



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION AND DESIGN REPORT
WABIGOON RIVER BRIDGE REHABILITATION
HIGHWAY 17, UNORGANIZED KENORA DISTRICT, ONTARIO
AGREEMENT 6020-E-0025, WORK ORDER 1
G.W.P. 6117-17-00, SITE NO. 41S-0042/B0
LATITUDE: 49.815093°, LONGITUDE: -92.873885°**

GEOCRES No.: 52F-68

Report

to

MORRISON HERSHFIELD

Date: January 20, 2023
File: 34752



TABLE OF CONTENTS

PART 1: FACTUAL INFORMATION

| | | |
|-----|---|---|
| 1. | INTRODUCTION | 1 |
| 2. | SITE DESCRIPTION | 1 |
| 3. | INVESTIGATION PROCEDURES | 2 |
| 4. | LABORATORY TESTING | 4 |
| 5. | DESCRIPTION OF SUBSURFACE CONDITIONS | 4 |
| 5.1 | Asphalt | 4 |
| 5.2 | Sand and Gravel to Gravelly Sand Fill | 4 |
| 5.3 | Sandy Gravel to Gravel Fill | 5 |
| 5.4 | Silty Clay | 6 |
| 5.5 | Bedrock | 6 |
| 5.6 | Groundwater Conditions | 6 |
| 6. | MISCELLANEOUS | 7 |

PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

| | | |
|-----|--|----|
| 7. | GENERAL..... | 9 |
| 8. | TEMPORARY EXCAVATIONS | 10 |
| 9. | ABUTMENT BACKFILL AND LATERAL EARTH PRESSURES..... | 11 |
| 10. | TEMPORARY ROADWAY PROTECTION SYSTEMS | 12 |
| 11. | SCOUR AND EROSION PROTECTION | 13 |
| 12. | CONSTRUCTION CONCERNS..... | 13 |
| 13. | CLOSURE | 13 |

STATEMENT OF LIMITATIONS AND CONDITIONS

APPENDICES

| | |
|------------|--|
| Appendix A | Record of Borehole Sheets |
| Appendix B | Laboratory Test Results |
| Appendix C | Site Photographs |
| Appendix D | Borehole Locations and Soil Strata Drawing |
| Appendix E | Stratigraphic Profile Drawing from Geocres 52F00-007 |
| Appendix F | List of Referenced OPSS and OPSD Documents and Suggested Wording for NSSP |



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PART 1: FACTUAL INFORMATION

1. INTRODUCTION

This report presents the factual data obtained from a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) to support the detailed design of the Wabigoon River Bridge rehabilitation. Thurber's scope specifically included provision of geotechnical parameters for design of Temporary Roadway Protection Systems (TPS). The Wabigoon River Bridge is located on Highway 17, 6 km west of Dryden, in the District of Kenora, Ontario.

The purpose of this investigation was to explore the subsurface conditions at the TPS locations and, based on the data obtained, to provide a borehole location plan, stratigraphic profile, records of boreholes, laboratory test results and a written description of the subsurface conditions.

Thurber carried out the investigation as a sub-consultant to Morrison Hershfield, under the Ministry of Transportation Ontario (MTO) Retainer Agreement Number 6020-E-0025, Work Order 1.

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

2. SITE DESCRIPTION

The site is located on Highway 17, approximately 6 km west of Dryden, in the Unorganized District of Kenora, Ontario. The existing bridge is aligned in a general west-east direction and crosses the Wabigoon River, which flows from south to north.

The March 2021 preliminary Structural Design Report (SDR) by WSP indicates that the existing structure is a single span, steel girder bridge, with a cast-in-place concrete deck, asphalt wearing surface and metal traffic barriers. The original Wabigoon River bridge was constructed in 1961, but has gone through several rehabilitations since, including a major rehabilitation in 2001 for a



replacement superstructure and concrete repairs to the substructure (Contract 2000-0220), cleaning and coating the steel in 2006 (Contract 2005-6005) and repaving the asphalt wearing surface in 2007 (Contract 2016-6270). The bridge deck is approximately 24.4 m long and has a width of 12.75 m. The bridge is supported on concrete abutments founded on bedrock. The road surface elevation at the existing bridge deck ranges from approximately 361 to 362 m. The water level of Wabigoon River was measured at Elevation 354.3 m in November 2014.

The lands surrounding the Wabigoon River bridge are heavily forested. An area of surficial erosion was observed near the toe of the northwest bridge approach embankment. Surficial vegetation loss was also observed at the southwest and southeast approach embankments. Also observed near the southwest approach embankment was a slide area on the south bank of the south ditchline (beyond the approach embankment toe of slope). Photographs of the bridge and surrounding area are presented in Appendix C, including the erosion and slide areas in Photos 5 to 10.

Based on an existing Geocres report (52F00-007) from 1960, the subsurface soils near the project site were anticipated to consist of mainly sand and gravel/rock embankment fill, underlain by old paper mill refuse fill mixed with sand and silt (in a very loose or liquid state), and thin layers of clay and sand and gravel overlying bedrock. The bedrock surface was anticipated to generally slope downwards from the west to east approaches to the bridge. The stratigraphic profile drawing showing the paper mill refuse fill is included in Appendix E.

Based on published geological information, the general site area lies within an area of glaciolacustrine deposits (silt and clay and minor sands), and is underlain by Pre-Cambrian bedrock (muscovite-bearing granitic rocks).

3. INVESTIGATION PROCEDURES

The site investigation and field-testing program for this project was carried out from October 13 to 17, 2022. The field program consisted of drilling and sampling two (2) boreholes, 22-01 and 22-02, to depths of 10.5 and 15.0 m below the ground surface (Borehole termination Elevation 350.5 and 346.7 m), respectfully. Both boreholes were drilled through the paved portion of Highway 17 at the approaches to the bridge. Borehole 22-01 was drilled near the proposed west TPS location and Borehole 22-02 was drilled near the proposed east TPS location. The Record of Borehole sheets are included in Appendix A. The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing included in Appendix D.

Utility clearances were obtained prior to the start of drilling. The horizontal coordinates and ground surface elevations for the boreholes were estimated from field measurements relative to existing



site features and the topographic drawings provided to Thurber by Morrison Hershfield. The coordinate system MTM NAD 83, Zone 16 was used for the boreholes.

The boreholes for the project were advanced using a rubber tire-mounted CME750 drill rig, using hollow stem auger and/or wash boring techniques and NQ coring. In all boreholes, soil samples were obtained at selected intervals with a 50 mm outside diameter split spoon sampler driven in conjunction with the Standard Penetration Test (SPT), supplemented by Dynamic Cone Penetration Tests (DCPTs). Bedrock coring using an NQ size core barrel was used to advance both boreholes into bedrock.

Due to the anticipated presence of old paper mill refuse in the subsurface fill, the air quality was monitored using a gas reader throughout the drilling activities for health and safety purposes. The presence of sulfur-like odors was also noted where encountered when drilling in the embankment fill material. Due to strong sulfur-like odor in Borehole 22-01, the initial borehole was terminated and moved to an offset location of 1.4 m west to continue drilling.

Due to shearing of drilling casing within the gravel fill in Borehole 22-02, the initial borehole was terminated and moved to an offset location of 4.9 m east to continue drilling.

The drilling and sampling operations were supervised on a full-time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing. The rock cores were logged, and the Total Core Recovery (TCR), Solid Core Recovery (SCR), Rock Quality Designation (RQD) and Fracture Indices (FI) were measured.

Details of the drilling program, including drilling depths and completion details are summarized in Table 3.1 below.

Table 3.1: Borehole Completion Details

| Borehole Number | Borehole Depth / Base Elevation (m) | Completion Details |
|------------------------|--|--|
| 22-01 | 10.5 / 350.5 | Borehole caved to 3.8 m and was backfilled with bentonite holeplug to 0.5 m, sand and gravel to 0.3 m, concrete to 0.1 m and asphalt to surface. |
| 22-02 | 15.0 / 346.7 | Borehole caved to 10.2 m and was backfilled with bentonite holeplug to 0.5 m, sand and gravel to 0.3 m, concrete to 0.2 m, and asphalt to surface. |



4. LABORATORY TESTING

All recovered soil samples were subjected to visual identification and natural moisture content determination. Selected samples were subjected to grain size distribution analyses (sieve and hydrometer). Point Load Tests were also conducted on the bedrock core samples to estimate the bedrock strength. The results of this testing program are summarized on the Record of Borehole sheets in Appendix A and are shown on the figures included in Appendix B.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendix A. Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets and on the Borehole Locations and Soil Strata drawing in Appendix D. 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 in the Record of Borehole sheets governs any interpretation of the site conditions. It must be recognized that soil conditions may vary between and beyond the borehole locations.

In general, the subsurface stratigraphy below the asphalt typically consists of sand and gravel to gravelly sand fill, sandy gravel to gravel fill, and a thin layer of silty clay, which are underlain by bedrock. Although no obvious paper mill refuse was observed in the boreholes, a sulfur-like odor was encountered within the embankment fill in both boreholes. More detailed descriptions of individual strata are presented below.

5.1 Asphalt

Both Boreholes were drilled through the paved portion of Highway 17. The asphalt ranged in thickness from 165 to 178 mm at these locations.

5.2 Sand and Gravel to Gravelly Sand Fill

Embankment fill ranging from sand and gravel to gravelly sand was encountered below the asphalt in both boreholes. The fill also contained trace to some silt. Cobbles and boulders were also encountered in the lower part of the fill in Borehole 22-02 as described below.

The sand and gravel to gravelly sand fill ranged in thickness from 2.8 to 5.4 m, with an underside depth ranging from 3.0 m to 5.6 m below ground surface (Elevation 358.0 m to 356.1 m).

SPT 'N' values in the sand and gravel to gravelly sand fill generally ranged from 34 to over 100 blows per 0.3 m penetration, indicating a dense to very dense relative density; typically very dense. In Borehole 22-02, coring methods were required to penetrate a 1.1 m thick zone of



cobbles and boulders of up to 225 mm in diameter from a depth of 4.4 to 5.5 m (Elevation 357.3 to 356.2 m). A sulfur-like odor was encountered within the fill at a depth of 5.6 m in Borehole 22-02.

The measured moisture contents generally ranged from 1 to 3%.

The results of grain size analyses conducted on selected samples of the sand and gravel to gravelly sand fill are provided on the Record of Borehole sheets in Appendix A and plotted on Figure B1 in Appendix B. The results are summarized as follows:

| Soil Particle | Percentage (%) |
|---------------|----------------|
| Gravel | 24 to 51 |
| Sand | 41 to 70 |
| Silt & Clay | 6 to 12 |

5.3 Sandy Gravel to Gravel Fill

A layer of sandy gravel to gravel fill was encountered below the upper granular fill in both boreholes. The fill ranged in composition from sandy gravel to gravel with trace sand, and also contained trace silt. Cobbles and possible boulders were also encountered in the lower part of the fill in Borehole 22-02 as described below.

The sandy gravel to gravel fill ranged in thickness from 3.7 to 5.1 m, with an underside depth ranging from 6.7 m to 10.7 m below ground surface (Elevation 354.3 m to 351.0 m).

SPT 'N' values in the fill ranged from 24 to 85 blows per 0.3 m penetration, indicating a compact to very dense relative density. A sulfur-like odor was encountered within the fill at a depth of 3.7 m in Borehole 22-01. In Borehole 22-02, the drilling casing sheared at a depth of 8.2 m within the gravel fill, and therefore a DCPT was conducted from 8.2 m depth to continue the borehole in lieu of sampling. The DCPT encountered refusal of 100 blows per 0.3 m penetration at a depth of 10.7 m (Elevation 351.0 m). The borehole was then offset to readvance the casing and continue drilling. Coring methods were required to penetrate a 0.7 m thick zone of cobbles of up to 125 mm in diameter from a depth of 9.8 to 10.5 m (Elevation 351.9 to 351.2 m).

The measured moisture contents generally ranged from 0.2 to 4%.

5.4 Silty Clay

A 1.2 m thick layer of possibly native silty clay was encountered below the gravel fill in Borehole 22-02 from a depth of 10.7 to 11.9 m (Elevation 351.0 to 349.8 m). No samples of this material were recovered.

5.5 Bedrock

The overburden soils described above are underlain by bedrock. The bedrock is described as granite, is red and grey in colour and is slightly weathered to fresh. Bedrock was proven by coring 3.1 to 3.8 m in both boreholes.

Table 5.1 summarizes the depths and elevations to the top of the bedrock at the borehole locations. Based on Boreholes 22-01 and 22-02, the bedrock surface slopes down in a general west to east direction. Photographs of the rock cores are included in Appendix B.

Table 5.1 - Depths and Elevations of Top of Bedrock

| Borehole | Top of Bedrock | |
|----------|--------------------------------------|---------------|
| | Depth Below Existing Grade Level (m) | Elevation (m) |
| 22-01 | 6.7 | 354.3 |
| 22-02 | 11.9 | 349.8 |

Total Core Recovery (TCR) in the bedrock ranged between 98% to 100% throughout all runs, and Solid Core Recovery (SCR) ranged between 81% to 100%. The Rock Quality Designation (RQD) measures from the recovered cores ranged between 66% and 100%, which indicates fair to excellent rock quality; typically excellent. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core ranged from 0 to 3.

Average unconfined compressive strengths (UCS) of the rock ranged between 119 and 218 MPa, indicating the rock is typically very strong. These estimated rock strength values are interpreted from point load tests that were conducted on rock cores recovered from the boreholes. A summary of the point load tests results are presented in Appendix B.

5.6 Groundwater Conditions

Groundwater conditions were observed during drilling operations and groundwater levels were measured in the open boreholes upon completion of drilling (inside the drill casing). The measured groundwater levels are summarized in Table 5. below.



Table 5.2: Groundwater Measurements

| Borehole | Date | Water Level (m) | | Remark |
|----------|------------------|-----------------|-----------|--|
| | | Depth | Elevation | |
| 22-01 | October 15, 2022 | 6.7 | 354.3* | Open Borehole (inside drill casing) |
| 22-02 | October 17, 2022 | 7.7 | 354.0* | Open Borehole (inside drill casing) |

* May not represent stabilized water level as water was incorporated in the boreholes for drilling advancement and coring bedrock

The local surface water level of Wabigoon River was reportedly measured at Elevation 354.3 m in November 2014.

It should also be noted that groundwater levels are short term observations and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after periods of significant and/or prolonged precipitation and spring snow melts. The water level will also vary due to dam control near Wabigoon River.

6. MISCELLANEOUS

RPM Drilling Ltd. of Thunder Bay, Ontario supplied a rubber tire-mounted CME750 drill rig to conduct the drilling, sampling and in-situ testing operations for the boreholes. Traffic control services conforming to Ontario Book 7 were provided by Men at Worx Inc.

The field investigation was supervised on a full-time basis by Mr. Greg Stanhope, E.I.T. of Thurber. Overall supervision of the field program was provided by Ms. Madisan Chiarotto, E.I.T. and Mr. Mark Farrant, P. Eng. of Thurber.

Interpretation of the field data and preparation of the report was carried out by Ms. Madisan Chiarotto, E.I.T. and Mr. Mark Farrant, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

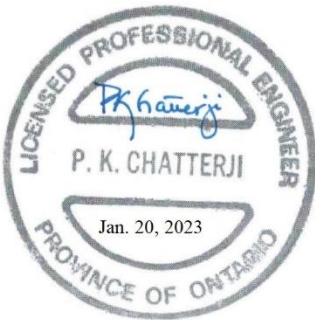


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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7. GENERAL

This report provides an interpretation of the factual data from Part 1 of the report and presents geotechnical recommendations to support the detailed design of the Wabigoon River Bridge rehabilitation. Thurber's scope specifically included provision of geotechnical parameters for design of Temporary Roadway Protection Systems (TPS). The discussion and recommendations presented in this report are based on the information provided by Morrison Hershfield and on the factual data obtained during the course of the investigation.

This foundation investigation and design report with the interpretation and recommendations are intended for the use of the Ministry of Transportation and Morrison Hershfield, and shall not be used or relied upon for any other purposes or by any other parties including the construction or design-build contractor. The construction or design-build contractor must make their own interpretation based on the factual data in Part 1 of the report. Where comments are made on construction, they are provided only in order to highlight those aspects which could affect the design of the project. Contractors must make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods and scheduling.

The existing bridge on Highway 17 is aligned in a general west-east direction and crosses the Wabigoon River, which flows from south to north. The existing structure is a single span, steel girder bridge, with a cast-in-place concrete deck, asphalt wearing surface and metal traffic barriers. The original Wabigoon River bridge, built in 1961, has undergone several rehabilitations including a replacement superstructure and concrete repairs to the substructure in 2001, cleaning and coating the steel in 2006, and repaving the asphalt wearing surface in 2007. The bridge deck is approximately 24.4 m long and has a 12.75 m width. The bridge is supported on concrete abutments founded on bedrock. The road surface elevation at the existing bridge deck ranges



from approximately 361 to 362 m. The water level of Wabigoon River was measured at Elevation 354.3 m in November 2014.

The proposed rehabilitation works will include conversion of the abutments to semi-integral abutments, replacing the existing two tube barrier railings on the bridge and approach RSS walls with four tube barrier railings, and replacing the asphalt pavement on the bridge deck and immediate approaches. Construction staging will be required to permit “half-and-half” construction of the rehabilitation works. Temporary excavations of the roadway at both abutments will also be required for the abutment conversion. This section of the report provides foundation recommendations for temporary excavations and temporary roadway protection systems (TPS) for construction staging purposes.

8. TEMPORARY EXCAVATIONS

The conversion of the bridge abutments to semi-integral design will require excavations to replace the existing ballast walls. Excavations up to approximately 2 m deep in the approach embankment adjacent to the abutments will therefore be required. The excavations will be carried out through sand and gravel to gravelly sand embankment fill.

All excavations should be carried out in accordance with OPSS.PROV 902 and the Occupational Health and Safety Act (OHSA). For the purposes of the OHSA, the sand and gravel to gravelly sand fill is classified as a Type 3 soil above the water table. All excavations at this site are anticipated to remain above the groundwater level. However, sumps and pumps should be available during construction to remove any potential seepage of perched groundwater that could exist in the fill, and to control surficial runoff into the excavations.

Support of excavations such as through the use of temporary roadway protection systems or trench boxes will be required to maintain traffic during construction. Due to the presence of dense to very dense granular fills, and obstructions such as occasional cobbles and boulders, driven sheet piles will not be able to penetrate this material and are therefore not suitable for temporary roadway protection at this site. A suitable option for roadway protection systems would be drilled-in soldier pile and lagging to advance through the cobbles and boulders. Depending on the required depth of penetration of the TPS, the soldier piles may need to be socketed into bedrock. If the excavations are small enough however, a trench box could be considered. Temporary roadway protection systems are discussed further in Section 10.

9. ABUTMENT BACKFILL AND LATERAL EARTH PRESSURES

Backfill behind the rehabilitated bridge abutments should be placed in accordance with OPSS.PROV 902. All backfill should consist of free-draining, non-frost susceptible granular materials such as Granular A or B Type II or Type III conforming to the requirements of OPSS.PROV 1010. Reference should be made to the backfill arrangements stipulated in OPSD 3101.150, as appropriate. Compaction equipment to be used adjacent to the walls should be restricted in accordance with OPSS.PROV 501.

Earth pressures acting on the structures may be assumed to be distributed triangularly and to be governed by the characteristics of the abutment backfill. For a fully drained condition, the pressures should be computed in accordance with the CHBDC 2019, but generally are given by the expression:

$$p_h = K (\gamma h + q)$$

Where:

- p_h = horizontal pressure on the wall at depth h (kPa)
- K = coefficient of lateral earth pressure (see Table 9.1)
- γ = unit weight of retained soil (see Table 9.1)
- h = depth below top of fill where pressure is computed (m)
- q = value of any surcharge (kPa)

Earth pressure coefficients for backfill to the abutment walls are dependent on the material used as backfill. Typical values are given in Table 9.1.

Table 9.1 – Coefficients of Lateral Earth Pressure (K)

| Loading Condition | OPSS Granular A or Granular B Type II $\phi = 35^\circ, \gamma = 22.8 \text{ kN/m}^3$ | | OPSS Granular B Type I or Type III $\phi = 32^\circ, \gamma = 21.2 \text{ kN/m}^3$ | |
|-------------------------------------|--|--------------------------|---|--------------------------|
| | Horizontal Backfill | Sloping Backfill (2H:1V) | Horizontal Backfill | Sloping Backfill (2H:1V) |
| Active K_A (Unrestrained Wall) | 0.27 | 0.38 | 0.31 | 0.46 |
| At-rest K_0 (Restrained Wall) | 0.43 | - | 0.47 | - |
| Passive K_P | 3.7 | - | 3.3 | - |

The use of a material with a high friction angle and low active pressure coefficient (e.g. Granular A, Granular B Type II) is preferred as it results in lower earth pressures acting on the wall.

In accordance with Clause 6.12.3 of the CHBDC 2019, a compaction surcharge should be added. The magnitude of the surcharge should be 12 kPa at the top of fill which linearly decreases to 0 kPa at a depth of 1.7 m (for Granular B Type I) or at a depth of 2.0 m (for Granular A or B Type II).

10. TEMPORARY ROADWAY PROTECTION SYSTEMS

Temporary roadway protection systems for support of excavations at the abutments should be designed and constructed in accordance with OPSS.PROV 539 and designed for Performance Level 2.

Options for roadway protection are trench boxes or drilled-in soldier pile and lagging. Depending on the required depth of penetration, the soldier piles may need to be socketed into bedrock.

The soil parameters in Table 10.1 may apply for the design of temporary roadway protection systems with horizontal backfill.

Table 10.1 – Soil Parameters for Temporary Protection System Design

| Soil Parameter | Sand and Gravel, Gravelly Sand or Gravel Fill | Silty Clay |
|--|---|----------------------|
| Φ (angle of internal friction) | 34° | 25° |
| γ (total unit weight) | 21 kN/m ³ | 18 kN/m ³ |
| γ_w (submerged unit weight) | 11 kN/m ³ | 10 kN/m ³ |
| K_a (horizontal surface) | 0.28 | 0.41 |
| K_p | 3.5 | 2.5 |

The design of the temporary protection system is the responsibility of the Contractor. The actual pressure distribution acting on the protection/shoring system is a function of the construction sequence and the relative flexibility of the wall, and these factors have to be considered when designing the shoring system. All protection systems should be designed by a Professional Engineer experienced in such designs, who will determine an appropriate support system. The designer of the roadway protection system should consider the presence of an uneven or sloping bedrock surface at this site, and check whether the depth of soldier piles, if utilized, is sufficient to provide base fixity.



11. SCOUR AND EROSION PROTECTION

Areas of surficial erosion and vegetation loss were observed on the approach embankments to the bridge, particularly at the toe of the northwest approach embankment where loss of soil has occurred near the river (Appendix C, Photos 5 to 7). Surficial vegetation loss was observed at the southwest and southeast approach embankments (Photos 9 and 10). An area of slide activity was also observed beyond the toe of slope of the southwest approach embankment (Photo 8). In this area, a slide has occurred on the south bank of the south ditchline.

The affected areas along the Highway 17 embankments should be repaired. These and any other disturbed or regraded earth slopes must be provided with erosion protection in accordance with OPSS.PROV 804. Additional erosion protection measures such as rip rap or rock protection may be required to prevent future loss of material where the embankment is in contact with the river. Erosion protection measures must be designed by specialists with experience in this field.

The area of slide activity beyond the southwest ditchline should be observed for signs of future impact to the Highway 17 embankment toe, or potential blockage of the ditch.

12. CONSTRUCTION CONCERNS

Potential construction concerns include, but are not necessarily limited to:

- The bedrock surface is expected to vary along the length of the roadway projection systems and may be contacted at different depths beyond the borehole locations. Variations in the bedrock surface should be expected during shoring installation.
- Obstructions such as cobbles and boulders were noted to be present within the existing embankment fill, which may impede the installation of soldier piles. An NSSP on Obstructions is provided in Appendix F.
- Appropriate erosion protection measures must be provided to prevent future loss of material on the approach embankment slopes.

13. CLOSURE

Engineering analysis and preparation of the design report was carried out by Mr. Mark Farrant, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.



THURBER ENGINEERING LTD.



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Dr. P.K. Chatterji, Ph.D., P.Eng.
Designated MTO Principal Contact

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

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

| CLASSIFICATION | PARTICLE SIZE | VISUAL IDENTIFICATION |
|----------------|--------------------|---|
| Boulders | Greater than 200mm | same |
| Cobbles | 75 to 200mm | same |
| Gravel | 4.75 to 75mm | 5 to 75mm |
| Sand | 0.075 to 4.75mm | Not visible particles to 5mm |
| Silt | 0.002 to 0.075mm | Non-plastic particles, not visible to the naked eye |
| Clay | Less than 0.002mm | Plastic particles, not visible to the naked eye |

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

| TERMINOLOGY | PROPORTION |
|---------------------------------|---------------|
| Trace or Occasional | Less than 10% |
| Some | 10 to 20% |
| Adjective (e.g. silty or sandy) | 20 to 35% |
| And (e.g. sand and gravel) | 35 to 50% |

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

| DESCRIPTIVE TERM | UNDRAINED SHEAR STRENGTH (kPa) | APPROXIMATE SPT ⁽¹⁾ 'N' VALUE |
|------------------|--------------------------------|--|
| Very Soft | 12 or less | Less than 2 |
| Soft | 12 to 25 | 2 to 4 |
| Firm | 25 to 50 | 4 to 8 |
| Stiff | 50 to 100 | 8 to 15 |
| Very Stiff | 100 to 200 | 15 to 30 |
| Hard | Greater than 200 | Greater than 30 |

NOTE: Hierarchy of Soil Strength Prediction

- 1) Laboratory Triaxial Testing
- 2) Field Insitu Vane Testing
- 3) Laboratory Vane Testing
- 4) SPT value
- 5) Pocket Penetrometer


4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

| DESCRIPTIVE TERM | SPT "N" VALUE |
|------------------|-----------------|
| Very Loose | Less than 4 |
| Loose | 4 to 10 |
| Compact | 10 to 30 |
| Dense | 30 to 50 |
| Very Dense | Greater than 50 |

5. LEGEND FOR RECORDS OF BOREHOLES

| | | | |
|---|---|--|------------------------|
| SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE | SS Split Spoon Sample | WS Wash Sample | AS Auger (Grab) Sample |
| | TW Thin Wall Shelby Tube Sample | TP Thin Wall Piston Sample | |
| | PH Sampler Advanced by Hydraulic Pressure | PM Sampler Advanced by Manual Pressure | |
| | WH Sampler Advanced by Self Static Weight | RC Rock Core | SC Soil Core |

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$


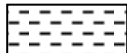



 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

| MAJOR DIVISIONS | | GROUP SYMBOL | TYPICAL DESCRIPTION |
|----------------------|---|--------------|---|
| COARSE GRAINED SOILS | 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 | SILTS AND CLAYS W _L < 50% | ML | Inorganic silts and 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. (W _L < 30%). |
| | | CI | Inorganic clays of medium plasticity, silty clays. (30% < W _L < 50%). |
| | | OL | Organic silts and organic silty-clays of low plasticity. |
| | SILTS AND CLAYS W _L > 50% | MH | Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts. |
| | | CH | Inorganic clays of high plasticity, fat clays. |
| | | OH | Organic clays of medium to high plasticity, organic silts. |
| HIGHLY ORGANIC SOILS | | Pt | Peat and other highly organic soils. |
| CLAY SHALE | | | |
| SANDSTONE | | | |
| SILTSTONE | | | |
| CLAYSTONE | | | |
| COAL | | | |

EXPLANATION OF ROCK LOGGING TERMS

| <u>ROCK WEATHERING CLASSIFICATION</u> | | <u>SYMBOLS</u> | |
|---------------------------------------|---|---|-------------------|
| Fresh (FR) | No visible signs of weathering. | | |
| Fresh Jointed (FJ) | Weathering limited to the surface of major discontinuities. |  | CLAYSTONE |
| Slightly Weathered (SW) | Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material. |  | SILTSTONE |
| Moderately Weathered (MW) | Weathering extends throughout the rock mass, but the rock material is not friable. |  | SANDSTONE |
| Highly Weathered (HW) | Weathering extends throughout the rock mass and the rock is partly friable. |  | COAL |
| Completely Weathered (CW) | Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved. |  | Bedrock (general) |

| <u>DISCONTINUITY SPACING</u> | | <u>STRENGTH CLASSIFICATION</u> | | | |
|------------------------------|-----------------------|--------------------------------|---|---------------------|---|
| Bedding | Bedding Plane Spacing | Rock Strength | Approximate Uniaxial Compressive Strength | | Field Estimation of Hardness* |
| | | | (MPa) | (psi) | |
| Very thickly bedded | Greater than 2m | Extremely Strong | Greater than 250 | Greater than 36,000 | Specimen can only be chipped with a geological hammer |
| Thickly bedded | 0.6 to 2m | | | | |
| Medium bedded | 0.2 to 0.6m | Very Strong | 100-250 | 15,000 to 36,000 | Requires many blows of geological hammer to break |
| Thinly bedded | 60mm to 0.2m | Strong | 50-100 | 7,500 to 15,000 | Requires more than one blow of geological hammer to break |
| Very thinly bedded | 20 to 60mm | | | | |
| Laminated | 6 to 20mm | Medium Strong | 25.0 to 50.0 | 3,500 to 7,500 | Breaks under single blow of geological hammer. |
| Thinly Laminated | Less than 6mm | | | | |




















| <u>TERMS</u> | | | | | |
|-------------------------------------|--|-----------------------|-------------|--------------|--|
| Total Core Recovery: (TCR) | Core recovered as a percentage of total core run length. | Weak | 5.0 to 25.0 | 750 to 3,500 | Can be peeled by a pocket knife with difficulty |
| Solid Core Recovery: (SCR) | Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run. | Very Weak | 1.0 to 5.0 | 150 to 750 | Can be peeled by a pocket knife, crumbles under firm blows of geological pick. |
| Rock Quality Designation: (RQD) | Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length. | Extremely Weak (Rock) | 0.25 to 1.0 | 35 to 150 | Indented by thumbnail |
| Uniaxial Compressive Strength (UCS) | Axial stress required to break the specimen | | | | |
| Fracture Index: (FI) | Frequency of natural fractures per 0.3m of core run. | | | | |

RECORD OF BOREHOLE No 22-01

1 OF 2

METRIC

GWP# 6117-17-00 LOCATION Wabigoon River Bridge; NAD83-16: N 5 519 740.1 E 313 849.0 ORIGINATED BY GS
DIST Kenora HWY 17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY MC
DATUM Geodetic DATE 2022.10.13 - 2022.10.15 LATITUDE 49.815131 LONGITUDE -92.874255 CHECKED BY MEF

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | | | | |
|---------------|--|---|---------|------|--------------|---|-----------------|---|-----|---|-----|---|--|--|--|---|--|--|--|--|--|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | WATER CONTENT (%) | | | | | | | | | | |
| 361.0 | GROUND SURFACE | | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | | | | | | |
| 0.0 | ASPHALT: (165mm) | | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | | | | | | |
| 0.2 | SAND and GRAVEL, trace to some silt Very Dense Brown Moist (FILL) |  | 1 | SS | 50/ 0.100 |  | 360 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| | | | 2 | SS | 59 | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| 358.0 | Sandy GRAVEL, trace silt Very Dense Brown Moist (FILL) |  | 3 | SS | 75 | | |  | 359 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| | | | 4 | SS | 92/ 0.250 | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| 3.0 | Sandy GRAVEL, trace silt Very Dense Brown Moist (FILL) |  | 5 | SS | 85 | | | | |  | 358 | | | | | | | | | | | |
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| | | | | | | | | | | | | | | | | | | | | | | |
| 354.3 | Strong sulfur-like odor encountered at 3.7m Below 3.7m, borehole offset 1.4m west |  | 6 | SS | 82 |  | 357 | | | | | | | | | | | | | | | |
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| 6.7 | Becoming dense |  | 7 | SS | 31 | | |  | 356 | | | | | | | | | | | | | |
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| 354.3 | BEDROCK (GRANITE), slightly weathered to fresh, medium to large grained rock with clear foliation, very strong, red/grey |  | 1 | RUN | | | | | |  | 355 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
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| 6.7 | BEDROCK (GRANITE), slightly weathered to fresh, medium to large grained rock with clear foliation, very strong, red/grey |  | 2 | RUN | |  | 354 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | | | | | | | | | |
| 6.7 | BEDROCK (GRANITE), slightly weathered to fresh, medium to large grained rock with clear foliation, very strong, red/grey |  | 3 | RUN | | | |  | 353 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
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| 6.7 | BEDROCK (GRANITE), slightly weathered to fresh, medium to large grained rock with clear foliation, very strong, red/grey |  | | | | | | | |  | 352 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
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| 6.7 | BEDROCK (GRANITE), slightly weathered to fresh, medium to large grained rock with clear foliation, very strong, red/grey | | | | |  | 351 | | | | | | | | | | | | | | | |
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Continued Next Page

+³, ×³: Numbers refer to Sensitivity
15 10 5 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 22-01

2 OF 2

METRIC

GWP# 6117-17-00 LOCATION Wabigoon River Bridge; NAD83-16: N 5 519 740.1 E 313 849.0 ORIGINATED BY GS
 DIST Kenora HWY 17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY MC
 DATUM Geodetic DATE 2022.10.13 - 2022.10.15 LATITUDE 49.815131 LONGITUDE -92.874255 CHECKED BY MEF

| 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 γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|--|--|--|--|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | | | |
| | Continued From Previous Page | | | | | | | | | | | | | | | | |
| 350.5 | | | | | | | | | | | | | | | | | |
| 10.5 | END OF BOREHOLE AT 10.5m. OPEN BOREHOLE TO 3.8m WITH WATER LEVEL READING TAKEN AT 6.7m INSIDE CASING (UNSTABILIZED). BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.5m, THEN SAND AND GRAVEL TO 0.3m, THEN CONCRETE TO 0.1m, THEN ASPHALT TO SURFACE. | | | | | | | | | | | | | | | | |

RECORD OF BOREHOLE No 22-02

1 OF 2

METRIC

GWP# 6117-17-00 LOCATION Wabigoon River Bridge; NAD83-16: N 5 519 734.1 E 313 894.2 ORIGINATED BY GS
DIST Kenora HWY 17 BOREHOLE TYPE Solid Stem Augers/NW Boring/NQ Coring COMPILED BY MC
DATUM Geodetic DATE 2022.10.14 - 2022.10.17 LATITUDE 49.815076 LONGITUDE -92.873626 CHECKED BY MEF

| 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 γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|---|------------|---------|------|---------------|----------------------------|-----------------|--|--|--|--|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE | | | | | | | | |
| 361.7 | GROUND SURFACE | | | | | | | | | | | | | | | |
| 0.0 | ASPHALT: (178mm) | | | | | | | | | | | | | | | |
| 0.2 | SAND and GRAVEL to Gravelly SAND, trace to some silt, trace cobbles and boulders Dense to Very Dense Brown Moist (FILL) Auger grinding from 1.4m to 4.5m | | 1 | SS | 88 | | | | | | | | | | | 29 60 11 (SI+CL) |
| | | | 2 | GS | | | | | | | | | | | | |
| | | | 3 | SS | 34 | | | | | | | | | | | 51 42 7 (SI+CL) |
| | | | 4 | SS | 46 | | | | | | | | | | | |
| | | | 5 | SS | 50/ 0.125 | | | | | | | | | | | |
| | No recovery | | 6 | GS | | | | | | | | | | | | |
| | Cored though cobbles and boulders up to 225mm diameter from 4.4m to 5.5m | | 7 | SS | 100/ 0.050 | | | | | | | | | | | 24 70 6 (SI+CL) |
| | Sulfur-like odor encountered at 5.6m | | | | | | | | | | | | | | | |
| 356.1 | | | | | | | | | | | | | | | | |
| 5.6 | GRAVEL, trace sand, trace silt, trace cobbles and boulders Compact White to Black Wet (FILL) | | 8 | SS | 24 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | 9 | SS | 35 | | | | | | | | | | | |
| 353.5 | | | | | | | | | | | | | | | | |
| 8.2 | NW Casing sheared at 8.2m. Dynamic Cone Penetration Test (DCPT) started at 8.2m. Re-advanced NW Casing from surface (offset 4.9m east). Cored through cobbles up to 125mm diameter from 9.8m to 10.5m (POSSIBLY FILL) | | | | | | | | | | | | | | | |

Continued Next Page

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

RECORD OF BOREHOLE No 22-02

2 OF 2

METRIC

GWP# 6117-17-00 LOCATION Wabigoon River Bridge; NAD83-16: N 5 519 734.1 E 313 894.2 ORIGINATED BY GS
 DIST Kenora HWY 17 BOREHOLE TYPE Solid Stem Augers/NW Boring/NQ Coring COMPILED BY MC
 DATUM Geodetic DATE 2022.10.14 - 2022.10.17 LATITUDE 49.815076 LONGITUDE -92.873626 CHECKED BY MEF

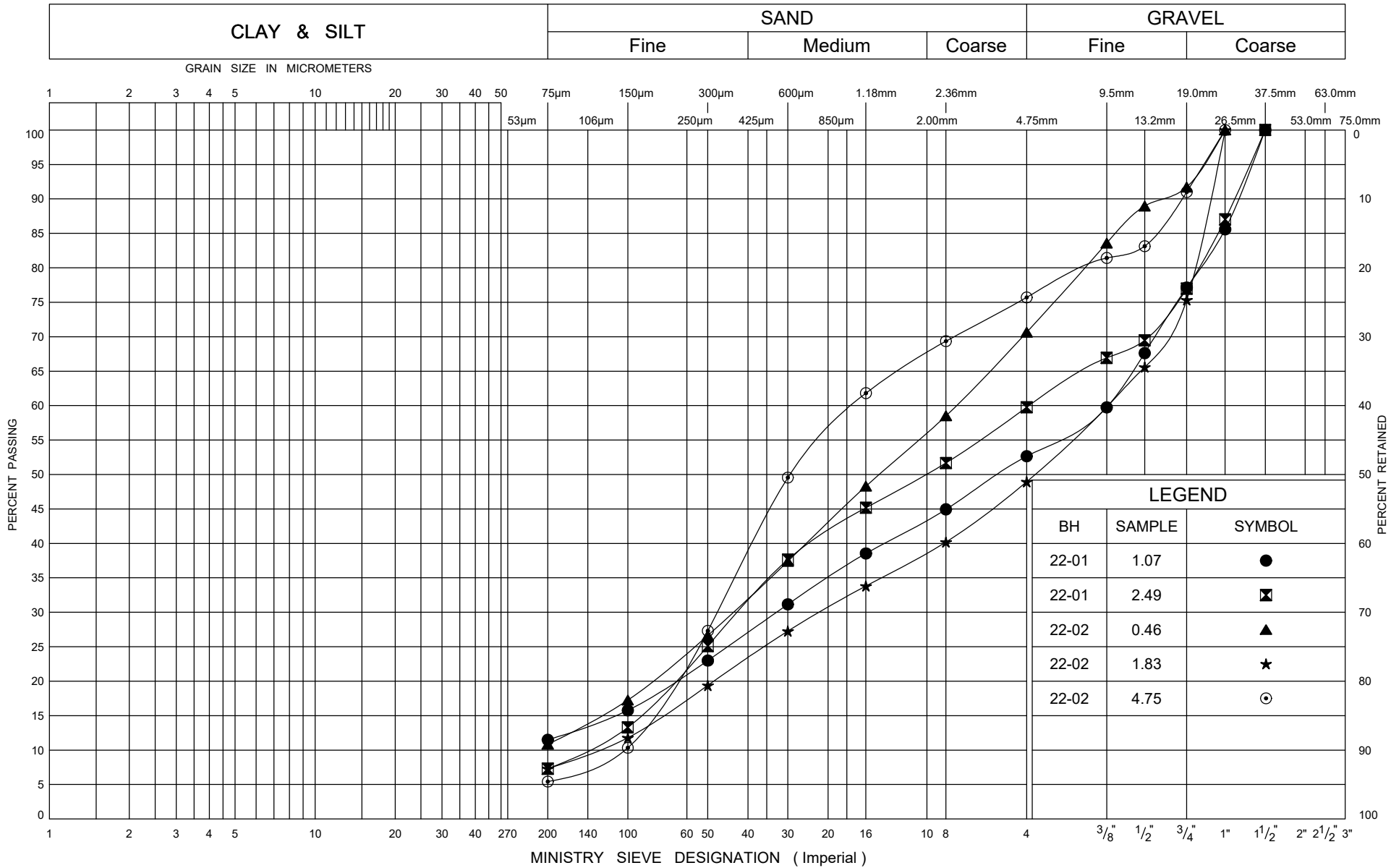
| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL | | |
|------------------------------|---|------------|---------|------|------------|----------------------------|-----------------|--|------------------------------------|-------------------------------------|---|--|-----------------------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | |
| | | | | | | | | 20 40 60 80 100 | PLASTIC LIMIT W _P | NATURAL MOISTURE CONTENT W | | | LIQUID LIMIT W _L | |
| Continued From Previous Page | | | | | | | | ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE | | | WATER CONTENT (%) | | | |
| 351.0 | DCPT refusal at 10.7m | | | | | | | | | | | | | |
| 10.7 | No sampling from 10.7m to 11.9m. Driller notes possible silty clay soil (POSSIBLY NATIVE) | | | | | | | | | | | | | |
| 349.8 | | | | | | | | | | | | | | |
| 11.9 | BEDROCK (GRANITE) , slightly weathered to fresh, medium to large grained rock with clear foliation, very strong, red/grey | | 1 | RUN | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | 2 | RUN | | | | | | | | | | |
| 346.7 | | | | | | | | | | | | | | |
| 15.0 | END OF BOREHOLE AT 14.9m. OPEN BOREHOLE TO 10.2m WITH WATER LEVEL READING TAKEN AT 7.7m INSIDE CASING (UNSTABILIZED). BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.5m, THEN SAND AND GRAVEL TO 0.3m, THEN CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE. | | | | | | | | | | | | | |

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Appendix B

Laboratory Test Results



POINT LOAD TEST SHEET

ASTM D5731-08

| | |
|----------------------|--------------------------|
| Job No: | 34752 |
| Client: | Morrison Hershfield |
| Project Name: | Wabigoon River Bridge |
| Core Size: | NQ BH No : 22-01B |

| | |
|---------------|-----------|
| Date Drilled: | 15-Oct-22 |
| Date Tested: | 15-Nov-22 |
| Tester: | GA |

[illegible]

POINT LOAD TEST SHEET

ASTM D5731-08

| | |
|----------------------|--------------------------|
| Job No: | 34752 |
| Client: | Morrison Hershfield |
| Project Name: | Wabigoon River Bridge |
| Core Size: | NQ BH No : 22-02C |

| | |
|---------------|-----------|
| Date Drilled: | 17-Oct-22 |
| Date Tested: | 15-Nov-22 |
| Tester: | GA |

[illegible]

Borehole 22-01 Bedrock Core: Runs 1, 2 and 3



Borehole 22-02 Bedrock Core: Runs 1 and 2





Appendix C

Site Photographs



Photo 1: Looking west at west approach to bridge on Highway 17 (October 2022)



Photo 2: Looking east at east approach to bridge on Highway 17 (October 2022)



Photo 3: Looking east along north side of bridge (October 2022)



Photo 4: Looking south at north side of bridge (October 2022)



**Photo 5: Looking southwest at northwest corner of bridge (embankment toe erosion)
(October 2022)**



Photo 6: Looking down at toe erosion at northwest corner of bridge (October 2022)



Photo 7: Looking southeast at toe erosion at northwest corner of bridge (October 2022)



Photo 8: Looking south towards slide beyond ditch at southwest corner of bridge (October 2022)



Photo 9: Looking east along south side of bridge (October 2022)

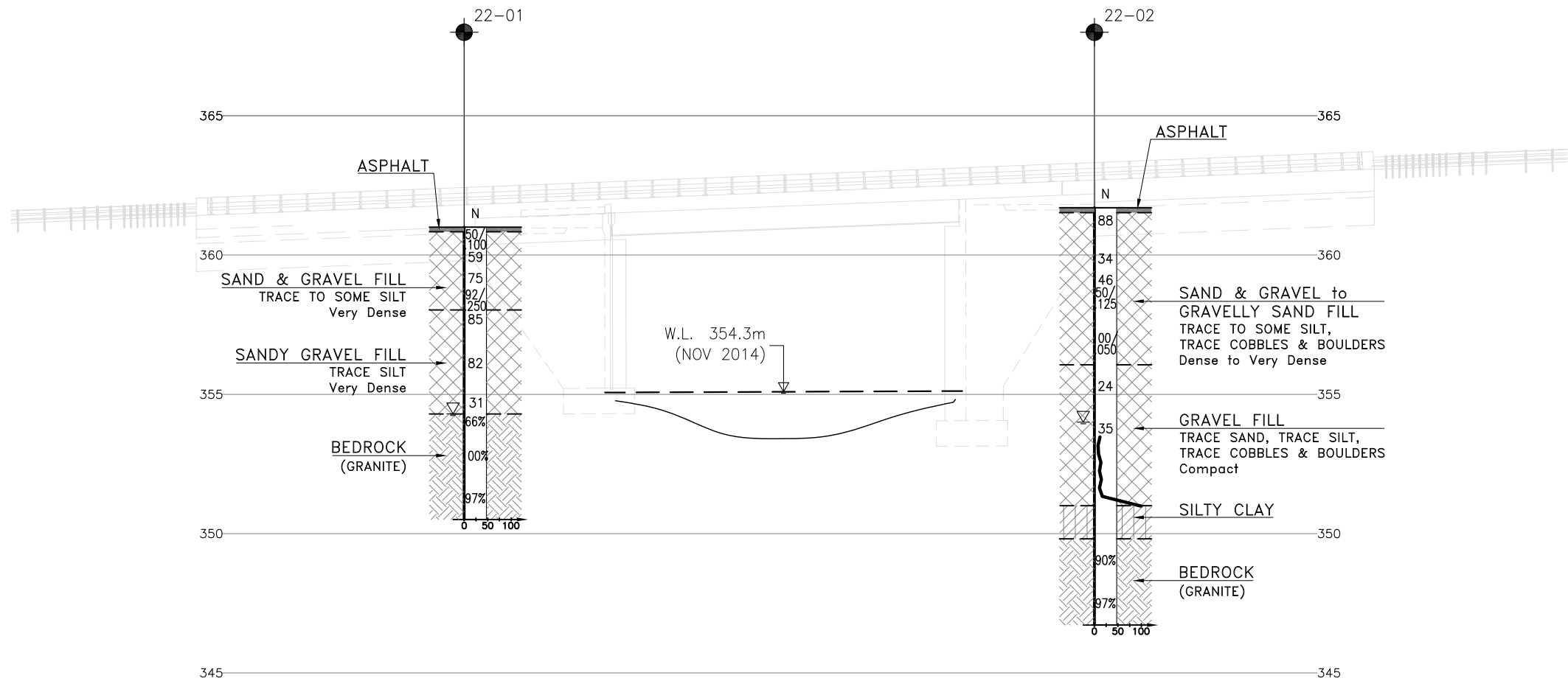
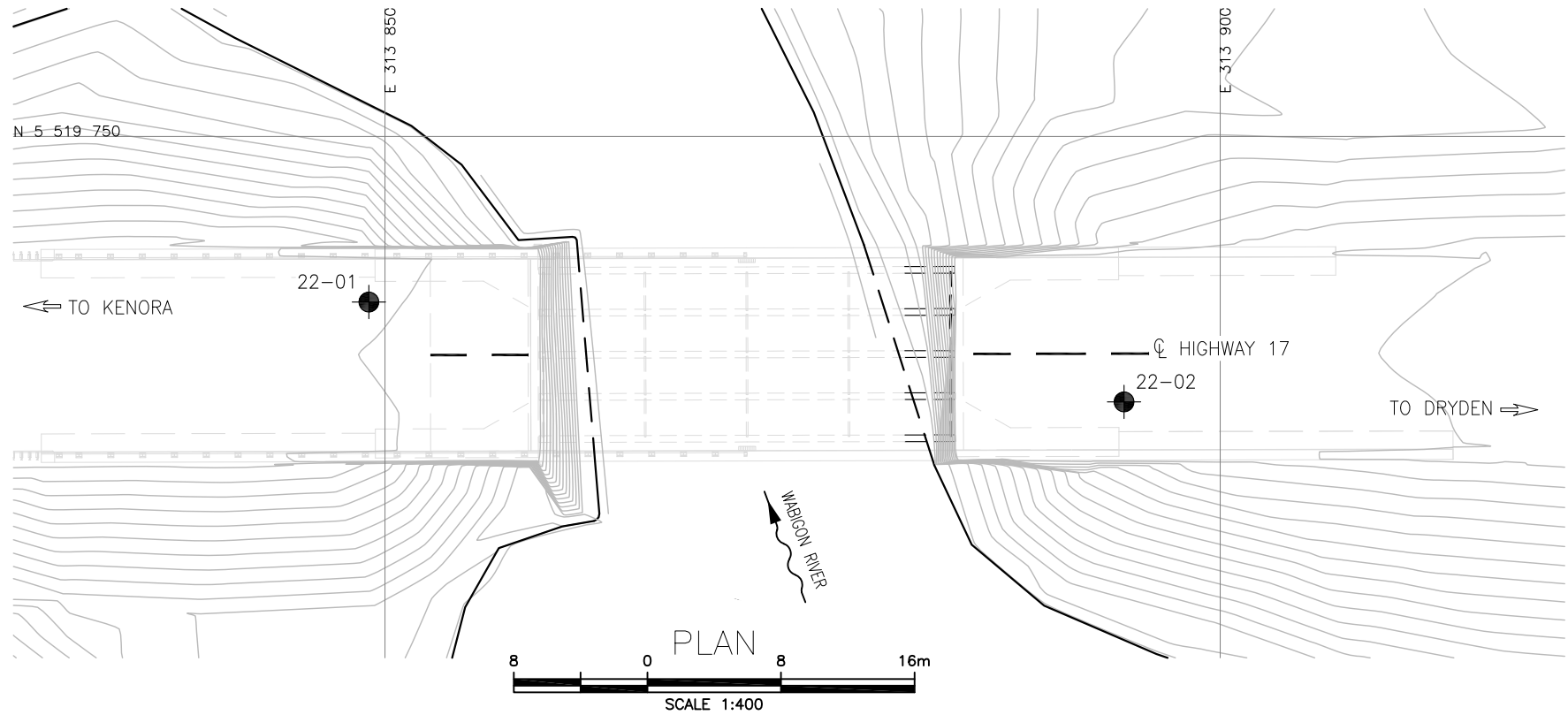


Photo 10: Looking west along south side of bridge (October 2022)



Appendix D

Borehole Locations and Soil Strata Drawing

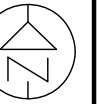


METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN



CONT No
GWP No 6117-17-00

HIGHWAY 11
WABIGOON RIVER BRIDGE
REHABILITATION
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET



THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

| | |
|------|---------------------------------------|
| | Borehole |
| | Borehole and Cone |
| 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 | 361.0 | 5 519 740.1 | 313 849.0 |
| 22-02 | 361.7 | 5 519 734.1 | 313 894.2 |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

-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 16.

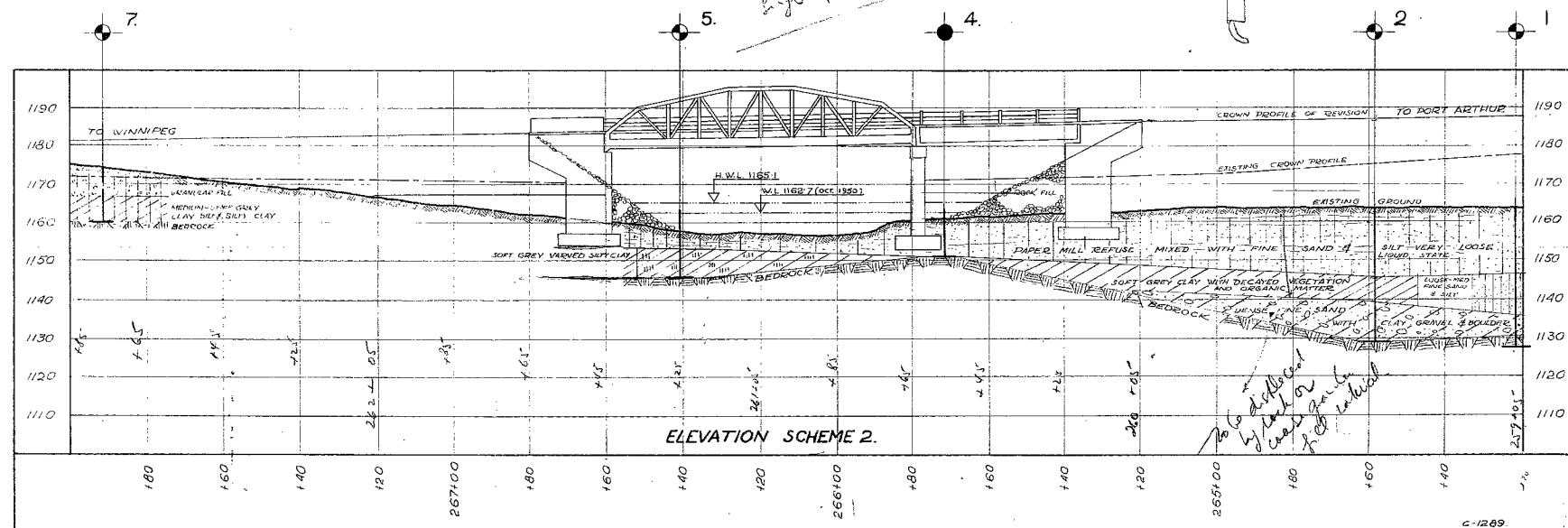
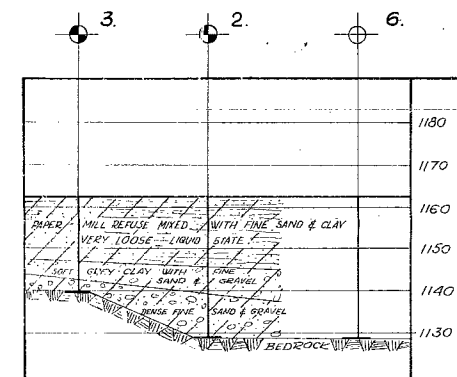
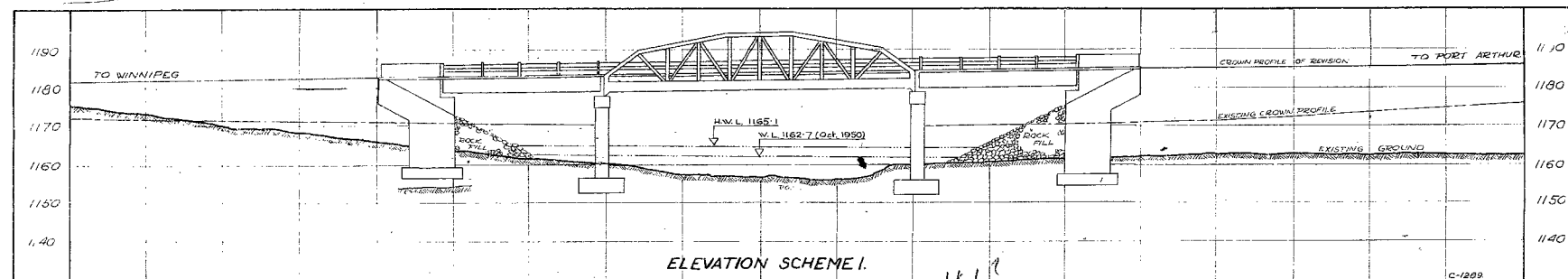
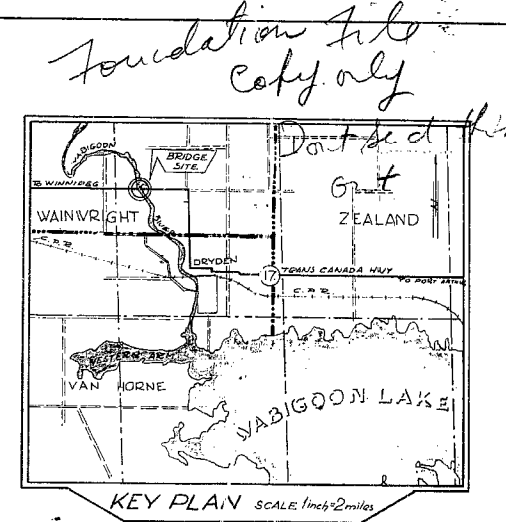
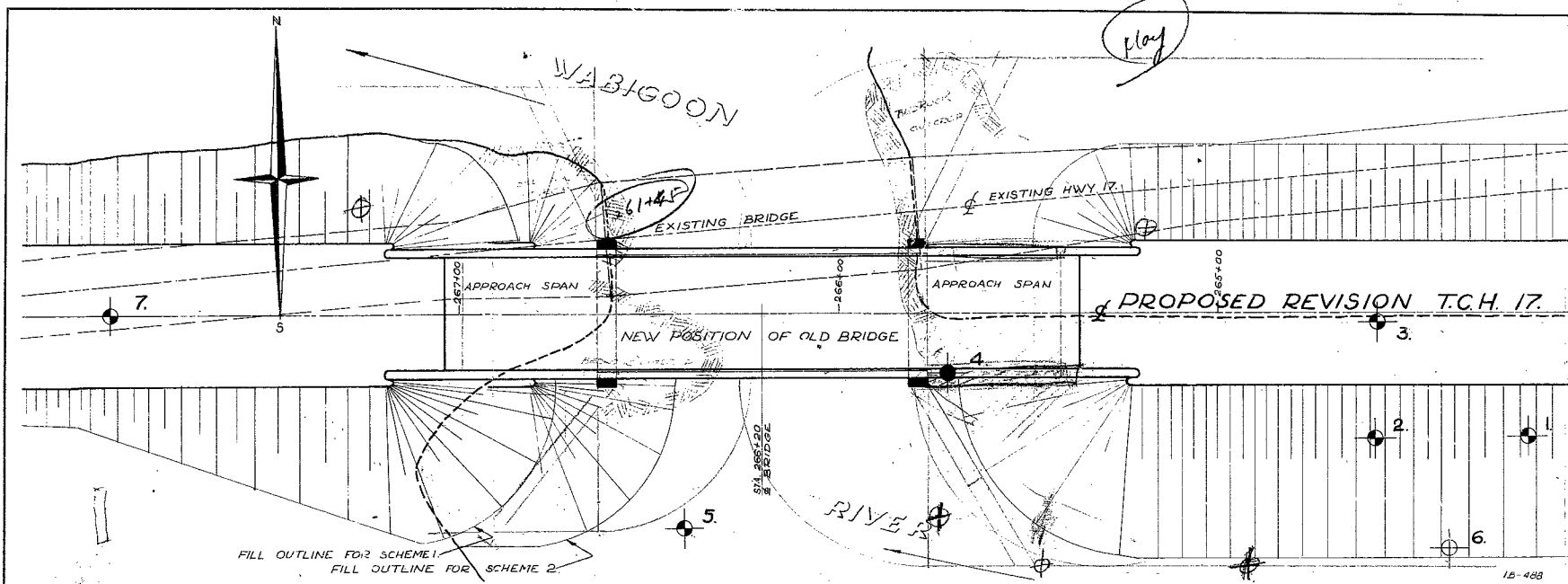
GEOCRES No. 52F-68

| REVISIONS | DATE | BY | DESCRIPTION |
|-----------|------|----------|------------------|
| DESIGN | MC | CHK MEF | CODE |
| DRAWN | AN | CHK MC | SITE 41S-0042/80 |
| LOAD | DATE | JAN 2023 | DWG 1 |



Appendix E

Stratigraphic Profile Drawing from Geocres 52F00-007



| LEGEND | |
|--------------------|---|
| BORE HOLE | ● |
| BORE & PENETRATION | ⊙ |
| PENETRATION HOLE | ⊕ |

NOTE -
THE BOUNDARIES BETWEEN SOIL STRATA HAVE BEEN ESTABLISHED ONLY AT BORE HOLE LOCATIONS. BETWEEN BORE HOLES THE BOUNDARIES ARE ASSUMED FROM GEOLOGICAL EVIDENCE AND MAY BE SUBJECT TO CONSIDERABLE ERROR.

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DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH SECTION

WABIGOON RIVER PROPOSED CROSSING

SHOWING POSITIONS & ELEVATIONS OF HOLES

| | | |
|---------------------------------|------------------|----------------------|
| HWY. 17 | DISTRICT 20 | COUNTY KENORA |
| TOWNSHIP WAINWRIGHT | LOC. 7 | CON. 7 |
| LOCATION 4 miles N.W. of DRYDEN | | |
| DRAWN BY J. Ferguson | CHECKED BY J. P. | W.P. 556-59 |
| DATE 17 DEC 1959 | APPROVED BY: | DRAWING NO. F-59-83A |
| SCALE 1 inch = 20 feet. | | |



Appendix F

List of Referenced OPSS and OPSD Documents and Suggested Wording for NSSP



1. The following Special Provisions and OPSS Documents are referenced in this report:

| | |
|----------------|---|
| OPSS.PROV 501 | Construction Specification for Compacting |
| OPSS.PROV 539 | Construction Specification for Temporary Protection Systems |
| OPSS.PROV 804 | Construction Specification for Temporary Erosion Control |
| OPSS 902 | Construction Specification for Excavating and Backfilling Structures |
| OPSS.PROV 1010 | Material Specification for Aggregates Base, Subbase, Select Subgrade, and Backfill Material |
| OPSD 3101.150 | Walls, Abutment, Backfill Minimum Granular Requirements |

2. Suggested Wording for NSSP

- **Suggested Text for NSSP on Obstructions**

Excavations and installation of temporary protections systems will encounter obstructions such as cobbles and boulders embedded in the fill and native soils. Such obstructions may impede excavation progress and/or temporary protection system installations, if employed; specifically, the conditions are such that it may not be feasible to drive sheet piles. Alternate methods of roadway protection may have to be considered. The Contractor shall be prepared to remove, drill through and/or penetrate these obstructions to achieve the design depths.