



June 29, 2011

FOUNDATION INVESTIGATION AND DESIGN REPORT

**VARIABLE MESSAGE SIGN #15
HIGHWAY 17 EASTBOUND
APPROXIMATELY 1.1 KM EAST OF REGIONAL ROAD 90
CITY OF GREATER SUDBURY, ONTARIO
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 5122-06-00**

Submitted to:

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GEOCRES NO.: 41I-268

Report Number: 10-1191-0006-15

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REPORT



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PART A

FOUNDATION INVESTIGATION REPORT

VARIABLE MESSAGE SIGN #15

HIGHWAY 17 EASTBOUND

APPROXIMATELY 1.1 KM EAST OF REGIONAL ROAD 90

CITY OF GREATER SUDBURY, ONTARIO

GWP 5122-06-00



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 #15) on Highway 17 eastbound in the City of Greater Sudbury, 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 Golder's Proposal P0-1191-0006, dated February 5, 2010 that 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 Trow Geomatics Inc. (Trow) on behalf of IBI in December 2010.

We understand that the proposed variable message sign will be mounted on a single pole supported by a spread footing.

2.0 SITE DESCRIPTION

The site of the proposed VMS #15 is located on the south side of Highway 17, approximately 1.1 km east of the intersection with Regional Road 90 at Station 19+588 in the City of Greater Sudbury, Ontario. This section of Highway 17 consists of one westbound lane and one eastbound lane. The eastbound shoulder is approximately 3 m wide, consisting of approximately 1 m of pavement and approximately 2 m of granular material, with a guide rail near the crest of the embankment at approximately 2.5 m from the edge of the pavement. The roadway embankment is about 4 m high and the ground surface at the toe of the slope is at approximately Elevation 254 m in the area of the proposed sign. The ground surface at the proposed structure location is approximately Elevation 258 m.

The topography of the site generally consists of relatively flat-lying areas with sparse vegetation separated by bedrock outcrops. A bedrock outcrop is located on the north side of the westbound lane ditch opposite the proposed sign location. Further, bedrock outcrops are located about 30 m east and 30 m south of the proposed sign and based on the existing topography, site drainage appears to be from west to south and/or north to south. The land use beyond about 100 m of the proposed sign location is either residential, commercial or industrial. An electrical corridor is located parallel and south of the highway. Two photographs of the site are presented on Figure 1.

3.0 INVESTIGATION PROCEDURES

The subsurface investigation work for the VMS #15 structure was carried out on November 1, 2010, at which time one sampled borehole, numbered BH-VMS#15, and two auger probes, numbered AP-E and AP-W, were drilled at the locations shown on Drawing 1. Borehole BH-VMS#15 was drilled on the granular section of the shoulder of the eastbound lane, approximately 4.8 m from the centre of the proposed sign location as it was not readily possible to set up the drilling equipment on the embankment slope at the proposed sign location and restrictions due to the guardrail at the top of the slope.

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 7.3 m below ground surface, including 3.2 m of bedrock core, using 108 mm inner diameter (I.D.) hollow stem augers, NW casing and



NQ coring equipment. The two auger probes were advanced to auger refusal at depths of 1.5 m and 1.8 m below the existing ground surface. Soil samples were obtained within the sampled borehole at intervals of 0.75 m, using a 50 mm outside diameter split-spoon sampler in accordance with the Standard Penetration Test (SPT) procedures (ASTM D1586-08). Details of the subsurface conditions encountered at the borehole locations are shown on the Record of Borehole and Record Drillhole sheets following the text of this report. The borehole and auger probes were backfilled with bentonite upon completion of drilling in accordance with Ontario Regulation 903 (as amended by O. Reg. 372).

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 boreholes and drillhole, 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 contents and grain size distributions) was carried out on selected soil samples. One Unconfined Compressive Strength (UCS) test was carried out on a sample of the bedrock core.

The boreholes were located in the field by Golder based on the position staked by IBI. The as-drilled borehole and auger probe locations and the ground surface elevations (referenced to Geodetic datum) were subsequently surveyed by Trow and forwarded to Golder. The approximate borehole and auger probe locations are shown on Drawing 1 and the coordinates and ground surface elevations are provided below.

Borehole Number	MTM NAD83 Zone 17 Northing (m)	MTM NAD83 Zone 17 Easting (m)	Ground Surface Elevation (m)	Depth Drilled (m)
BH-VMS#15	5149920.9	318009.0	258.3	7.3
AP-W	5149921.8	318006.6	258.2	1.8
AP-E	5149919.7	318011.4	258.4	1.5

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 glaciolacustrine deposits comprising primarily silts and sands, bordering with areas of organic terrain and outcropping bedrock. The bedrock in the vicinity of the site is characterized by mafic and ultramafic igneous rocks of the Precambrian eon².

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



4.2 Site Stratigraphy

Detailed descriptions of the subsurface soil, bedrock and groundwater conditions as encountered in the borehole advanced during this investigation, together with the results of the laboratory tests carried out on selected samples, are given on the attached Record of Borehole and Drillhole sheets in Appendix A. The stratigraphic boundaries shown on the Record of Borehole and Drillhole sheets are inferred from non-continuous sampling, observations of drilling progress and the results of SPTs. These boundaries, therefore, represent transitions between material 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) and blast rock fill underlain by bedrock. A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

4.2.1 Fill

A 1.7 m thick layer of moist, brown sand and gravel to gravelly sand fill containing trace to some silt was encountered from ground surface in Borehole BH-VMS#15 at Elevation 258.3 m. Auger Probes AP-W and AP-E extended to auger refusal at depths between 1.8 m and 1.5 m, respectively, corresponding to Elevation 256.4 m and 256.9 m, respectively.

SPT 'N'-values measured in the fill are 9 and 14 blows per 0.3 m of penetration, indicating a loose to compact relative density.

Grain size distribution tests were carried out on two samples of the granular fill and the test results are presented on Figure B-1.

The natural water content measured on two samples of the granular fill is 3 percent and 4 percent.

Underlying the granular fill in Borehole BH-VMS#15, a 2.4 m thick layer of blast rock fill was encountered at Elevation 256.6 m. The recovered rock fill pieces and the total core recovery in the core barrel for the two runs were 33 percent and 42 percent.

4.2.2 Bedrock

Bedrock was encountered and cored for a length of 3.2 m in Borehole BH-VMS#15. The top of the bedrock surface was encountered at a depth of 4.1 m below ground surface, corresponding to Elevation 254.2 m. Based on a review of the bedrock core samples, the bedrock generally consists of a medium grained, slightly weathered, grey mafic intrusive.

The Rock Quality Designation (RQD) values measured on the recovered bedrock core samples are 72 percent and 76 percent, indicating the rock is of fair to good quality in accordance with Table 3.10 of the 2006 Canadian Foundation Engineering Manual (CFEM)³.

³ Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual, 4th Edition.



One UCS test was performed on a sample of the rock core and the measured UCS of 155 MPa indicates the rock is very strong, in accordance with Table 3.5 of the 2006 CFEM.

4.2.3 Groundwater Conditions

Borehole BH-VMS#15 was dry upon completion of drilling, as noted on the Record of Borehole sheet following the text of this report. It should be noted that depending on precipitation, some perched groundwater may be encountered within the fill materials.

5.0 CLOSURE

The fieldwork for this project was carried out by Mr. Ed Savard from our Sudbury office under the coordination of Mr. David Muldowney, EIT. This report was prepared by Mr. David Muldowney, EIT, and the technical aspects were reviewed by Mr. André Bom, P.Eng., and Mr. Jorge M.A. Costa, P.Eng., a Principal with Golder. Mr. Costa, also a Designated MTO Contact for Golder, conducted a quality control review of the report.



Report Signature Page

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PART B

FOUNDATION DESIGN REPORT

VARIABLE MESSAGE SIGN #15

HIGHWAY 17 EASTBOUND

APPROXIMATELY 1.1 KM EAST OF REGIONAL ROAD 90

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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 #15). The recommendations are based on interpretation of the factual data obtained from the borehole and auger probes 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 the proposed sign will be located on the south side of Highway 17 with the centre of the footing located approximately 5 m from the edge of the pavement at Station 19+588 facing the eastbound traffic.

Borehole BH-VMS#15 was advanced at Station 19+588 approximately 4.8 m from the centre of the proposed sign location (i.e. approximately 1.3 m from the edge of the pavement) and encountered granular fill to a depth of 1.7 m below the existing ground surface and blast rock fill extending to the bedrock surface at a depth of 4.1 m below the existing ground surface, corresponding to Elevation 254.2 m. Borehole BH-VMS#15 was dry upon completion of drilling. Auger Probes AP-W and AP-E extended to auger refusal likely on the blast rock fill at depths between 1.8 m and 1.5 m, respectively, corresponding to Elevation 256.4 m and 256.9 m, respectively.

Overhead sign supports are typically designed with a standard caisson foundation in accordance with the requirements in MTO's *Sign Support Manual* (2007). The foundation for the sign support can be designed as caissons socketted into the rock or, alternatively, the sign can be supported on a spread footing, founded on either bedrock or the existing rock fill. Recommendations for these foundation options are provided in Sections 6.2.1 and 6.2.2.

We understand from discussions with IBI, the structural designer and MTO that the preferred alternative from a constructability perspective is founding the footing on the existing rock fill at the site. Table 1 (attached) summarizes the advantages, disadvantages, relative costs and risks/consequences of the foundation alternatives. Given the subsurface conditions at this sign location, a spread footing founded on the bedrock is considered to be the preferred option from a foundations perspective as it would avoid the coring of a large-diameter holes through the existing blast rock into the very strong mafic intrusive bedrock for a caisson foundation and it would eliminate the concerns associated with founding the footing on the existing rock fill for a spread footing foundation.

6.2.1 Caisson Foundation

It may be extremely difficult to advance a caisson through the blast rock fill and socket the caisson into the very strong mafic intrusive bedrock at this site. Further, we understand from IBI's structural designer that the current proposed sign is larger and different in configuration than the standard Changeable Message Sign in the *Sign Support Manual* and a non-standard design would be required. As caissons are not proposed for the sign



foundation, as confirmed in the minutes of a meeting between MTO, IBI, IBI's structural designer and Golder on March 1, 2011, the specific design parameters (i.e. axial and lateral resistances) have not been included in this report.

6.2.2 Spread Footing

We understand from IBI that the preferred alternative foundation design for the support of VMS #15 is a spread footing and, based on discussions with IBI/designer, we have assumed for design purposes that the footing will have dimensions of 5 m long and 2.5 m wide.

Founded on Bedrock

At this site, the spread footing should be founded on the bedrock surface. In this case, sub-excavation of about 2.4 m of the existing rock fill to expose the bedrock surface will be required. Given the proximity of the footing to the existing edge of pavement and the anticipated size of footing, the excavation will extend up the slope towards the edge of pavement along the eastbound driving lane, unless the sign can be relocated further from the roadway. The main advantage for constructing the footings on bedrock, compared to a caisson foundation, is the elimination of drilling through rock fill and into bedrock; however, the disadvantage of a footing on bedrock is the need for a larger excavation and the potentially higher cost for concrete.

From a foundations perspective, a spread footing placed directly on bedrock at about Elevation 254.2 m is the preferred option. However, variation in the bedrock surface elevation should be anticipated and mass concrete or a thicker footing may be required to achieve the top of footing elevation. The bedrock at the founding depth will be of good quality but nevertheless the founding surface should be properly prepared (i.e. removing loose shattered rock fragments). A Non Standard Special Provision (NSSP) for mass concrete should be included in the Contract Documents in the event that a thicker footing is required due to the uneven nature of the bedrock surface; an example NSSP is provided in Appendix C. In addition, depending on the bedrock surface slope, doweling may be required as discussed in Section 6.2.3 and the Contract Documents should make allowance for such construction.

For spread footings founded directly on the bedrock or on mass concrete over bedrock, frost susceptibility is not an issue.

Founded on Rock Fill

As an alternative to founding the footing on bedrock, consideration could be given to supporting the sign on a spread footing placed on a properly prepared rock fill surface at or below the frost depth. The advantages of a spread footing constructed on the existing rock fill are reduced costs, reduced risks associated with impacting the existing traveled lane(s) during construction, as well as the elimination of the mass concrete or dowels in the event the footing is constructed on sloping bedrock. Although the existing embankment has been in place for longer than 20 years, there is a risk of continued rearrangement of rock fill particles below the footing during and after construction resulting in a loss of support under the foundation.



For spread footings placed on the rock fill, a levelling pad of a minimum of 300 mm thick SP110S13 Granular 'B' Type II compacted to 100 percent standard Proctor maximum dry density (SPMDD) should be placed underneath the footing. To avoid the requirement for a geotextile separator between the granular fill and the rock fill, chinking of the rock fill surface should be carried out in accordance with the NSSP provided in Appendix C. As indicated in the NSSP, the Quality Verification Engineer (QVE) should be on site to verify and document the chinking of the rock fill prior to placing the granular pad.

Instead of a granular pad over the rock fill, consideration could also be given to grouting the rock fill subgrade prior to footing construction to "interlock" the surficial and lower rock fill particles below the footing. However, depending on the gradation of the rock fill and presence and interconnectedness of voids, larger volumes of grout may be required if there are a large number or volume of voids, or the grout may not adequately penetrate the rock fill if the voids are filled with finer material and/or the voids are not interconnected. We understand based on discussions with the structural designer and MTO that a granular pad placed and compacted over the chinked rock fill subgrade is preferred to grouting the rock fill.

As shown on the depth of frost penetration isopleths for Northern Ontario in OPSD 3090.100 (Foundation Frost Penetration Depth), the depth of frost penetration for the Sudbury area is approximately 2.0 m. Although rock fill is typically considered to be non-frost susceptible, it is recommended that the footing be covered with a minimum thickness of 2.0 m (about Elevation 256.3 m, depending on final grading) of Granular 'B' Type II material or equivalent thickness of insulation for protection from frost penetration in the event that fine material is present within the rock fill subgrade below the footing, which could prevent the dissipation of infiltrated water, resulting in perched water within the rock fill at/below the footing.

It should be noted that rock fill cover thickness provides only half of the protection compared to soil cover therefore requiring twice as much cover and we recommend that granular backfill be placed as cover instead of rock fill. In addition, the thickness of frost cover should be measured perpendicular to the slope, resulting in the footing having to be located further into the embankment or needing an adequate thickness of soil/granular fill on the embankment slope.

General

Care must be taken by the Contractor during excavation adjacent to the highway to minimize impact to the existing roadway. Open cut excavations of short duration through the granular fill and rock fill are considered feasible for the proposed footing. Excavations 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 and rock 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 size of the rock fragments, localized flatter side slopes may form naturally.

If side slopes flatter than 1H:1V are required during construction, provision for protection of the existing pavement structure will be required in accordance with MTO's Ontario Provincial Standard Specification (OPSS) 539 (Temporary Protection Systems), designed to meet Performance Level 2. However, installing shoring in rock fill may prove extremely difficult and standard sheet-pile or soldier pile and lagging walls will not be appropriate for this site. A trench box may be the most practical alternative. Since trench boxes will not be in intimate contact with the surrounding rock fill, the use of trench boxes will not provide significant benefits in terms of reducing the horizontal extent of the excavation, but would provide protection from sloughing of the rock fill. Lane closures will likely be required for the areas of the sign foundation excavations.



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 slope. Generally, for this site, the distance between the crest of the excavation and the toe of the stockpile should be greater than the diameter of the base of the stockpile.

As indicated above, inspection and approval of the foundation area by the QVE prior to footing construction should be required in accordance with OPSS 902 (Excavating and Backfilling), to ensure that the foundation base has been properly prepared for the placement of the granular pad and concrete.

6.2.3 Geotechnical Resistance

For footings bearing directly on the bedrock surface or on mass concrete, a factored geotechnical resistance at Ultimate Limit States (ULS) of 1 MPa may be used for design. Serviceability Limit States (SLS) for 25 mm settlement conditions do not apply for footings founded on bedrock or on mass concrete.

For a 2.5 m wide footing placed on the properly constructed granular pad on the chinked surface of the existing rock fill, a factored geotechnical resistance at ULS of 700 kPa may be used for design. A geotechnical resistance at SLS of 300 kPa may be used for design, based on a 25 mm of settlement and assuming a 2.5 m wide footing. It must be noted that the settlement could occur differentially such that the sign foundation could “tilt/rotate”, depending on the extent of degradation of the rock fill over time, pressure and size of voids in the rock fill, and/or loss of the granular pad under the footing as a result of infiltration of this finer material into the voids in the rock fill mass.

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.

6.2.4 Resistance to Lateral Loads

Resistance to lateral forces / sliding resistance between the cast-in-place concrete footings and the prepared bedrock surface should be calculated in accordance with Section 6.7.5 of the *CHBDC* using a coefficient of friction, $\tan \phi'$, equal to 0.70. This value is unfactored. For a cast-in-place footing constructed on a granular pad over the rock fill, a coefficient of friction, $\tan \phi'$, equal to 0.58 should be used in assessing lateral forces/sliding resistance between the concrete footings and the granular pad and for a precast concrete footing constructed on a granular pad over rock fill, a coefficient of friction, $\tan \delta$, equal to 0.45 should be used.

For footings on bedrock, the sliding/lateral resistance between the concrete footing/mass concrete and the bedrock may be supplemented by dowelling/anchoring into the bedrock, if necessary. The horizontal resistance of the dowels is dependent on the strength of the bedrock, grout and steel. For this site, where the rock mass is essentially as strong as or stronger than concrete, the design of the dowels into the rock may be considered in the same way as dowels embedded into the concrete. This assumes that the Unconfined Compressive Strength (UCS) of the grout will be similar to that of the concrete. The dowels should have a 1 m minimum embedded length within the bedrock, and the structural strength of the dowel and compressive strength of the grout should not be exceeded. If dowelling into bedrock is adopted at this site, an NSSP should be included in the Contract Documents to specify the installation, materials and testing of the dowels; an example is provided in Appendix C.



6.3 Construction Considerations

The excavation around and above the spread footing may be backfilled using an approved granular material such as MTO's Special Provision (SP) SP110S13 (Aggregates) Granular 'B' (Type II) placed in 0.3 mm thick loose lifts and uniformly compacted to not less than 95 percent of the standard Proctor maximum dry density of the material.

The existing gravelly sand fill slightly exceeds the maximum fines (i.e. smaller than 75 µm) content for a Granular 'B' Type 1, but is considered suitable for re-use for the roadway shoulder. The surface of the rock fill directly below the roadway subbase fill should be well graded with low voids and chinked with the excavator tracks to minimize ingress of the subbase into the rock fill. Should the rock fill be poorly graded at the surface, a geotextile separator fabric should be placed over the rock fill surface.

The final grade surrounding the sign should be sloped to promote surface water drainage and pavement structure drainage away from the pavement and sign, to the adjacent ditch and surfaced with rock fill or R-10 Rip-Rap in accordance with OPSS 1004 (Aggregates – Miscellaneous) to reduce the potential for erosion of the slope locally.

7.0 CLOSURE

This report was prepared by Mr. David Muldowney, EIT, and Mr. André Bom, P.Eng. The technical aspects were reviewed by Mr. Jorge M.A. Costa, P.Eng., a Principal with Golder. Mr. Costa, also a Designated MTO Contact for Golder, conducted a quality control review of the report.

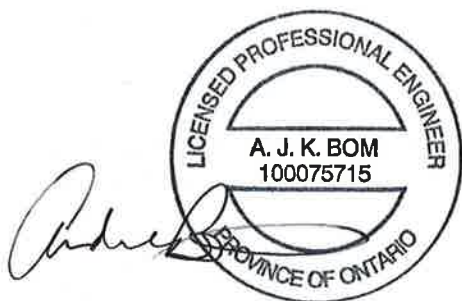


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- Canadian Highway Bridge Design Code (CHBDC) and Commentary on CAN/CSA S6-06, 2006. CSA Special Publication, S6.1-06. Canadian Standard Association.
- Ministry of Transportation, Ontario, 2007. Sign Support Manual. Policy, Planning & Standards Division, Engineering Standards Branch, Bridge Office, April 2007.
- Occupational Health and Safety Act and Regulation for Construction Projects, January 2006.

STANDARDS

ASTM International

- | | |
|---------------|---------------------------------------------------------------------------------------------|
| ASTM D1586-08 | Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils |
|---------------|---------------------------------------------------------------------------------------------|

Ministry of Transportation Ontario Special Provisions

- | | |
|-----------|--------------------------------------------------------------------------------------|
| SP 110S13 | Material Specification for Aggregates – Base, Subbase, Select Subgrade, and Backfill |
|-----------|--------------------------------------------------------------------------------------|

Ontario Provincial Standard Drawings

- | | |
|---------------|----------------------------------------------|
| OPSD 3090.100 | Foundation Frost Depths for Northern Ontario |
|---------------|----------------------------------------------|

Ontario Provincial Standard Specifications

- | | |
|-----------|------------------------------------------------------------------------|
| OPSS 902 | Construction Specification for Excavating and Backfilling – Structures |
| OPSS 1004 | Material Specification for Aggregates – Miscellaneous |

Ontario Water Resources Act

- | | |
|---------------------------|-------------------------------------|
| Ontario Regulation 372/07 | Amendment to Ontario Regulation 903 |
| Ontario Regulation 903/90 | Wells |



Table 1: Evaluation of Foundation Alternatives

Options	Rank	Advantages	Disadvantages	Relative Costs	Risks/Consequences
Spread Footings Founded on Bedrock Surface	1	<ul style="list-style-type: none"> ■ Conventional construction. ■ Better known condition/quality subgrade and high geotechnical resistances available. ■ Frost cover protection not required for footings on bedrock. 	<ul style="list-style-type: none"> ■ Requires excavation to depth of about 4 m to bedrock surface with side slopes that will impact existing lane(s) of traffic. ■ Requires traffic protection of travelled lanes(s). ■ Sloping bedrock may require a levelling concrete pad and/or anchors/dowels for footing construction depending on size of footing. 	<ul style="list-style-type: none"> ■ Much lower overall cost compared to caissons. ■ Additional costs associated with excavation through rock fill and impacting existing lane(s) of traffic compared to spread footings on rock fill. ■ Additional costs for levelling concrete pad and/or dowels. 	<ul style="list-style-type: none"> ■ Greater depth of excavation and greater impact to existing lane(s) of traffic if depth to bedrock is greater than 4 m. ■ Larger volumes of mass concrete for levelling the footing subgrade and/or requirement for anchors/dowels for lateral sliding resistance if bedrock is sloping.
Spread Footings on Rock Fill	2	<ul style="list-style-type: none"> ■ Conventional construction. ■ Reduced excavation depth, minimizes impact to existing lane(s) of traffic during excavation. 	<ul style="list-style-type: none"> ■ Unknown condition/quality of subgrade (and material below) resulting in differential settlement under the footing. ■ Rock fill mass will likely require some form of mitigation works to properly prepare the subgrade and "homogenize" the rock fill mass: <ul style="list-style-type: none"> - Chinking of the surface layer requires large excavation for equipment to travel on and compact the subgrade; - Granular fill as subgrade and will have potential for loss of material into the rock fill voids in the long term; - "Cement" grout may be required to fill voids and minimize possible movement of rock fill particles but may lead to uncontrolled loss of grout, long-term breakage of grouted mass. ■ Lower geotechnical resistances available on the rock fill material. 	<ul style="list-style-type: none"> ■ Much lower overall cost compared to caissons. ■ Lower excavation costs than spread footings on bedrock but cost will likely increase due to the need for remedial works. 	<ul style="list-style-type: none"> ■ Inability for grout to penetrate rock fill or conversely large volume of grout if rock fill has a large void ratio. ■ Rearrangement of rock fill particles over time and differential settlement of rock fill resulting in loss of support under the foundation. ■ Borehole was dry on completion of drilling, but potential for perched groundwater after "chinking" rock fill exists and the thickness of material required for protection from frost protection would increase.

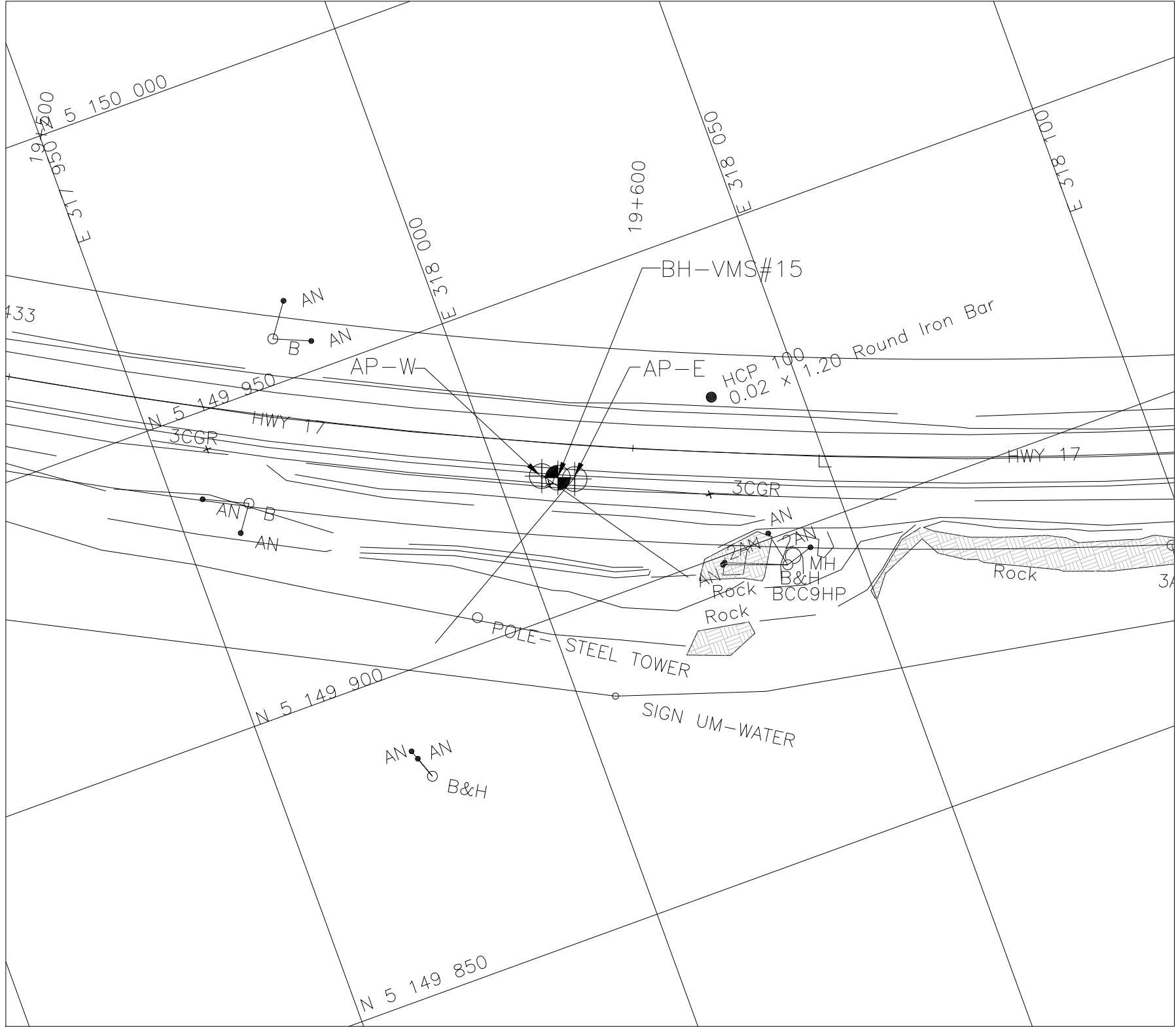


FOUNDATION REPORT, VMS #15 HIGHWAY 17 EASTBOUND
GWP 5122-06-00

Options	Rank	Advantages	Disadvantages	Relative Costs	Risks/Consequences
			<ul style="list-style-type: none"> ■ Frost protection cover required for footing; rock fill cover thickness provides only half of the protection compared to soil cover, therefore requiring twice as much cover unless it can be shown that the rock fill is well drained and is not founded on a soil subgrade (MTO Structural Manual, 2008). ■ Frost protection cover thickness to be measured perpendicular to slope, resulting in footing having to be located further into the embankment, being set at a greater depth or needing an adequate thickness of soil/granular fill on the embankment slope. 		
Caissons Socketted into Bedrock	3	<ul style="list-style-type: none"> ■ High bearing resistances available in the very strong bedrock. ■ Standard design in accordance with MTO Sign Support Manual. 	<ul style="list-style-type: none"> ■ May be difficult socketting caissons through rock fill and into the very strong bedrock. ■ Requires specialized drilling equipment to penetrate through rock fill and into bedrock. ■ May require a levelling pad (fill or excavation of slope) to accommodate drilling equipment. 	<ul style="list-style-type: none"> ■ Cost many times higher than spread footings. 	<ul style="list-style-type: none"> ■ Difficulties socketting large diameter hole through rock fill and into bedrock.

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

Compiled by: AB
Reviewed by: JMAC



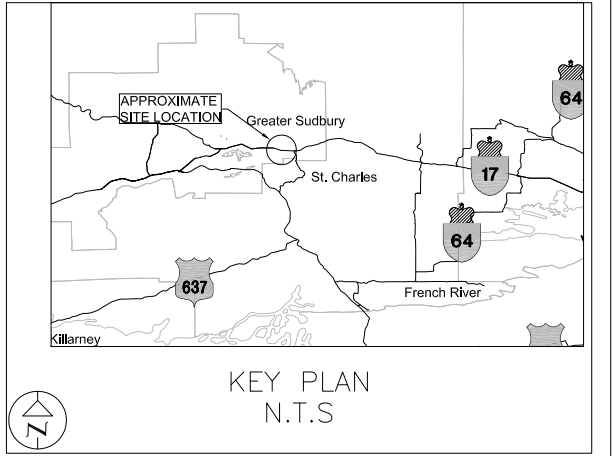
METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 5122-06-00

VARIABLE MESSAGE SIGN #15
HIGHWAY 17 EASTBOUND, SUDBURY
BOREHOLE AND AUGER PROBE
LOCATIONS

SHEET

Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA



LEGEND			
	BH-VMS#15	Approximate Borehole Location	
	AP-E	Approximate Auger Probe Location	
No.	ELEVATION(m)	CO-ORDINATES	
		NORTHING	EASTING
BH-VMS#15	258.3	5149920.9	318009.0
AP-W	258.2	5149921.8	318006.6
AP-E	258.4	5149919.7	318011.4

NOTES

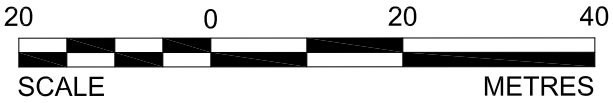
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The 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 plan provided in digital format by TROW Geomatics inc, drawing file no.Ntb-01007030 sudbury.dwg, received December 7, 2010



NO.	DATE	BY	REVISION
Geocres No.411-268			
HWY. 17	PROJECT NO.10-1191-0006		DIST.
SUBM'D. DAM	CHKD. AB	DATE: JUNE 2011	SITE:
DRAWN: PL	CHKD.	APPD. JMAC	DWG. 1



Figure 1 – Photographs of VMS #15 Site, Sudbury

Photograph 1: Looking east



Photograph 2: Looking west





APPENDIX A

Record of Borehole and Drillhole



LIST OF SYMBOLS

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

1. 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
V	volume
W	weight

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. 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	liquid limit
w_p	plastic limit
I_p	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_a	coefficient of secondary consolidation
m_v	coefficient of volume change
c_v	coefficient of consolidation
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation pressure
OCR	over-consolidation ratio $= \sigma'_p / \sigma'_{vo}$

(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 $\tau = c' + \sigma' \tan \phi'$
2 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
SS	Split-spoon
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
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) 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

Percent 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 (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 texture and structure are preserved.

BEDDING THICKNESS

<u>Description</u>	<u>Bedding Plane Spacing</u>
Very thickly bedded	> 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	< 6 mm

JOINT OR FOLIATION SPACING

<u>Description</u>	<u>Spacing</u>
Very wide	> 3 m
Wide	1 – 3 m
Moderately close	0.3 – 1 m
Close	50 – 300 mm
Very close	< 50 mm

GRAIN SIZE

<u>Terms</u>	<u>Size*</u>
Very Coarse Grained	> 60 mm
Coarse Grained	2 – 60 mm
Medium Grained	60 microns – 2 mm
Fine Grained	2 – 60 microns
Very Fine Grained	< 2 microns

* Note: Grains > 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 varies 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 separation) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to (W.R.T.) 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 abbreviated description of the discontinuities, whether naturally occurring separation such as fractures, bedding planes and foliation planes or mechanically induced fractures 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

B - Bedding	⊥ - Perpendicular To
FO - Foliation / Schistosity	- Parallel To
CL - Cleavage	P - Polished
SH - Shear Plane / Zone	K - Slickensided
VN - Vein	SM - Smooth
F - Fault	R - Rough
CO - Contact	ST - Stepped
J - Joint	PL - Planar
FR - Fracture	U - Undulating
MF - Mechanical Fracture	C - Curved

PROJECT		10-1191-0006		RECORD OF BOREHOLE No BH-VMS#15				1 OF 1 METRIC										
W.P.		5122-06-00		LOCATION		N 5149920.9; E 318009.0		ORIGINATED BY EHS										
DIST		HWY 17		BOREHOLE TYPE		108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, NQ Coring		COMPILED BY DAM										
DATUM		GEODETIC		DATE		November 1, 2010		CHECKED BY AB										
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	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
258.3	GROUND SURFACE							20	40	60	80	100						
0.0	Sand and gravel to gravelly sand, trace to some silt (FILL) Loose to compact Brown Moist		1	AS	-		258											51 43 (6)
			2	SS	14		257											22 64 (14)
256.6	Blast rock (FILL)		3	SS	9													
1.7	Auger refusal at 1.9 m depth, switched to NW casing.						256											
							255											
254.2	MAFIC INTRUSIVE (BEDROCK)						254											
4.1	Bedrock cored from 4.1 m depth to 7.3 m depth. For coring details see Record of Drillhole BH-VMS#15.		1	RC	REC 100%		253											RQD = 72%
			2	RC	REC 100%		252											RQD = 76%
251.0	END OF BOREHOLE						251											
7.3	Note: 1. Borehole dry upon completion of drilling. 2. Auger probes AP-E and AP-W: advanced 2.5 m east and 2.5 m west of borehole and encountered auger refusal at 1.5 m and 1.8 m, respectively, below ground surface.																	

SUD-MTO 001 1011910006.GPJ GAL-MISS.GDT 28/06/11 DATA INPUT:

PROJECT: 10-1191-0006

RECORD OF DRILLHOLE: BH-VMS#15

SHEET 1 OF 1

LOCATION: HWY 17 SUDBURY E.B.L.

DRILLING DATE: November 1, 2010

DATUM: GEODETIC

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Landcore Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	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.													NOTES WATER LEVELS INSTRUMENTATION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
							RECOVERY		FRACT. INDEX METRES	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY		Diameter Point Load Index (MPa)	RMC -Q AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
							TOTAL CORE %	SOLID CORE %		R.Q.D. %	B Angle	DIP w.r.t CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja			Jn	k, cm/s																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
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DEPTH SCALE

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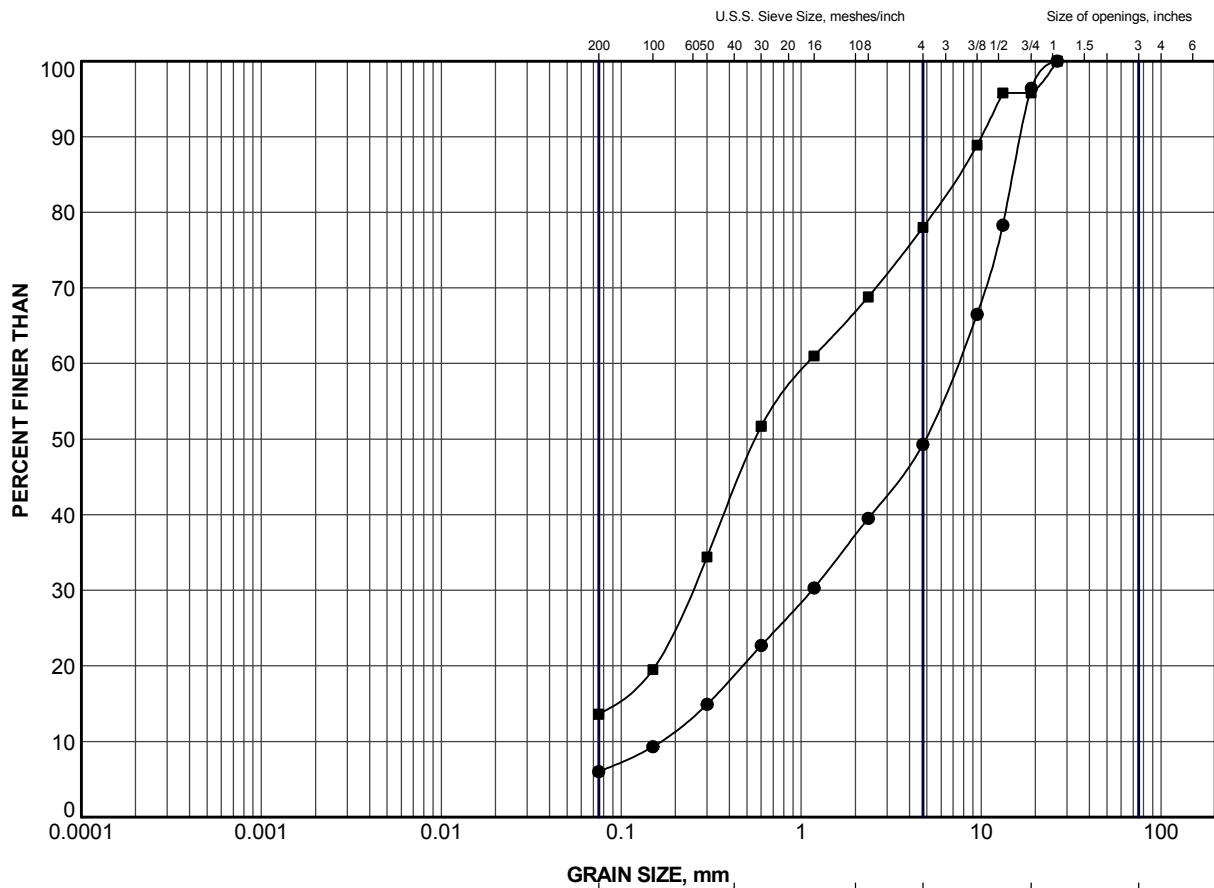
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APPENDIX B


Laboratory Test Results



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BH-VMS#15	1	257.9
■	BH-VMS#15	2	257.2

PROJECT					
HIGHWAY 17 EASTBOUND VMS #15					
TITLE					
GRAIN SIZE DISTRIBUTION					
SAND AND GRAVEL TO GRAVELLY SAND (FILL)					
PROJECT No.		10-1191-0006		FILE No. 1011910006.GPJ	
DRAWN	JJL	Jun 2011	SCALE	N/A	REV.
CHECK	AB	Jun 2011			
APPR		Jun 2011			
 Golder Associates SUDBURY, ONTARIO			FIGURE B-1		



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 VMS #15 Footing to raise the founding grade to the design level of the underside of the footing.

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.



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 904 (Concrete Structures). All reinforcing steel supplied shall be in accordance with OPSS 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 D3689-90 and ASTM 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.

Foundation	Number of Dowels for Performance Testing
Variable Message Sign #15	2 per foundation element

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 pint.

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 abutment and pier 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 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.



GRANULAR 'B' TYPE II – CHINKING OF ROCK FILL SURFACE

Special Provision

Scope

This special provision covers the requirements for all the labour, equipment, and material required for chinking the new top of rock fill following excavation for VMS #15.

Construction

Following rock fill excavation, the new top of rock fill shall be chinked with new Granular B Type II to the grade line specified elsewhere in the Contract Documents. The intention is to achieve a tight, compact, and level Granular B Type II surface that will prevent migration of granular material into the underlying and surrounding rock fill. The Contractor shall be responsible for selecting, placing and compaction system, or systems, suitable to achieve the required surface.

Following chinking of the new top of rock fill, the Contractor shall demonstrate the adequacy of the finished surface, in the presence of the Contract Administrator and the Quality Verification Engineer, by providing one hundred percent pass coverage of the chinked new top of rock fill surface by a minimum of four passes with vibratory smooth drum roller compaction equipment of a minimum operating dynamic force of 60 kilonewtons. Following the demonstration, the compacted surface shall still be within acceptable tolerances of the grade lines specified elsewhere in the Contract Documents.

Certificate of Conformance upon Completion of the Work

Upon completion of the work and prior to granular pad construction (specified elsewhere in the Contract Documents), the Contractor shall submit to the Contract Administrator a Certificate of Conformance sealed and signed by a Quality Verification Engineer. The Certificate shall state that the chinking of the new top of rock fill, as described herein, has been carried out in general conformance with the Contract Documents. The Quality Verification Engineer shall be licensed in the Province of Ontario and have a minimum of five years demonstrated experience in geotechnical or foundation engineering. The Certificate of Conformance shall be submitted to the Contract Administrator prior to the commencement of the construction of the sign footing.

Measurement for Payment

Measurement shall be by the tonne and the method of determining the weight of material for payment shall conform to OPSS 102.

Basis of Payment

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



ROCK FILL EXCAVATION (GRADING)

Special Provision

Scope

This special provision covers the requirements for all the labour, equipment, and material required for the excavation of rock fill from the existing road embankment for VMS #15..

Construction

Rock fill from the existing road embankment shall be excavated to the specified limits for the sign footing construction. Large rock particles protruding above the new top of rock fill design elevation shall be selectively removed, or broken, to provide an excavated surface free of any protrusions.

The Contractor shall be responsible for constructing an excavation without disturbing the sides or base of the excavation that could affect the performance of the roadway, including the provision of temporary roadway protection to allow for the construction of the sign footing at the design location.

Rock fragments larger than 1 m³ are anticipated during excavation.

Measurement for Payment

Measurement shall be by Plan Quantity as may be revised by Adjusted Plan Quantity, of the volume excavated in cubic metres.

Basis of Payment

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

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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