and EBL embankments in the High Fill Area H3. Further, the estimated differential settlement of 40 mm between the new centreline and north edge of pavement also exceeds the criterion of 200:1. It should be noted that higher magnitudes of total and differential settlement are expected to occur beyond the outside edge of pavement along the slope.

6.5.3.3 Mitigation of Stability Issues and/or Time Dependent Settlements

In order to construct the embankments in the widened areas and minimize post-construction settlements, the alternatives presented below can be considered. The alternatives described have been evaluated and ranked on the basis of the advantages, disadvantages, relative costs and risk/consequences and are summarised in Table C1 in Appendix C. A summary of the results of settlement analysis for each alternative is provided in Table 4.

Outside of the critical areas, there will be a minimal grade raise and little to no embankment widening and therefore no settlement or stability mitigation will be necessary. The sections listed below do not require settlement or stability mitigation:

- Highway 17 WBL and EBL – STA 13+900 to 13+950;
- Highway 17 EBL – STA 14+150 to 14+200; and
- Highway 17 WBL, – STA 14+175 to 14+200.

The areas not listed above will require settlement mitigation. Given the thick cohesive deposit (the bottom of which is up to about 19.5 m below ground surface), the associated magnitude of primary and secondary consolidation settlement (150 mm) and 40 mm of expected differential settlement of the foundation soils under a 3.1 m grade raise in the widened area, the most practical method of construction is to preload the embankment widening, allowing settlement to occur while the traffic is using the widened highway section, followed by maintenance of the roadway in the future. This method does not meet the MTO settlement criteria for post-construction settlement but is more practical from a cost and a construction standpoint compared to other technically feasible options.

6.5.3.3.1 Consolidation and Maintenance

We recommend a construction approach that involves constructing (widening and raising) the embankments to their final geometry, utilizing the embankments as the travelled highway and then conducting ongoing maintenance, as may be required to re-grade the highway to accommodate the estimated 80 mm of settlement (approximately 90 per cent of the primary consolidation settlement) expected to occur over about 6 years. While this construction option does not meet the MTO settlement criteria in the short term, it is still considered the most practical option given that the magnitude of total settlement at the new outside north edge of the EBL pavement is about 150 mm (90 mm primary and 60 mm creep). The widened embankment will remain stable while in use as a travelled lane but the expected post constructed settlements will require maintenance. This alternative relies on the fact that while the expected settlements exceed the MTO settlement criteria for a widened embankment (Figure 3, MTO 2010), the embankment can still function as a travelled lane while consolidation takes place.

While this construction approach does not strictly require the installation of instrumentation to monitor for settlement, it would be prudent and it is recommended that settlement be monitored, however, it is not required to monitor pore pressures for embankment stability. The embankment monitoring can consist of a series of settlement plates installed within the embankment at the crest of the widened portions of the embankments provided guide rail installation is not impacted and the monitoring points remain accessible. Settlement plates in the shoulder or on the slope (or nail pins in pavement) will be required to be installed along the full length of the high fill section on the south side of the widened embankment at offsets to be determined once the final cross sections are known. For a 300 m long section, settlement plates at approximately 50 m spacing would be appropriate. Monthly readings of the settlement plates are recommended for the first year of monitoring and quarterly readings afterwards until the decrease in the rate of settlement indicates that the remaining settlement is within the MTO criteria, likely up to 6 years.

The total post-construction settlement (i.e., after construction of the widened embankments is complete and traffic is using the lanes) for the Highway 17 EBL embankment expected during the consolidation period is estimated to be 150 mm (comprised of 90 mm of primary settlement plus 60 mm creep settlement plus fill settlement) which exceeds the settlement criteria. The differential settlement of 40 mm between the new centreline and new outside edge of pavement lane also exceeds the criterion of 200:1. During the approximately 6 year consolidation period, approximately 80 mm of settlement will have occurred on the new outside edge of pavement and approximately 50 mm at the new highway centreline. The estimated total and differential settlement after approximately 6 years is about 50 mm and 5 mm at the new outside edge of pavement, respectively, which meet the MTO criteria. The results of the analysis are shown on Figure C25.

The main advantages of this option are that there is neither a delay in the construction schedule nor any need to divert traffic for multiple years during staged construction. The disadvantages of this option are that it does not meet the MTO settlement criteria and future highway maintenance is likely to be required.

6.5.3.3.2 Lightweight Fill

In order to meet the settlement criteria in the short term, lightweight (EPS) fill could be incorporated into the widened embankment mass. The Highway 17 WBL and EBL embankments can be widened to the north using a 1 m thick layer of EPS under the pavement structure of the new embankment (full width, not to interfere with guide rail installation) and an additional 1 m of EPS (for a total of 2 m) would be required within the remainder of the north half of the new embankment. This will require sub-excavation of the existing fill to accommodate the EPS. The EPS should be stepped in 0.3 m to 0.5 m increments across the embankment and in the taper zones longitudinally along the highway. Essentially, with the incorporation of this volume of EPS into the embankment mass, the induced settlement will be minimal and will not result in creep settlement. Total and differential post-construction settlement is estimated to be less than 10 mm.

The main advantages of this option are that it meets the post-construction settlement criteria in the short term and does not create delays in the construction schedule. The disadvantage of this option is the substantial cost of EPS fill, which is typically an order of magnitude higher than other fill materials, as well as the need to excavate a portion of the existing embankments in order to install the EPS. Generally, this option is not considered practical due to the added cost of material compared to the consolidation and maintenance option.

6.6 Subgrade Preparation and Embankment Construction

The following sections discuss general aspects of subgrade preparation and embankment construction for the high fill/swamp crossing areas, including: removal of organic materials; excavation and replacement of soft, cohesive deposits; groundwater control; placement of embankment fills, slope flattening and platform widening.

A summary of the recommended/preferred foundation mitigation option for each high fill/swamp crossing area is presented in Table 5. The summary contains: recommendations on embankment fill types and side slope profiles; estimated maximum depth of organic deposits encountered; the magnitude of estimated settlement (during and post-construction) for the embankment materials and the foundation soils; recommended width of platform widening as may be required to accommodate future raising of the embankment; and the recommended Ontario Provincial Standard Drawings (OPSD) excavation guideline.

6.6.1 Removal of Organic Deposits

Based on the subsurface information from the boreholes advanced during the field investigation, the thickness of organic deposits (i.e., peat and topsoil) in the proposed Highway 17 alignment generally ranges from about 0.1 m to 4.0 m, as presented in Table 3. After clearing and grubbing the high fill/swamp crossing areas and prior to the placement of any fill for the new construction, all organic deposits should be stripped from the plan limits of the proposed works, including toe berms, if applicable. The organic materials should be removed using construction procedures in accordance with OPSS 209 (Embankments Over Swamps and Compressible Soils) where the removal and backfilling operations are carried out simultaneously. An NSSP for excavation of organics should be included in the contract documents and an example is included in Appendix D.

In areas where the new embankments are being constructed away from existing embankments, the excavation limits should be consistent with OPSD 203.010 (Embankments Over Swamp, New Construction, modified to remove the restrictions on the height of the embankment and the depth of excavation (i.e., Note A). In areas where the existing embankments are to be widened, the organics should be removed below the toe of the widened embankment in accordance with OPSD 203.020 (Embankments over Swamp, Existing Slope Excavated to 1H:1V). If space is not sufficient for the proposed slopes (as be determined by the grading), then temporary roadway protection may be required as per OPSS 539 (Temporary Protection Systems) using Performance Level 2.

All excavations must be carried out in accordance with Ontario Regulation 213 of the Ontario Occupational Health and Safety Act for Construction Projects (as amended). In addition, provisions for traffic control measures should be included in the Contract Documents to maintain the safe operation of Highway 17, St. Pothier Road and any associated side roads or detours that are in close proximity to the excavation operations.

6.6.2 Groundwater and Surface Water Control

Excavation within the plan limits of the proposed works will be required to remove organic deposits prior to embankment fill placement, which will extend below the water table. Groundwater flow into the excavations will occur due to the presence of relatively permeable deposits and relatively high groundwater levels observed in the low-lying high fill/swamp crossing areas. Unwatering is not required for the excavation and backfilling in the high fill/swamp crossing areas, however, surface water should be directed away from the excavations at all times.

6.6.3 Backfilling

In general, it is recommended that rock fill be used for replacement of the sub-excavated materials. However, in areas where wick drains are required to mitigate stability and/or post-construction settlements, it is recommended that OPSS.PROV 1010 (Aggregates) Granular 'B' Type II be used for the replacement of the sub-excavated materials. Where sub-excavation of organic deposits is being carried out as a foundation mitigation option, it will not likely be possible to place rock fill or granular fill in accordance with OPSS.PROV 206 (Grading), as discussed in Section 6.6.5. For placement below the water table, rock fill and granular fill will likely have to be end dumped as the excavation advances.

6.6.4 Embankment Fill Placement

Placement of rock fill and granular fill above the water table for construction of new embankments should be should be placed and compacted in accordance with OPSS 501 (Compacting) and with the requirements as outlined in OPSS.PROV 206 (Grading). The rock fill should not be dumped in final position, but should be deposited on and pushed forward over the end of the layer being constructed. Voids and bridging should be minimized by blading, dozing and 'chinking' the rock to form a dense, compacted mass. Side slopes for rock fill embankments should be no steeper than 1.25H:1V.

Where a surcharge fill or EPS levelling pad is required, granular fill should be placed in regular lifts with loose thickness not exceeding 300 mm and compacted to at least 95 per cent of the standard Proctor maximum dry density. Side slopes for granular fill should be no steeper than 2H:1V.

Where a large thickness of EPS is required in the embankment and a partial preload is recommended, consideration should be given to constructing the preload embankment of OPSS.PROV 1010 (Aggregates) Granular 'B' Type II at side slopes of 2H:1V.

Where the existing embankments are to be widened, the new fill should be "keyed-in" or benched into the existing embankment fills, in accordance with OPSD 208.010 (Benching of Earth Slopes).

The EPS fill should be installed in accordance with the manufacturer's requirements. It is recommended that a levelling pad comprised of a minimum 300 mm thick layer of OPSS.PROV 1010 (Aggregates) Granular 'A' be placed prior to the installation of the EPS. The EPS should be encapsulated by a 10 mil thick polyethylene sheet, and a minimum 125 mm thick reinforced concrete pad (designed by others) should be constructed on top of the EPS, followed by the placement of a protective cover/pavement structure over the EPS (for a minimum thickness of 1 m including the concrete pad, compacted granular materials and asphalt). The EPS on the side slopes of the embankments should be covered with a 2 m thick layer of conventional soil. The EPS should be placed to avoid conflict with guide rail installation, if any. Specifications to supply and install the EPS should be incorporated into an NSSP in the Contract (an example is included in Appendix D.

6.7 Slope Flattening

We understand that consideration is being given to flattening the proposed embankment rock fill slopes using surplus excavated materials, which is typically considered for all embankments under 4.5 m high as per OPSD 203.010 (Embankments Over Swamp) and OPSD 203.020 (Embankments over Swamp, Existing Slope Excavated to 1H:1V). However, depending on the type of material used, and the timing of placement of the surplus material, slope flattening may adversely affect the long-term performance of the roadway by inducing further post-construction settlement. Considerations with respect to settlement and stability are discussed below. It is assumed that the rock fill embankment side slopes will be constructed at an inclination of 1.25H:1V and that the flattened side slopes will be constructed at 3H:1V or flatter. It is also understood that the material used for the slope flattening will likely consist of the excavated organic material or other excess earth material, excavated elsewhere or locally.

6.7.1.1 Stability

In general, global stability is enhanced when side slopes are flattened, hence the FoS of the flattened embankment slopes would be greater than the FoS of the existing embankment slopes.

6.7.1.2 Settlement

Post-construction settlement of the embankments will occur as a result of placement of the excess material in the slope flattening areas of the embankments. Therefore, the timing of placement of the additional/excess material load should be considered in determining whether slope flattening should be implemented. Three scenarios are presented below for different stages of placement of the additional slope flattening material as well as the corresponding settlement implications.

1) Concurrently with construction of the embankment (in stages where required). This construction method would produce the least amount of post-construction settlement of the roadway embankment.

2) After construction of the preload embankment and prior to placement of the final surcharge and/or prior to the full preload/surcharge period. Any settlement induced prior to construction of the final roadway could be accommodated by grading operations.

3) After the preload/surcharge period is complete. This construction method imposes additional loads from the slope flattening material, which will cause immediate and long-term settlement beneath both the embankment side slopes and the roadway and is the least preferred construction method. The magnitude of the settlement could be significant, depending on the embankment geometry and subsoil conditions in the area.

6.8 Embankment Platform Widening

In accordance with the requirements of MTO Northern Region Engineering Directive NRE 98-200, Northern Region Embankment Design Guidelines, the construction of the embankments should include an allowance for platform widening (in 0.5 m increments) to accommodate settlements during construction, as well as post-construction settlements, so that the minimum standard shoulder widths are maintained if future grade raises on the embankments are required. According to NRE 98-200, the need for future raises in road grade could occur due to settlement/compression of the embankment fill, settlement of the foundation soils and to accommodate future pavement overlays up to 200 mm thick. We understand that this directive applies to all rock fill embankments, as well as for granular fill embankments, where widening restrictions are present (such as the presence of a sensitive body of water or due to space/property issues). It is further understood that the minimum required platform widening on major highways (i.e., including Highway 17) over swamp crossings is 2 m per side, unless the preferred mitigation option eliminates uncertainty regarding embankment settlement/performance (i.e., full sub-excavation to bedrock and backfilling with granular material). For non-major highways and roadways (i.e., St. Pothier Road) over swamp crossings, the minimum required platform widening is 1 m per side.

The minimum required embankment platform widening (per embankment side) is calculated based on the estimated consolidation settlement of the foundation soils (including creep) and the settlement/compression of the embankment fill plus an additional 200 mm for the future pavement overlay, multiplied by the horizontal component of the side slope of the pavement structure (4H:1V), but cannot be less than the minimum platform widening requirements as described above.

For the proposed embankments in these swamp crossing/high fill areas, the minimum platform widening values are summarized in Table 5. The initial platform widening is required to account for settlement during and post construction. The final platform widening is required to account for post-construction settlement and future overlay.

7.0 CLOSURE

This report was prepared by Mr. Evan Childerhose, P.Eng., and the technical aspects were reviewed by Ms. Sarah E. M. Poot, P.Eng., a senior geotechnical engineer and Associate of Golder. Mr. Jorge M.A. Costa, P.Eng., Golder's Designated MTO Contact for this project and a Principal of Golder, conducted an independent quality control review of the report.

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ASTM D1586	Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
ASTM D1587	Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes
ASTM D2573	Standard Test Method for Field Vane Shear Test in Cohesive Soil

Commercial Software:

GeoStudio (Version 7.19) by Geo-Slope International Ltd.

Settle^{3D} (Version 2.0) by Rocscience Inc.

Ministry of Transportation Ontario:

Embankment Settlement Criteria for Design. March 2010.

MTO Guideline for Rock Fill Settlement and Rock Fill Quantity Estimates. September 2010.

Northern Region Engineering Directive NRE 98-200. Northern Region Embankment Design Guidelines. October 1998.

Northeastern Region Geotechnical Section Memorandum. "Use of Mid-Slope Berms for Rockfill Embankments, Northeastern Region" dated February 8, 2005.

Ontario Occupational Health and Safety Act:

Ontario Regulation 213/91 Construction Projects (as amended)

Ontario Provincial Standard Drawings:

OPSD 203.010	Embankments Over Swamp – New Construction
OPSD 203.020	Embankments Over Swamp – Existing Slope Excavated to 1H:1V
OPSD 208.010	Benching of Earth Slopes

Ontario Provincial Standard Specifications:

OPSS.PROV 209	Construction Specification for Embankments Over Swamps and Compressible Soils
OPSS.PROV 501	Construction Specification for Compacting
OPSS.PROV 539	Construction Specification for Temporary Protection Systems
OPSS PROV. 206	Construction Specification for Grading
OPSS PROV. 1010	Material Specification for Aggregates – Base, Subbase, Select Subgrade and Backfill Material

Ontario Water Resources Act:

Ontario Regulation 903/90 Wells (as amended)

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
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
σ_1, σ_2, σ_3	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

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

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio $= \sigma'_p / \sigma'_{vo}$

(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
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 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

Density Index / **Relative Density**	**N** / **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	c_u, s_u 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

Table 1: Summary of High Fill Areas

Foundation Investigation Area	Foundation Investigation High Fill Area Designation	Maximum Proposed Embankment Height[1]	Boreholes/DCPTs	Appendix
Highway 17 WBL STA 12+220 to 12+570 Township of Louise	H1	5.7 m	16 Boreholes (H1-1 to H1-9, H1-11 to H1-15, C1-1 and C1-2) and 6 DCPTs (H1-DC1 to H1-DC6)	A
Highway 17 EBL STA 12+220 to 12+570 Township of Louise	H1	5.7 m	17 Boreholes (H1-16 to H1-30, C1-3, C1-4) 6 DCPTs (H1-DC7 to H1-DC12)	A
Highway 17 WBL STA 13+140 to 13+390 Township of Louise	H2	5.0 m	21 Boreholes (H2-1 to H2-21) 10 DCPTs (H2-DC1 to H2-DC10)	B
Highway 17 EBL STA 13+140 to 13+390 Township of Louise	H2	5.0 m	22 Boreholes (H2-22 to H2-43) 11 DCPTs (H2-DC11 to H2-DC21)	B
St. Pothier Road STA 9+400 to 9+600 Township of Louise	H2	4.4 m	17 Boreholes (H2-44 to H2-60) 8 DCPTs (H2-DC22 to H2-DC29)	B
Highway 17 WBL STA 13+900 to 14+200 Township of Denison	H3	3.8 m	13 Boreholes (H3-1 to H3-13) 6 DCPTs (H3-DC1 to H3-DC6)	C
Highway 17 EBL STA 13+900 to 14+200 Township of Denison	H3	3.8 m	13 Boreholes (H3-14 to H3-26) 6 DCPTs (H3-DC7 to H3-DC12)	C

Note: 1. Based on centreline of highway and existing ground surface profiles, dated February 2013. Prepared by: EC Checked by: SEMP

Table 2: Summary of Consolidation Test Parameters

Foundation Investigation Area	Borehole/ Sample No.	Elevation (m)	σ_{vo}' (kPa)	σ_p' (kPa)	$\sigma_p' - \sigma_{vo}'$ (kPa)	OCR	e_o	C_c	C_r	c_v^* (cm^2/s)	Appendix
Highway 17 EBL High Fill H1	H1-19/Sa 6	236.4	31	256	225	8.3	1.86	1.04	0.02	2.1×10^{-3}	A
Highway 17 EBL High Fill H1	H1-25/Sa 8	234.6	56	135	79	2.4	1.52	0.66	0.02	3.8×10^{-3}	
Highway 17 EBL High Fill H2	H2-26/Sa 7	233.3	39	128	89	3.2	1.67	0.48	0.01	2.0×10^{-3}	B
Highway 17 EBL High Fill H2	H2-36/Sa 8A	232.7	47	132	85	2.8	2.13	0.48	0.08	3.8×10^{-4}	
Highway 17 WBL High Fill H3	H3-12/Sa 7	231.4	97	129	32	1.3	1.13	0.41	0.02	1.3×10^{-3}	C
Highway 17 EBL High Fill H3	H3-24/Sa 9	231.3	149	149	0	1.0	1.14	0.36	0.05	1.2×10^{-3}	

Note: For the normally consolidated stress range.

Prepared by: EC

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where:
- σ_{vo}' is the in situ vertical effective overburden stress in kPa
- σ_p' is the preconsolidation stress in kPa
- OCR is the over consolidation ratio
- e_o is the initial void ratio
- C_c is the compression index
- C_r is the recompression index
- c_v is the coefficient of consolidation in cm^2/s