



November 28, 2014

FOUNDATION INVESTIGATION AND DESIGN REPORT

**VARIABLE MESSAGE SIGN #20
HIGHWAY 17 NORTHBOUND
APPROXIMATELY 0.8 KM SOUTH OF HIGHWAY 101
WAWA, ONTARIO
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 5143-11-00**

Submitted to:

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GEOCRES NO.: 41N-28

REPORT

Report Number: 10-1191-0006-20

Distribution:

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PART A

FOUNDATION INVESTIGATION REPORT

VARIABLE MESSAGE SIGN #20

HIGHWAY 17 NORTHBOUND

APPROXIMATELY 0.8 KM SOUTH OF HIGHWAY 101

WAWA, ONTARIO

GWP 5143-11-00



1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by IBI Group (IBI) on behalf of Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for a variable message sign (VMS #20) on Highway 17 northbound approximately 0.8 km south of Highway 101 near Wawa, Ontario. The general location of the site is shown on the Key Plan on Drawing 1.

The terms of reference for the scope of work were outlined in MTO's Request for Proposal (RFP) dated January 11, 2010. Golder's Proposal P0-1191-0006, dated February 5, 2010 and subsequent Change Request No. 1, dated December 3, 2010, and Revised Change Request No. 2, dated October 31, 2011, formed part of IBI's agreement (Number 5009-E-0018) for this project. The work was carried out in accordance with Golder's Quality Control Plan for this project dated August 23, 2010. The site plan was provided to Golder by EXP Services Inc. on behalf of IBI in September 2014.

The purpose of this investigation is to establish the subsurface conditions at the location of the proposed sign by methods of borehole drilling, in situ testing and laboratory testing on selected soil samples.

2.0 SITE DESCRIPTION

The proposed VMS #20 is to be located on the east side of Highway 17 approximately 0.8 km south of the intersection with Highway 101 at approximately STA 17+552 in the Township of McMurray, Wawa, Ontario. This section of Highway 17 consists of one northbound lane and two southbound lanes. The northbound gravel shoulder is approximately 3 m wide and a shallow drainage ditch and all-terrain vehicle (ATV)/snowmobile trail parallels the gravel shoulder. The ground surface at the proposed structure location is at Elevation 284.8 m.

The topography of the site consists of a generally flat-lying area vegetated with trees and low lying shrubs and grass. The land use beyond the highway right-of-way in the area of the proposed sign is generally commercial on the west side of the highway with the landing strip for the Wawa airport on the east side of the highway. Two photographs of the site are presented following the text of this report.

3.0 INVESTIGATION PROCEDURES

The subsurface investigation for the VMS #20 structure was carried out on December 14, 2011, at which time one sampled borehole, numbered BH-VMS#20, was drilled on the shoulder of the northbound lane, as shown on Drawing 1.

The foundation investigation was carried out using a truck-mounted CME-55 drill rig supplied and operated by Landcore Drilling of Chelmsford, Ontario. The borehole was advanced to a depth of 9.8 m below the existing ground surface using 108 mm inside diameter hollow stem augers and soil samples were obtained at intervals of depth ranging from 0.75 m to 1.5 m, using a 50 mm outside diameter split-spoon sampler in accordance with the Standard Penetration Test (SPT) procedures (ASTM D1586). Details of the subsurface conditions encountered at the borehole location are shown on the Record of Borehole sheet following the text of this report. The borehole was backfilled with bentonite upon completion in accordance with Ontario Regulation 903 (as amended).



The fieldwork was supervised throughout by a member of Golder's technical staff, who located the borehole, arranged for the clearance of underground services and for traffic protection, supervised the drilling, sampling and in situ testing operations, logged the borehole, and examined and cared for the soil 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 classification testing (water contents and grain size distributions) of selected samples. All of the laboratory tests were carried out to MTO and/or ASTM standards, as appropriate.

The borehole was located in the field by Golder based on the position staked in the field by IBI. The as-drilled borehole location and the ground surface elevation (referenced to Geodetic datum) was subsequently surveyed by exp. and forwarded to Golder. The borehole coordinates and ground surface locations and drilled/driven depths are presented below.

Borehole Number	MTM NAD83 Zone 13 Northing (m)	MTM NAD83 Zone 13 Easting (m)	Ground Surface Elevation (m)
BH-VMS#20	5 314 195.9	245 689.6	285.0

4.0 GENERAL SITE GEOLOGY AND STRATIGRAPHY

4.1 Regional Geology

Based on terrain mapping by the Ontario Geological Survey¹, the subsurface soils in the vicinity of the site consist of glaciofluvial outwash plain deposits comprising primarily sand and gravel. The bedrock in the vicinity of the site is characterized by felsic to intermediate metavolcanic rocks very closely bordered by mafic metavolcanic rocks both of the early Precambrian Era².

4.2 Site Stratigraphy

Detailed descriptions of the subsurface soil and groundwater conditions as encountered in Borehole BH-VMS#20, advanced during this investigation, together with the results of the laboratory tests carried out on selected samples, are given on the Record of Borehole sheet in Appendix A and the soil laboratory test sheets provided in Appendix B. The results of the in situ field tests (i.e., SPT 'N'-values) as presented on the Record of Borehole sheets and in this section are uncorrected. The stratigraphic boundaries shown on the Record of Borehole sheet are inferred from non-continuous sampling, observations of drilling progress and the results of SPTs. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Further, subsurface conditions will vary beyond the borehole location.

In summary, the subsoil conditions at the site consist of granular fill (roadway shoulder materials) underlain by a deposit of loose to compact sand. A more detailed description of the subsurface conditions encountered in the borehole is provided in the following sections.

¹ Ontario Geological Survey, Ministry of Northern Development and Mines, and Northeast Science and Information Section, Ministry of Natural Resources 2005. Digital Northern Ontario Engineering Geology Terrain Study (NOEGTS); Ontario Geological Survey, Miscellaneous Release--Data 160.

² Ministry of Natural Resources, 1980, Geological Highway Map, Northern Ontario, Map 2440.



4.2.1 Sand and Gravel to Sand (Fill)

A 0.8 m thick layer of moist, brown sand and gravel to sand fill containing trace to some silt was encountered from ground surface at Elevation 285.0 m.

A grain size distribution test was performed on one sample of the fill and the test result is presented on Figure B1 in Appendix B.

The natural water content measured on one sample of the fill is 6 per cent.

4.2.2 Sand

A deposit of moist, brown sand, trace to some gravel, trace to some silt, was encountered below the granular fill. The surface of the sand deposit was encountered at Elevation 284.2 m and the deposit was explored for a thickness of 9.0 m without penetrating through the layer.

The SPT 'N'-values measured in the sand deposit range from 5 blows to 14 blows per 0.3 m of penetration indicating a loose to compact relative density.

Grain size distribution tests were carried out on two representative samples of the sand deposit and the results are presented on Figure B2 in Appendix B.

The natural water content measured on four samples of the deposit is between 3 per cent and 5 per cent.

4.2.3 Groundwater Conditions

Borehole BH-VMS#20 was dry upon completion of drilling as noted on the Record of Borehole sheet. It should be noted that the groundwater elevation will fluctuate seasonally depending on precipitation and local soil permeability and should be expected to rise during wet periods of the year.

5.0 CLOSURE

The fieldwork for this project was carried out by Mr. Ed Savard under the direction of Mr. David Muldowney P.Eng. This report was prepared by Mr. Adam Core, EIT, and the technical aspects were reviewed by Ms. Sarah E. M. Poot, P.Eng., Associate. Mr. Jorge M. A. Costa, P.Eng., a Principal with Golder and a Designated MTO Contact for Golder, conducted a quality control review of the report.



Report Signature Page

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N:\Active\2010\1190 Sudbury\1191\10-1191-0006 IBI Various VMS\Reporting\VMS 20 Wawa\Final\10-1191-0006 RPT 14Nov28 IBI VMS 20 Wawa FIDR.Docx



PART B

FOUNDATION DESIGN REPORT

VARIABLE MESSAGE SIGN #20

HIGHWAY 17 NORTHBOUND

APPROXIMATELY 0.8 KM SOUTH OF HIGHWAY 101

WAWA, ONTARIO

GWP 5143-11-00



6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides foundation design recommendations for the proposed Variable Message Sign (VMS #20) on the east side of Highway 17 near Wawa, Ontario. The recommendations are based on interpretation of the factual data obtained from the borehole advanced during the subsurface investigation at this site and from site observations. The interpretation and recommendations provided are intended only to provide the designers with sufficient information to assess feasible foundation design alternatives and to design the proposed sign foundation. As such, where comments are made on construction, they are provided only in order to highlight those aspects which could affect the planning of the project. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods, scheduling and the like.

6.2 Sign Foundation

We understand that the proposed sign will be located on the east side of Highway 17 at STA 17+552 facing the northbound lane of traffic with the centre of the sign support located approximately 4.5 m from the edge of the pavement.

Borehole BH-VMS#20 was advanced at STA 17+552 approximately 2.3 m west of the centre of the proposed sign location (i.e., approximately 2.3 m from the edge of the pavement). Borehole BH-VMS#20 encountered granular fill to a depth of 0.8 m underlain by a loose to compact sand deposit extending to a depth of 9.8 m below the ground surface, corresponding to Elevation 275.2 m. Borehole BH-VMS#20 was dry upon completion of drilling.

VMS pole mounted sign supports are typically designed using a standard caisson foundation in accordance with the requirements in MTO's Sign Support Manual (2011). Based on discussions with IBI and the structural designer, given the existing subsurface conditions at the location of the proposed sign, the preferred foundation alternative for supporting the overhead sign is a standard caisson founded on native soils. Alternatively, a spread footing option is also suitable, from a foundations perspective, and the foundation options are discussed in Sections 6.2.2 and 6.2.3.

Table 1, attached, summarizes the advantages, disadvantages, relative costs and risks/consequences of the foundation alternatives.

6.2.1 Frost Protection

As shown on Ontario Provincial Standard Drawing (OPSD) 3090.100 (Foundation, Frost Penetration Depths for Northern Ontario), the depth of frost penetration for the Wawa area is about 2.2 m. As such, it is recommended that the footing if adopted as the support foundation, be covered with a minimum thickness of 2.2 m of soil cover or equivalent thickness of insulation for protection from frost penetration.



6.2.2 Caisson Foundation

A caisson foundation for overhead sign should be designed in accordance with the requirements in the Sign Support Manual (2011) for standard size signs. The Sign Support Manual (2011) includes a standard caisson foundation design (Section 8 and Standard Drawing SS118-3), in which caissons are extended 5 m (Note 9) below the design frost depth (2.2 m for this site), except where bedrock is encountered within this depth. For a pole mounted sign foundation for the VMS #20 site, the minimum caisson founding depth would therefore be 7.2 m below ground surface.

The minimum design parameters/values specified in the Sign Support Manual (2011) for caissons are applicable to the design of the foundation for VMS #20, given that the minimum soil conditions for Case 1 (Sand) are available:

- Sand with a friction angle of 28 degrees surrounding the upper two-thirds of the portion of caisson foundation below the frost depth, and sand with a friction angle of 30 degrees surrounding the lower one-third portion of the caisson below the design frost depth.

For cohesionless soils, the unfactored passive lateral earth pressure, P_p (kPa), distributed along the depth of the caisson foundation, may be calculated using the following equations:

$$P_p = K_p \gamma d_w \text{ above the groundwater table; and}$$

$$P_p = K_p \gamma d_w + K_p \gamma' (d - d_w) \text{ below the groundwater table}$$

where K_p is the passive earth pressure coefficient;

γ is the bulk unit weight of the soil (kN/m³);

γ' is the effective unit weight of the soil below the groundwater level (kN/m³);

d is the depth below the ground surface (m); and

d_w is the depth to the groundwater level (m).

In the design of the foundations, the passive resistance within the upper 2.2 m below ground surface should be neglected to account for frost action. In addition, for foundation design, full passive resistance will be mobilized only where the ground surface in front of and behind the caisson is level. The K_p value of the sand deposit is 3.0 and the bulk unit weight may be taken as 20 kN/m³. Where sloping ground is present adjacent to the caisson foundation or where the foundation will be installed at the crest of an embankment, the K_p values used in the calculation of the passive resistance should be adjusted to account for the presence of the sloping ground.

Based on the subsurface conditions encountered at the proposed sign location (i.e., loose to compact sand), the installation of the caisson should be carried out with a temporary steel liner to avoid the open hole from caving or sloughing prior to pouring concrete. Although at the time of drilling the borehole was noted to be dry, if water is encountered at or near the base of the caisson a full balanced water head condition should be maintained at all times during construction to reduce the potential for base heave in the bottom of the caisson and ground loss. If the liner is generally dry following augering/excavation, cast-in-place concrete may be used; however, tremie concrete will be required if dewatering inside the liner is not possible.



As concrete is placed in the liner-protected hole (by tremie placement method when under water) the temporary steel liner should be removed progressively to the extent that the surface of the concrete is always within the steel liner to prevent caving-in of the hole, and removal of the liner can occur simultaneously.

Consideration can be given to leaving the steel liner in place permanently. However, the standard caisson foundation design for a cantilever static sign support, as specified in the Sign Support Manual (2011), assumes that there is intimate contact between the poured concrete and the subgrade soils, which cannot occur with use of a permanent steel liner. If the temporary steel liner is to be left in place, the design for the caisson foundation should be checked considering a friction factor between the steel and the native subgrade soil of $\tan \delta = 0.25$.

6.2.3 Spread Footing

As an alternative to a caisson foundation, this section of the report provides recommendations for the support of VMS #20 on a spread footing.

A spread footing constructed on the properly prepared subgrade at or below the frost depth given in Section 6.2.1 may be designed based on a factored geotechnical axial resistance of 250 kPa at Ultimate Limit States (ULS) for a footing rectangular in shape up to 5.0 m long by 2.5 m wide. A geotechnical axial reaction value of 125 kPa for Serviceability Limit States (for 25 mm settlement) may be used for design. The ULS resistance and settlement are dependent on the footing size, configuration and applied loads; the geotechnical resistances should, therefore, be reviewed if the selected footing dimensions or founding depth differs from those given above. The geotechnical resistances provided above are given for loads applied perpendicular to the surface of the footing. Where the load is not applied perpendicular to the surface of the footing, inclination of the load should be taken into account in accordance with Clauses 6.7.4 and C6.7.4 of the Canadian Highway Bridge Design Code (CHBDC, 2006) and the related commentary.

Resistance to lateral forces/sliding resistance between the concrete footing and the prepared subgrade should be calculated in accordance with Section 6.7.5 of the CHBDC. For a cast-in-place concrete footing constructed on a compacted granular working pad/bedding, the coefficient of friction, $\tan \delta$, can be taken as 0.55. For a cast-in-place concrete footing constructed directly on the native sand, the coefficient of friction, $\tan \delta$, can be taken as 0.50 (NAVFAC, 1982). The above noted values are unfactored.

Open cut excavations of short duration through the granular fill and native sand are considered feasible for the proposed footing. The Excavation for the proposed footing should be carried out in accordance with the latest Occupational Health and Safety Act for Construction Projects (OHSA). When referencing OHSA, the existing granular fill should be considered as "Type 3 Soil" and temporary excavation side slopes should be made no steeper than 1 horizontal (H) to 1 vertical (V). Depending on the groundwater level at the time of construction, the excavation side slopes may have to be flatter (i.e., 2H:1V).

Care must be taken by the Contractor during excavation adjacent to the highway to minimize impact to the existing roadway. Provision for protection of the existing pavement structure may be required in accordance with MTO's Ontario Provincial Standard Specifications (OPSS) 539 (Temporary Protection Systems), designed to meet Performance Level 2. Relevant design parameters for the shoring are provided below.



Design Parameter	Granular Fill & Sand
Unit Weight of soil above Groundwater Level γ (kN/m ³)	20
Unit Weight of soil below Groundwater Level γ' (kN/m ³)	10
Friction Angle ($^{\circ}$)	30
K_a^*	0.33
K_p^*	3.0
K_o^*	0.5

*Earth pressure coefficients for horizontal backfill.

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 the overall local embankment slope. For this site, the distance between the crest of the excavation and the toe of the stockpile should generally be greater than the diameter of the base of the stockpile.

Disturbance of the underlying materials during construction of the spread footing could influence the settlement of the structure. Therefore, OPSS 902 (Excavating and Backfilling – Structures) should be included in the Contract Documents, requiring inspection and approval of the foundation area by the Quality Verification Engineer (QVE) prior to footing construction, to ensure that the foundation area has been adequately prepared for construction of the spread footing.

The base of the excavation should be free of water and loose soil prior to placing concrete. Should the material(s) at bearing level become saturated or disturbed, we recommend that the affected material be removed immediately prior to placing concrete. We recommend that the prepared subgrade be protected using a 300 mm thick granular working pad consisting of compacted Granular 'A' or Granular 'B' Type II meeting the requirements in OPSS.PROV 1010 (Aggregates) or by a concrete working slab as detailed in the NSSP included in Appendix C. The working pad/concrete working slab would be placed across the bottom of the excavation immediately upon completion of the excavation and review by the QVE. The purpose of the working granular/slab pad is to limit disturbance of the native sand and to provide a platform for construction of the spread footing. The Granular 'A' or Granular 'B' Type II should be placed in 300 mm loose lifts and uniformly compacted to the requirements outlined in OPSS 501 (Compacting).

6.3 Construction Considerations

The performance of the caisson is dependent on the cleanliness of the base of the caisson such that all loose cuttings are removed to ensure the concrete is in intimate contact with the founding stratum at the base of the shaft. The inspection of the base of the shafts can be accomplished, after flushing and cleaning of the base by means of a Shaft Inspection Device (SID) such as a video camera. Should the camera inspection indicate that loosened/unacceptable soil is present at the base; the caisson base would need to be re-cleaned and re-inspected. The drilling and construction of the caisson foundations should be observed throughout by the QVE to confirm that the conditions encountered are consistent with the information obtained from the boreholes



and that the required base and cleanliness has been achieved. At the least, the caisson should be measured for depth to verify/confirm that it is fully open/unobstructed to the design and drilled depth.

The excavation around and above the spread footing, if this foundation option is adopted, should be backfilled using an approved granular material such as OPSS.PROV 1010 (Aggregates) Granular 'A' or 'B' (Type I or II) placed in 300 mm loose lifts and uniformly compacted to the requirements outlined in OPSS 501 (Compacting). The existing sand fill meets the maximum fines (i.e., smaller than 75 µm) content for a Granular 'B' Type I and is considered suitable for re-use for the roadway shoulder and for backfill to the footing.

The final grade surrounding the sign support should be sloped to promote drainage of surface water and from the pavement structure away from the pavement and sign, to the adjacent ditch and surfaced with topsoil and seed in accordance with OPSS 804 (Seed and Cover), or granular sheeting in accordance with OPSS.PROV 1004 (Aggregates - Miscellaneous). If the resulting side slopes in the immediate vicinity of the sign support foundation are steeper than 2 Horizontal to 1 Vertical, the slope should be covered with R-10 Rip-Rap, in accordance with OPSS.PROV 1004 (Aggregates - Miscellaneous), to reduce the potential for erosion of the slope locally.

7.0 CLOSURE

This report was prepared by Mr. Adam Core, E.I.T. and the technical aspects were reviewed by Ms. Sarah E. M. Poot, P.Eng., Associate. Mr. Jorge M. A. Costa, P.Eng., a Principal with Golder and Designated MTO Contact for Golder, conducted a quality control review of the report.



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Canadian Highway Bridge Design Code (CHBDC) and Commentary on CAN/CSA-S6-06, 2006. CSA Special Publication, S6.1-06. Canadian Standard Association.

Ministry of Natural Resources, 1980, Geological Highway Map, Northern Ontario, Map 2440.

Ministry of Transportation, Ontario, 2011. Sign Support Manual. Policy, Planning & Standards Division, Engineering Standards Branch, Bridge Office

Occupational Health and Safety Act and Regulation for Construction Projects, January 2006.

Ontario Geological Survey, Ministry of Natural Resources 2005. Ministry of Northern Development and Mines, and Northeast Science and Information Section, Digital Northern Ontario Engineering Geology Terrain Study (NOEGTS); Ontario Geological Survey, Miscellaneous Release--Data 160.

Unified Facilities Criteria, U.S. Navy. 1982. NAVFAC Design Manual 7.02. Soil Mechanics, Foundation and Earth Structures. Alexandria, Virginia.

STANDARDS

ASTM International

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

OPSD 3090.100	Foundation, Frost Penetration Depths for Northern Ontario
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Ontario Provincial Standard Specifications

OPSS 501	Construction Specifications for Compacting
OPSS 539	Construction Specification for Temporary Protection Systems
OPSS 902	Construction Specification for Excavating and Backfilling – Structures
OPSS.PROV 1004	Material Specification for Aggregates – Miscellaneous
OPSS.PROV 1010	Material Specification for Aggregates – Base, Subbase, Select Subgrade and Backfill Material

Ontario Water Resources Act

Ontario Regulation 903/90	Wells
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FOUNDATION REPORT
VMS #20 HIGHWAY 17 NORTHBOUND GWP 5143-11-00

Table 1: Evaluation of Foundation Alternatives

Options	Rank	Advantages	Disadvantages	Relative Costs	Risks/Consequences
Caisson	1	<ul style="list-style-type: none"> ■ Subsurface conditions are suitable for standard caisson foundation design as per the Sign Support Manual. ■ Typical foundation alternative for sign of standard size. 	<ul style="list-style-type: none"> ■ Requires specialized drilling equipment. ■ Temporary liner for soil support likely required during installation for sloughing and caving of cohesionless deposits. ■ Depending on water level at time of construction, dewatering may be required within liner for concrete placement in the dry, or concrete will have to be placed by tremie methods below water. ■ May require a levelling pad (fill or excavation of slope) to accommodate drilling equipment. 	<ul style="list-style-type: none"> ■ Mobilization of specialized drilling equipment is relatively expensive, compared to equipment required to construct spread footing. ■ Reduced cost if equipment is available locally for construction of the additional caisson sign foundations for this project. 	<ul style="list-style-type: none"> ■ Risk of need for placement of concrete by tremie methods if unable to dewater within caisson liner.
Spread Footing	2	<ul style="list-style-type: none"> ■ Conventional construction and construction equipment. ■ Design easily adaptable for non-standard sign size/configuration. 	<ul style="list-style-type: none"> ■ Larger excavation required compared to caisson with potential impact to roadway. ■ Depending on water level at time of construction, local dewatering and/or temporary shoring of excavation may be required. ■ Site specific design to determine footing size to satisfy all loading conditions may result in large footings being required. 	<ul style="list-style-type: none"> ■ Much lower overall cost compared to caisson. ■ Additional costs required for control of overburden as applicable. 	<ul style="list-style-type: none"> ■ Risk of requiring dewatering and/or temporary shoring during construction depending on season of construction.


Note: This table should be read in conjunction with the Foundation Investigation and Design Report.

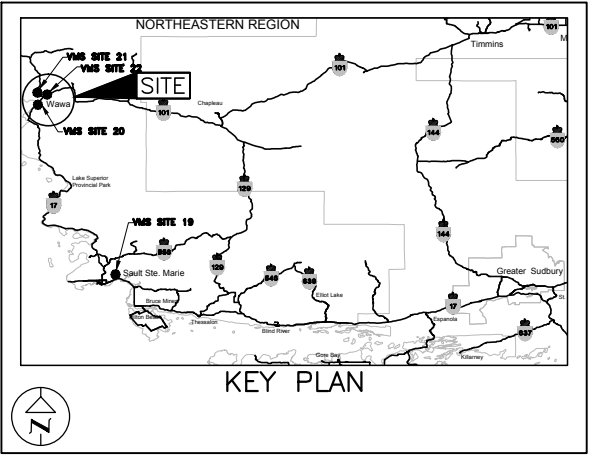
Prepared by: AC Reviewed by: JMAC

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

CONT No.
GWP No.5143-11-00

VARIABLE MESSAGE SIGN #20
HIGHWAY 17, WAWA
BOREHOLE LOCATION


SHEET



LEGEND



Approximate Borehole Location

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
BH-VMS#20	285.0	5314195.9	245689.6

NOTES

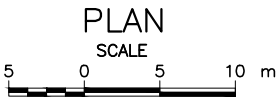
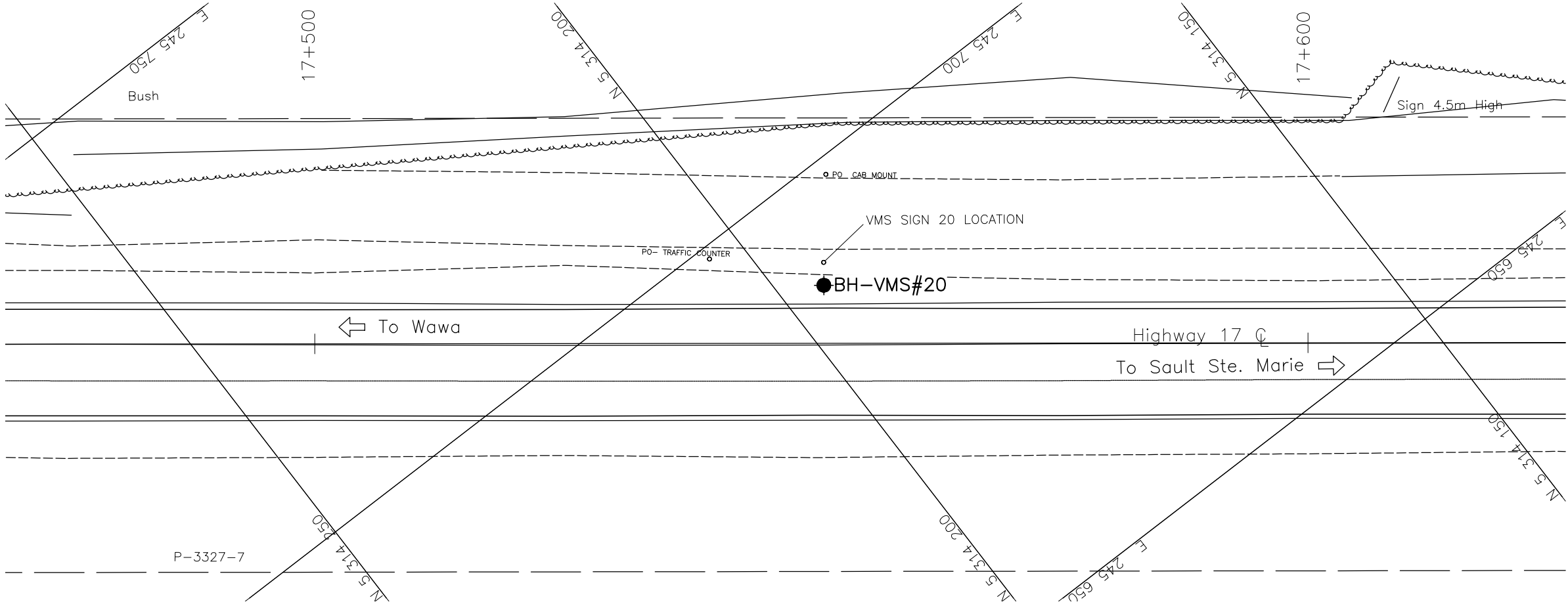
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Key plan provided in digital format by IBI, drawing file no. TM-TWG-keyplan.dwg, received December 7, 2010.
Base plans provided in digital format by IBIGroup, drawing file no. VMS SIGN 20.dwg, received Sep 03, 2014.



NO.	DATE	BY	REVISION
Geocres No. 41N-28			
HWY. 17	PROJECT NO. 10-1191-0006		DIST. .
SUBM'D.	CHKD.	DATE: 11/28/2014	SITE: VMS #20
DRAWN: TB	CHKD. AB	APPD. JMAC	DWG. 1



Photograph 1: Looking north at sign location



Photograph 2: Looking south from sign location





APPENDIX A

Record of Borehole



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

(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

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

Notes: 1
2

$$\tau = c' + \sigma' \tan \phi'$$

$$\text{shear strength} = (\text{compressive strength})/2$$



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 (Cohesionless) 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

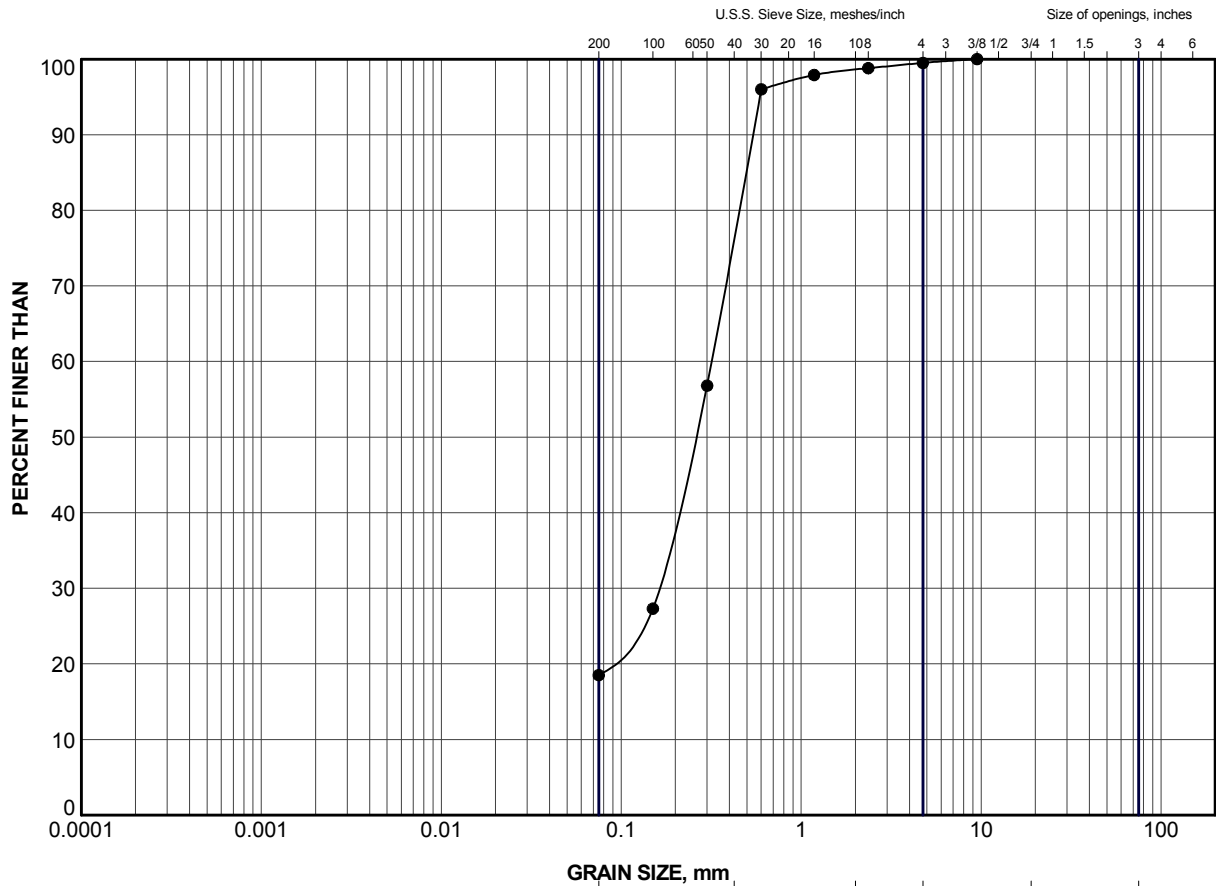


+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE



APPENDIX B

Laboratory Test Results



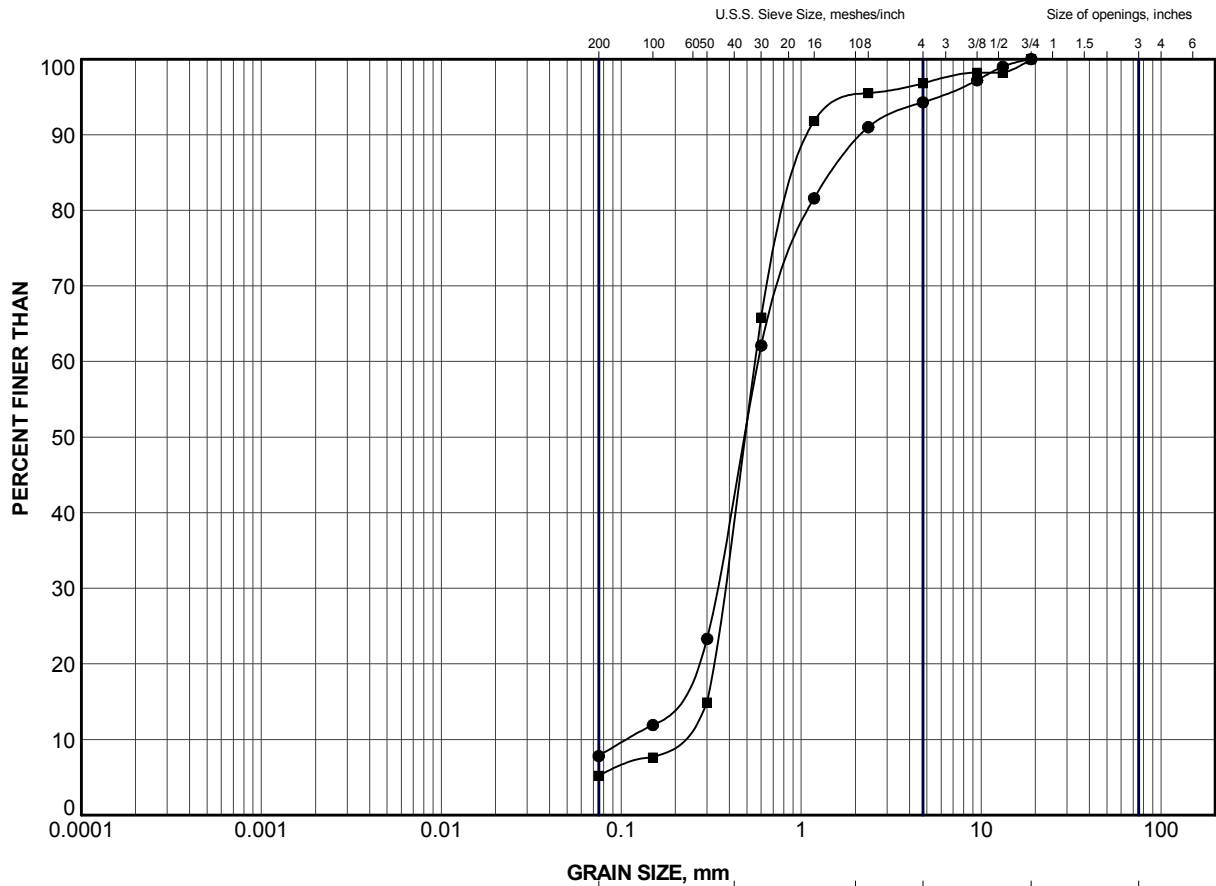
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BH-VMS#20	2	284.4

PROJECT						HIGHWAY 17 VARIABLE MESSAGE SIGN #20					
TITLE						GRAIN SIZE DISTRIBUTION SAND (FILL)					
PROJECT No.			10-1191-0006			FILE No.			1011910006.GPJ		
DRAWN	TB	Nov 2014	SCALE	N/A	REV.	FIGURE B1					
CHECK	AB	Nov 2014									
APPR	JMAC	Nov 2014									






CLAY AND SILT	GRAIN SIZE, mm					Cobble Size
	fine	medium	coarse	fine	coarse	
SAND SIZE				GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BH-VMS#20	4	283.2
■	BH-VMS#20	9	278.6

PROJECT						HIGHWAY 17 VARIABLE MESSAGE SIGN #20					
TITLE						GRAIN SIZE DISTRIBUTION SAND					
PROJECT No.				10-1191-0006		FILE No.				1011910006.GPJ	
DRAWN	TB	Nov 2014		SCALE	N/A	REV.					
CHECK	AB	Nov 2014									
APPR	JMAC	Nov 2014									
 Golder Associates SUDBURY, ONTARIO						FIGURE B2					



APPENDIX C

Non Standard Special Provision

WORKING SLAB - Item No.

Special Provision

1.0 SCOPE

This Special Provision covers the requirements for the supply and placement of a concrete working slab under structure foundations.

2.0 REFERENCES

This Special Provision refers to the following standards, specifications or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 902 Excavating and Backfilling - Structures

3.0 DEFINITIONS - Not Used

4.0 DESIGN AND SUBMISSION REQUIREMENTS - Not Used

5.0 MATERIALS

Concrete for working slabs shall have a minimum 28 day strength of 20 MPa.

6.0 EQUIPMENT - Not Used

7.0 CONSTRUCTION

7.01 Excavation

Excavation for the working slab shall be according to OPSS 902.

7.02 Protection of Founding Soil

Following inspection and approval of the prepared subgrade, a working slab with a minimum thickness of 100 mm shall be placed on the foundation subgrade as specified in the Contract Documents.

7.03 Protection of Founding Bedrock

The surface of the footing founding rock shall be exposed, cleaned and any loose or fractured parts removed so that sound rock is exposed. The working slab shall be placed on the exposed cleaned sound founding rock surface as specified in the Contract Documents.

Thickness of the mass concrete pad shall depend on the slope and irregularities in the exposed founding rock surface. A nominal thickness and a footprint plan view area has been specified on the Contract Documents

7.04 Dewatering

Dewatering shall be carried out according to OPSS 902.

8.0 QUALITY ASSURANCE - Not Used

9.0 MEASUREMENT FOR PAYMENT - Not Used

10.0 BASIS OF PAYMENT

10.01 Working Slab - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment and Material to do the work.

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