



FINAL REPORT

**Foundation Investigation and Design Report
Highway 129 - Vincent Creek Culvert Replacement
Structure No. 46-004C
Algoma District, Reaney Township
Ministry of Transportation, Ontario
GWP 411-00-00, WP 5291-13-01**

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PART A

FOUNDATION INVESTIGATION REPORT
HIGHWAY 129 - VINCENT CREEK CULVERT REPLACEMENT
STRUCTURE NO. 46-004C
ALGOMA DISTRICT, REANEY TOWNSHIP
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 411-00-00, WP 5291-13-01

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Parsons Corporation (Parsons) on behalf of Ministry of Transportation, Ontario (MTO) to provide foundation engineering services associated with the replacement of the Vincent Creek Culvert (Structure No. 46-004C). The Vincent Creek Culvert is located in the Algoma District on Highway 129, approximately 33.7 km South of the Highway 101 and Highway 129 junction in Reaney Township. The key plan showing the general location of this section of Highway 129 is shown on Drawing 1.

The Terms of Reference (TOR) and Scope of Work for the Foundation Investigation are outlined in MTO's Request for Proposal, dated June 2018. Golder's proposal for foundation engineering services associated with replacement of the Vincent Creek Culvert is contained in Section 17.8 of Parson's Technical Proposal for this assignment. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for foundations engineering services for this project, dated August, 2018.

2.0 SITE DESCRIPTION AND LOCAL GEOLOGY

In general, the topography of the site and surrounding area is undulating to rolling terrain beyond the creek. The area is surrounded by dense tree cover beyond the highway right-of-way.

Based on MTO's current General Arrangement (GA) dated March 2018, the existing culvert is a 20 m long, 3.6 m diameter corrugated steel pipe and the water level in the creek in September 2014 was reportedly at Elevation 442 m. Also based on MTO's GA, the existing culvert invert is approximately 441.4 m and 441.3 m at the west and east ends respectively. The existing embankment is about 4 m high relative to the creek bottom. Views at the culvert site are shown on Photographs 1 and 2, following the text of this report.

3.0 INVESTIGATION PROCEDURES

3.1 Previous Investigation

A foundation investigation was carried out at the Highway 129 Vincent Creek Culvert in 2015 by Peto MacCallum Ltd., (PML), GEOCRE 410-16, comprised of the drilling of four boreholes (VC-1 to VC-4), at the locations shown on Drawing 1. A copy of the previous investigation Borehole Location and Soil Strata drawing (Drawing VC-1), Record of Boreholes and laboratory testing plots are included in Appendix A. The borehole locations, ground surface elevations and borehole depths presented on the borehole records are summarized below.

Borehole Number	MTM NAD83 Northing	MTM NAD83 Easting	Ground Surface Elevation (m)	Borehole Depth (m)
VC-1	5263599.2	364112.7	444.0	11.3
VC-2	5263586.3	364114.4	445.5	13.0
VC-3	5263590.8	364123.7	445.4	13.0
VC-4	5263579.5	364124.9	443.6	8.2

3.2 Current Investigation

The field work for the current investigation was carried out between September 26 and 28, 2018, during which time two boreholes (BH-1 and BH-2) were advanced at the locations shown on Drawing 1.

The boreholes were advanced from the existing roadway platform using a truck mount drill rig supplied and operated by Landcore Drilling (Landcore) of Chelmsford, Ontario. Traffic control was performed by Leroy Construction of Blind River, Ontario. All traffic control was performed in accordance with the Ontario Traffic Control Manual Book 7 – Temporary Conditions. The boreholes were advanced using NW casing and wash boring techniques. Where coring through cobbles and boulders or bedrock was required, an NQ-size core barrel was used. Soil samples were obtained at intervals of depth of about 0.75 m and 1.5 m, using a 50 mm outer diameter split-spoon sampler operated by an automatic hammer, in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586). The groundwater level in the open boreholes was observed during the drilling operations as described on the borehole records in Appendix B. The boreholes were backfilled upon completion in accordance with Ontario Regulation 903 Wells (as amended).

The field work for this investigation was supervised on a full-time basis by a member of Golder's staff, who located the boreholes in the field, cleared the site for buried services, directed the drilling and sampling operations, and logged the boreholes. The soil samples were identified in the field, placed in labelled containers, and transported to Golder's Sudbury Laboratory for further examination and laboratory testing. Laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Index and classification tests consisting of water content and grain size distribution were carried out on selected soil samples. An unconfined compression (UC) strength test was carried out on a specimen of the bedrock core obtained in Borehole BH-1.

The degree of weathering of the bedrock samples (i.e., fresh to slightly weathered) and the strength classification of the intact rock mass based on field identification (i.e., strong to very strong) are described in accordance with Table B.3 and Table B.6, respectively, of the International Society for Rock Mechanics (ISRM¹) standard classification system. Classification of the rock mass quality of the bedrock with respect to the Rock Quality Designation (RQD) and Uniaxial Compressive Strength are described based on Table 3.10 and Table 3.5, respectively, of the Canadian Foundation Engineering Manual (CFEM, 2006²).

The borehole locations and elevations for this investigation were measured and surveyed by a member of our technical staff, referenced to the intersection of the centerline of Highway 129 and centerline of the culvert. The borehole locations (referenced to the MTM NAD83, Zone 13 co-ordinate system), ground surface elevations (referenced to Geodetic datum) and borehole depths are presented on the borehole records in Appendix B, and summarized below.

¹ International Society for Rock Mechanics Commission on Test Methods, 1985. Int. J. Rock Mech. Min. Sci. & Geomech. Abstr. Vol 22, No. 2, pp. 51-60.

² Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual, 4th Edition.

Borehole Number	MTM NAD83 Northing (Latitude)	MTM NAD83 Easting (Longitude)	Ground Surface Elevation (m)	Borehole Depth (m)
BH-1	5263576.5 (47.508701)	364116.1 (-83.212514)	445.4	18.3*
BH-2	5263600.4 (47.508915)	364122.0 (-83.212432)	445.3	15.4

* Includes 3.1 m of bedrock core

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

Based on Northern Ontario Engineering Geology Terrain Study (NOEGTS)³ mapping, the Vincent Creek Culvert site is located within an outwash plain, valley train deposit consisting primarily of sand and gravel.

Based on geological mapping by the Ontario Ministry of Northern Development and Mines (MNDM)⁴, the site is underlain by gneissic tonalite suite with minor supracrustal inclusions of the Superior Province.

4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions as encountered in the boreholes from the previous investigation, together with the results of in situ and laboratory testing are given on the Record of Borehole sheets contained in Appendix A. The detailed subsurface soil and groundwater conditions as encountered in the boreholes from the current investigation, together with the results of in situ and laboratory testing are given on the Record of Borehole sheets contained in Appendix B. The detailed results of the geotechnical laboratory testing for the previous investigation are contained in Appendix A and for the current investigation are combined in Appendix C. The results of the in-situ field tests (i.e., SPT 'N' values) as presented on the Record of Borehole sheets for the current investigation and in Section 4.2 are uncorrected. The stratigraphic boundaries shown on the Record of Borehole sheets and on the interpreted stratigraphic profile shown on Drawings 1 and VC-1 (in Appendix A) are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsurface conditions will vary between and beyond the borehole locations. A summary of the subsurface conditions encountered in the boreholes advanced for the current and previous investigations is presented below.

³ Ontario Ministry of Natural Resources and Forestry. Northern Ontario Engineering Geology Terrain Study. Ontario Geological Society Electronic Mapping. Map 410NW

⁴ Ontario Ministry of Northern Development and Mines. Bedrock Geology of Ontario – East Central Sheet, Ontario Geological Survey – Map 2543

4.2.1 Soil Conditions

Deposit/Layer Description	Boreholes	Deposit Surface Elevation (m)	Deposit Thickness (m)	SPT N Values (Blows), Su Vanes (kPa)	Laboratory Testing
				Compactness Condition/ Consistency	
(FILL) Asphalt over Sand and Gravel	VC-2, VC-3, BH-1, and BH-2	445.5 to 445.3	0.2 to 2.3	16 - 84, 39/0.15	n/a
				Compact	
(ROCK FILL) Cobble and Boulder Sizes	VC-2 , VC-3, BH-1, and BH-2	445.3 to 443.0	1.5 to 1.9	n/a, 27	n/a
				Compact	
(FILL) Sandy Gravel	BH-2	441.5	0.8	1	n/a
				Very Loose	
PEAT (fibrous/amorphous)	VC-1, VC-4 and BH-2	443.8, 443.6 and 440.7	0.1 to 0.9	n/a, WH	w = 20% and 852%
				Very Soft	
Sand to Silty Sand, layers of peat	VC-1 to VC-4	443.7 to 442.8	3.2 to 3.8	WH to 37	w = 20% to 83% and 223% 1-MH (Fig. VC-GS-1 in App. A)
				Very Loose to Dense	
SILT to CLAYEY SILT to CLAYEY SILT with Sand	VC-1 to VC-4, and BH-2	440.3 to 439.0	1.4 to 2.1	WH to 13, Su = 12 kPa to 65 kPa	w = 19% - 42% 4-MH (Fig. VC-GS-2 in App. A) 4-ATT (Fig. C2 and Fig. VC-PC-1 in App. A) w _i = 20% - 29% w _p = 15% - 17% I _p = 5% - 12%
				Very Soft to Stiff	

Deposit/Layer Description	Boreholes	Deposit Surface Elevation (m)	Deposit Thickness (m)	SPT N Values (Blows), Su Vanes (kPa)	Laboratory Testing
				Compactness Condition/ Consistency	
Sandy SILT to SAND	VC-1 to VC-4, BH-1 and BH-2	442.4 to 437.6	>2.9 (VC-1 to VC-4 terminated in this deposit) to 10.3	2 – 32 Very Loose to Dense	w = 15% - 24% 8-MH (Fig. C2 and Fig. VC-GS-3 in App. A) 1-M (Fig. C2)
SAND and GRAVEL and COBBLES	BH-1 & BH-2	432.0 & 431.6	1.8 & 1.7 (BH-2 terminated in this deposit)	24 – 26/0.05 Compact to Very Dense	n/a

Where:

N = SPT 'N'-value; number of blows for 0.3 m of penetration

S_u = Undrained Shear Strength (kPa)

w = Natural Moisture Content (%)

MH = Combined sieve and hydrometer analysis

ATT = Atterberg Limits Testing

w_p = Plastic Limit (%)w_L = Liquid Limit (%)I_p = Plasticity Index (%)

4.2.2 Bedrock/Refusal

Bedrock was cored in Borehole BH-1 and the depth/elevation of the actual/inferred bedrock surface is presented below. Refusal to further split spoon advancement was encountered on inferred bedrock in Borehole BH-2.

Borehole No.	Depth to Bedrock Surface (Below Ground Surface) (m)	Bedrock Surface Elevation (Inferred) (m)	Refusal Condition (m)
BH-1	15.2	430.2	3.1 m length of bedrock core
BH-2	15.4	(429.9)	Split-Spoon

The retrieved bedrock core from Borehole BH-1 is described as fresh, fine to medium grained, grey gneiss. More detailed descriptions of the bedrock core are presented on the Record of Drillhole BH-1 in Appendix B, including data regarding the discontinuity frequency and type. A photograph of the bedrock core samples is shown on Figure C3 in Appendix C. The bedrock properties, as encountered in the cored borehole and the result of an unconfined compression (UC) test on a specimen of the bedrock core are summarized below. The detailed results of the UC test are presented in Table C1 in Appendix C.

Borehole No.	Total Core Recovery (TCR)	Rock Quality Designation (RQD)	Quality Classification (Table 3.10 of CFEM 2006 ⁵)	UCS (MPa)	Strength Classification (Table 3.5 of CFEM 2006 ³)
BH-1	100%	90% - 100%	Excellent	196	(R5) Very Strong

4.2.3 Groundwater Conditions

The unstabilized groundwater levels presented on the borehole records upon completion of drilling are summarized below; however, these are not considered representative of stabilized in situ groundwater conditions. Groundwater levels in the area are subject to seasonal fluctuations and variations due to precipitation events.

Borehole No.	Depth to Unstabilized Groundwater Level (m)	Approximate Groundwater Elevation (m)
VC-1	0.7 (0.9*)	443.1
VC-2	2.0	443.5
VC-3	5.2	440.2
VC-4	0.8	442.8
BH-1	1.4	444.0
BH-2	1.3	444.0

* Below ice surface

5.0 CLOSURE

The field drilling program was carried out under the supervision of Ms. Kirsten Janssen, EIT. This Foundation Investigation Report was prepared by Ms. Kirsten Janssen, EIT, and the technical aspects were reviewed by Mr. André Bom, P.Eng., a geotechnical engineer and Associate of Golder. Mr. Jorge M.A. Costa, P.Eng., an MTO Foundations Designated Contact and Senior Consultant for Golder, conducted an independent quality control review and technical audit of this report.

⁵ Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual, 4th Edition.

Signature Page

Golder Associates Ltd.

Kjanssen

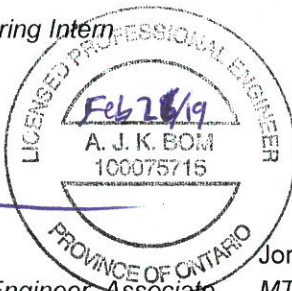
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PART B

FOUNDATION DESIGN REPORT
HIGHWAY 129 - VINCENT CREEK CULVERT REPLACEMENT
STRUCTURE NO. 46-004C
ALGOMA DISTRICT, REANEY TOWNSHIP
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 411-00-00, WP 5291-13-01

6.0 DISCUSSIONS AND ENGINEERING RECOMMENDATIONS

This section of the report provides foundation engineering design recommendations in support of the proposed replacement of the existing Vincent Creek Culvert (Structure No. 46-004C). These recommendations are based on interpretation of the factual data obtained from the boreholes advanced during the current subsurface investigation. The discussion and recommendations presented are intended to provide the designer with sufficient information to assess feasible foundation alternatives and to design the proposed replacement culvert. The Foundation Investigation Report (FIR), discussion and recommendations are intended for the use of the Ministry of Transportation, Ontario (MTO) and shall not be used or relied upon for any other purpose or by any other parties, including the construction or design-build contractor. The contractor must make their own interpretation based on the factual data in Part A (Foundation Investigation) of the report. Where comments are made on construction, they are provided to highlight those aspects that could affect the design of the project, and for which special provisions may be required in the Contract Documents. Those requiring information on the aspects of construction must make their own interpretation of the factual information provided as such interpretation may affect equipment selection, proposed construction methods, scheduling and the like.

6.1 General

Golder Associates Ltd. (Golder) has been retained by Parsons Corporation (Parsons) to provide foundation engineering recommendations on the foundation aspects for the design of the replacement of Vincent Creek Culvert. The replacement works will also require temporary protection systems, and likely widening of the existing embankment along one or both sides of the roadway, traffic staging and to maintain stability of the existing roadway embankment during replacement of the culvert. It is anticipated that traffic flow will be reduced to one lane in the vicinity of the culvert during replacement operations.

Based on the General Arrangement (GA) drawing dated December 2018 as prepared by MTO provided to us by Parsons on January 8, 2019, excavations will be required to expose the native subgrade at approximately Elevation 440.5 m (for proposed inverts at Elevation 441.1 m and 441.0 m), about 5 m below the existing roadway surface. The existing 20 m long and 3.6 m diameter CSP culvert will be replaced with a 24.4 m long, 3.6 m wide and 3 m high precast box culvert founded on 300 mm thick granular bedding, which we understand was specified by Peto MacCallum Ltd. (PML, GEOCRETS 410-16). Golder's Scope of Work consists of providing foundation recommendations for the culvert replacement and parameters for the contractor's design of temporary protection system(s). We note that upon review of a preliminary GA prepared by MTO, the culvert bedding specified is to consist of clear stone. As discussed further in Section 6.3, we recommend that consideration be given to the use of OPSS.PROV 1010 (Aggregates) Granular B Type II as bedding in lieu of clear stone due to concerns for fines from the surrounding native soil potentially migrating into the clear stone, unless an appropriate geotextile fully envelops the clear stone bedding layer. Further, consideration could be given to specifying a clear stone gradation of 9.5 mm nominal maximum size as specified in OPSS.PROV 1004 (Aggregates – Miscellaneous).

In order to provide foundation recommendations for detail design of the culvert replacement, Golder has relied on the subsurface information gathered by PML as presented in the Record of Boreholes VC-1 to VC-4.

6.2 Consequence and Site Understanding Classification

The replacement culvert is being designed in accordance with the current Canadian Highway Bridge Design Code CAN/CSA-S6-14 (CHBDC 2014).

In accordance with Section 6.5 of CHBDC (2014) and its Commentary, the proposed culvert and its foundation system are considered to be classified as having a "typical consequence level" associated with exceeding limits states design. This consequence classification should be confirmed by MTO. In addition, given the level of foundation investigation completed at the site, the degree of site and model understanding is considered "typical" as described in Clause 6.5.3.2 of CHBDC (2014). Accordingly, the appropriate corresponding ultimate limit states (ULS) and serviceability limit states (SLS) consequence factors (Ψ), and geotechnical resistance factors at ULS (ϕ_{gu}) and SLS (ϕ_{gs}), from Tables 6.1 and 6.2, respectively, of the CHBDC have been used for design in this report.

6.3 Culvert Foundation Design Recommendations

Prior to placing the bedding/levelling course for the replacement culvert, it is recommended that all organic material, existing fill and very soft to soft clay encountered below the culvert footprint at subgrade elevation be sub-excavated and replaced with Ontario Provincial Standard Specification, Provincial Oriented (OPSS.PROV) 1010 (Aggregates) Granular 'B' Type II, which is suitable for placement/use in wet ground conditions. The subgrade should be inspected following sub-excavation to ensure that all organics and other unsuitable materials have been removed and an OPSS.PROV 1860 (Geotextiles) Class II non-woven geotextile, with a Filtration Opening Size not greater than 150 μm should be placed between the granular bedding material and the native subgrade as a separation layer under the full extent (area) of the new box culvert.

As discussed with Parsons and MTO at the Design Complete Presentation on January 31, 2019, it is recommended that sub-excavation to at least 1.2 m below the base of the culvert be completed within the footprint of the widening beyond the existing embankment toe and the sub-excavated area be backfilled with OPSS.PROV 1010 (Aggregates) Granular 'B' Type II to improve the foundation conditions below the culvert. The sub-excavation and backfilling to 1.2 m depth should extend horizontally at least 1 m beyond the outside edges of the proposed culvert.

For the 3.6 m wide box culvert constructed on a 500 mm thick layer of OPSS.PROV 1010 (Aggregates) Granular B Type II bedding within the footprint of the existing embankment footprint and 1.2 m thick layer of backfill comprised of Granular B Type II bedding beyond the footprint of the existing embankment (i.e. sub-excavated area under the proposed culvert), a factored ultimate geotechnical resistance at ULS of 105 kPa may be used in design. It is understood from the MTO Structural Office that an SLS value of 73 kPa extending from crest to crest across the top of the new embankment (i.e. between the TCBs), reducing to a load of 50 kPa along the portions of the exposed culvert extruding beyond the side slopes of the embankment, is required. Based on the loading conditions, the subsurface conditions at the site, and considering similar loading components (i.e. in terms of loadings from embankment fill, culvert, traffic and water) acting on the original culvert and embankment, it is estimated that a maximum total (factored) settlement of about 65 mm will occur below the east widening, a total (factored) settlement of about 48 mm will occur below the west widening (i.e. due to slope flattening), and a total (factored) settlement of about 15 mm will occur below the centerline of the roadway embankment. This results in an estimated maximum differential settlement of about 50 mm that will have to be accommodated in the structural design of the culvert. It is understood from the MTO Structural Office that this differential settlement will be

mitigated by a distribution slab to be constructed over the culvert. The loading stress conditions and estimated factored settlement profile along the new culvert centerline are presented on Figure 1.

The loading on the foundation soils below the culvert and the associated settlement at the culvert location will be impacted by loading from the embankment fill immediately adjacent to the culvert. The factored geotechnical serviceability resistance provided above assumes there will not be a permanent grade raise at the culvert location. However, as an approximately 1.6 m temporary widening of the existing embankment is proposed in the culvert area for traffic staging purposes, some settlement of the widened embankment fill zone should be expected given the presence of the very soft to soft clayey silt deposit in the culvert end areas as encountered in Boreholes VC-1 and VC-4. An assessment of stability and settlement of the embankment widening fill zone(s) is presented in Section 6.4.

Provided that the box culvert is tolerant of small magnitudes of movement related to freeze-thaw cycles, the culvert can be founded above the depth of frost penetration, which is 2.4 m at this site as interpreted from OPSD 3090.100 (Foundation Frost Protection Depths for Northern Ontario).

Resistance to lateral forces (sliding resistance) should be calculated in accordance with Section 6.10.5 of CHBDC (2014), applying the appropriate consequence and degree of site understanding factors as noted above in Section 6.2. A coefficient of friction, $\tan \delta'_i$, of 0.45 may be used at the interface between the base of the box culvert and the granular bedding. In the event that clear stone bedding is utilized as originally proposed by MTO, it should be encapsulated in a geotextile surround as described above, in which case $\tan \delta'_i$ of 0.25 between the geotextile and the precast box culvert section should be used in the assessment of lateral resistance. It is recommended however that a leveling course of Granular 'A' or OPSS.PROV 1002 (Aggregates-Concrete) Concrete Fine Aggregate be included between the geotextile encapsulated clear stone and the pre-cast culvert (box) in which case a coefficient of friction equal to 0.45 may be used in assessing resistance to lateral forces.

The culvert should be constructed consistent with elements shown on OPSD 803.010 (Backfill and Cover for Concrete Culverts) and in accordance with OPSS 422 (Precast Reinforced Concrete Box Culverts).

6.4 Embankment Stability

The proposed reconstructed embankment adjacent to the culvert is about 4 m high relative to the creek bottom and is stable from a geotechnical perspective if reconstructed of granular material at an inclination of 2 horizontal to 1 vertical (2H:1V). Backfill placement for the reconstruction of the roadway embankment(s) along and over the culvert should be carried out as per OPSD 208.010 (Benching of Earth Slopes) to integrate the existing embankment fill and new fill along the cut faces.

It is understood from Parsons that a grade raise of the existing embankment(s) is not proposed in the area of the replaced culvert (except for 60 mm for pavement purposes). However, it is also understood that a temporary 1.6 m widening of the existing embankment may be required on the east portion of the embankment in Stage 2 to facilitate traffic staging. Slope stability analyses were carried out to verify that the temporary widened zone is stable in the short term as required by the CHBDC (2014) (i.e. Factor of Safety (FoS) > 1.2 – adopting a “low” consequence level factor for the short-term condition). The results of the analysis indicate that a FoS greater than 1.3 is obtained for a 1.6 m widening zone at 2H:1V slope inclination utilizing either granular fill or rock fill material for slope widening, as shown in Figure 2, thus satisfying the short term condition.

As discussed with Parsons, the stability analysis for the temporary widening assumes that the creek bed at the east end of the culvert is not lower than the proposed culvert invert (at Elevation 441.1 m to 441.0 m). If the creek bottom is lower than the culvert invert, filling-in the creek to the proposed culvert invert should be completed in advance of regrading; however, this will need to be considered from an environmental perspective.

6.5 Excavations and Temporary Cut Slopes

The proposed works will require excavations through the embankment fill to/into the native subgrade in order to replace the existing culvert. Depending on the creek water level at the time of construction works, and as the excavation will extend to about Elevation 440.5 m which is about 1.5 m below the creek water level as measured in September 2014 (i.e. at Elevation 442 m), groundwater will likely be encountered in the excavation. The groundwater level will be subject to fluctuations and the depth of excavation below the groundwater will depend on the time of year of construction. Also, perched groundwater may be present within the granular fill deposits. Surface water runoff and seepage from the granular fill/native soil strata into the excavations should be expected and will be greater during periods of sustained precipitation. Unwatering by properly filtered sumps located at the base of the excavations will be required to provide groundwater control, but these should be located outside of the actual excavation limits required for the culvert replacement works. Surface water runoff should be directed away from the excavations at all times. Unwatering of all excavations should be carried out in accordance with OPSS.PROV 517 (Dewatering), as modified by Special Provision (SP) FOUN0003 (Unwatering of Structure Excavation). An example of FOUN0003 is included in Appendix D with the specific fill-in completed for Section 902.04.02.01. A Notice to Contractor should be included in the Contract Documents to alert the contractor to the potential for surface water runoff and groundwater seepage conditions and that the excavation must be unwatered and the side walls and base kept stable during construction; an example Notice to Contractor is included in Appendix D.

All excavations should be carried out in accordance with the latest edition of the Ontario *Occupational Health and Safety Act* and Regulations for Construction Projects. The existing embankment fill and native soils are classified as Type 3 soils above the groundwater level and Type 4 soils below the groundwater level. Open cut excavation side slopes in the existing embankment fill (i.e., sand and gravel, sandy gravel) should remain stable during construction if the temporary side slopes are cut back no steeper than 1 Horizontal to 1 Vertical (1H:1V) above the groundwater level; the excavation slopes should be flattened to 3H:1V below the groundwater level. While the Rock Fill zone of the roadway embankment may be stable at steeper cut slopes than the soil zones, we recommend that the Rock Fill zone also be cut at slopes no steeper than 1H:1V.

During construction, stockpiles should be placed at a distance away from the edge of the excavation not less than 1.5 times the depth of excavation, and their heights should be controlled to prevent surcharging the sides of the excavation and/or overall slope.

As the temporary open cut excavations required to allow for culvert replacement works to be carried out are expected to be of limited depth (to about 5 m) there are no expected issues with stability of the reconstructed portion of the embankment side slopes at an inclination of 2H:1V, nor with reconstruction of the fill portion of the roadway. The embankment fill open cut slopes parallel to the culvert walls should be cut consistent with OPSD 208.010 (Benching of Earth Slopes) at the time of backfilling to integrate the new backfill into the existing roadway fill.

6.6 Temporary Roadway Protection

Due to the presence of a zone of 1.5 m to 1.7 m thick cobble and boulder size Rock Fill within the roadway embankment, as encountered in Boreholes BH-1 and BH-2, a temporary protection system consisting of steel sheet piling is not anticipated to be feasible at this site. The temporary protection system will likely have to consist of soldier piles and lagging where the H-piles would be placed in pre-bored holes to a suitable depth and horizontal lagging installed as the excavation proceeds. Support to the system could be in the form of struts and wales or rakers and anchors.

The Contractor is responsible for the complete detailed design of the temporary protection system. The temporary protection systems should be designed and constructed in accordance with OPSS.PROV 539 (Temporary Protection Systems), to Performance Level 2 for any excavation adjacent to the existing roadway. Design of the temporary system should include an evaluation of base stability, soil squeezing stability and hydraulic uplift stability as defined in the Canadian Foundation Engineering Manual (CFEM 2006).

The temporary protection system may be designed using the following parameters:

Soil Type	Unit Weight	Internal Angle of Friction	Undrained Shear Strength	Coefficient of Earth Pressure ¹		
	(kN/m ³)	(ϕ , degrees)	(Su, kPa)	Active K _a	At Rest K _o	Passive K _p ²
Existing Granular Embankment Fill (Compact to Dense)	20	30	-	0.33	0.50	3.00
Cobbles and Boulders (Rock Fill)	19	40	-	0.22	0.36	4.56
Peat (Amorphous)	12	27	1	0.38	0.55	2.64
Clayey Silt	16	-	45	-	-	-
Sandy Silt to Sand (Very Loose to Compact)	18	29	-	0.35	0.52	2.85
Sand and Gravel (Dense to Very Dense)	20	32	-	0.31	0.47	3.26

1. The lateral earth pressure coefficients noted above are based on a horizontal surface adjacent to the excavation. If sloped surfaces are present, the coefficient of earth pressure should be adjusted accordingly.
2. The total passive resistance below the base of the excavation (i.e., within and/or adjacent to the temporary protection system) may be calculated based on the values of K_p indicated above but reduced by an appropriate factor that considers the allowable wall movement in accordance with Figure C6.16 of the CHBDC (2014) to account for the fact that a large strain would be required for mobilization of the full passive resistance.

Consideration should be given to the risk of potentially inducing additional settlement in the foundation soils (and along the culvert) due to vibrations associated with the removal of the sheet pile cofferdam. Considering the laboratory index testing available for the site in comparison to the guidelines for the susceptibility of fine grained soils to liquefaction/softening (as presented in Figure 6.15 of the Canadian Foundation Engineering Manual, 4th Edition), it is recommended that the sheet pile cofferdam not be removed following construction but be left in-place and cutoff in accordance with OPSS.PROV 539 as required by the NSSP – Sheet Piles Remaining in Place. A sample NSSP is included in Appendix D.

6.7 Obstructions

The Contractor should be alerted to the presence of cobble and boulder size Rock Fill within the embankment fill at this site as inferred from augers grinding and split-spoon refusal and as encountered by coring in Boreholes BH-1 and BH-2. It should be noted that the extent/depth of the cobble and boulder obstructions may vary beyond and between the borehole locations. A sample NSSP is included in Appendix D.

7.0 CLOSURE

This Foundation Design Report was prepared by Ms. Kirsten Janssen, EIT, and the technical aspects were reviewed by Mr. André Bom, P.Eng., a geotechnical engineer and Associate of Golder. Mr. Jorge M.A. Costa, P.Eng., an MTO Foundation Designated Contact and Senior Consultant of Golder, conducted an independent quality control review and technical audit of this report.

Signature Page

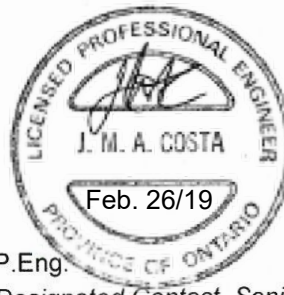
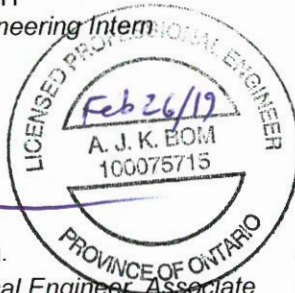
Golder Associates Ltd.

KJanssen

Kirsten Janssen, EIT
Geotechnical Engineering Intern

Andre Bom

Andre Bom, P.Eng.
Senior Geotechnical Engineer, Associate



Jorge M.A. Costa, P.Eng.
MTO Foundations Designated Contact, Senior Consultant

KJ/AB/JMAC/sb

[https://golderassociates.sharepoint.com/sites/29404g/deliverables/foundations-vincent creek/3-final february xx, 2019/18104216-r-rev0-parsons vincent creek fidr 26feb_19.docx](https://golderassociates.sharepoint.com/sites/29404g/deliverables/foundations-vincent%20creek/3-final%20february%20xx,%202019/18104216-r-rev0-parsons%20vincent%20creek%20fidr%2026feb_19.docx)

REFERENCES

ASTM International: ASTM D1586 Standard Test Method for Standard Penetration Test and Split-Barrel Sampling of Soils

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

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

Ministry of Natural Resources. Northern Ontario Engineering Geology Terrain Study. Ontario Geological Society Electronic Mapping. Map 41LNW

Ministry of Northern Development of Mines. Bedrock Geology of Ontario – East Central Sheet, Ontario Geological Survey – Map 2543

Ministry of Transportation (2014). Ontario Traffic Manual Book 7 – Temporary Conditions, Queen's Printer for Ontario. ISBN 978-1-4606-3505-6.

Occupational Health and Safety Act and Regulation for Construction Projects (as amended)

Ontario Provincial Standard Specifications (OPSS) – Provincial Oriented

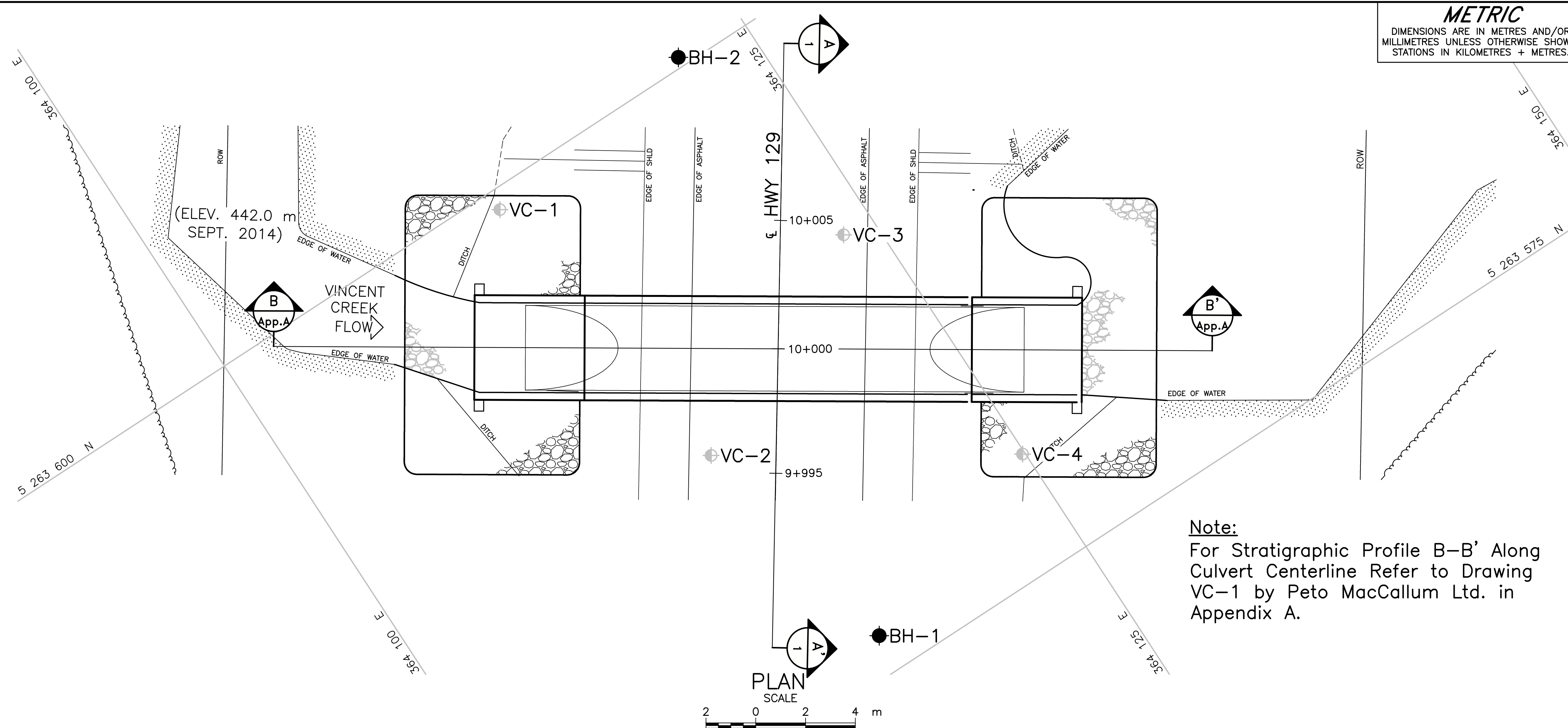
OPSS.PROV 422	Construction Specification for Precast Reinforced Concrete Box Culverts in Open Cut
OPSS.PROV 517	Construction Specification for Dewatering
OPSS.PROV 539	Construction Specification for Temporary Protection Systems
OPSS.PROV 1002	Material Specification for Aggregates – Concrete
OPSS.PROV 1004	Material Specification for Aggregates – Miscellaneous
OPSS.PROV 1010	Material Specification for Aggregates – Base, Subbase, Select Subgrade and Backfill Material
OPSS.PROV 1860	Material Specification for Geotextiles

Ontario Provincial Standard Drawings (OPSD)

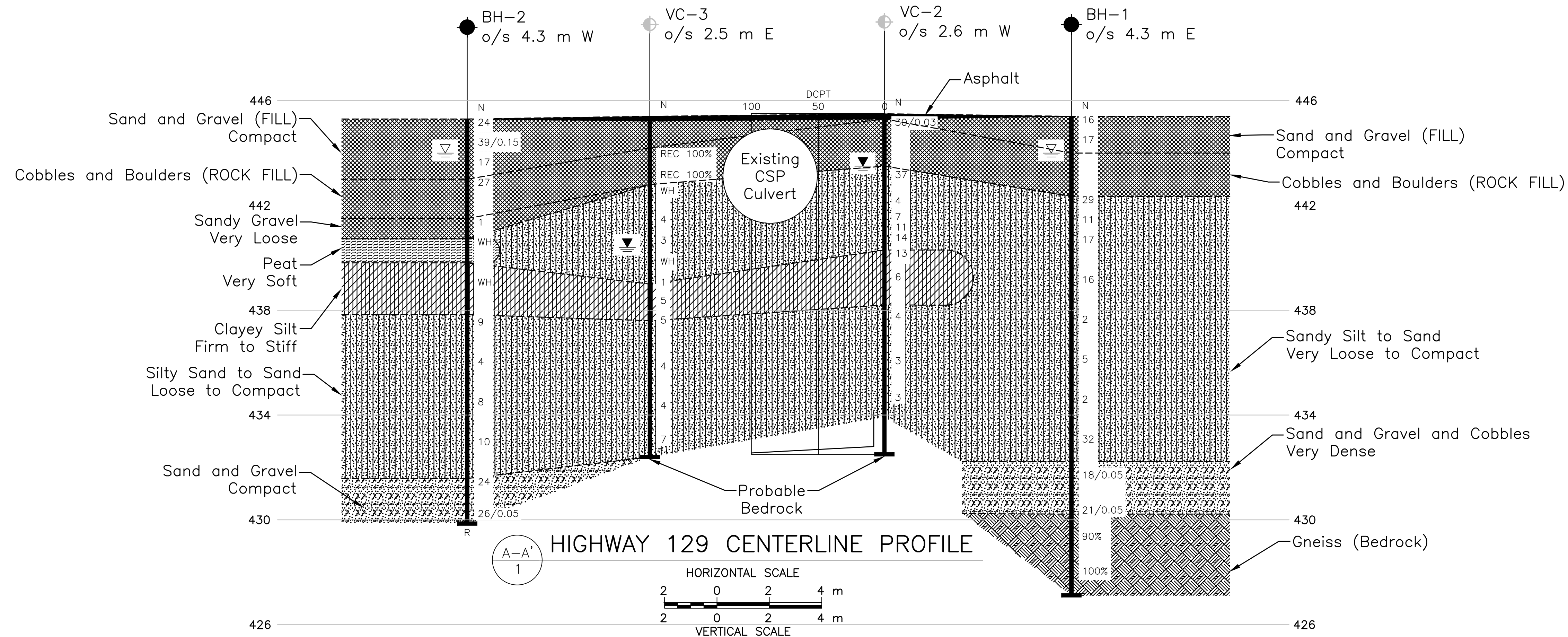
OPSD 208.010	Benching of Earth Slopes
OPSD 803.010	Backfill and Cover for Concrete Culverts
OPSD 3090.100	Foundation Frost Penetration Depths for Northern Ontario

Ontario Water Resource Act: Regulation 903 Wells (as amended)

Peto MacCallum Ltd. 2016, Preliminary Foundation Investigation and Design, GEOCREs No. 41O-16.



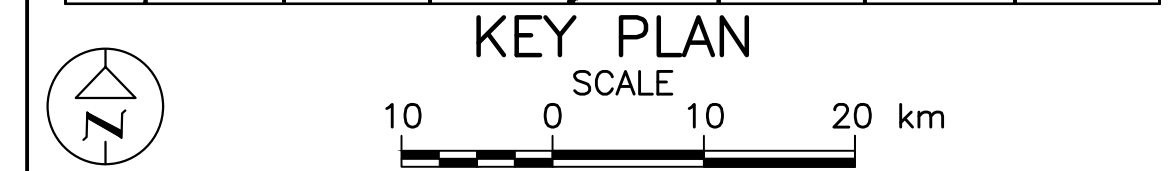
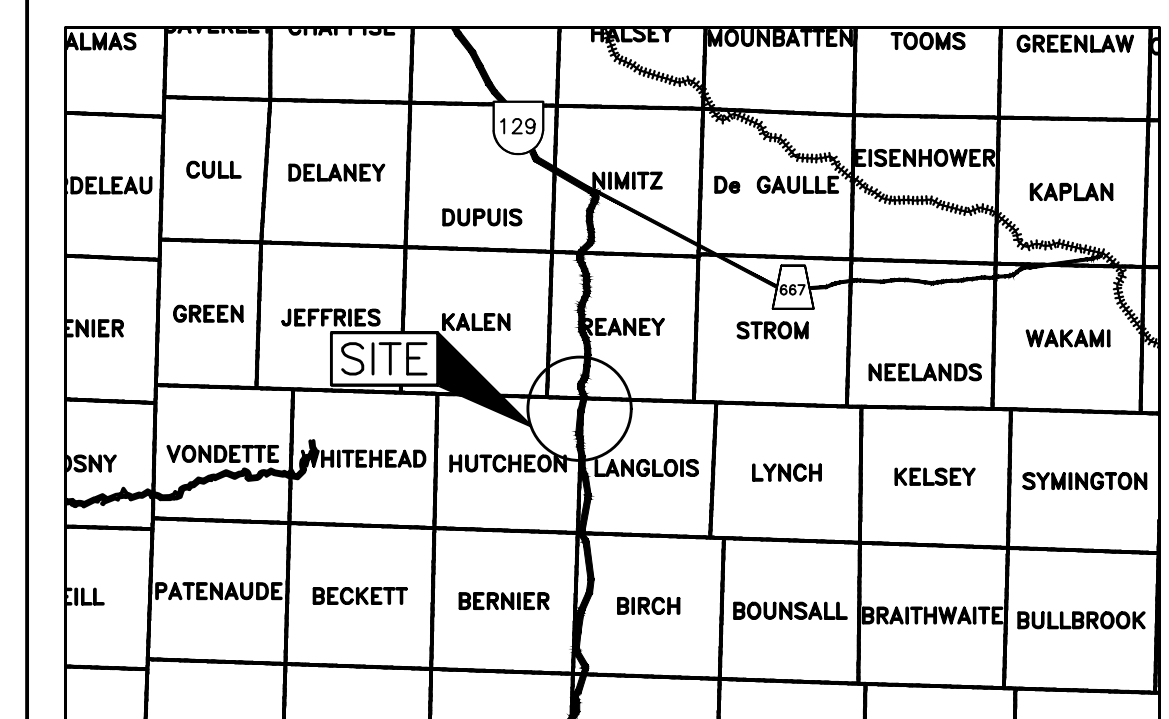
Note:
For Stratigraphic Profile B-B' Along
Culvert Centerline Refer to Drawing
VC-1 by Peto MacCallum Ltd. in
Appendix A.



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

CONT No.
WP No. 5291-13-01

HIGHWAY 129
VINCENT CREEK CULVERT
BOREHOLE LOCATIONS AND SOIL
STRATA



LEGEND

- Borehole - Current Investigation
- ⊕ Borehole - Previous Investigation 1
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- REC Recovery (%)
- R Refusal
- ▽ WL in piezometer, measured on MMM DD, YYYY
- ≡ WL upon completion of drilling

BOREHOLE CO-ORDINATES (NAD83 MTM ZONE 13)

No.	ELEVATION	NORTHING	EASTING
BH-1	445.4	5263576.5	364116.1
BH-2	445.3	5263600.4	364122.0
VC-1	444.0	5263599.2	364112.7
VC-2	445.5	5263586.3	364114.4
VC-3	445.4	5263590.8	364123.7
VC-4	443.6	5263579.5	364124.9



NOTES

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

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

REFERENCE

Base plans provided in digital format by MTO, drawing file nos. WP 5291-13-01 Site 46-004C - Vincent.dwg, received Oct 16, 2018.

NO.	DATE	BY	REVISION
1	2/14/2019	JMAC	Initial Design
2	2/14/2019	JMAC	Revised Design
3	2/14/2019	JMAC	Final Design

Geocres No. 410-037

HWY. 129	PROJECT NO. 18104216	DIST.
SUBM'D.	CHKD. KJ	DATE: 2/14/2019
DRAWN: TR	CHKD. AB	APPD. JMAC
		SITE: 46-004/C
		DWG. 1



Photograph 1: Vincent Creek Culvert – Hwy 129 – Reaney Twp., Outlet Facing South (taken September 26, 2018)

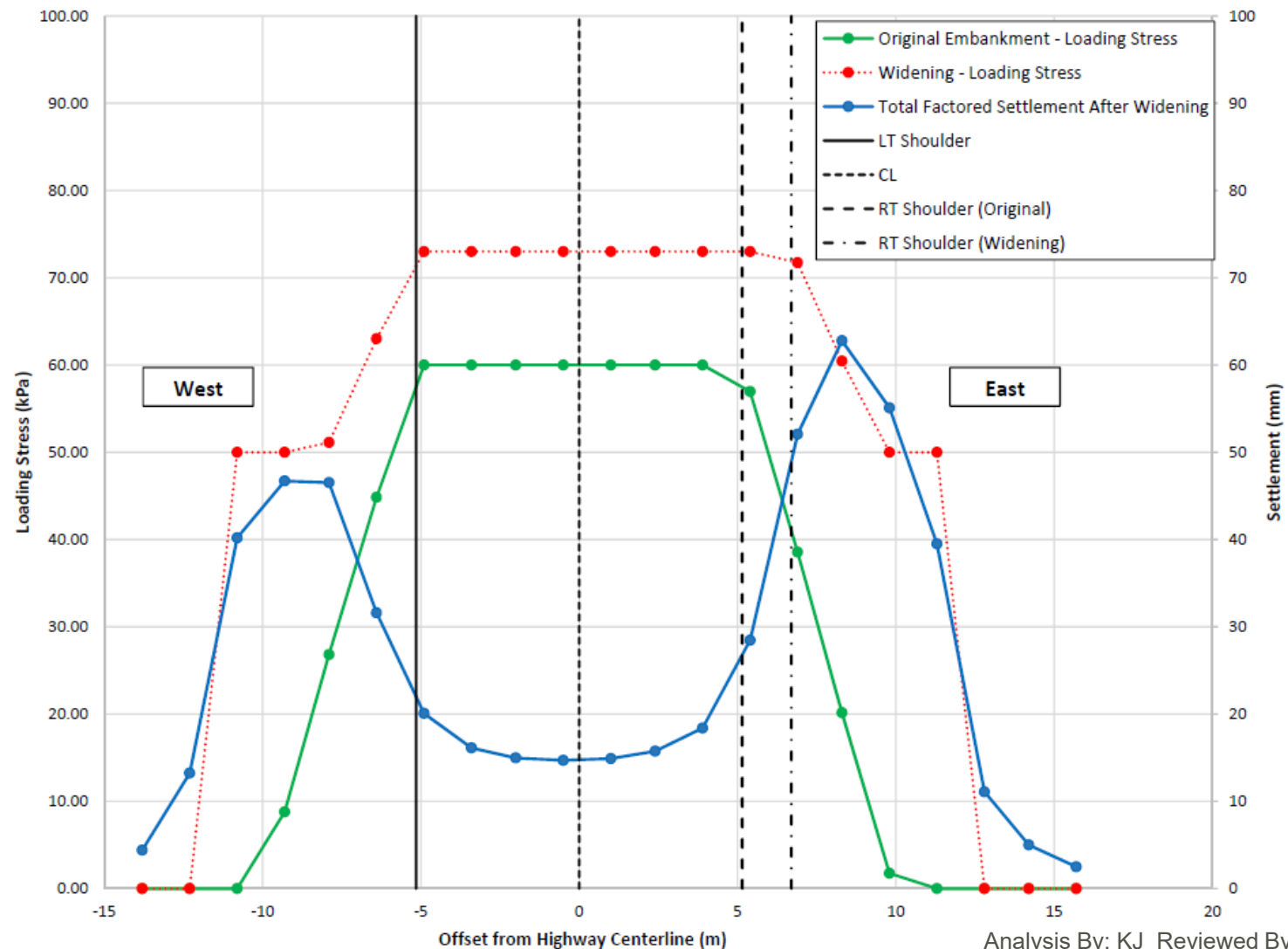


Photograph 2: Vincent Creek Culvert – Hwy 129 – Reaney Twp., Inlet Facing South (taken September 26, 2018)

Settlement Profile

Figure 1

18104216 – VINCENT CREEK CULVERT SETTLEMENT ANALYSIS

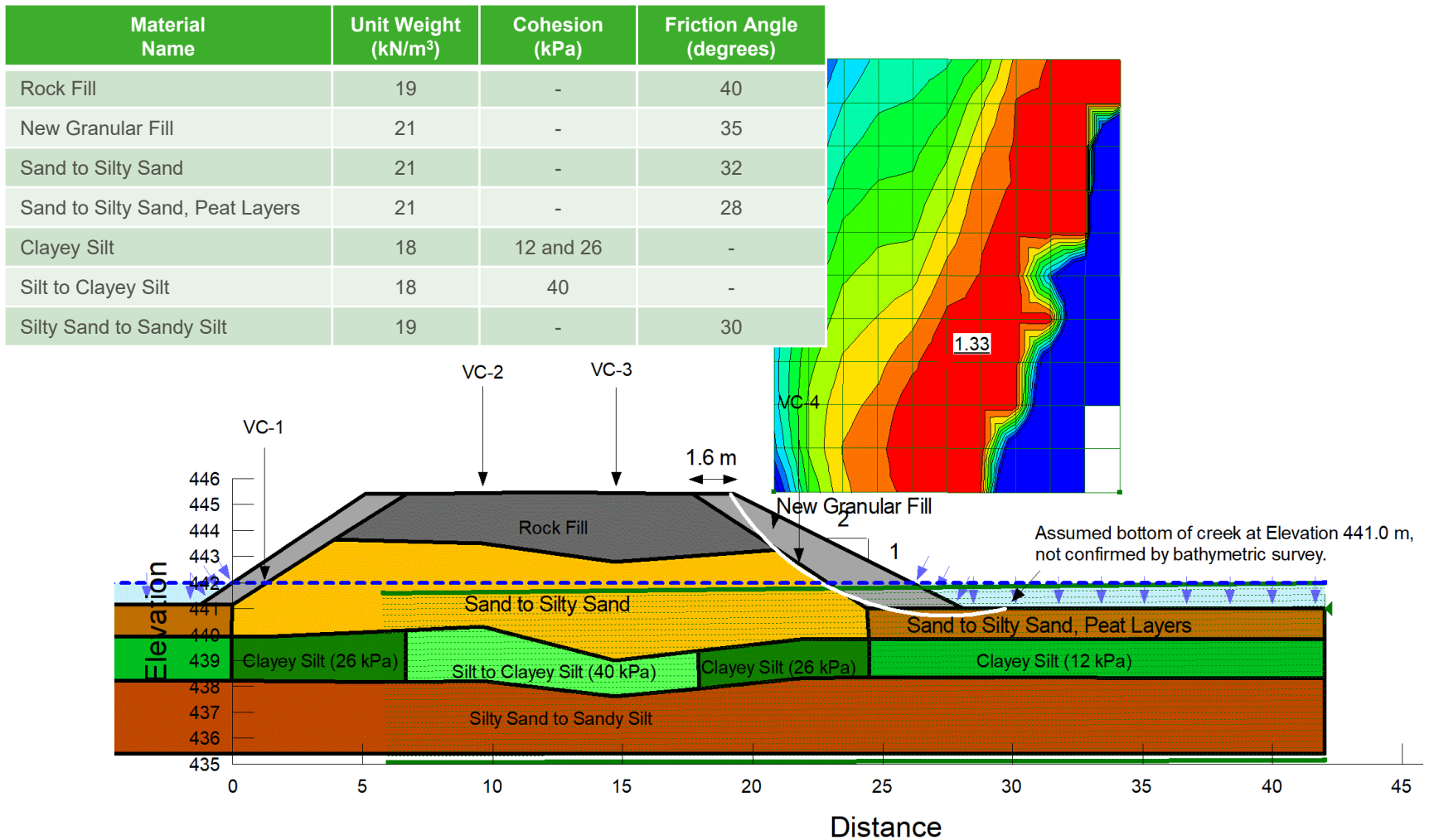


Analysis By: KJ Reviewed By: AB/JMAC

Slope Stability Analysis

Figure 2

18104216 – VINCENT CREEK CULVERT EMBANKMENT WIDENING (2H:1V)



Note:

1. Stratigraphy based on boreholes advanced during previous investigation by others.

Analysis By: KJ Reviewed By: AB/JMAC

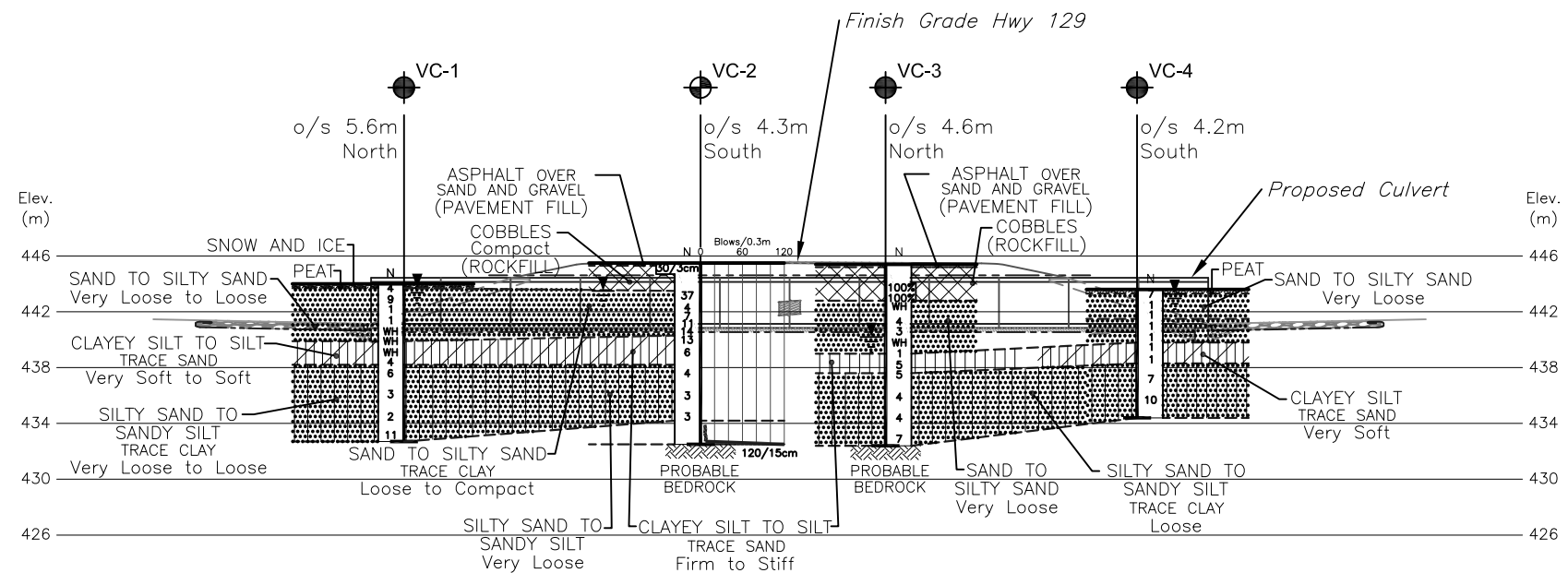
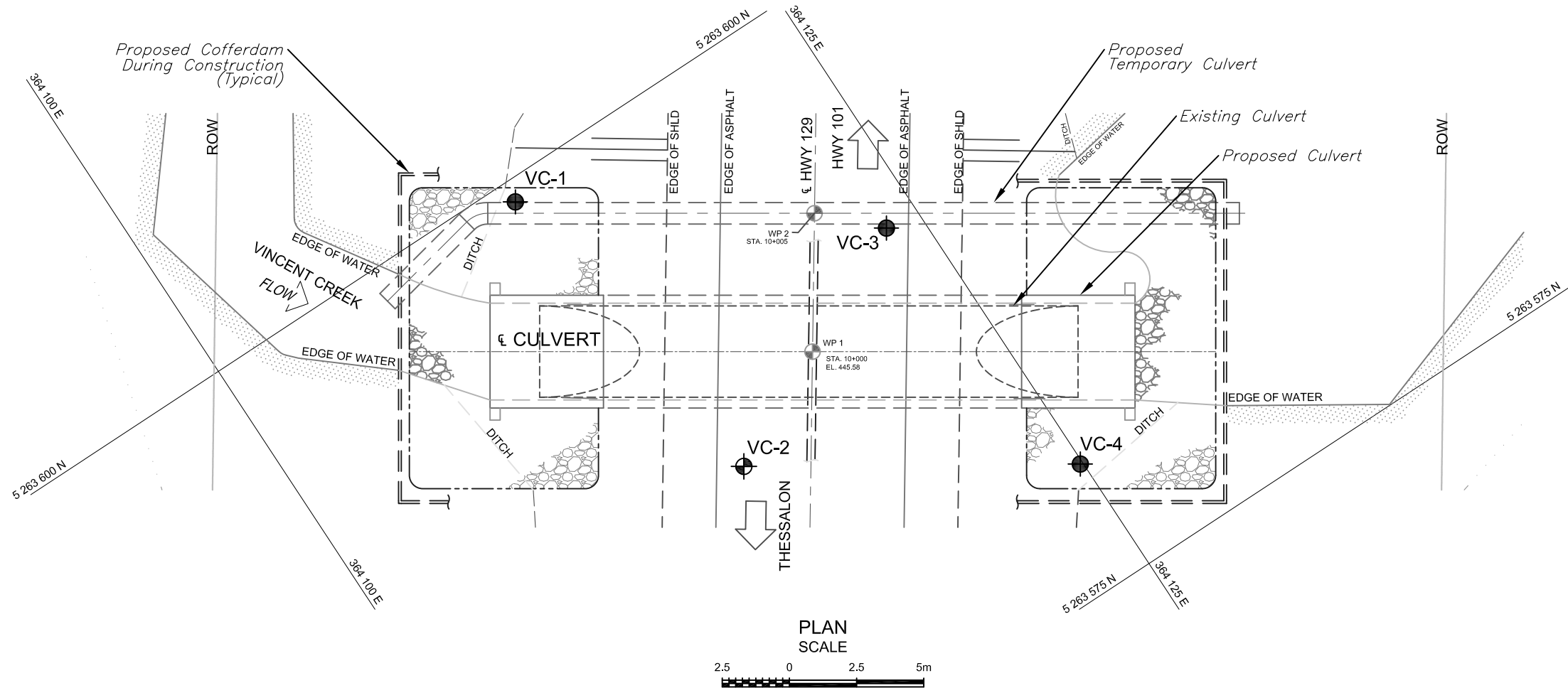
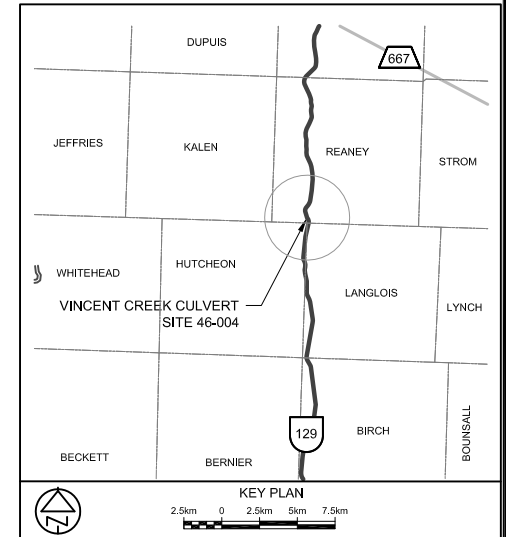
APPENDIX A

Foundation Drawing, Record of
Boreholes and Laboratory Testing –
Previous Investigation

SHEET



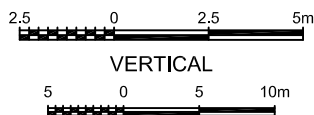
Peto MacCallum Ltd.
CONSULTING ENGINEERS



PROFILE ALONG CENTRELINE VINCENT CREEK CULVERT

SCALE
HORIZONTAL

VERTICAL



NOTES:

1. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT OF REPORT AND RECORD OF BOREHOLE LOGS.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
3. DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.

- NOTE -

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

REVISIONS			
	DATE	BY	DESCRIPTION

Geocres No. 410-16

HWY No 129				DISTSALT ST. MARIE	
SUBM'D	NA	CHECKED MKh	DATE OCT. 04, 2016	SITE 46-004/C	
DRAWN	NA	CHECKED MV	APPROVED CN	DWG VC-1	

REF AECOM Drawing: 60333079-P60.dwg dated June 2015

RECORD OF BOREHOLE No VC-1

1 of 1

METRIC

G.W.P. 5222-05-00 LOCATION Vincent Creek Coords: 5 263 599.2 N; 364 112.7 E ORIGINATED BY F.P.
DIST Algoma HWY 129 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY M.Kh.
DATUM Geodetic DATE January 9 and 11, 2015 CHECKED BY M.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED	● QUICK TRIAXIAL	+ FIELD VANE	× LAB VANE	20						40	60	80
444.0	Ground Surface																			
443.8	Snow and ice					▽*														
443.7	Peat, coarse fibrous Dark brown		1	SS	4															
443.7	Sand, layers of peat fine fibrous to amorphous		2	SS	9															
443.7	Very loose Dark Wet to loose brown		3	SS	1															
			4	SS	1															
			5	SS	WH**											83				
439.9	Clayey silt, trace sand		6	SS	WH															
439.9	Very soft Grey Wet to soft		7	SS	WH												0 9 65 26			
438.2			8	SS	4															
5.8	Silty sand to sandy silt trace clay		9	SS	6												0 52 42 6			
	Very loose Grey Wet to compact		10	SS	3															
			11	SS	2															
			12	SS	11															
432.7	End of borehole																			
11.3																				
	* 2015 01 09 & 11																			
	▽ Water level observed during drilling																			
	▽ Water level measured on completion																			
	WH** denotes penetration due to weight of hammer and rods																			
	NOTE Borehole caved in at 0.9m																			

* 2015 01 09 & 11
▽ Water level observed during drilling
▽ Water level measured on completion
WH** denotes penetration due to weight of hammer and rods
NOTE Borehole caved in at 0.9m

RECORD OF BOREHOLE No VC-2

1 of 2

METRIC

G.W.P. 5222-05-00

LOCATION

Vincent Creek

Coords: 5 263 586.3 N; 364 114.4 E

ORIGINATED BY F.P.

DIST Algoma

HWY 129

BOREHOLE

TYPE C.F.H.S.A. + Casing and Dynamic Cone Penetration Test

COMPILED BY M.Kh.

DATUM Geodetic

DATE

December 13, 2014

CHECKED BY M.V.

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 (%)			
								○ UNCONFINED	+ FIELD VANE							● QUICK TRIAXIAL	× LAB VANE	
445.5	Ground Surface						20	40	60	80	100	20	40	60	GR SA SI CL			
445.3 0.2	180mm Asphalt over sand and gravel (PAVEMENT FILL) cobbles and boulders compact (ROCKFILL)		1	AS	30/3cm										Top 0.3m is frozen			
443.5 2.0	Sand to silty sand trace clay, trace gravel Loose to Grey Wet dense		2	SS	37													
			3	SS	4													
			4	SS	7													
			5	SS	11										0 63 35 **			
			6	SS	14										2			
440.3 5.2	Clayey silt to silt with sand Firm to Grey Wet stiff		7	SS	13													
			8	SS	6										0 27 71 2			
438.2 7.3	Silty sand to sandy silt Very loose Grey Wet		9	SS	4**													
			10	SS	3**													
			11	SS	3**													
434.2 11.3	End of borehole Switch to dynamic cone penetration at 11.3m Probable sandy silt Very loose																	
432.5 13.0	End of dynamic cone penetration test Probable bedrock Sample 1: Sampler bouncing																	
				</														

Cont'd

RECORD OF BOREHOLE No VC-2

2 of 2

METRIC

G.W.P.	5222-05-00	LOCATION	Vincent Creek Coords: 5 263 586.3 N; 364 114.4 E	ORIGINATED BY	F.P.
DIST	Algoma	HWY	129	BOREHOLE TYPE	C.F.H.S.A. + Casing and Dynamic Cone Penetration Test
DATUM	Geodetic	DATE	December 13, 2014	CHECKED BY	M.V.

[illegible]

RECORD OF BOREHOLE No VC-3

1 of 2

METRIC

G.W.P. 5222-05-00 LOCATION Vincent Creek Coords: 5 263 590.8 N; 364 123.7 E ORIGINATED BY F.P.
DIST Algoma HWY 129 BOREHOLE TYPE Continuous Flight Hollow Stem Augers and casing COMPILED BY M.Kh.
DATUM Geodetic DATE December 14, 2014 CHECKED BY M.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	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 (%)
							20 40 60 80 100										
							20 40 60 80 100										
445.4	Ground Surface																
0.0	180mm Asphalt over sand and gravel																
444.7	(PAVEMENT FILL)																
0.7	cobbles and boulders																
	(ROCKFILL)																
	1.5m boulder penetrated		1	RC	REC 100%												
			2	RC	REC 100%												
442.8	Sand to silty sand layers of peat, fine fibrous		3	SS	WH**												
2.6	Very loose Moist		4	SS	4												
	organics		5	SS	3										151		
	Brown Moist		6	SS	WH												
	clay seams wet		7	SS	1												
439.0	Silt to clayey silt trace sand		8	SS	5												
6.4	Firm Grey Moist		9	SS	5												
437.6	Silty sand to sandy silt trace clay		10	SS	4												
7.8	Loose Grey Wet		11	SS	4												
	silt seams		12	SS	7												
432.4	End of borehole																
13.0	Probable bedrock																

RECORD OF BOREHOLE No VC-3

2 of 2

METRIC

G.W.P.	5222-05-00	LOCATION	Vincent Creek Coords: 5 263 590.8 N; 364 123.7 E	ORIGINATED BY	F.P.
DIST	Algoma	HWY	129	BOREHOLE TYPE	Continuous Flight Hollow Stem Augers and casing
DATUM	Geodetic	DATE	December 14, 2014	CHECKED BY	M.V.
COMPILED BY M.Kh.					

[illegible]

RECORD OF BOREHOLE No VC-4

1 of 1

METRIC

G.W.P. 5222-05-00 LOCATION Vincent Creek Coords: 5 263 579.5 N; 364 124.9 E ORIGINATED BY F.P.
DIST Algoma HWY 129 BOREHOLE TYPE Tripod + Casing COMPILED BY M.Kh.
DATUM Geodetic DATE January 14, 2015 CHECKED BY M.V.

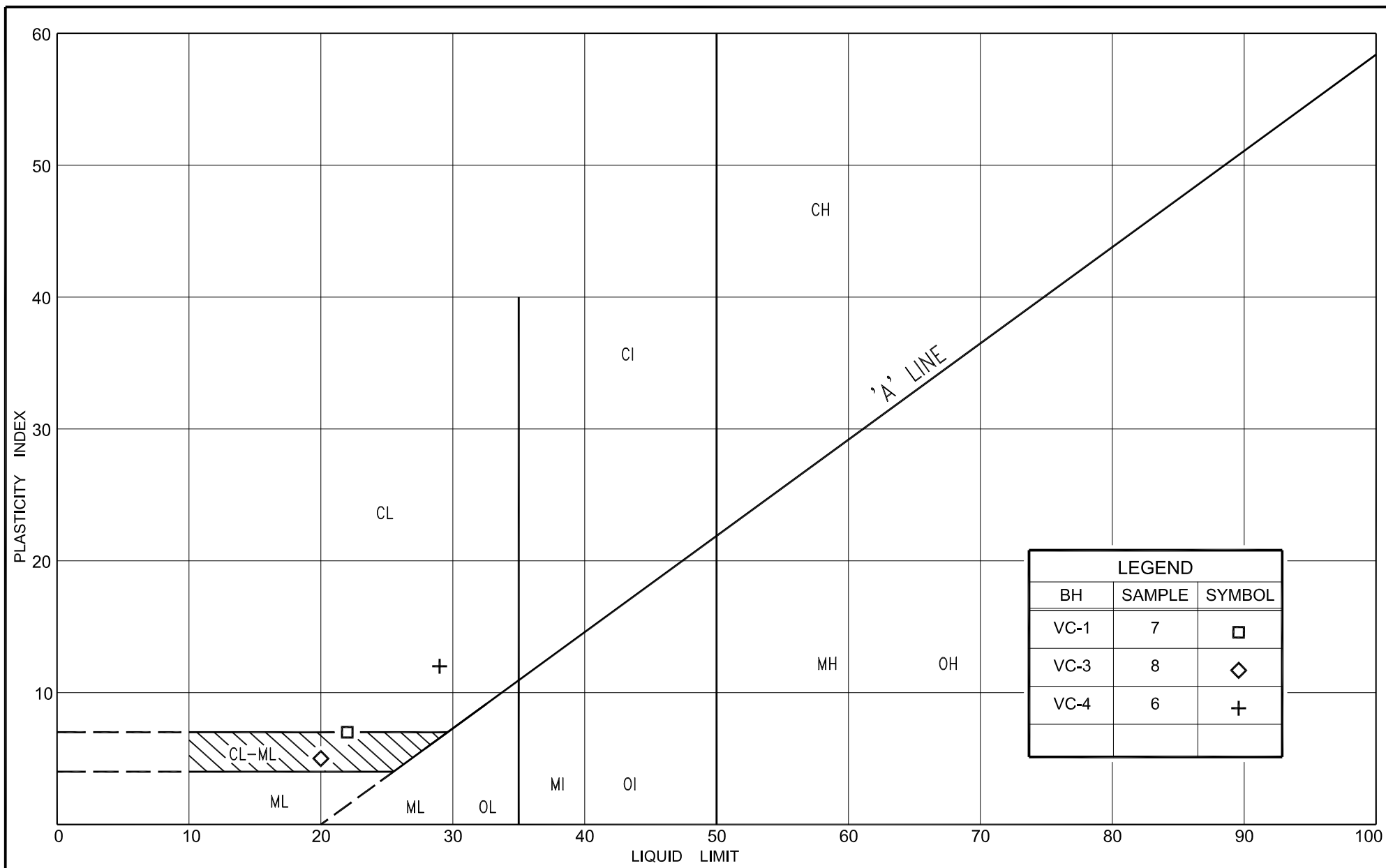
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED		+ FIELD VANE		● QUICK TRIAXIAL						× LAB VANE		
443.6	Ground Surface						20	40	60	80	100									
0.0 443.3 0.3	Peat, fine fibrous Dark brown		1	SS	7	▽*									852					
	Sand to silty sand organics layers of fine fibrous peat Very loose Brown Wet					▽	443													
			2	SS	1															
			3	SS	1															
	amorphous peat layers														223					
			4	SS	1															
			5	SS	1															
439.8 3.8	Clayey silt, trace sand Very soft Grey Wet		6	SS	1											0 2 64 34				
	some clay			FV																
			7	SS	1															
438.3 5.3	Silty sand to sandy silt trace clay Loose Brown Wet to compact															0 42 51 7				
			8	SS	7															
			9	SS	10															
435.4 8.2	End of borehole																			
	* 2015 01 14 ▽ Water level observed during drilling ▽ Water level measured on completion NOTE: Borehole caved in at 1.5m																			

* 2015 01 14

▽ Water level observed during drilling

▽ Water level measured on completion

NOTE: Borehole caved in at 1.5m



PLASTICITY CHART

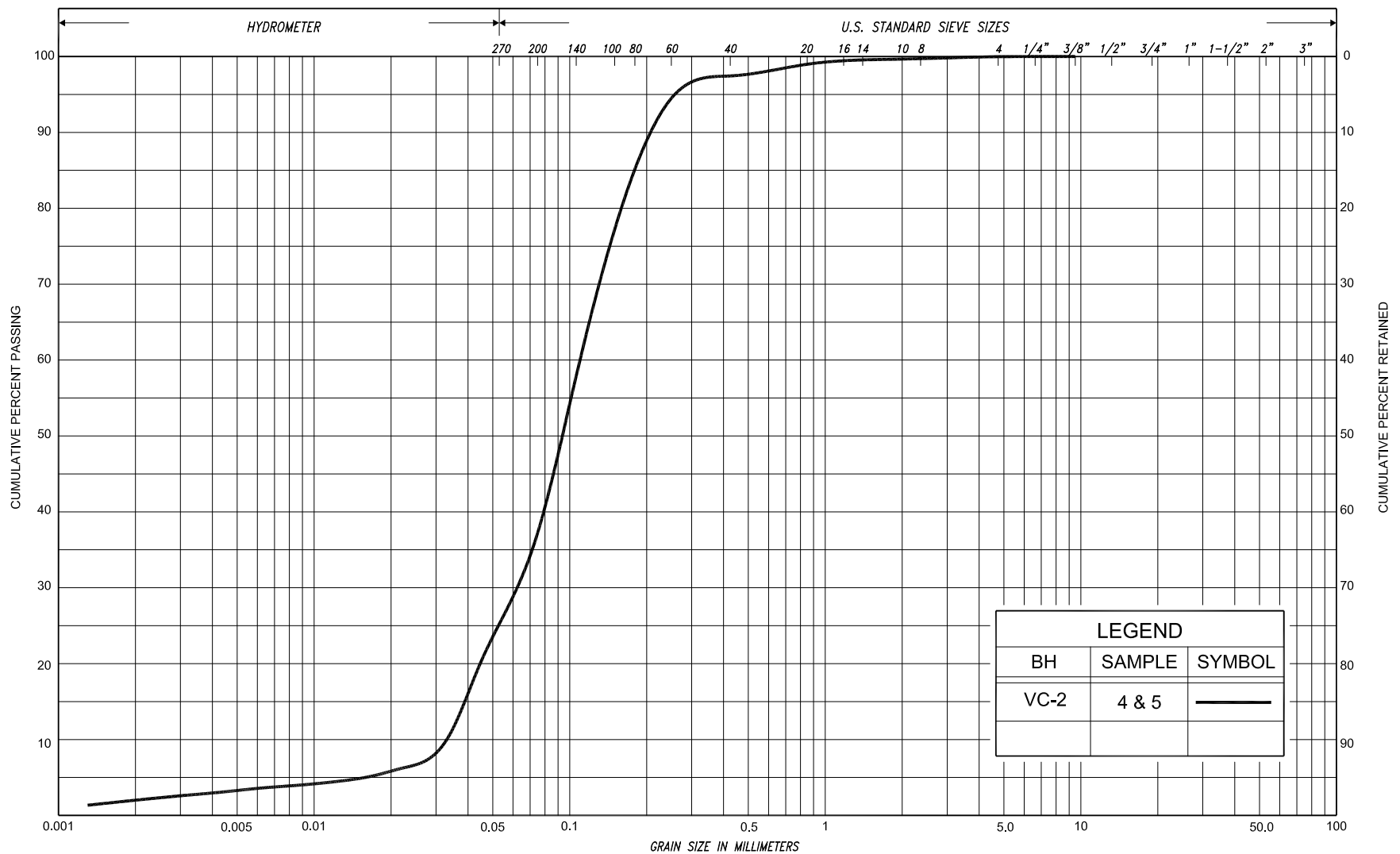
SILT TO CLAYEY SILT, trace to with sand (CL-ML to CL)

FIG No. VC-PC-1

HWY: 129

G.W.P. No. 5222-05-00





LEGEND		
BH	SAMPLE	SYMBOL
VC-2	4 & 5	—

SILT & CLAY				FINE		MEDIUM		COARSE	GRAVEL			COBBLES	UNIFIED
CLAY	SAND			FINE		MEDIUM		COARSE	GRAVEL			COBBLES	M.I.T.
	SILT			V. FINE		FINE		MED.	COARSE	GRAVEL			U.S. BUREAU



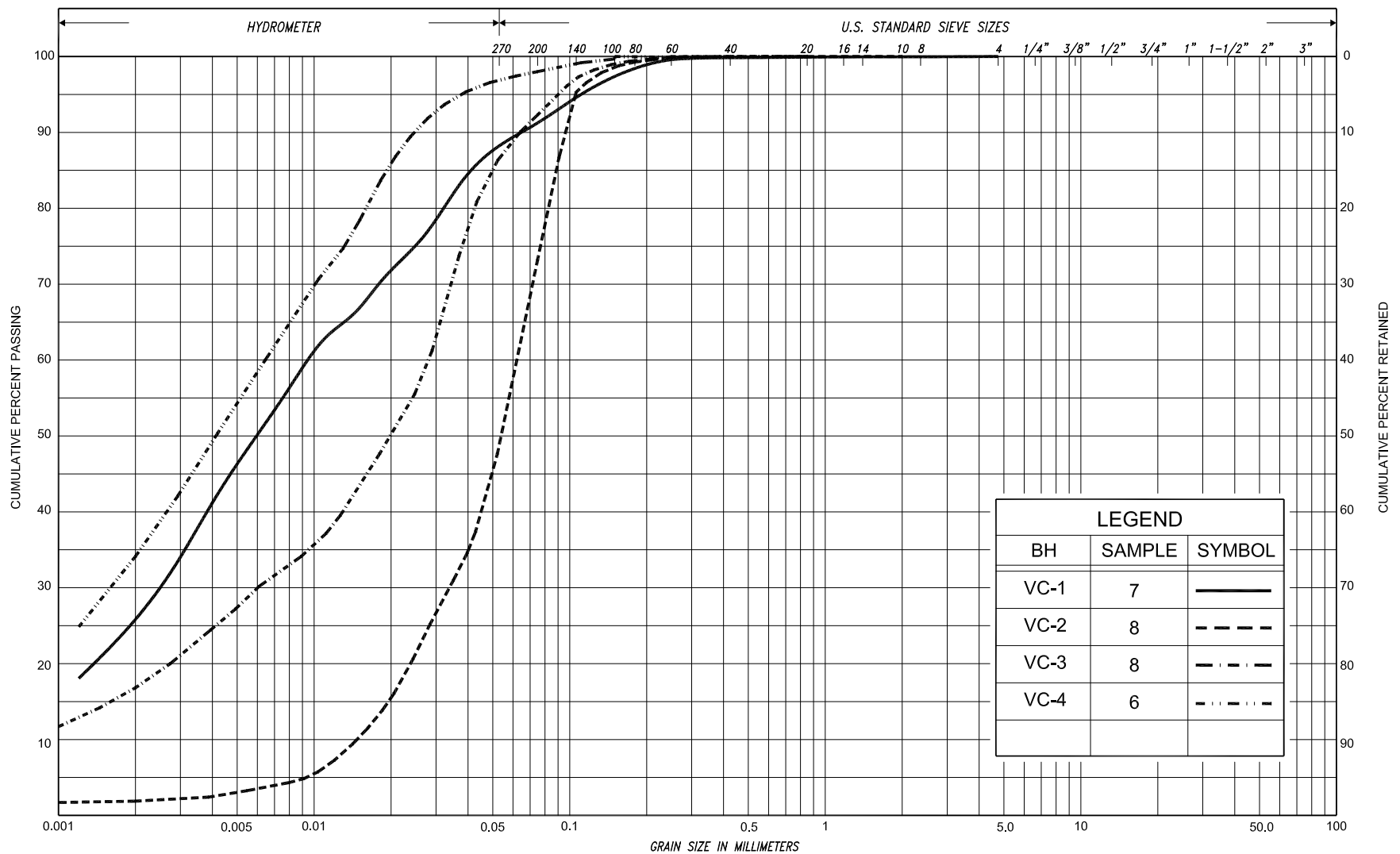
GRAIN SIZE DISTRIBUTION

SAND TO SILTY SAND, trace clay

FIG No. VC-GS-1

HWY: 129

G.W.P. No. 5222-05-00



SILT & CLAY					FINE		MEDIUM		COARSE	GRAVEL			COBBLES	UNIFIED	
CLAY	FINE		MEDIUM		COARSE	FINE		MEDIUM		COARSE	GRAVEL			COBBLES	M.I.T.
	SILT				V. FINE		FINE	MED.	COARSE	GRAVEL					



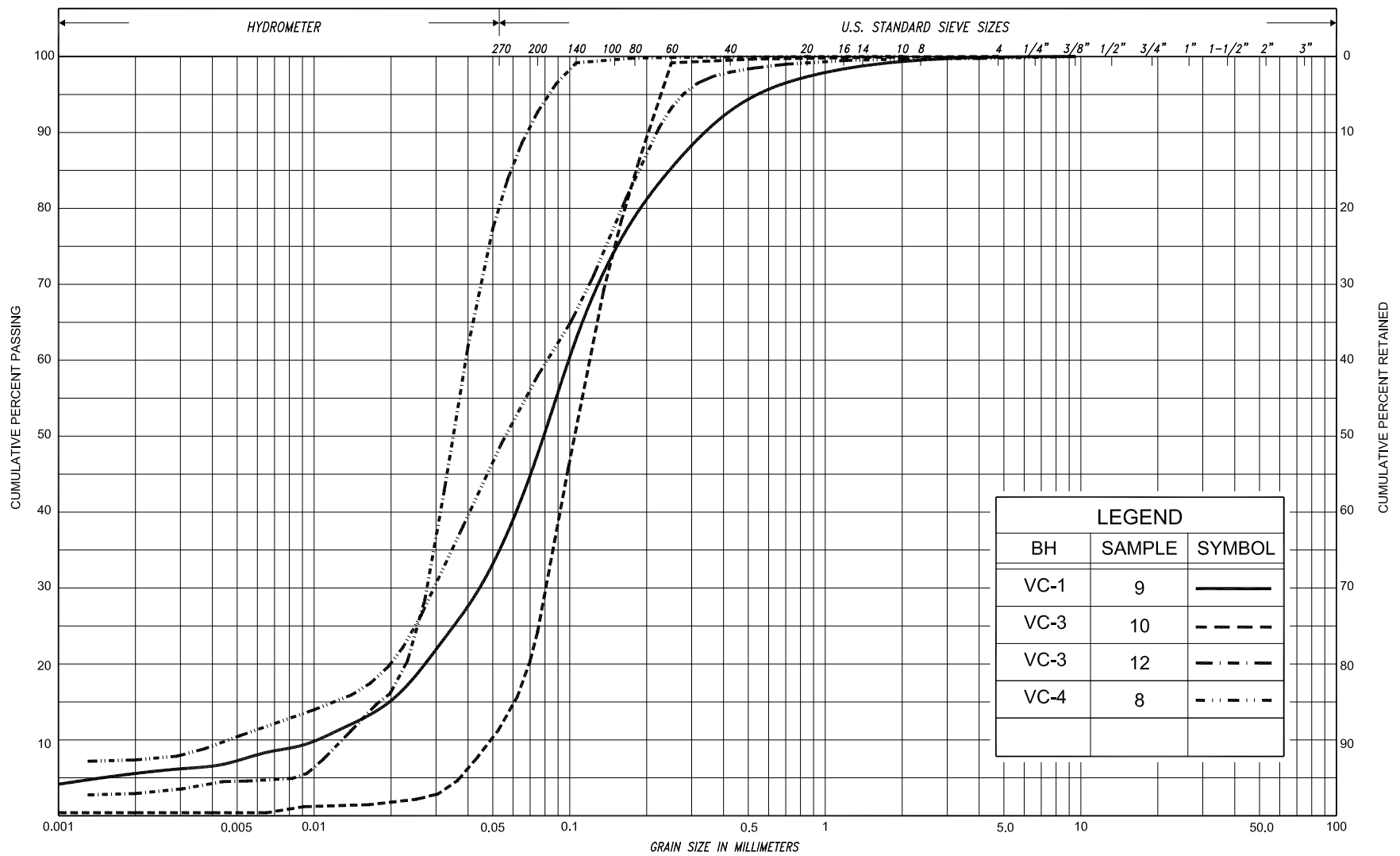
GRAIN SIZE DISTRIBUTION

SILT TO CLAYEY SILT, trace to with sand (CL-ML)

FIG No. VC-GS-2

HWY: 129

G.W.P. No. 5222-05-00



SILT & CLAY					FINE		MEDIUM		COARSE	GRAVEL			COBBLES	UNIFIED	
CLAY	FINE		MEDIUM		COARSE	FINE		MEDIUM		COARSE	GRAVEL			COBBLES	M.I.T.
	SILT				SAND							GRAVEL	COBBLES	M.I.T.	
CLAY		SILT			V. FINE	FINE	MED.	COARSE	GRAVEL						U.S. BUREAU



GRAIN SIZE DISTRIBUTION SILTY SAND TO SANDY SILT, trace clay

FIG No. VC-GS-3

HWY: 129

G.W.P. No. 5222-05-00

APPENDIX B

**Record of Boreholes – Current
Investigation**

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

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

LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

Dynamic Cone Penetration Resistance; N_d :

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

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

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

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

Compactness	N
Condition	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

WEATHERINGS STATE

Fresh: no visible sign of weathering

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

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

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

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

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

BEDDING THICKNESS

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

JOINT OR FOLIATION SPACING

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

GRAIN SIZE

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

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

CORE CONDITION

Total Core Recovery (TCR)

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

Solid Core Recovery (SCR)

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

Rock Quality Designation (RQD)

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

DISCONTINUITY DATA

Fracture Index

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

Dip with Respect to Core Axis

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

Description and Notes

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

Abbreviations

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

PROJECT <u>18104216</u>		RECORD OF BOREHOLE No BH-1				1 OF 2 METRIC	
W.P. <u>5291-13-01</u>		LOCATION <u>N 5263576.5; E 364116.1 NAD83 MTM ZONE 13 (LAT. 47.508701; LONG. -83.212514)</u>				ORIGINATED BY <u>KJ</u>	
DIST <u> </u> HWY <u>129</u>		BOREHOLE TYPE <u>NW Casing, Wash Boring and NQ Coring</u>				COMPILED BY <u>TR/KJ</u>	
DATUM <u>GEODETIC</u>		DATE <u>September 26 and 27, 2018</u>				CHECKED BY <u>AB</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								20	40	60	80	100	W _p	W	W _L		
445.4 0.0	GROUND SURFACE Sand and gravel (FILL) Compact Brown Moist		1	SS	16	▽	445										
			2	SS	17		444										
444.0 1.4	Cobbles and boulders (ROCK FILL)				443												
			NQ		442												
442.3 3.1	Sandy SILT to SAND Very loose to dense Grey Wet		3	SS	29		441										
			4	SS	11		440										
			5	SS	17		439										
			6	SS	16		438										
			7	SS	2		437										
			8	SS	5		436										
			9	SS	2	435											
						434											

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

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PROJECT 18104216		RECORD OF BOREHOLE No BH-1				2 OF 2 METRIC											
W.P. 5291-13-01		LOCATION N 5263576.5; E 364116.1 NAD83 MTM ZONE 13 (LAT. 47.508701; LONG. -83.212514)				ORIGINATED BY KJ											
DIST _____ HWY 129		BOREHOLE TYPE NW Casing, Wash Boring and NQ Coring				COMPILED BY TR/KJ											
DATUM GEODETIC		DATE September 26 and 27, 2018				CHECKED BY AB											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa		WATER CONTENT (%)		γ kN/m³	GR SA SI CL				
							20 40 60 80 100	○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	W _p W W _L	20 40 60							
	--- CONTINUED FROM PREVIOUS PAGE ---																
432.0	Sandy SILT to SAND Very loose to dense Grey Wet		10	SS	32		433							5	65	25	5
432.0 13.4	SAND and GRAVEL and COBBLES, trace silt Very loose to dense Grey Wet		11	SS	18/0.05		432										
							431										
430.2 15.2	GNEISS (BEDROCK)		12	SS	21/0.05		430										
	Bedrock cored from 15.2 m to 18.3 m depth. For coring details see Record of Drillhole BH-1.		1	RC	REC 100%		429										RQD = 90%
			2	RC	REC 100%		428										RQD = 100%
427.1 18.3	END OF BOREHOLE Note: 1. Water level inside casing at a depth of 1.4 m (Elev. 444.0 m) below ground surface upon completion of coring bedrock.																

INCLINATION: -90° AZIMUTH: --

DRILLING CONTRACTOR: Landcore Drilling

DATUM: GEODETIC

1 : 60



CHECKED: AB

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PROJECT <u>18104216</u>		RECORD OF BOREHOLE No BH-2		1 OF 2 METRIC	
W.P. <u>5291-13-01</u>		LOCATION <u>N 5263600.4; E 364122.0 NAD83 MTM ZONE 13 (LAT. 47.508915; LONG. -83.212432)</u>		ORIGINATED BY <u>KJ</u>	
DIST <u> </u> HWY <u>129</u>		BOREHOLE TYPE <u>NW Casing, Wash Boring and NQ Coring</u>		COMPILED BY <u>TR/KJ</u>	
DATUM <u>GEODETIC</u>		DATE <u>September 27 and 28, 2018</u>		CHECKED BY <u>AB</u>	

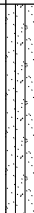

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIMIT MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	20	40	60	80	100	w _p	w		w _L			
445.3	GROUND SURFACE																			
0.0	Sand and gravel (FILL) Compact Brown Moist		1	SS	24		445													
			2	SS	39/0.15		444													
	- Auger grinding on inferred cobbles.																			
		3	SS	17																
443.0							443													
2.3	Cobbles and boulders (ROCK FILL) Compact		4	SS	27															
				NQ			442													
441.5																				
3.8	Sandy gravel (FILL) Very loose Grey Wet		5	SS	1		441													
440.7																				
4.6	PEAT (amorphous) Very soft Brown to black Wet		6	SS	WH															
						440														
439.8																				
5.5	CLAYEY SILT Firm to stiff Grey Wet		7	SS	WH	439														
437.8						438														
7.5	Silty SAND to SAND Loose to compact Grey Wet		8	SS	9															
							437													
				9	SS	4	436													
						435														
			10	SS	8	434														

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

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PROJECT <u>18104216</u>		RECORD OF BOREHOLE No BH-2		2 OF 2 METRIC	
W.P. <u>5291-13-01</u>		LOCATION <u>N 5263600.4; E 364122.0 NAD83 MTM ZONE 13 (LAT. 47.508915; LONG. -83.212432)</u>		ORIGINATED BY <u>KJ</u>	
DIST <u> </u> HWY <u>129</u>		BOREHOLE TYPE <u>NW Casing, Wash Boring and NQ Coring</u>		COMPILED BY <u>TR/KJ</u>	
DATUM <u>GEODETIC</u>		DATE <u>September 27 and 28, 2018</u>		CHECKED BY <u>AB</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE LIQUID CONTENT LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
								20	40	60	80	100	w _p	w	w _L					
--- CONTINUED FROM PREVIOUS PAGE ---																				
431.6	Silty SAND to SAND Loose to compact Grey Wet		11	SS	10		433													
							432													
13.7	SAND and GRAVEL Compact Grey Wet		12	SS	24		431													
429.9			13	SS	26/0.05		430													
15.4	END OF BOREHOLE Split spoon refusal Note: 1. Water level inside casing at a depth of 1.3 m (Elev. 444.0 m) below ground surface upon completion of drilling.																			

APPENDIX C

Laboratory Test Results – Current Investigation

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

TABLE C1: SUMMARY OF ROCK CORE TEST DATA

PROJECT NO.: 18104216/2002
 PROJECT NAME: MTO/5017-E-0021.22.23/NE LVR
 TYPE OF UNIT: Rock Core
 TESTED BY: JM
 DATE TESTED: October 10, 2018

GOLDER LAB NUMBER	S1298				
BOREHOLE NUMBER:	BH-1				
SAMPLE NUMBER:	N/A				
DEPTH OF TESTED CORE	50.5'				
LENGTH AS CUT (mm)	102.6				
DIAMETER (mm)	47.6				
DENSITY (kg/m3)	2628				
COMPRESSIVE STRENGTH (KN)	348.2				
CORRECTED STRENGTH (MPa)	195.6				
TYPE OF FRACTURE	1				

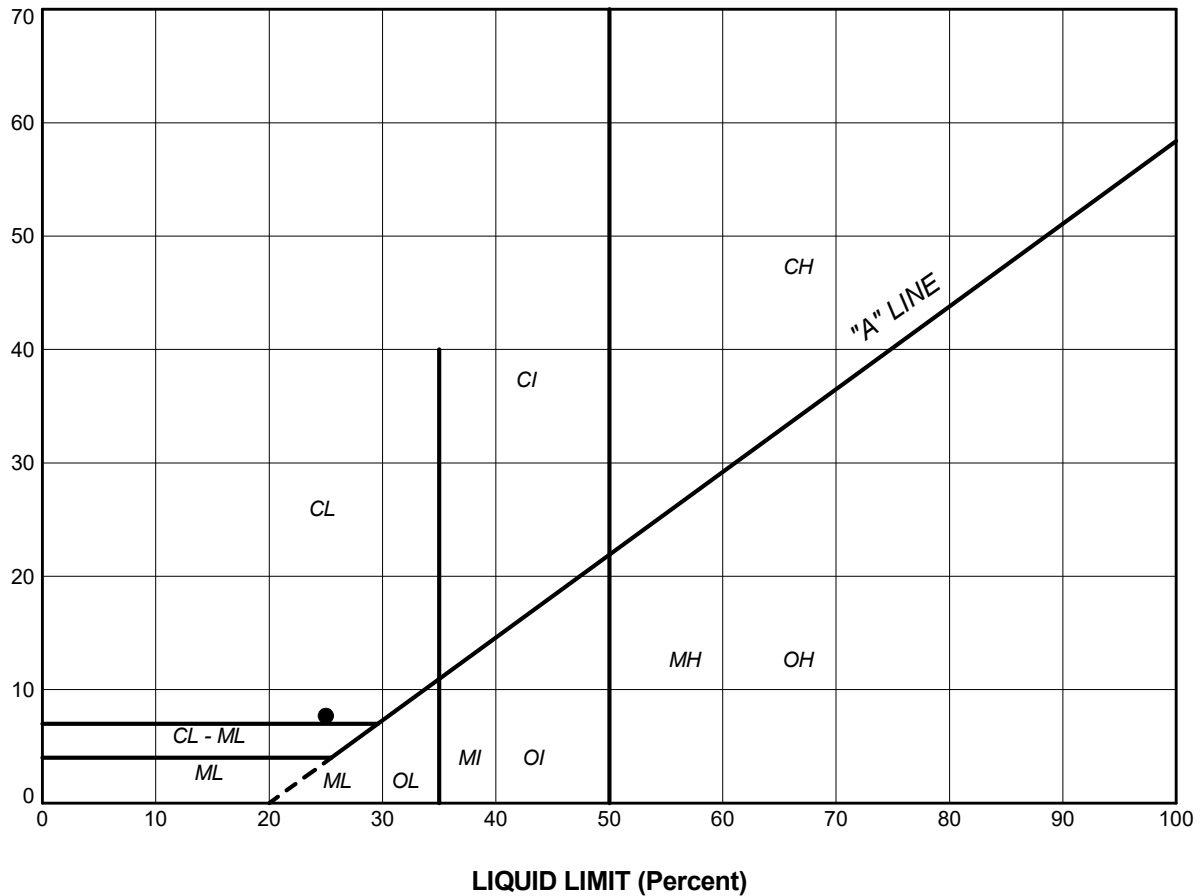
Type of Fracture

1 2 3 4 5 6

COMMENTS:

Input by: KJ
 Reviewed by: AB

PLASTICITY INDEX (Percent)



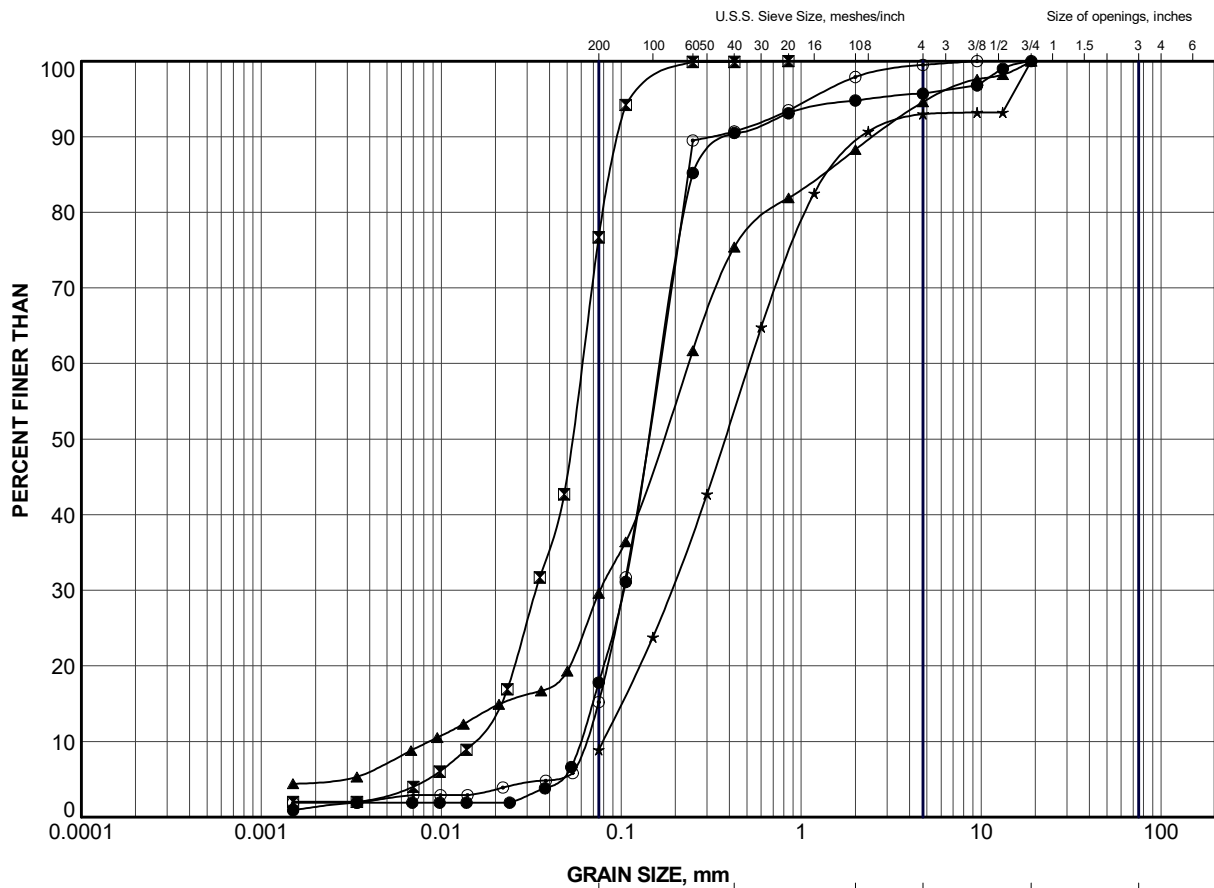
SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	BH-2	7	25.0	17.3	7.7


PROJECT					
HIGHWAY 129 Vincent Creek Culvert					
TITLE					
PLASTICITY CHART CLAYEY SILT					
PROJECT No. 18104216			FILE No. 18104216.GPJ		
DRAWN	TR	Oct 2018	SCALE	N/A	REV.
CHECK	AB	Oct 2018	FIGURE C1		
APPR	AB	Oct 2018			
SUDBURY, ONTARIO					



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

LEGEND

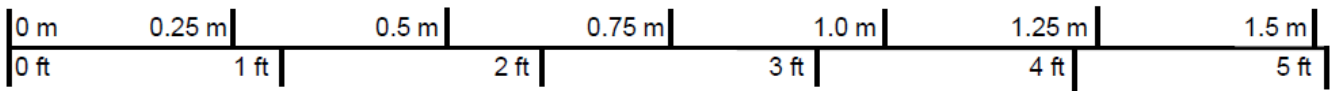
SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BH-1	4	441.3
⊠	BH-1	7	437.5
▲	BH-1	10	432.9
★	BH-2	8	437.4
⊙	BH-2	9	435.9

PROJECT					
HIGHWAY 129 Vincent Creek Culvert					
TITLE					
GRAIN SIZE DISTRIBUTION Sandy SILT to SAND					
PROJECT No.		18104216		FILE No. 18104216.GPJ	
DRAWN	TR	Oct 2018	SCALE	N/A	REV.
CHECK	AB	Oct 2018	FIGURE C2		
APPR	AB	Oct 2018			
 GOLDER SUDBURY, ONTARIO					

Borehole BH-1



Box 1: 15.2 m – 18.3 m



Scale

PROJECT					
Vincent Creek Culvert (Structure No. 46-004/C) Hwy 129, Reaney Twp., Ontario					
TITLE					
Bedrock Core Photograph					
PROJECT No. 18104216			FILE No. ---		
DESIGN	KJ	Oct. 18	SCALE	NTS	REV.
CADD	--		FIGURE C3		
CHECK	KJ				
REVIEW	AB				

APPENDIX D

**Non-Standard Special Provisions
and Notice to Contractor**

DEWATERING STRUCTURE EXCAVATIONS - Item No.

Special Provision No. FOUN0003

March 8, 2018

Amendment to OPSS 902, November 2010

OPSS 902, November 2010, Construction Specification for Excavating and Backfilling – Structures is amended as follows:

902.02 REFERENCES

Section 902.02 of OPSS 902 is amended by the addition of the following:

Ontario Provincial Standard Specifications, Construction

OPSS 517 Dewatering

OPSS 805 Temporary Erosion and Sediment Control Measures

902.03 DEFINITIONS

Section 903.03 of OPSS 902 is amended by the addition of the following:

Automatic Transfer Switch means as defined in OPSS 517.

Cofferdam means as defined in OPSS 539.

Cut-Off Wall means as defined in OPSS 517.

Design Storm Return Period means as defined in OPSS 517.

Groundwater Control System means as defined in OPSS 517.

Plug means as defined in OPSS 517.

Sediment means as defined in OPSS 517.

Sediment Control Measure means as defined in OPSS 517.

Temporary Flow Passage System means as defined in OPSS 517.

Unwatering means as defined in OPSS 517.

Vegetated Discharge Area means as defined in OPSS 517.

Waterbody means as defined in OPSS 517.

Watercourse means as defined in OPSS 517.

902.04 DESIGN AND SUBMISSION REQUIREMENTS

902.04.01 Design Requirements

902.04.01.01 Dewatering

Clause 902.04.01.01 of OPSS 902 is deleted in its entirety and replaced with the following:

A dewatering system shall be designed to control water and the flow of water into the excavation, prevent disturbance of the foundation, permit the placing of concrete in the dry, and complete the excavating and backfilling for structures work.

When the system includes temporary flow passage system, the system shall be designed, as a minimum, for a [* Designer Fill-In, See Notes to Designer] year design storm return period, and groundwater discharge. A longer return period shall be used when determined appropriate for the work.

The dewatering system shall be according to the design requirements specified in OPSS 517.

The design Engineer and the design-checking Engineer shall have a minimum 5 years of experience in designing systems of similar nature and scope to the required work.

902.04.02 Submission Requirements

Subsection 902.04.02 of OPSS 902 is deleted in its entirety and replaced with the following:

902.04.02.01 Working Drawings

Working Drawings for the dewatering system shall be according to OPSS 517.

902.04.02.02 Preconstruction Survey

When a groundwater control system by wells or a well point system will be used, a condition survey of property and structures that may be affected by the work shall be carried out. The condition survey shall include the location and condition of adjacent properties, buildings, underground structures, water wells, Utilities, and structures, within a distance of 300 metres from the groundwater control system. In addition, all water wells used as a supply of drinking water and located within this distance shall be tested for compliance with Ontario Drinking Water Quality Standards.

Water wells within the preconstruction survey distance can be located using the website <https://www.ontario.ca/environment-and-energy/map-well-records> or its successor site.

Copies of the condition survey and water quality test results shall be submitted to the Contract Administrator prior to the operation of the groundwater control system.

902.04.02.03 Milestone Inspections

Clause 902.04.02.03 of OPSS 902 is deleted in its entirety.

902.07 CONSTRUCTION

Subsection 902.07.04 of OPSS 902 is deleted in its entirety and replaced with the following:

902.07.04 Dewatering Structure Excavation

902.07.04.01 General

The dewatering systems shall be constructed and operated according to the Working Drawings.

Activation and deactivation of a temporary flow passage system, if applicable, shall be according to OPSS 517.

The dewatering system shall be continuously operational to control buoyancy forces until such forces can be resisted by backfill and structure self-weight, to keep excavations stable, to avoid erosion impacts from the release of accumulated water, and to keep the work area in the condition required to complete the associated work as specified in the Contract Documents.

When a temporary flow passage system is to remain operational through a seasonal shutdown period, the Contractor shall be responsible for any maintenance or repair costs due to the system during the seasonal shutdown period.

Temporary erosion and sediment control measures, including controlling the discharge of water, shall be according to OPSS 805. Measures not specified in OPSS 805 shall be according to the Working Drawings. Temporary erosion and sediment control measures and cover material to protect exposed soils, as required by the Working Drawings, shall be installed as soon as is practical.

Stranded fish shall be managed as specified in the Contract Documents.

Unwatering shall be carried out as necessary.

Water suspected of being contaminated as indicated by visual or olfactory observations shall be reported to the Contract Administrator.

Dewatering and temporary flow passage systems shall be discontinued in a manner that does not disturb any structure, pipeline, or flow channel. Operation of the dewatering system shall be shut down according to the procedures specified in the Working Drawings, where applicable.

902.07.04.02 Discharge of Water

The discharge of water shall be according to OPSS 517.

902.07.04.03 Monitoring

Monitoring shall be according to OPSS 517.

902.07.04.04 System Amendments

Amendments to stop any displacement, damage, soil loss or erosion due to the operation of the dewatering system shall be according to OPSS 517.

902.07.04.05 Removal

Removal of dewatering system and temporary flow passage system components shall be according to OPSS 517.

NOTES TO DESIGNER:

* Fill in the design storm return period according to MTO Drainage Design Standard TW-1.

** Fill in the preconstruction survey distance as recommended by the foundation engineer.

WARRANT: Include with this standard tender item **only** on the recommendation of a foundation engineer.

CUSTODIAN: Tony Sangiuliano, MERO - Foundation Group.

UNWATERING OF STRUCTURE EXCAVATION - Item No.

Notice to Contractor

The Vincent Creek Culvert replacement (Structure No. 46-004C) may require excavations to extend below the groundwater level and the adjacent creek water level. The embankment fill and sandy silt to sand deposits within the excavation may slough, run, boil or cave into the excavation unless appropriate groundwater controls are in place. The Contractor is to design and install an appropriate excavation temporary protection system to allow for the unwatering of the excavation, and enable construction of the culvert in relatively dry conditions and prevent disturbance to the foundation soils.

SHEET PILES REMAINING IN PLACE

Non-Standard Special Provision

The Contactor is hereby notified that the Temporary Protection System sheet piles at the Vincent Creek Culvert site (Structure No. 46-004C) used for culvert replacement shall remain in place following construction and be cutoff at a level as specified in OPSS.PROV 539, Item 539.07.02.

OBSTRUCTIONS

Non-Standard Special Provision

The Contactor is hereby notified that the embankment fill contains a zone of cobble and boulder size Rock Fill as encountered in Boreholes BH-1 to BH-2 (and PML Boreholes VC-2 and VC-3) at the Vincent Creek Culvert site (Structure No. 46-004C). The extent / depth and the thickness of the zone of the cobble and boulder size Rock Fill may vary beyond and between our borehole location(s). Consideration of the presence of these obstructions shall be made in the selection of appropriate equipment and procedures for excavations and temporary protection systems.



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