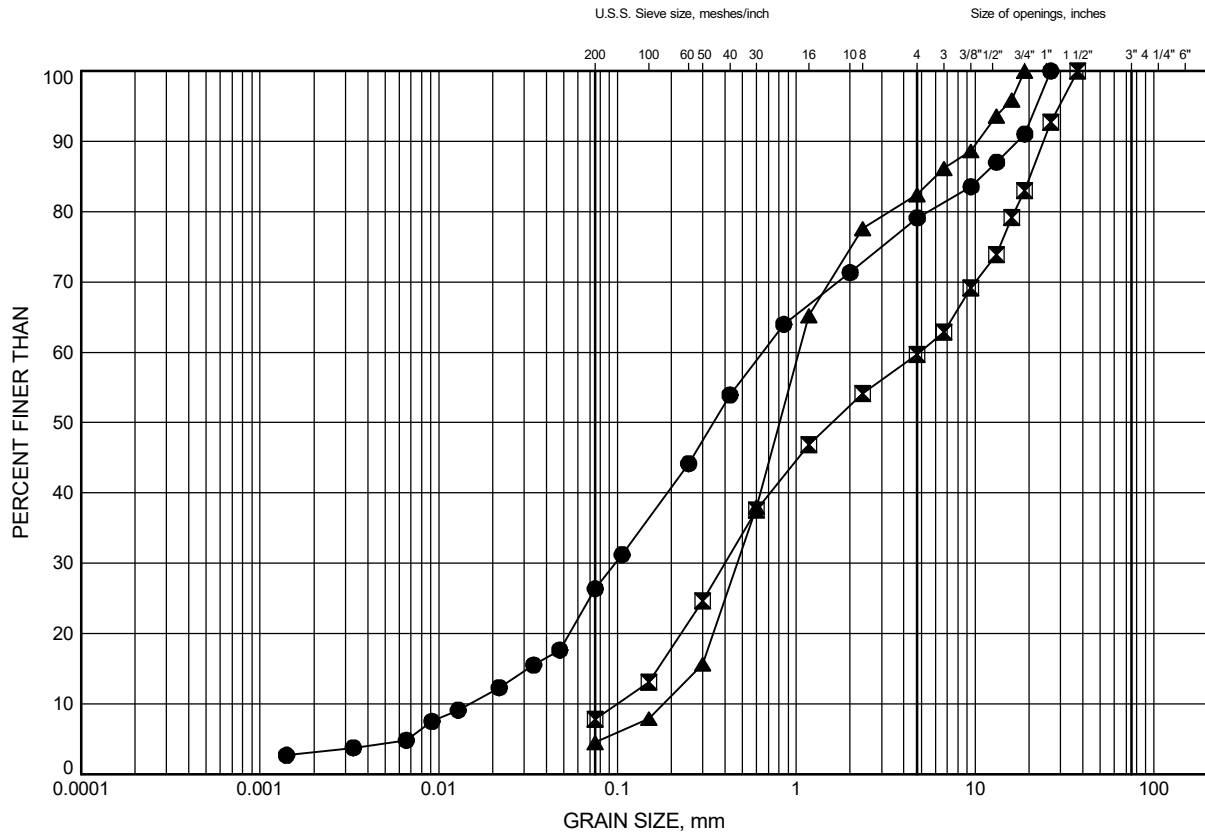
## **Appendix C Laboratory Testing**

### Particle Size Analysis Figures Analytical Testing Results

# Highway 17 Old Woman River GRAIN SIZE DISTRIBUTION

FIGURE C1

FILL: Silty Sand with Gravel to Sand with Silt and Gravel



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	22-01	1.1	186.5
⊠	22-02	1.1	186.6
▲	22-02	3.4	184.3

Date August 2023  
GWP# 5207-18-00

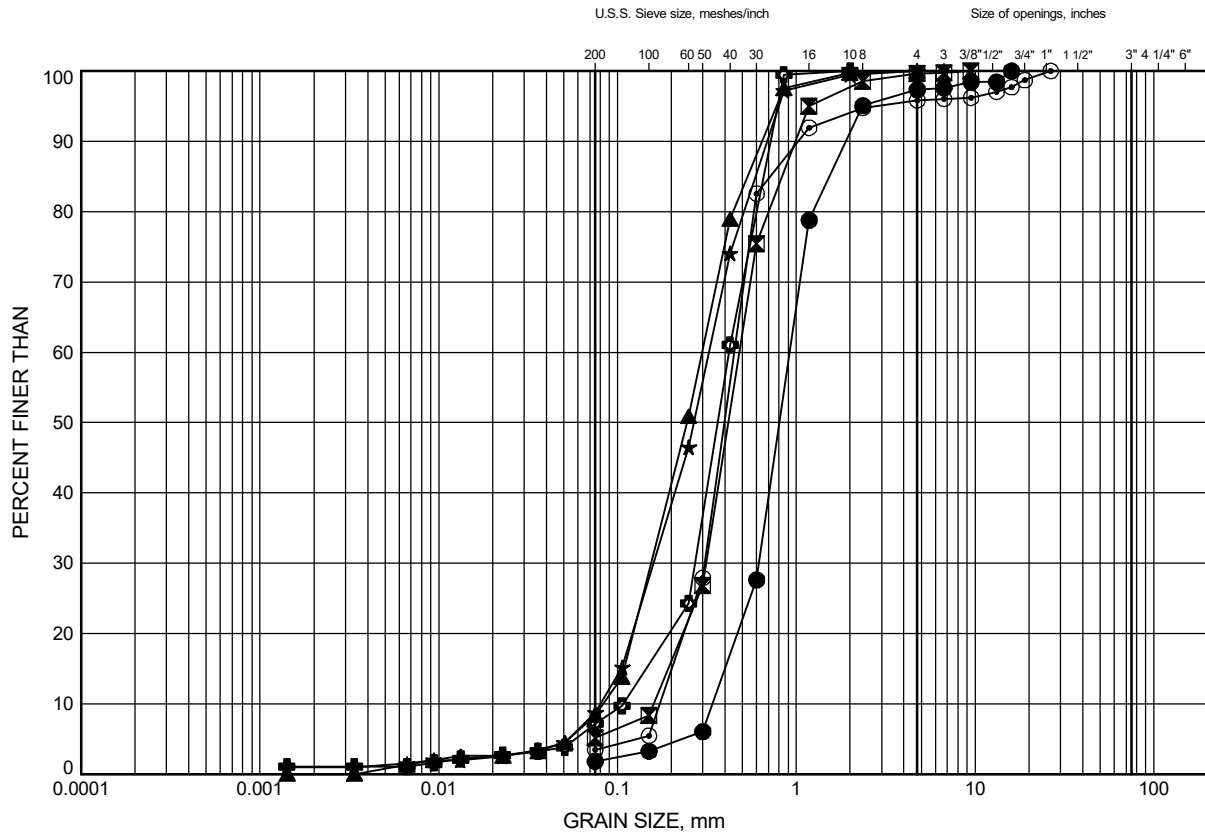


Prep'd RH  
Chkd. AO

# Highway 17 Old Woman River GRAIN SIZE DISTRIBUTION

FIGURE C2

## Sand with Silt



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	22-01	4.1	183.5
⊠	22-01	5.8	181.8
▲	22-01	11.0	176.6
★	22-01	15.5	172.1
⊙	22-02	7.9	179.8
⊕	22-02	14.0	173.7

Date August 2023

GWP# 5207-18-00



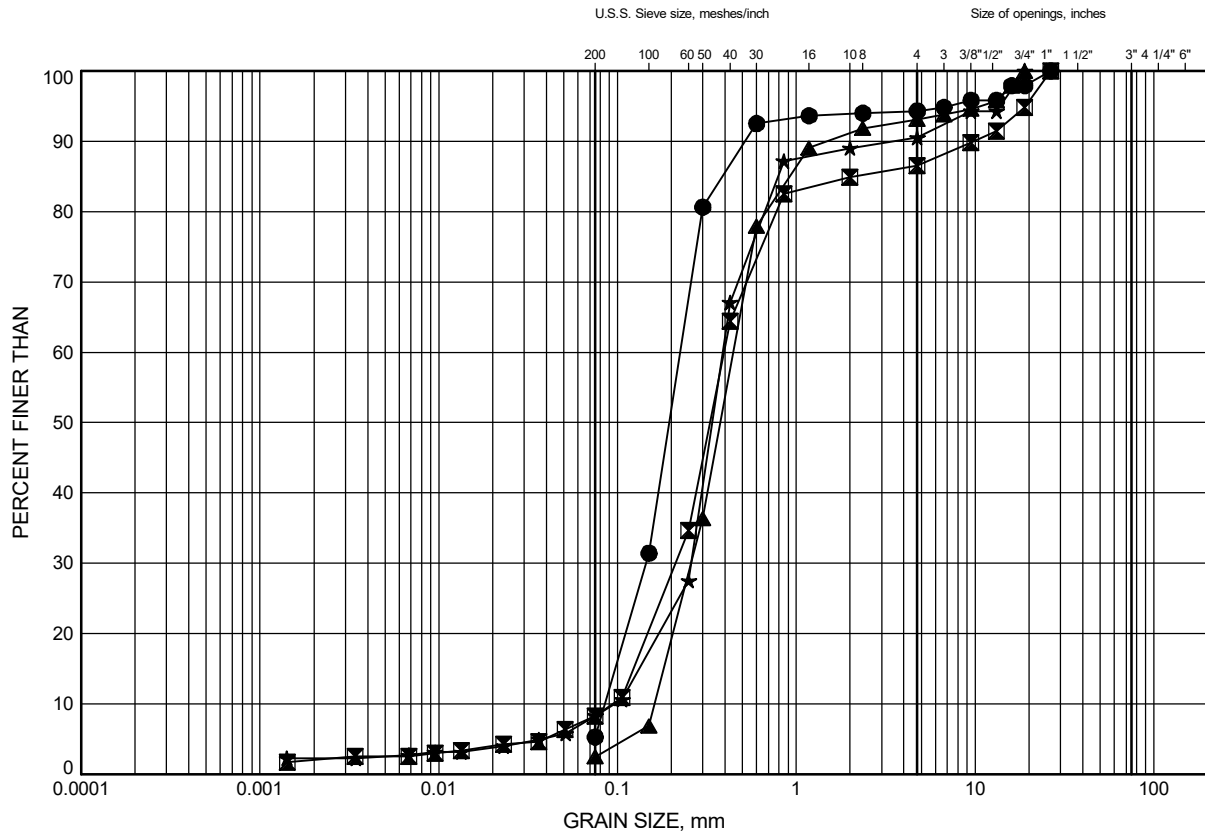
Prep'd RH

Chkd. AO

# Highway 17 Old Woman River GRAIN SIZE DISTRIBUTION

FIGURE C3

## Sand with Silt



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OW-23-01	0.3	184.1
⊠	OW-23-01	3.7	180.7
▲	OW-23-02	0.3	184.8
★	OW-23-02	3.4	181.7

Date August 2023  
GWP# 5207-18-00

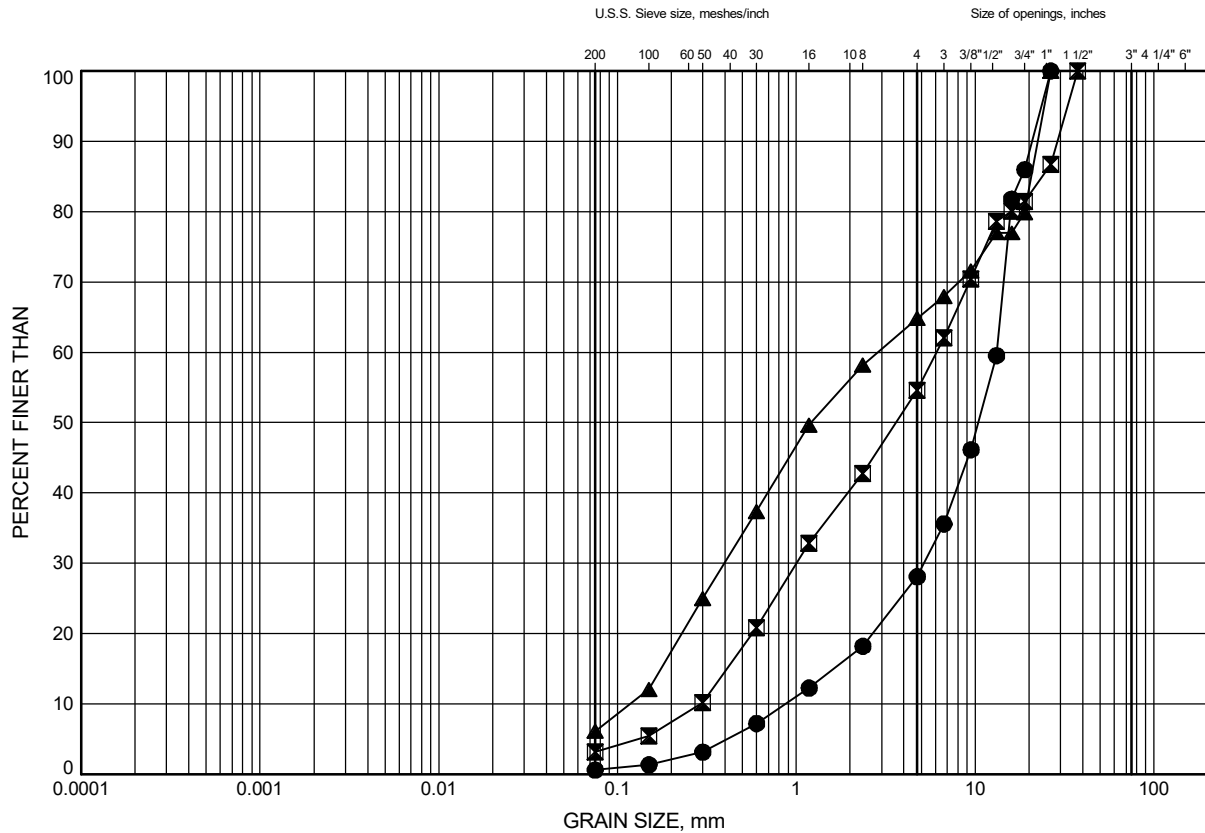


Prep'd RH  
Chkd. AO

# Highway 17 Old Woman River GRAIN SIZE DISTRIBUTION

FIGURE C4

## Sand with Gravel to Gravel with Sand



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	22-01	7.9	179.7
⊠	22-02	4.9	182.8
▲	OW-23-01	0.9	183.5

Date August 2023  
GWP# 5207-18-00



Prep'd RH  
Chkd. AO

Certificate of Analysis

Report Date: 22-Aug-2022

Client: Thurber Engineering Ltd.

Order Date: 12-Aug-2022

Client PO:

Project Description: 31653 Hwy 17 Old Woman River

Client ID:	22-01 SS5 (10'-12')	22-02 SS6 (12'6"-14'6")	-	-	
Sample Date:	04-Aug-22 09:00	05-Aug-22 09:00	-	-	-
Sample ID:	2233615-01	2233615-02	-	-	-
Matrix:	Soil	Soil	-	-	-
MDL/Units					

**Physical Characteristics**

% Solids	0.1 % by Wt.	92.7	90.4	-	-	-	-
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**General Inorganics**

Conductivity	5 uS/cm	86	158	-	-	-	-
pH	0.05 pH Units	7.38	6.88	-	-	-	-
Resistivity	0.1 Ohm.m	116	63.4	-	-	-	-

**Anions**

Chloride	5 ug/g	5	39	-	-	-	-
Sulphate	5 ug/g	<5	29	-	-	-	-

Certificate of Analysis

Report Date: 24-Aug-2022

Client: Thurber Engineering Ltd.

Order Date: 17-Aug-2022

Client PO:

Project Description: 31653 Hwy 17 Old Woman River

Client ID:	22-02 SS9 (20'-22')	-	-	-	-
Sample Date:	06-Aug-22 09:00	-	-	-	-
Sample ID:	2234368-01	-	-	-	-
Matrix:	Soil	-	-	-	-
MDL/Units					

#### Physical Characteristics

% Solids	0.1 % by Wt.	81.3	-	-	-	-
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#### General Inorganics

Conductivity	5 uS/cm	45	-	-	-	-
pH	0.05 pH Units	7.15	-	-	-	-
Resistivity	0.1 Ohm.m	220	-	-	-	-

#### Anions

Chloride	5 ug/g	<5	-	-	-	-
Sulphate	5 ug/g	6	-	-	-	-



Certificate of Analysis

Report Date: 06-Jul-2023

Client: Thurber Engineering Ltd.

Order Date: 27-Jun-2023

Client PO:

Project Description: 31653 Hwy 17 Old Woman River

Client ID:	OW-23-02 SS8 (10'-12')	-	-	-
Sample Date:	25-May-23 09:00	-	-	-
Sample ID:	2326229-01	-	-	-
MDL/Units	Soil	-	-	-

**Physical Characteristics**

% Solids	0.1 % by Wt.	82.3	-	-	-
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**General Inorganics**

Conductivity	5 uS/cm	18 [1]	-	-	-
pH	0.05 pH Units	6.84 [1]	-	-	-
Resistivity	0.1 Ohm.m	547	-	-	-

**Anions**

Chloride	10 ug/g dry	<10 [1]	-	-	-
Sulphate	10 ug/g dry	<10 [1]	-	-	-

Certificate of Analysis

Client: Thurber Engineering Ltd.

Client PO:

Report Date: 06-Jul-2023

Order Date: 27-Jun-2023

Project Description: 31653 Hwy 17 Old Woman River

**Qualifier Notes:**

***Login Qualifiers :***

Sample - One or more parameter received past hold time - Conductivity, chloride, sulphate, pH, and sulphide.

*Applies to samples: OW-23-02 SS8 (10'-12')*

***Sample Qualifiers :***

- 1 : Holding time had been exceeded upon receipt of the sample at the laboratory or prior to the analysis being requested.
- 3 : OW-23-02 SS8 (10'-12') - client confirmed sample collected May 25, 2023 as per the collection date on the sample, and not June 1, 2023 as per the COC.

**Sample Data Revisions**

None

**Work Order Revisions / Comments:**

None

**Other Report Notes:**

n/a: not applicable

ND: Not Detected

MDL: Method Detection Limit

Source Result: Data used as source for matrix and duplicate samples

%REC: Percent recovery.

RPD: Relative percent difference.

NC: Not Calculated

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.

Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

**SGS Canada Inc.**

P.O. Box 4300 - 185 Concession St.  
Lakefield - Ontario - K0L 2H0  
Phone: 705-652-2000 FAX: 705-652-6365

**Paracel Laboratories**

Attn : Dale Robertson

300-2319 St.Laurent Blvd.  
Ottawa, ON  
K1G 4K6, Canada

Phone: 613-731-9577  
Fax:613-731-9064

26-August-2022

**Date Rec. :** 17 August 2022  
**LR Report:** CA13718-AUG22  
**Reference:** Project#: 2233615

**Copy:** #1

## CERTIFICATE OF ANALYSIS

### Final Report

Sample ID	Sample Date & Time	Sulphide (Na <sub>2</sub> CO <sub>3</sub> ) %
1: Analysis Start Date		24-Aug-22
2: Analysis Start Time		09:03
3: Analysis Completed Date		25-Aug-22
4: Analysis Completed Time		17:01
5: QC - Blank		< 0.04
6: QC - STD % Recovery		112%
7: QC - DUP % RPD		ND
8: RL		0.02
9: 22-01 SS5 (10'-12')	04-Aug-22	< 0.04
10: 22-02 SS6 (12'6"-14'6")	05-Aug-22	< 0.04

RL - SGS Reporting Limit  
ND - Not Detected

Kimberley Didsbury  
Project Specialist,  
Environment, Health & Safety

**SGS Canada Inc.**

P.O. Box 4300 - 185 Concession St.  
Lakefield - Ontario - K0L 2H0  
Phone: 705-652-2000 FAX: 705-652-6365

**Paracel Laboratories**

Attn : Dale Robertson

300-2319 St.Laurent Blvd.  
Ottawa, ON  
K1G 4K6, Canada

Phone: 613-731-9577  
Fax:613-731-9064

18-July-2023

**Date Rec. :** 30 June 2023  
**LR Report:** CA19636-JUN23  
**Reference:** Project#: 2326229

**Copy:** #1

## CERTIFICATE OF ANALYSIS

### Final Report

Sample ID	Sample Date & Time	Sulphide (Na <sub>2</sub> CO <sub>3</sub> ) %
1: Analysis Start Date		18-Jul-23
2: Analysis Start Time		12:08
3: Analysis Completed Date		18-Jul-23
4: Analysis Completed Time		14:07
5: QC - Blank		< 0.04
6: QC - STD % Recovery		112%
7: QC - DUP % RPD		ND
8: RL		0.02
9: OW-23-02 SS8 (10'-12")	25-May-23 09:00	< 0.04

RL - SGS Reporting Limit  
ND - Not Detected

Kimberley Didsbury  
Project Specialist,  
Environment, Health & Safety



## **Appendix D Site Photographs**



Photograph 1: Looking west of bridge *[taken August 2022]*



Photograph 2: Looking east of bridge *[taken August 2022]*





Photograph 3: Looking south of bridge *[taken August 2022]*



Photograph 4: Looking north of bridge *[taken August 2022]*



Photograph 5: Looking at north wing wall and abutment *[taken August 2022]*



Photograph 6: Looking at south wing wall and abutment *[taken August 2022]*





Photograph 7: Looking north at river alignment *[taken August 2022]*



Photograph 8: Erosion at the south abutment's west side slope *[taken August 2022]*





Photograph 9: Sheet piles below water at the east side of the north abutment *[taken August 2022]*



Photograph 10: Deposited sand and tree debris near the south abutment *[taken August 2022]*