



January 10, 2018

FOUNDATION INVESTIGATION AND DESIGN REPORT

**CANTILEVERED OVERHEAD STATIC SIGN
HIGHWAY 11 NORTHBOUND, STA 16+800, TOWNSHIP OF NORTH
HIMSWORTH
MINISTRY OF TRANSPORTATION, ONTARIO
G.W.P. 5231-14-00**

Submitted to:

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REPORT



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PART A

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services related to the proposed overhead sign located on the Highway 11 Northbound, Station 16+800 in the Township of North Huron, approximately 150 m south of the Highway 11 and Highway 654 (Lake Simcoe Road).

The Terms of Reference and the Scope of Work for the foundation investigation are outlined in MTO's Work Order / Assignment #12, dated September 5, 2017 and subsequent email correspondence dated September 20, 2017. Golder's proposal for the foundation engineering services associated with the overhead static sign is contained in Golder's letter addressed to MTO, dated September 22, 2017. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for foundation engineering services for this project, dated October 17, 2017.

This report addresses the investigation carried out for the proposed overhead static sign at Station 16+800 on Highway 11. A separate report addresses the investigation at the proposed temporary sign associated with this assignment.

2.0 SITE DESCRIPTION

The proposed cantilever overhead static sign is located at about Station 16+800 on Highway 11 about 1.5 m right of the outside guardrail of the northbound lane. The location is about 150 m south of the Highway 11 and Highway 654 (Lake Simcoe Road) interchange. The location of the sign is within a rock cut with exposed bedrock to the west, east and south of the proposed location and Wabigoon River to the north of the site. The road surface at the proposed overhead sign location is at approximately Elevation 237.0 m. The site location is shown on the key plan on Drawing 1. Figure 1 contains photographs at the proposed overhead sign location.

3.0 INVESTIGATION PROCEDURES

A geotechnical field investigation was carried out by Golder at the site of the proposed overhead sign on October 2, 2017, at which time one borehole (Borehole 12-1) and four probeholes (Probeholes PA1 to PA4) were advanced in the vicinity of the proposed overhead static sign. The location of the borehole and probeholes are shown in plan on Drawing 1.

The borehole investigation was carried out using a buggy-mounted CME55 drill rig supplied and operated by Landcore Drilling of Chelmsford, Ontario. The borehole was advanced through the overburden using 'NW' casing and washbore techniques. A single soil sample was obtained at ground surface using a 50 mm outside diameter split-spoon sampler driven by automatic hammers in accordance with the Standard Penetration Test (SPT) procedures (ASTM D1586)¹. Samples of the bedrock were obtained using an 'NQ' size rock core barrel. The probeholes were advanced using 152 mm diameter solid stem augers also by the CME55.

¹ ASTM D1586

Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils



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The borehole was advanced to a depth of 4.6 m, including coring of bedrock for a core length of 3.6 m. The probeholes were advanced through the overburden to auger refusal (i.e. inferred shattered rock or inferred bedrock), to depths between 0.7 m and 1.1 m.

The groundwater conditions and water level in the open borehole were observed during and immediately following the completion of drilling operations. It should be noted, groundwater elevations will vary depending on seasonal fluctuations, precipitation and local soil permeability. All boreholes and probeholes were backfilled upon completion of drilling in accordance with Ontario Regulation 903 (as amended).

The field work was observed by a member of Golder's engineering staff who located the borehole, arranged for the clearance of underground services, observed the drilling, sampling and in situ testing operations, logged the borehole and examined and cared for the soil and rock samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to Golder's Sudbury geotechnical laboratory where the samples underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Classification testing (water content and grain size distribution) was carried out on a selected soil sample. The results of the laboratory testing are presented on the Record of Borehole sheets and on the laboratory test result figures included in Appendices A and B, respectively.

Classification of the bedrock rock mass quality with respect to the Rock Quality Designation (RQD) is described based on Table 3.10 of the Canadian Foundations Engineering Manual (CFEM, 2006)². The degree of weathering of the bedrock samples (i.e. fresh – W1) and the strength classification of the intact rock mass based on field identification (i.e. strong – R4) are described in accordance with the International Society for Rock Mechanics (ISRM, 1985)³ standard classification system. A laboratory Unconfined Compression (UC) test was carried out on one core sample of the bedrock and the uniaxial compressive strength (UCS) of the bedrock is described as per Table 3.5 of CFEM (2006)².

The borehole location was surveyed relative to stationing provided by the MTO and the ground surface elevation was determined using a DTM surface model. The borehole and probehole locations provided on the Records of Borehole and Probehole sheets and shown on Drawing 1 are given using MTM NAD 83 northing and easting coordinates, and the ground surface elevation is referenced to Geodetic datum. The borehole/probehole locations, including the MTM NAD 83 (Zone 10) coordinates, ground surface elevation and drilled depth are summarized below.

² Canadian Geotechnical Society, 2016. Canadian Foundations Engineering Manual, 4th Edition.

³ International Society for Rock Mechanics Commission on Test Methods, 1985. Int. J. Rock Mech. Min. Sci & Geomech. Abstr. Vol 22, No. 2, pp.51-60.



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| Borehole / Probehole Number | Location (MTM NAD 83, Zone 10) | | Ground Surface Elevation | Borehole / Probehole Depth |
|-----------------------------------|-----------------------------------|-------------------------------|-----------------------------|----------------------------------|
| | Northing / Latitude | Easting / Longitude | | |
| 12-1 | 5,117,275.8 m / 46.195150 ° | 315,914.0 m / -79.356004 ° | 236.1 m | 4.6 m* |
| PA1 | 5,117,276.5 m / 46.195156 ° | 315,914.9 m / -79.355993 ° | 235.9 m | 0.7 m |
| PA2 | 5,117,275.1 m / 46.195144 ° | 315,913.0 m / -79.356017 ° | 236.3 m | 1.1 m |
| PA3 | 5,117,274.7 m / 46.195140 ° | 315,914.1 m / -79.356004 ° | 235.9 m | 1.0 m |
| PA4 | 5,117,277.0 m / 46.195161 ° | 315,913.8 m / -79.356007 ° | 236.3 m | 1.0 m |

* Includes 3.6 m of rock coring

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

The site, just south of the Wasi River, is located within the Algonquin Highlands physiographic region just north of the Number 11 Strip, as delineated in *The Physiography of Southern Ontario (1984)*⁴. The Algonquin Highlands physiographic region generally covers from the Trans-Canada Highway (Highway 17) south to where it meets the Georgian Bay Fringe, about 100 km from Lake Ontario's north shore and runs from west of Highway 11 to roughly the edge of the Ottawa Valley. The region is divided by the Number 11 Strip physiographic region which runs along the Highway 11 corridor from about 10 km north of Orillia to about 6 km north of Powassan. The Algonquin Highlands physiographic region generally consists of Precambrian bedrock which is generally overlain by shallow soils. The rock at the site is from the Algonquin Terrane of the Central Gneiss Belt within the Grenville Province and typically consists of quartzofelspathic gneiss (Easton, 1992)⁵. The topography is generally comprised of rough local relief with dome shaped or rounded knob ridges with bedrock outcrops⁴.

4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions encountered in the borehole and probeholes, together with the results of in situ and laboratory testing, are presented on the Record of Borehole and Probehole sheets and laboratory test summary figures provided in Appendices A and B, respectively.

The results of the in situ field tests (i.e. SPT 'N'-values) carried out during the investigation as presented on the Record of Borehole sheet and in Section 4.2 are uncorrected.

⁴ Chapman, L.J., and Putnam, D.F., 1984. *The Physiography of Southern Ontario*, 3rd Edition. Ontario Geological Survey, Special Volume 2. Ontario Ministry of Natural Resources.

⁵ Easton, R. M. 1992. The Grenville Province and the Proterozoic History of Central and Southern Ontario; in *Geology of Ontario*, Ontario Geological Survey, Special Volume 4, Part 2, p.715-904.



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The stratigraphic boundaries shown on the Record of Borehole and Probehole sheets are inferred from observations of drilling progress and non-continuous sampling and, therefore, represent transitions between soil and rock types rather than exact planes of geological change. The subsoil conditions will vary beyond the borehole location.

In general, the subsurface conditions at the site consist of a layer of sand to sand and gravel fill, underlain by shattered rock, which is in turn underlain by granite gneiss bedrock. A description of the subsurface conditions encountered in the borehole and probeholes are provided in the following sections.

4.2.1 Granular Fill

A 0.7 m to 1.1 m thick deposit of granular fill consisting of sand to sand and gravel was encountered at ground surface in Borehole 12-1 and inferred at Probeholes PA1 to PA4. The upper 0.1 m to 0.3 m of the fill deposit contains organics, or topsoil.

A SPT 'N'-value measured from the surface of the sand and gravel fill deposit is 67 blows per 0.3 m of penetration, indicating a very dense relative density.

The natural water content measured on a sample of the granular fill deposit was 0.4 per cent.

The results of a grain size distribution test carried out on a sample of the granular fill are shown on Figure B1 in Appendix B.

4.2.2 Shattered Rock

A deposit of shattered rock, about 0.2 m thick was encountered below the sand and gravel fill in Borehole 12-1.

4.2.3 Bedrock / Refusal

Bedrock was encountered below the shattered rock in Borehole 12-1 at a depth of 1.2 m below existing ground surface (Elevation 235.1 m), and core samples were recovered, as shown on Figure B2. Auger refusal was encountered in Probeholes PA1 to PA4 at depths ranging from 0.7 m to 1.1 m below ground surface, ranging from Elevations 235.3 m to 235.0 m. The depth to bedrock and auger refusal below ground surface and the corresponding elevations are summarized below.

| Borehole No. | Depth to Bedrock Surface / Refusal | Bedrock Surface / Refusal Elevation | Refusal Type |
|--------------|------------------------------------|-------------------------------------|--------------------------------------|
| 12-1 | 1.0 m / - | 235.1 m / - | Casing Advancement; Bedrock Cored |
| PA1 | - / 0.7 m | - / 235.2 m | Auger Refusal |
| PA2 | - / 1.1 m | - / 235.3 m | Auger Refusal |
| PA3 | - / 1.0 m | - / 235.0 m | Auger Refusal |
| PA4 | - / 1.0 m | - / 235.3 m | Auger Refusal |



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Based on the rock core samples, the bedrock consists of granite gneiss. In general the bedrock samples are described as fresh, crystalline, grey to pink, and medium grained with strong foliation. The Rock Quality Designation (RQD) measured on the core samples ranges from 17 per cent to 98 per cent, indicating a rock mass of very poor to excellent quality. The Total Core Recovery (TCR) of the core samples is between 90 per cent and 98 per cent and the Solid Core Recovery (SCR) of samples recovered is between 45 per cent and 98 per cent.

An Unconfined Compression (UC) test performed on a core sample of the bedrock from Borehole 12-1 measured a uniaxial compressive strength (UCS) of about 176 MPa. Based on the laboratory UC test, the bedrock is classified as very strong (R5, 100 MPa < UCS < 250 MPa). The UC test result is presented in Figure B3 in Appendix B.

4.3 Groundwater Conditions

In general, the overburden samples taken in the borehole were moist. The water level encountered upon completion of drilling in Borehole 12-1 was at a depth of 0.7 m below ground surface, corresponding to Elevation 235.4 m. The water level observed in the open borehole during and/or on completion of drilling may not represent the longer-term, stabilized groundwater level at the site.

5.0 CLOSURE

Mr. Shane Albert supervised the borehole investigation program. This report was prepared by Ms. Madison Kennedy, B.A.Sc., a member of Golder's geotechnical engineering group and was reviewed by Mr. Andre Bom, P.Eng., a senior geotechnical engineer and Associate of Golder. Mr. Fintan Heffernan, P.Eng., a Golder Designated MTO Foundations Contact, conducted an independent quality control review of this report.



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PART B

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6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

This section of the report provides geotechnical parameters and recommendations for the design and construction of foundations for the proposed overhead sign. These recommendations are based on interpretation of the factual data obtained from the borehole and probeholes advanced during the subsurface investigation for this project. The interpretation and recommendations presented are intended to provide the designers with sufficient information to design the proposed sign foundations. Where comments are made on construction, they are provided to highlight those aspects that could affect the planning and design of the project and for which special provisions or operational constraints may be required during construction. Those requiring information on the aspects of construction should make their own interpretation of the factual information provided as such interpretation may affect equipment selection, proposed construction methods, scheduling and the like.

6.1 General

Golder Associates Ltd. (Golder) has been retained by the Ministry of Transportation, Ontario (MTO) to provide an assessment of foundation options, geotechnical parameters and recommendations on foundation aspects for the proposed overhead sign located on the Highway 11 Northbound, Station 16+800 in the Township of North Himsforth, approximately 150 m south of the Highway 11 and Highway 654 (Lake Nosbonsing Road).

The recommendations provided in this report assume that the existing road and embankment configuration will be maintained, as the details of the proposed construction staging is unknown at this time.

6.2 Overhead Sign Foundations

Support of the overhead sign, understood to be a cantilever static sign for this site, is typically designed with a “standard” caisson foundation design, in accordance with the requirements in MTO’s *Sign Support Manual* (2015). However, given that the bedrock at the proposed overhead sign location is shallow the foundations for the support of the overhead signs can be designed as caissons socketed into bedrock as specified in Note 1 of Notes to the Designer on Standard Drawing SS118-3 in the *Sign Support Manual* or as spread footings founded on, and potentially dowelled into, the bedrock. It is our understanding that caissons in very strong rock in Northern Ontario are feasible but generally cost prohibitive for diameters greater than 900 mm. The advantages, disadvantages, relative costs and risks/consequences for each of the foundation options are summarized in Table 1.

6.2.1 Caisson

As noted above, caisson foundations for overhead sign supports should be designed in accordance with the requirements in MTO’s *Sign Support Manual* (2015). The *Sign Support Manual* includes a standard caisson foundation design for cantilever static sign supports (Section 3 and Standard Drawings SS118-3, SS118-4 and SS118-5), in which the caisson extends 5 m below the design of frost penetration depth, except where bedrock is encountered within this depth as stated in Note 1 on the Notes to Designer on Standard Drawing SS118-3. As shown on the depth to frost penetration isopleths for Southern Ontario in OPD 3090.101 (Foundation Frost Penetration Depths), the estimated depth of frost penetration at the site is approximately 2.0 m. In addition, the top 0.5 m of very poor quality rock should not be considered as competent rock for the design of the caisson.



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In accordance with Note 1 of the Notes to Design on Standard Drawing SS118-3 of MTO's *Sign Support Manual* (2015), where bedrock is encountered at a depth less than 5 m below the bottom of the depth of frost penetration, the required depth of the caisson foundation below the frost depth may be taken as follows:

$$L = Y + \frac{5 - Y}{2}$$

where: L = length of caisson below depth of frost penetration (m)

Y = distance between depth of frost penetration and depth to bedrock (m)

Based on the above equation, the length of caisson as well as the length of caisson socketed into the competent granite gneiss bedrock for the overhead sign are summarized below.

| Borehole No. | Depth to Competent Bedrock (m) | Depth of Frost Penetration (m) | Distance Between Depth of Frost Penetration and Depth to Competent Bedrock Y (m) | Caisson Length Below Depth of Frost Penetration $L = Y + \left(\frac{5 - Y}{2}\right)$ (m) | Total Caisson Length (m) | Length of Caisson Socketed into Bedrock (m) |
|--------------|--------------------------------|--------------------------------|--|--|--------------------------|---|
| 12-1 | 1.5 | 2.0 ¹ | 0.0 | 2.5 | $2.5 + 1.5$ $= 4.0$ | $4.0 - 1.5$ $= 2.5$ |

Note: 1. The depth of frost penetration as outlined in in OPSD 3090.101 (Foundation Frost Penetration Depths) is greater than the depth to competent bedrock.

It should be noted that the recommendations provided above are applicable for the existing site conditions.

For concrete caissons socketed into bedrock, the lateral resistance will be developed primarily from the fixity (in concrete) within the drilled sockets. In this case, the structural resistance of the caisson will govern the ultimate lateral resistance. A minimum socket length as noted above is required.

Based on the existing subsurface soil conditions encountered above the competent bedrock (non-cohesive fill, shattered rock fill and very poor granite gneiss bedrock) and the relatively shallow depth to the groundwater level, the construction of the caisson should be carried out within a temporary steel liner to avoid the open hole from caving or sloughing prior to pouring concrete. As concrete is placed in the liner-protected hole (by tremie placement method) the temporary steel liner should be removed progressively to the extent that the surface of the concrete is always within the steel liner and above the discharge point to prevent caving-in of the hole and mitigate the potential for segregation or the formation of voids in the concrete. Removal of the liner can occur simultaneously or, as the caisson will be socketed into bedrock, consideration can be given to leaving the steel liner in place permanently.

The bedrock at the proposed overhead sign location is classified as very poor to excellent quality bedrock based on the RQD of the rock core samples taken at the sign foundation location and as such, appropriate equipment and construction procedures (such as coring or churn drilling techniques) would be required to advance the sockets into the bedrock.



6.2.2 Spread Footings

As an alternative to caissons socketed into bedrock, consideration could be given to using spread footings founded on bedrock to support the overhead sign. The founding surface should consist of properly prepared bedrock, with shattered, loose and fractured bedrock removed. Based on Borehole 12-1, the upper 0.5 m of poor quality (fractured) bedrock should be removed. The highest recommended founding elevation for the design of the footings is at Elevation 234.6 m. In addition, if the bedrock surface is sloping mass concrete and/or hoe ramming may be required to achieve a level footing at the design elevation. Given the potential of encountering an uneven and sloping bedrock surface, consideration could be given to including Non-Standard Special Provisions (NSSP) for mass concrete and levelling of the bedrock surface in the contract documents; example NSSPs are provided in Appendix C.

Given that the sign is to be founded on bedrock, or mass concrete over bedrock, frost protection is not required.

Inspection and approval of the foundation area prior to spread footing construction should be carried out by a Foundation Specialist in accordance with OPSS 902 (Excavating and Backfilling), as amended by SP 109S12, to ensure that all fractured rock has been removed from the foundation areas and that the foundation base has been properly prepared for the placement of concrete.

Given the anticipated limited size of the excavation and limited overburden thickness, as well as the presence of groundwater in the borehole essentially at/near the bedrock surface, seepage into the excavation for spread footings should be adequately controlled by pumping from properly filtered sumps. However, it should be noted that the groundwater levels are subject to seasonal fluctuations and precipitation events and as such, the proposed construction method and/or the construction schedule should be planned accordingly.

Construction of the footing foundations for the sign support structures should be in accordance with OPSS.PROV 915 (Sign Support Structures).

6.2.2.1 Geotechnical Axial Resistance

For spread footings bearing directly on the granite gneiss bedrock surface, or mass concrete over bedrock, a factored geotechnical axial resistance at Ultimate Limit State (ULS) of 5 MPa may be used for design. Serviceability Limit State (SLS) conditions do not apply for footings founded on bedrock or on mass concrete.

The factored geotechnical resistances provided above are given for loads that will be applied perpendicular to the surface of the footings. Where the load is not applied perpendicular to the footing, inclination of the load should be taken into account in accordance with Section 6.10.4 of the *CHBDC (2014)*.

6.2.2.2 Resistance to Lateral Loads

Resistance to lateral forces/sliding resistance between cast-in-place concrete footings and the bedrock should be calculated in accordance with Section 6.10.5 of the *CHBDC (2014)*. The following presents the coefficient of friction, $\tan \delta$, for the interface between the concrete footing on bedrock as interpreted from NAVFAC (1982):

| Founding Material | Coefficient of Friction ($\tan \delta$) |
|-----------------------|---|
| Mass Concrete on Rock | 0.70 |



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For footings on bedrock, the sliding/lateral resistance between the concrete footing/mass concrete and the bedrock, and the passive earth pressure, may be supplemented by dowelling into the bedrock, if necessary. The horizontal resistance of the dowels is dependent on the strength of the bedrock, grout and steel. The measured uniaxial compression (UC) test indicates that the bedrock is stronger than concrete (assuming that 30 MPa concrete will be used for construction of the footings and for “mass concrete” filling, as applicable). The design of the dowels into the rock may be handled in the same way as the dowel embedded into the concrete. This assumes that the unconfined Compressive Strength (UCS) of the grout will be similar to that of the concrete. The actual bond stress along the rock-grout interface may vary from the design value and should therefore be verified in the field as noted below. The dowels should have a 1 m minimum embedded length within the competent bedrock, and the structural strength of the dowel and compressive strength of the grout should not be exceeded. If dowelling is required for structural considerations a Non-Standard Special Provision (NSSP) should be included in the Contract Documents to specify the installation, materials and testing of the dowels; an example NSSP is provided in Appendix C.

6.3 Construction Considerations

The following sections identify future construction considerations that may impact the detail design and construction of the new overhead structure.

6.3.1 Temporary Protection Systems

All excavations must be carried out in accordance with Ontario Regulation 213 (Ontario Occupational Health and Safety Act for Construction Projects) (as amended).

Open cut excavations of short duration through the granular fill and shattered rock deposits should be carried out in accordance with the latest Occupational Health and Safety Act for Construction Projects (OHSA). When referencing OHSA, the granular fills, shattered rock and poor quality (fractured) bedrock should be considered as a “Type 3 Soil.” As such, excavations should be sloped at a gradient of 1 Horizontal to 1 Vertical (1H:1V) or flatter. For excavations into good quality bedrock, if necessary, the overall slope to the cut face may be formed vertically, or near vertically (i.e. about 0.5H:1V).

Temporary protection systems may be required to facilitate installation of the overhead static sign given the proposed proximity to the travelled portion of the highway. Where required, temporary protection systems should be designed and constructed in accordance with OPSS.PROV 539 (Temporary Protection System), and the lateral movement should meet Performance Level 2 provided that any existing adjacent utilities can tolerate this magnitude of deformation. The temporary protection system should be removed after completion of construction or cut-off to at least bedrock surface. The following design parameters may be used for the design of the temporary protection systems at the proposed overhead sign location.

| Soil Deposit | Unit Weight γ' | Friction Angle ϕ' | Coefficient of Earth Pressure | | |
|----------------|--------------------------|---------------------------|-------------------------------|----------------|----------------|
| | | | Active, K_a | At Rest, K_o | Passive, K_p |
| Granular Fill | 21 kN/m ³ | 30° | 0.33 | 0.50 | 3.00 |
| Shattered Rock | 19 kN/m ³ | 40° | 0.22 | 0.36 | 4.60 |



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The selection and design of the protection system will be the responsibility of the contractor.

During construction, stockpiles should be placed well away from the edge of the excavation, and their height should be controlled so they do not surcharge the sides of the excavation and/or overall existing highway embankment slopes. Generally, the distance between the crest of the excavation and the toe of the stockpile should be greater than the depth to bedrock at the excavation location.

6.3.2 Embankment Fill Placement

The excavation around and above the spread footings may be backfilled using granular material such as OPSS.PROV 1010 (Aggregates) Granular 'A' or 'B' (Type II) placed in 300 mm thick loose lifts and uniformly compacted to the requirements outlined in OPSS.PROV 501 (Compacting).

The final grade surrounding the sign should be sloped to promote surface water drainage away from the pavement and sign, to the adjacent ditch, and surfaced with top soil and seed, in accordance with OPSS.PROV 804 (Seed and Cover), should be used to reduce the potential for erosion of the slope locally.

7.0 CLOSURE

This Foundation Design Report was prepared by Ms. Madison Kennedy, B.A.Sc., a member of Golder's geotechnical group, and reviewed by Mr. Andre Bom, P.Eng., a senior geotechnical engineer and Associate of Golder. Mr. Fintan Heffernan, P.Eng., a Golder Designated MTO Foundations Contact, conducted an independent quality control review of this report.



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International Society for Rock Mechanics Commission on Test Methods, 1985. Int. J. Rock Mech. Min. Sci & Geomech. Abstr. Vol 22, No. 2, pp.51-60.

Ministry of Transportation, Ontario, 2015. Sign Support Manual. Provincial Highways Management Division, Highway Standards Branch, Bridge Office.

Unified Facilities Criteria, U.S. Navy. 1986. NAVFAC Design Manual 7.02. Soil Mechanics, Foundation and Earth Structures. Alexandria, Virginia.

ASTM International:

| | |
|------------|---|
| ASTM D1586 | Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils |
|------------|---|

Contract Design, Estimating and Documentation – Special Provisions

| | |
|-----------|-----------------------|
| SP 109S12 | Amendment to OPSS 902 |
|-----------|-----------------------|

Ontario Provincial Standard Specifications (OPSS)

| | |
|----------------|---|
| OPSS.PROV 501 | Construction Specifications for Compacting |
| OPSS.PROV 539 | Construction Specifications for Temporary Protection Systems |
| OPSS.PROV 804 | Construction Specifications for Seed and Cover |
| OPSS 902 | Construction Specification for Excavating and Backfilling - Structures |
| OPSS.PROV 915 | Construction Specifications for Sign Support Structures |
| OPSS.PROV 1010 | Material Specification for Aggregates-Base, Subbase, Select Subgrade, and Backfill Material |

Ontario Provincial Standard Drawings (OPSD)

| | |
|---------------|---|
| OPSD 3090.101 | Foundation, Frost Penetration Depths for Southern Ontario |
|---------------|---|

Ontario Water Resources Act:

Ontario Regulation 903 Wells (as amended)



TABLES



FOUNDATION REPORT - HIGHWAY 11 CANTILEVER OVERHEAD STATIC SIGN

Table 1: Evaluation of Foundation Alternatives

| Option | Rank | Advantages | Disadvantages | Relative Cost | Risk / Consequences |
|--|------|---|--|---|--|
| Spread Footings founded on and Dowelled into Bedrock | 1 | <ul style="list-style-type: none"> ■ Relative ease of construction ■ No bedrock coring and/or churn drilling required ■ No post-construction settlement. ■ Soil cover for frost protection is not required for footings on bedrock. ■ Very high geotechnical axial resistance available. ■ Bedrock near ground surface. | <ul style="list-style-type: none"> ■ Larger excavation of overburden is required producing a larger volume of excavation spoils. ■ Larger volume of mass concrete may be required to achieve level footing. ■ Dowels may be required to anchor spread footings (due to structural considerations). ■ Groundwater control may be required. ■ Temporary protection system will be required to maintain the existing lane of traffic. ■ Removal of fractured bedrock will be required for construction of the footings. | <ul style="list-style-type: none"> ■ Relatively lower cost in comparison to caissons socketed into bedrock. ■ Additional cost required for the disposal of larger volumes of excavation spoils. ■ Additional costs required for installation of dowels into the bedrock. ■ Additional costs required for temporary protection systems, if required. ■ Additional costs required for pull out test on dowels. | <ul style="list-style-type: none"> ■ Risk that additional excavation and mass concrete may be required if bedrock is sloping below the design founding elevation. ■ Must ensure foundation base is properly prepared. ■ Must ensure temporary protection systems are in place to prevent damage to the existing infrastructure. |
| Caissons socketed into Bedrock | 2 | <ul style="list-style-type: none"> ■ No post-construction settlement. ■ Soil cover for frost protection is not required for caissons socketed into bedrock. | <ul style="list-style-type: none"> ■ Coring or churn drilling into the very strong bedrock will be required to advance sockets for caisson construction. ■ Temporary liner for soil support during installation to prevent sloughing and caving of cohesionless soil. ■ Large diameter caisson advanced into the very strong bedrock are cost prohibitive. | <ul style="list-style-type: none"> ■ Relatively higher cost of installation compared to spread footings. ■ Additional cost associated with specialized drilling equipment to advance the caisson holes into the bedrock. ■ Prohibitive cost of installation compared to spread footings. | <ul style="list-style-type: none"> ■ Specialized drilling equipment will be required to socket caissons into bedrock. |

Prepared By: MCK
Reviewed By: AB
Reviewed By: FJH



FOUNDATION REPORT - HIGHWAY 11 CANTILEVER OVERHEAD STATIC SIGN

FIGURES




East of Highway 11 at STA 16+800 (Township of North Himsworth), looking east. October 2, 2017.



East of Highway 11 at STA 16+800 (Township of North Himsworth), looking north. October 2, 2017.

REVISION DATE: December 13, 2017 BY: MCK Project: 1541608 (12000)

| | | | | | |
|--|--|---|-------|---------------|-----------------|
| PROJECT | | Cantilevered Overhead Static Sign Hwy 11 NBL STA 16+800, Township of North Himsworth Ministry of Transportation, Ontario, G.W. P. 5231-14-00 | | | |
| TITLE | | Site Photographs | | | |
|  | | PROJECT No. 1541608(12000) | | FILE No. ---- | |
| | | DESIGN | MCK | Dec '17 | SCALE NTS |
| | | CADD | -- -- | | REV. |
| | | CHECK | AB | Dec '17 | |
| | | REVIEW | FJH | Dec '17 | |
| | | | | | FIGURE 1 |



APPENDIX A

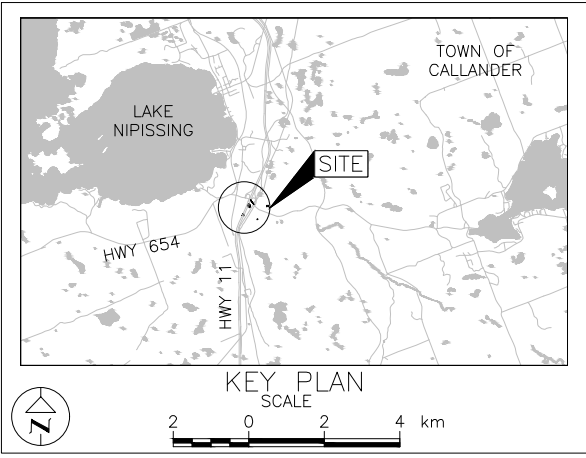
Record of Boreholes, Drillhole and Probeholes

METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No.5231-14-00

HIGHWAY 11 OHS 16+800,
NORTH HIMSWORTH
BOREHOLE LOCATION PLAN

SHEET



LEGEND

Borehole – Current Investigation
 Probehole

| BOREHOLE CO-ORDINATES | | | |
|-----------------------|-----------|-----------|----------|
| No. | ELEVATION | NORTHING | EASTING |
| 12-1 | 236.1 | 5117275.8 | 315914.0 |
| PA1 | 235.9 | 5117276.5 | 315914.9 |
| PA2 | 236.3 | 5117275.1 | 315913.0 |
| PA3 | 235.9 | 5117274.7 | 315914.1 |
| PA4 | 236.3 | 5117277.0 | 315913.8 |

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

REFERENCE

Base plans provided in digital format by MTO, drawing file "b0824011001.dwg", dated November, 2017, received October 26, 2017.

Horizontal Datum – NAD83 (CSRS) MTM Grid Coordinate System Zone 10.

Vertical Datum – Elevations are geodetic base on (CGVD28)



| | | | |
|---------------------|---------------------|----------------|----------|
| | | | |
| NO. | DATE | BY | REVISION |
| Geocres No. 31L-208 | | | |
| HWY. 11 | PROJECT NO. 1541608 | | DIST. . |
| SUBM'D. MCK | CHKD. MCK | DATE: 1/9/2018 | SITE: – |
| DRAWN: SD | CHKD. AB | APPD. FJH | DWG. 1 |



LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

| | |
|-------------|---------------------------------------|
| π | 3.1416 |
| $\ln x$, | natural logarithm of x |
| \log_{10} | x or log x, logarithm of x to base 10 |
| g | acceleration due to gravity |
| t | time |
| FoS | factor of safety |

II. STRESS AND STRAIN

| | |
|--------------------------------|--|
| γ | shear strain |
| Δ | change in, e.g. in stress: $\Delta \sigma$ |
| ε | linear strain |
| ε_v | volumetric strain |
| η | coefficient of viscosity |
| ν | Poisson's ratio |
| σ | total stress |
| σ' | effective stress ($\sigma' = \sigma - u$) |
| σ'_{vo} | initial effective overburden stress |
| $\sigma_1, \sigma_2, \sigma_3$ | principal stress (major, intermediate, minor) |
| σ_{oct} | mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$ |
| τ | shear stress |
| u | porewater pressure |
| E | modulus of deformation |
| G | shear modulus of deformation |
| K | bulk modulus of compressibility |

III. SOIL PROPERTIES

(a) Index Properties

| | |
|--------------------|--|
| $\rho(\gamma)$ | bulk density (bulk unit weight)* |
| $\rho_d(\gamma_d)$ | dry density (dry unit weight) |
| $\rho_w(\gamma_w)$ | density (unit weight) of water |
| $\rho_s(\gamma_s)$ | density (unit weight) of solid particles |
| γ' | unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$) |
| D_R | relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s) |
| e | void ratio |
| n | porosity |
| S | degree of saturation |

* Density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

| | |
|-------------|--|
| w | water content |
| w_l or LL | liquid limit |
| w_p or PL | plastic limit |
| I_p or PI | plasticity index = $(w_l - w_p)$ |
| w_s | shrinkage limit |
| I_L | liquidity index = $(w - w_p) / I_p$ |
| I_C | consistency index = $(w_l - w) / I_p$ |
| e_{max} | void ratio in loosest state |
| e_{min} | void ratio in densest state |
| I_D | density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density) |

(b) Hydraulic Properties

| | |
|---|---|
| h | hydraulic head or potential |
| q | rate of flow |
| v | velocity of flow |
| i | hydraulic gradient |
| k | hydraulic conductivity (coefficient of permeability) |
| j | seepage force per unit volume |

(c) Consolidation (one-dimensional)

| | |
|--------------|---|
| C_c | compression index (normally consolidated range) |
| C_r | recompression index (over-consolidated range) |
| C_s | swelling index |
| C_{α} | secondary compression index |
| m_v | coefficient of volume change |
| C_v | coefficient of consolidation (vertical direction) |
| C_h | coefficient of consolidation (horizontal direction) |
| T_v | time factor (vertical direction) |
| U | degree of consolidation |
| σ'_p | pre-consolidation stress |
| OCR | over-consolidation ratio = σ'_p / σ'_{vo} |

(d) Shear Strength

| | |
|------------------|--|
| τ_p, τ_r | peak and residual shear strength |
| ϕ' | effective angle of internal friction |
| δ | angle of interface friction |
| μ | coefficient of friction = $\tan \delta$ |
| c' | effective cohesion |
| c_u, s_u | undrained shear strength ($\phi = 0$ analysis) |
| p | mean total stress $(\sigma_1 + \sigma_3)/2$ |
| p' | mean effective stress $(\sigma'_1 + \sigma'_3)/2$ |
| q | $(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$ |
| q_u | compressive strength $(\sigma_1 - \sigma_3)$ |
| S_t | sensitivity |

Notes: 1
2

$\tau = c' + \sigma' \tan \phi'$
shear strength = (compressive strength)/2



LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

| | |
|----|---------------------|
| AS | Auger sample |
| BS | Block sample |
| CS | Chunk sample |
| DS | Denison type sample |
| FS | Foil sample |
| RC | Rock core |
| SC | Soil core |
| SS | Split-spoon |
| ST | Slotted tube |
| TO | Thin-walled, open |
| TP | Thin-walled, piston |
| WS | Wash sample |

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

Dynamic Cone Penetration Resistance; N_d :

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Non-Cohesive Soils

| Density Index | N |
|------------------|--------------------------|
| Relative Density | Blows/300 mm or Blows/ft |
| Very loose | 0 to 4 |
| Loose | 4 to 10 |
| Compact | 10 to 30 |
| Dense | 30 to 50 |
| Very dense | over 50 |

(b) Cohesive Soils Consistency

| | C_u, S_u | |
|------------|------------|----------------|
| | kPa | psf |
| Very soft | 0 to 12 | 0 to 250 |
| Soft | 12 to 25 | 250 to 500 |
| Firm | 25 to 50 | 500 to 1,000 |
| Stiff | 50 to 100 | 1,000 to 2,000 |
| Very stiff | 100 to 200 | 2,000 to 4,000 |
| Hard | over 200 | over 4,000 |

IV. SOIL TESTS

| | |
|-----------------|---|
| w | water content |
| w _p | plastic limit |
| w _l | liquid limit |
| C | consolidation (oedometer) test |
| CHEM | chemical analysis (refer to text) |
| CID | consolidated isotropically drained triaxial test ¹ |
| CIU | consolidated isotropically undrained triaxial test with porewater pressure measurement ¹ |
| D _R | relative density (specific gravity, G_s) |
| DS | direct shear test |
| M | sieve analysis for particle size |
| MH | combined sieve and hydrometer (H) analysis |
| MPC | Modified Proctor compaction test |
| SPC | Standard Proctor compaction test |
| OC | organic content test |
| SO ₄ | concentration of water-soluble sulphates |
| UC | unconfined compression test |
| UU | unconsolidated undrained triaxial test |
| V | field vane (LV-laboratory vane test) |
| γ | unit weight |

Note: 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

V. MINOR SOIL CONSTITUENTS

| Per cent by Weight | Modifier | Example |
|--------------------|--|---|
| 0 to 5 | Trace | Trace sand |
| 5 to 12 | Trace to Some (or Little) | Trace to some sand |
| 12 to 20 | Some | Some sand |
| 20 to 30 | (ey) or (y) | Sandy |
| over 30 | And (non-cohesive (cohesionless)) or With (cohesive) | Sand and Gravel Silty Clay with sand / Clayey Silt with sand |



LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING STATE

Fresh: no visible sign of weathering

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

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

JOINT OR FOLIATION SPACING

| Description | Spacing |
|------------------|------------------|
| Very wide | Greater than 3 m |
| Wide | 1 m to 3 m |
| Moderately close | 0.3 m to 1 m |
| Close | 50 mm to 300 mm |
| Very close | Less than 50 mm |

GRAIN SIZE

| Term | Size* |
|---------------------|-------------------------|
| Very Coarse Grained | Greater than 60 mm |
| Coarse Grained | 2 mm to 60 mm |
| Medium Grained | 60 microns to 2 mm |
| Fine Grained | 2 microns to 60 microns |
| Very Fine Grained | Less than 2 microns |

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varied from 0% for completely broken core to 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90° angle is horizontal.

Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes, or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

| | |
|---------------------|-------------------|
| JN Joint | PL Planar |
| FLT Fault | CU Curved |
| SH Shear | UN Undulating |
| VN Vein | IR Irregular |
| FR Fracture | K Slickensided |
| SY Stylolite | PO Polished |
| BD Bedding | SM Smooth |
| FO Foliation | SR Slightly Rough |
| CO Contact | RO Rough |
| AXJ Axial Joint | VR Very Rough |
| KV Karstic Void | |
| MB Mechanical Break | |

| PROJECT | | RECORD OF BOREHOLE No 12-1 | | | | SHEET 1 OF 1 | | METRIC | | | | | | | | | | |
|-------------------|--|--|----------|--|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|--|--|-------------------|
| 1541608 (12000) | | G.W.P. 5231-14-00 | | LOCATION N 5117275.8; E 315914.0 MTM NAD 83 ZONE 10 (LAT. 46.195150; LONG. -79.356004) | | ORIGINATED BY SA | | | | | | | | | | | | |
| DIST _____ HWY 11 | | BOREHOLE TYPE CME 55; NW Casing, Washbore, NQ Coring | | COMPILED BY SD | | | | | | | | | | | | | | |
| DATUM Geodetic | | DATE October 2, 2017 | | CHECKED BY MCK | | | | | | | | | | | | | | |
| 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 | | | | | | | | | | WATER CONTENT (%) |
| 236.1 | GROUND SURFACE | | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | | |
| 0.0 | Sand and gravel, trace silt, containing organics to a depth of 0.2 m(FILL) Very dense Brown Moist | | 1A 1B | SS | 67 | ▽ | 236 | | | | | | | | | | | 56 38 5 1 |
| 235.3 | Shattered Rock GRANITE GNEISS (BEDROCK) | | 1 | RC | REC 90% | | 235 | | | | | | | | | | | RQD = 17% |
| 1.0 | Bedrock cored between depths of about 1.0 m and 4.6 m For bedrock coring details refer to Record of Drillhole 12-1 | | 2 | RC | REC 98% | | 234 | | | | | | | | | | | RQD = 84% |
| | | | 3 | RC | REC 100% | | 233 | | | | | | | | | | | RQD = 98% |
| | | | | | | | 232 | | | | | | | | | | | |
| 231.5 4.6 | END OF BOREHOLE NOTE: 1. Water level in open borehole at a depth of 0.7 m below ground surface (Elev. 235.4 m) upon completion of drilling. | | | | | | | | | | | | | | | | | |

PROJECT: 1541608 (12000)

RECORD OF DRILLHOLE: 12-1

SHEET 1 OF 1

LOCATION: N 5117275.8 ; E 315914.0

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME55 Buggy

DRILLING CONTRACTOR: Landcore Drilling

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. | | RUN No. | PENETRATION RATE min(m) | COLOUR % RETURN | FLUSH | RECOVERY | | FRACT. INDEX PER 0.3 m | DISCONTINUITY DATA | | | | | ROCK STRENGTH INDEX | | WEATH- ERING INDEX | | | | Q AVG. | NOTES WATER LEVELS INSTRUMENTATION | | | | |
|--|-----------------|-------------|--------------|--------------|-------------|---------|----------------------------|--------------------|-------|--|----------------------------|---------------------------------|---------------------------------|---|----|----|----|--|----|--------------------------|----|------------------|----|-----------|--|---|--|--|--|
| | | | | DEPTH (m) | R.Q.D. % | | | | | B Angle | DIP w.r.t. CORE AXIS | | TYPE AND SURFACE DESCRIPTION | Jr | Ja | Jn | R1 | R2 | R3 | R4 | W1 | W2 | W3 | | | W4 | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| JN - Joint FLT - Fault SHR- Shear VN - Vein CJ - Conjugate | | | | | | | | | | BD- Bedding FO- Foliation CO- Contact OR- Orthogonal CL - Cleavage | | | | PL - Planar CU- Curved UN- Undulating ST - Stepped IR - Irregular | | | | PO- Polished K - Slickensided SM- Smooth Ro - Rough MB- Mechanical Break | | | | BR - Broken Rock | | | | NOTE: For additional abbreviations refer to list of abbreviations & symbols. | | | |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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



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| DIST <u> </u> HWY <u>11</u> | | BOREHOLE TYPE <u>CME 55; 152mm Solid Stem Augers</u> | | COMPILED BY <u>SD</u> | | | |
| DATUM <u>Geodetic</u> | | DATE <u>October 2, 2017</u> | | CHECKED BY <u>MCK</u> | | | |




| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | | PLASTIC LIMIT NATURAL MOISTURE LIQUID CONTENT | | | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL | | | |
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| 235.9 | GROUND SURFACE | | | | | | | | | | | | | | | | | | | | |
| 0.0 | TOPSOIL |  | | | | | | | | | | | | | | | | | | | |
| 0.3 | Sand and gravel, containing rock fragments (FILL) Brown Moist REFUSAL TO FURTHER PENETRATION - END OF PROBEHOLE |  | | | | | | | | | | | | | | | | | | | |
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| PROJECT | | RECORD OF BOREHOLE | | | | No PA2 | | SHEET 1 OF 1 | | METRIC | | | | | | | |
|-------------------|---|--------------------|---------|------|------------|---|-----------------|---|--|------------------|--|--|------------------------------------|-------------------------------------|-----------------------------------|---|--|
| G.W.P. 5231-14-00 | | LOCATION | | | | N 5117275.1; E 315913.0 MTM NAD 83 ZONE 10 (LAT. 46.195144; LONG. -79.356017) | | | | ORIGINATED BY SA | | | | | | | |
| DIST _____ HWY 11 | | BOREHOLE TYPE | | | | CME 55; 152mm Solid Stem Augers | | | | COMPILED BY SD | | | | | | | |
| DATUM Geodetic | | DATE | | | | October 2, 2017 | | | | CHECKED BY MCK | | | | | | | |
| 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 | | | | | | | | | |
| 236.3 | GROUND SURFACE | | | | | | | | | | | | | | | | |
| 0.0 | TOPSOIL | | | | | | | | | | | | | | | | |
| 0.1 | Sand, trace gravel, containg cobbles (FILL) | | | | | | | | | | | | | | | | |
| 235.6 | Brown Moist | | | | | | | | | | | | | | | | |
| 235.3 | Sand, trace gravel, containing rock fragments (FILL) | | | | | | | | | | | | | | | | |
| 1.1 | Brown Moist | | | | | | | | | | | | | | | | |
| | REFUSAL TO FURTHER PENETRATION - END OF PROBEHOLE | | | | | | | | | | | | | | | | |

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| | | | |
|--------------------------------------|---|-------------------------|---------------|
| PROJECT <u>1541608 (12000)</u> | RECORD OF BOREHOLE No PA3 | SHEET 1 OF 1 | METRIC |
| G.W.P. <u>5231-14-00</u> | LOCATION <u>N 5117274.7; E 315914.1 MTM NAD 83 ZONE 10 (LAT. 46.195140; LONG. -79.356004)</u> | ORIGINATED BY <u>SA</u> | |
| DIST <u> </u> HWY <u>11</u> | BOREHOLE TYPE <u>CME 55; 152mm Solid Stem Augers</u> | COMPILED BY <u>SD</u> | |
| DATUM <u>Geodetic</u> | DATE <u>October 2, 2017</u> | CHECKED BY <u>MCK</u> | |

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | | PLASTIC LIMIT NATURAL MOISTURE LIQUID CONTENT | | | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL | | | |
|---------------|---|---|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|--|---|--|--|--------------------------------------|--|--|--|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | w _p w w _L | | | | | | | |
| | | | | | | | | ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED | | | | | | WATER CONTENT (%) | | | | | | | |
| 235.9 | GROUND SURFACE |  | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | | | | | |
| 0.0 | TOPSOIL |  | | | | | | | | | | | | | | | | | | | |
| 0.2 | Sand and gravel, containing rock fragments (FILL) Brown Moist |  | | | | | | | | | | | | | | | | | | | |
| 235.0 | | | | | | | | | | | | | | | | | | | | | |
| 1.0 | REFUSAL TO FURTHER PENETRATION - END OF PROBEHOLE | | | | | | 235 | | | | | | | | | | | | | | |

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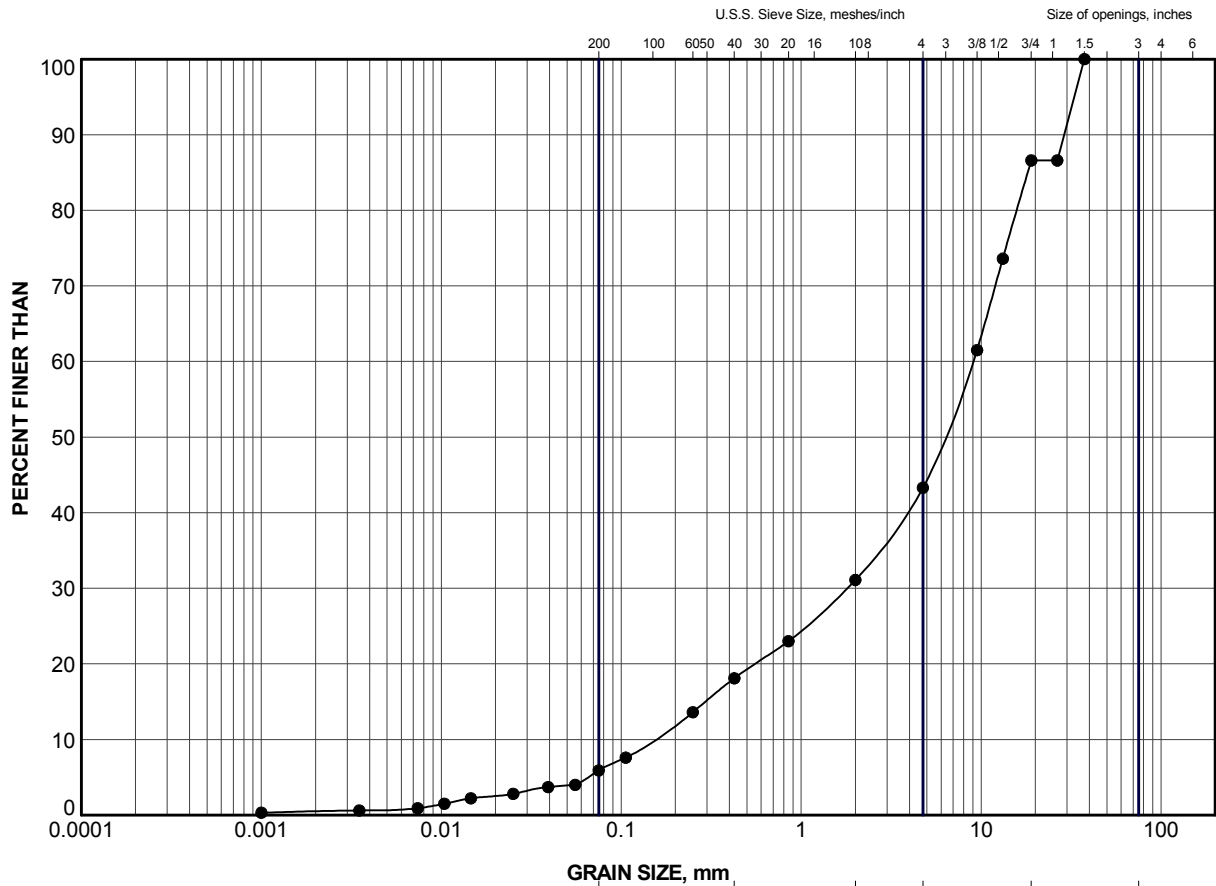
| PROJECT 1541608 (12000) | | RECORD OF BOREHOLE No PA4 | | | | SHEET 1 OF 1 | | METRIC | | | | | | | | | |
|-------------------------|--|--|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|---|--|
| G.W.P. 5231-14-00 | | LOCATION N 5117277.0; E 315913.8 MTM NAD 83 ZONE 10 (LAT. 46.195161; LONG. -79.356007) | | | | ORIGINATED BY SA | | | | | | | | | | | |
| DIST _____ HWY 11 | | BOREHOLE TYPE CME 55; 152mm Solid Stem Augers | | | | COMPILED BY SD | | | | | | | | | | | |
| DATUM Geodetic | | DATE October 2, 2017 | | | | CHECKED BY MCK | | | | | | | | | | | |
| 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 | | | | | | | | | |
| 236.3 | GROUND SURFACE | | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 0.0 | TOPSOIL | | | | | | 236 | | | | | | | | | | |
| 0.1 | Sand, trace gravel, containing cobbles (FILL) Brown Moist | | | | | | | | | | | | | | | | |
| 235.3 | | | | | | | | | | | | | | | | | |
| 1.0 | REFUSAL TO FURTHER PENETRATION - END OF PROBEHOLE | | | | | | | | | | | | | | | | |

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APPENDIX B

Laboratory Test Results



| | | | | | | |
|---------------|-----------|--------|--------|-------------|--------|----------------|
| CLAY AND SILT | fine | medium | coarse | fine | coarse | Cobble Size |
| | SAND SIZE | | | GRAVEL SIZE | | |

| LEGEND | | | |
|--------|----------|--------|----------|
| SYMBOL | BOREHOLE | SAMPLE | ELEV (m) |
| ● | 12-1 | 1B | 234.8 |

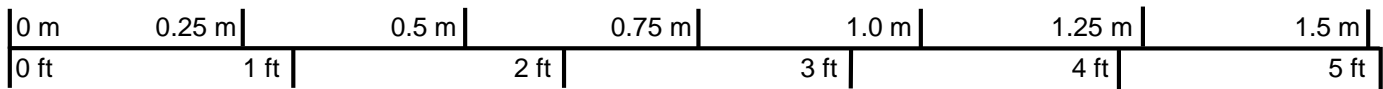
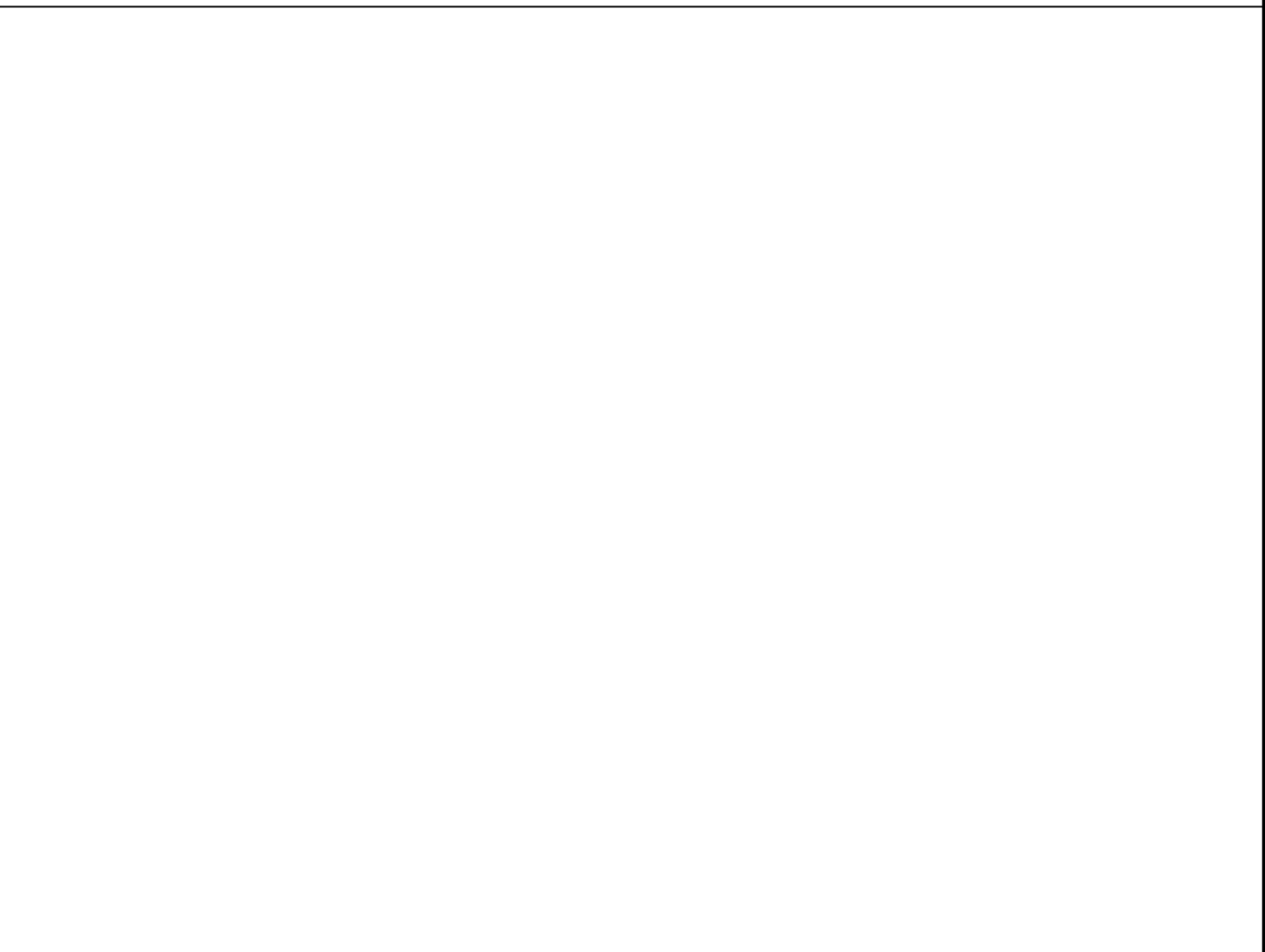
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|---|--|--|--|--|--|--|--|--|--|
| PROJECT | | | | | HIGHWAY 11 CANTILEVER OVERHEAD STATIC SIGN GEOTECHNICAL INVESTIGATION (GWP 5231-14-00) | | | | |
| TITLE | | | | | GRAIN SIZE DISTRIBUTION SAND and GRAVEL (FILL) | | | | |
|  Golder Associates SUDBURY, ONTARIO | | | | | PROJECT No. 1541608 (12000) FILE No. 1541608_LAB_FIG.GPJ DRAWN TB Nov 2017 SCALE N/A REV. CHECK MCK Nov 2017 APPR Nov 2017 | | | | |
| | | | | | FIGURE B1 | | | | |

SUD-MTO GSD (2016) GLDR_LDN.GDT


Borehole 12-1



Box 1: 0.97 m – 4.60 m



Scale

| | | | | | | | |
|--|--|--|--|--|-------|------------------|-----|
| PROJECT | | | | Cantilevered Overhead Static Sign Highway 11 NBL STA 16+800, Township of North Himsworth, G.W.P. 5231-14-00 | | | |
| TITLE | | | | Bedrock Core Photograph Borehole 12-1 | | | |
|  | | | | PROJECT No. 1541608 | | FILE No. ---- | |
| | | | | DESIGN | MCK | SCALE | NTS |
| | | | | CADD | -- -- | FIGURE B2 | |
| | | | | CHECK | AB | | |
| | | | | REVIEW | FJH | | |

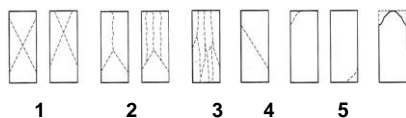
Golder Associates Ltd.

33 Mackenzie Street
Sudbury, Ontario, Canada P3C 4Y1
Telephone: (705) 524-6861
Fax: (705) 524-1984

**FIGURE B3 - UNCONFINED COMPRESSION TEST (UC)**

PROJECT NO.: 1541608-12000
PROJECT NAME: MTO/5015-E-0012/NER Retainer
TYPE OF UNIT: Rock Core
TESTED BY: JP
DATE TESTED: October 31, 2017

| | | | | | |
|---------------------------|--------|--|--|--|--|
| GOLDER LAB NUMBER | C1898B | | | | |
| BOREHOLE NUMBER: | 12-1 | | | | |
| RUN NUMBER: | 2 | | | | |
| DEPTH OF TESTED CORE (m) | 2.7 | | | | |
| LENGTH AS CUT (mm) | 100.8 | | | | |
| DIAMETER (mm) | 47.5 | | | | |
| DENSITY (kg/m3) | 2631 | | | | |
| COMPRESSIVE STRENGTH (KN) | 312.1 | | | | |
| CORRECTED STRENGTH (MPa) | 176.1 | | | | |
| TYPE OF FRACTURE | 1 | | | | |

Type of Fracture

COMMENTS:

Input by: SMReviewed by: MCK



APPENDIX C

Non-Standard Special Provisions

Mass Concrete – Item No.

Non-Standard Special Provision

Scope of Work

The scope of work for the above noted tender item includes the supply and placement of mass concrete under the overhead sign spread footings to raise the founding grade to the design level of the underside of the footings.

Construction

Concrete shall be the same strength as the footing concrete and placed in accordance with OPSS 904 Concrete Structures.

Basis of Payment

Payment at the Contract Price for the above tender item includes full compensation for all labour, equipment and material to do the required work.

END OF SECTION

Levelling Bedrock Surface – Item No.

Non-Standard Special Provision

Scope of Work

The scope of work for the above noted tender item includes bedrock excavation at the cantilever overhead static sign at Highway 11 STA 16+800, Township of North Himsworth to provide a level founding surface for the footing.

Construction

Prior to placing concrete for the proposed footing, the bedrock shall be levelled using mechanical means (i.e. hoe ram, line drilling, or equivalent) such that the surface of the bedrock is sloping less than 10 degrees throughout the footprint of the footing. The exposed bedrock must be cleaned by removing loose debris and rock shatter. The Foundations Specialist shall review the footing subgrade prior to placing concrete in accordance with OPSS 902, as amended by SP 109S12.

Basis of Payment

Payment at the Contract Price for the above tender item includes full compensation for all labour, equipment and material to do the required work.

END OF SECTION

Dowels Into Rock – Item No.

Non-Standard Special Provision

Scope of Work

Work under this item is for the placement and field testing of dowels into rock.

Construction

Dowels into rock shall be constructed in accordance with OPSS.PROV 904 Concrete Structures. All reinforcing steel supplied shall be in accordance with OPSS.PROV 1440 (Steel Reinforcement for Concrete) (dowel bars conforming to CSA Standard CSAG30.18, Grade 400).

For dowels into rock, holes shall be drilled to the required depth and size. Hole diameter shall be two times the nominal diameter of the dowel. Each hole shall be cleaned out, grouted and the dowel set in place. Grout shall be of the same strength as the footing concrete, or at least 25 MPa at 28 days.

If the hole contains water, the Contractor shall remove the water, otherwise, a tremie procedure shall be used to completely fill the hole with grout. The dowel shall be forced into the hole after the grout has been placed and while it is still fresh.

Rock Dowel Testing

All proposed testing procedures shall be in general conformance with ASTM D3689/D3689M-07 and ASTM D1143/D1143M-07. Field testing must be carried out in the presence of, and the results reviewed and approved by, the Contract Administrator.

Performance Tests

The following table summarizes the number of dowels into rock where performance testing shall be carried out to confirm that the design load of the rock dowels can be achieved. The Contract Administrator will select the rock dowels to be tested.

| Structure | Number of Dowels for Performance Testing |
|--|---|
| Overhead Sign STA 16+800, Township of North Himsworth | 2 per spread footing |

Performance test shall be by axial tensioning using a hydraulic jack with a capacity of at least 1.5 times the ultimate strength of the dowels.

Rock dowels shall be loaded and unloaded in 3 cycles and measurements of the displacement of the dowel shall be carried out at each load increment (step) in accordance with the following schedule:

| | | | | | | | |
|---------------|-----|-----|-----|-----|-----|-----|-----|
| Cycle-Step | 1-1 | 1-2 | 1-3 | 2-1 | 2-2 | 2-3 | 2-4 |
| % Design Load | 50 | 75 | 25 | 50 | 75 | 100 | 25 |

| | | | | | |
|---------------|-----|-----|-----|-----|-----|
| Cycle-Step | 3-1 | 3-2 | 3-3 | 3-4 | 3-5 |
| % Design Load | 50 | 75 | 100 | 110 | 25 |

The design load shall be taken as 360 kN for 35M dowels, 252 kN for 30M dowels, 180 kN for 25M dowels and 108 kN for 20M dowels.

Displacement measurements shall be carried out at each load increment using calibrated displacement gauges capable of measuring movements of 0.025 mm. Measurements shall be referenced to an independent fixed referenced point.

Rock dowels which fail to meet the acceptance criteria shall be replaced at the Contractor's expense and re-tested. If a rock dowel fails, 3 additional rock dowels shall be tested at the same spread footing as directed by the Contract Administrator.

Acceptance criteria for the rock dowels will be in accordance with the Post-Tensioning Institute (1985) as follows:

- The dowels are acceptable if the total elastic movement is greater than 80 percent of the theoretical elastic elongation of the free stressing length and is less than the theoretical elongation of the free stressing length plus 50 percent of the bond length.

Basis of Payment

Payment at the Contract Price for the above tender item includes full compensation for all labour, equipment and material to do the required work.

END OF SECTION

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

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