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SOLICITATION AMENDMENT
MODIFICATION DE L'INVITATION

The referenced document is hereby revised; unless otherwise indicated, all other terms and conditions of the Solicitation remain the same.

Ce document est par la présente révisé; sauf indication contraire, les modalités de l'invitation demeurent les mêmes.

Title - Sujet Lane Repair POE Coutts	
Solicitation No. - N° de l'invitation EP922-171435/A	**Amendment No. - N° modif.** 002
Client Reference No. - N° de référence du client CBSA EP922-171435	**Date** 2016-11-03
GETS Reference No. - N° de référence de SEAG PW-$PWU-202-10882	
File No. - N° de dossier PWU-6-39192 (202)	**CCC No./N° CCC - FMS No./N° VME**
Solicitation Closes - L'invitation prend fin **at - à** 02:00 PM **on - le** 2016-11-10	**Time Zone** **Fuseau horaire** Mountain Standard Time MST
F.O.B. - F.A.B. **Plant-Usine:** ☐ **Destination:** ☑ **Other-Autre:** ☐	
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MODIFICATION À LA DEMANDE DE SOUMISSIONS 002

Cette modification à la demande de soumissions vise à répondre aux besoins suivants :

- Questions et réponses
- Rapport géotechnique

Questions et réponses

Q1 : Comme il n'est pas pratique d'asphalter en hiver et la fourniture d'asphalte est extrêmement difficile, quelles sont les mesures temporaires recommandées pour les zones d'asphalte proposées? (p. ex. asphalte mélangé à froid à remplacer au printemps, remplacer l'asphalte par du béton...)

R1 : L'asphalte mélangé à froid est l'option recommandée, à remplacer par de l'asphalte mélangé à chaud au printemps.

Q2 : Y a-t-il une aire de dépôt, un talus de déblai et des installations temporaires que l'entrepreneur peut utiliser?

R2 : Les membres du personnel de TPSGC et du site travailleront avec l'entrepreneur retenu pour veiller à ce qu'il y ait des endroits où peuvent être entreposés du matériel, des matériaux et des déblais. Les dessins d'appel d'offres montrent également une zone dans le parc de stationnement nord pour l'aire de dépôt de l'entrepreneur.

Q3 : Les dessins montrent que le substrat rocheux doit être excavé et enlevé. Le substrat est-il facile à excaver ou est-il très dur et exigera-t-il beaucoup d'effort à excaver (gros engins)?

- Le rapport géotechnique à la disposition des soumissionnaires ?
- Indique-t-il le type et la dureté de la roche?
- Il se peut qu'EBA ait à donner plus de précisions sur la dureté du substrat rocheux.

R3 : Le rapport sera présenté sous forme de modification à la publication dans Achatetventes. Le rapport indique le type et la dureté de la roche, veuillez le rapport géotechnique attentivement.

Q4 : Quelles sont les caractéristiques du béton proposé?

R4 : Voir la section 32 13 13 du devis technique.

Q5 : La voie adjacente à l'ouest du chantier peut-elle être utilisée pour le coulage du béton (conduite du camion en béton sur cette dernière)? Au lieu d'utiliser un camion à flèche pour pomper le béton…

R5 : La voie adjacente est fermée de 22 h (HNR) à 7 h (HNR) de sorte que la voie sera ouverte pendant ces périodes. TPSGC collaborera avec l'entrepreneur et le site pour veiller à ce que l'accès à la voie soit disponible.

Q6 : Doit-on couler la voie en béton en coulées multiples ou peut-on le faire en une seule coulée?

R6 : Le but est d'une coulée avec des joints de construction sciés, une attention particulière devra être portée pour s'assurer que l'armature soit placée de sorte que les traits de scie soient au point médian de la barre d'armature.

Q7 : Y a-t-il des limites aux heures qui peuvent être travaillées sur le chantier?

R7 : Les travaux peuvent avoir lieu au chantier 24 heures par jour 7 jours sur 7, au besoin. Veuillez tenir compte du personnel de l'installation quand des travaux sont effectués à l'extérieur des heures normales de travail.

Q8 : Des lignes peuvent-elles être ajoutées au barème de prix pour les articles suivants :

- Chauffage et palissades
- Excavation du substrat rocheux

- Signaleurs/gestion de la circulation

R8 : Ceux-ci peuvent être ajoutés en tant qu'addenda aux soumissions de prix. Assurez-vous de montrer clairement où ces coûts peuvent se produire.

Q9 : Y aura-t-il des provisions supplémentaires faites pour les éléments suivants :

- Les installations sanitaires temporaires
- Génération d'électricité
- Remorque de chantier

R9 : Il incombera à l'entrepreneur de fournir :

- Des installations temporaires à ses employés.
- La génération d'électricité sur le chantier. L'électricité ne doit pas provenir de l'installation.
- Il incombe à l'entrepreneur de fournir sa propre remorque de chantier, le cas échéant.

Le coût des articles susmentionnés doit être établi en conséquence et indiqué dans le cadre de l'offre.

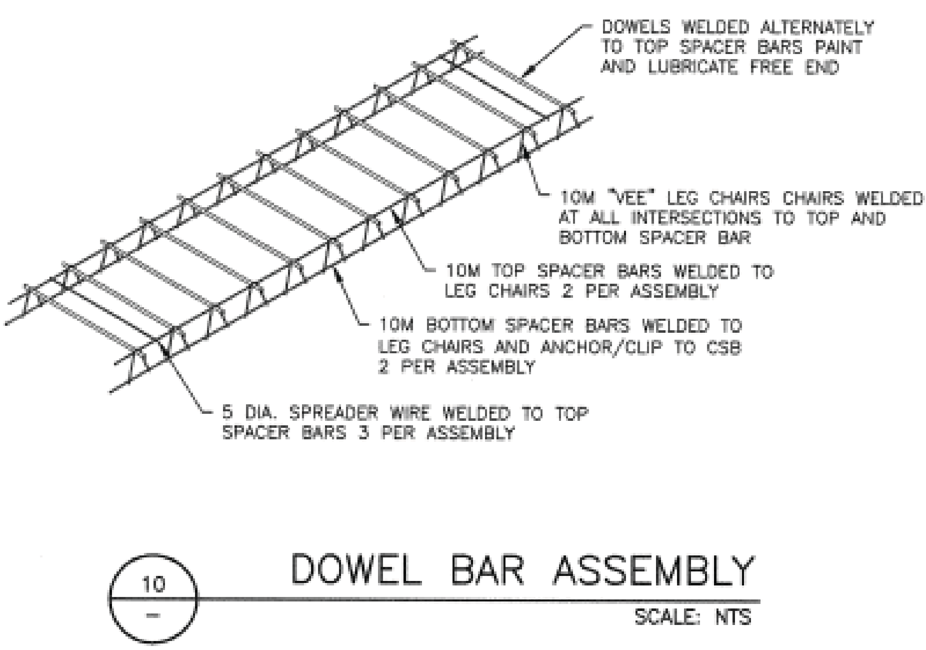
Q10 : Conditions hivernales:

- Le gel dans le substrat rocheux doit-il être complètement enlevé?
- Des appareils de chauffage peuvent-ils être laissés en marche tout le long de la journée aux fins de chauffage?

R10 : Des appareils de chauffage peuvent être laissés en marche tout le long de la journée, mais ils devraient être aussi loin des kiosques et des installations que les conditions le permettent.

Q11 : L'expert-conseil peut-il donner des détails additionnels sur les paniers à goujons?

R11 : Un détail du panier à goujons sera fourni comme modification à la publication dans Achatsetventes.



Rapport géotechnique

Pièce ci-joint.

Geotechnical Evaluation
Port of Entry Lane Repair
Coutts, Alberta



PRESENTED TO

Associated Engineering Alberta Ltd.

NOVEMBER 2015
ISSUED FOR USE
FILE: L12104011-01

CONSULTING ENGINEERS & SCIENTISTS · www.eba.ca

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442 - 10 Street N.
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Tel 403.329.9009 Fax 403.328.8817

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LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Associated Engineering Alberta Ltd. and their agents. Tetra Tech EBA Inc. (Tetra Tech EBA) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Associated Engineering Alberta Ltd., or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in Associated Engineering Alberta Ltd.'s Services Agreement. Tetra Tech EBA's General Conditions are provided in Appendix A of this report.

1.0 INTRODUCTION

This report presents the results of a geotechnical evaluation conducted by Tetra Tech EBA Inc. (Tetra Tech EBA) for the Lane Repair Port of Entry Coutts/Sweetgrass project located in Coutts, Alberta. The scope of work was outlined in a proposal issued to Mr. Bruce Thurber, of Associated Engineering Alberta Ltd. (AEAL), on September 4, 2015. The objective of this work was to determine the causes of poor pavement performance of the primary commercial truck lane and provide recommended repair and/or reconstruction options.

Authorization to proceed with the evaluation was provided by AEAL by signing the Services Agreement on November 17, 2015.

2.0 PROJECT DETAILS AND SCOPE OF WORK

It is understood that the existing Canada Border Services Agency (CBSA) facility was originally constructed in 2004. Responsibility for the roads on the Canadian side is split between Alberta Transportation and CBSA. While most of the existing roads are performing well, the final 75 m approach for the primary commercial truck lane has become severely rutted.

The scope of work for this evaluation included an investigation to determine the root causes of the pavement failure, present design options for remediation/reconstruction, and provide expected lifecycle costs for the proposed options.

The evaluation comprised drilling four (4) geotechnical boreholes, a laboratory program to assist in classification of the subsurface soils, and measurements of existing pavement distress. The laboratory testing program was reduced to only natural moisture contents, given the subgrade is comprised of sandstone bedrock. The geotechnical evaluation report provides the following pavement design and construction recommendations:

- Recommendations for granular base course and sub-base course including reuse of existing materials.
- Recommendations for subgrade preparation.
- Recommendations for backfill materials and compaction.
- Recommended construction provisions for control of groundwater.

3.0 GEOTECHNICAL FIELD AND LABORATORY WORK

The fieldwork for this evaluation was carried out on November 9, 2015 (drilling) and November 13, 2015 (coring and survey). Drilling was conducted using a truck-mounted drill rig contracted from Chilako Drilling Services Ltd. of Coaldale, Alberta. The rig was equipped with 150 mm diameter solid stem continuous flight augers. Tetra Tech EBA's field representative was Mr. Jamie LaMontagne.

The four (4) boreholes (referenced as 15BH001 through 15BH004) were drilled on the roadway to depths ranging between 1.95 m and 3.45 m below ground surface. The approximate borehole locations are shown on Figure 1.

From the boreholes, disturbed grab samples were obtained at approximate 600 mm intervals. In addition, Standard Penetration Tests (SPTs) were generally performed at depth intervals of 750 mm. All soil samples were visually classified in the field and the individual soil strata and the interfaces between them were noted. The borehole logs are presented in Appendix B. An explanation of the terms and symbols used on the borehole logs is also included in Appendix B.

Slotted 25 mm diameter PVC standpipes were installed in the boreholes to monitor groundwater levels. Auger cuttings were backfilled around the standpipes and they were sealed at ground surface with bentonite chips and sand. Following completion of groundwater monitoring, the top of the boreholes were filled with compacted cold mix asphalt.

Natural moisture content testing was performed in a laboratory on samples collected from the boreholes to aid in the determination of engineering properties. The results of the laboratory tests are presented on the borehole logs.

The existing pavement surface was surveyed in cross-section at one location (shown on Figure 1), with asphalt coring along the cross-section (as shown on Figure 2). The survey results show the depth of the rutting. The asphalt cores were examined visually, but asphalt testing was not included in the work.

4.0 PAVEMENT CONDITION INVESTIGATION

4.1 Site Conditions

The existing CBSA roadways were observed to be in good condition generally, with the only exception being the primary truck lane. The truck lane is surfaced with Asphalt Concrete Pavement (ACP) on the Canadian side, and transitions to Portland Cement Concrete Pavement (PCCP) on the American side. The final 70 m of the approach to the border crossing is heavily rutted with rut depths in the order of 100 mm (Figure 2). The PCCP on the American side of the truck lane was observed visually and appears to be performing adequately, with the exception of some cracking and patching at the transition from ACP and PCCP (Photos 1 and 2).

Relevant anecdotal information based on discussions with CBSA personnel included the following:

- It is believed that the existing PCCP was constructed along with the rest of the facility in 2004, and has a nominal thickness of 200 mm, with steel dowel bar cages used. Confirmation in the form of as-built drawings has not been received at the time of issuing this report.
- The truck lane is constructed in an area where the sandstone bedrock was blasted during construction of the facility. This information was confirmed during borehole exploration, as sandstone bedrock was encountered below the road structure.

The roads appear to have a mild crown to direct surface runoff toward gutters and with collection at catchbasins. In observing the ACP visually, no evidence of poor subgrade support was noted.

4.2 Soil Stratigraphy

It should be noted that geological conditions are innately variable. At the time of preparation of this report, information on subsurface stratigraphy was available only at discrete borehole locations. In order to develop recommendations from this information, it is necessary to make some assumptions concerning conditions other than at borehole locations. Adequate field reviews should be provided during construction to check that these assumptions are reasonable.

The general subsurface stratigraphy for the property was comprised of a surficial ACP overlying a layer of gravel base course, overlying sandstone bedrock.

The following sections provide a summary of the stratigraphic units encountered at the project site at the specific borehole locations. A more detailed description is provided on the borehole logs provided in Appendix B.

4.2.1 Granular Base Material

The existing granular base material encountered at the borehole locations was described as a 20 mm nominal maximum size, sandy, trace silt, well graded, subangular and angular, damp, dense, and dark brown in colour. The gravel thickness was measured as approximately 230 mm in 15BH001 through 15BH003, and approximately 200 mm in 15BH004. Natural moisture contents measured from gravel samples ranged between 3.2% and 3.6%.

At the core locations, gravel with maximum nominal sizes up to approximately 50 mm was noted just below the asphalt, and appeared to be rounded to subrounded in shape. It is postulated that a surficial layer of pit run gravel may have been used as a levelling course in this area.

Based on the above information, the existing granular base material is likely suitable for reuse for the proposed reconstruction. Select removal of pit run type material (material that is rounded, poorly graded, etc.) may be necessary, as only well-graded 20 mm crushed gravel is recommended for granular base course. Additional discussion of granular base material is provided in Section 5.

4.2.2 Bedrock

Underlying the granular base material, sandstone bedrock was encountered and extended to borehole termination depths. The sandstone was described as silty, fine grained, very weak to weak, weathered, dry to damp, and yellowish brown in colour. Natural moisture contents were measured from samples of sandstone and ranged between 11% and 14%.

The bedrock strength was not tested in the laboratory, but based on visual observations, SPTs, and drill rig resistance, approximate strength descriptions were provided. The descriptors “very weak” and “weak” correspond to unconfined compressive strengths of between 1 MPa to 5 MPa, and 5 MPa to 25 MPa, respectively.

4.3 Groundwater Conditions

At the time of drilling, no seepage or sloughing was encountered at the borehole locations. The groundwater levels were measured dry on November 13, 2015. Based on the groundwater monitoring data obtained, it appears that groundwater is not a problem at the subject site; however, groundwater levels normally fluctuate seasonally and in response to climatic conditions.

4.4 Asphalt Concrete Pavement Surfacing

Asphalt coring indicated thicknesses varying between 127 mm and 133 mm both within the wheel paths and at the edge of the lane (well outside the wheel paths and beyond the pavement ruts). The asphalt thickness within the centre portion between the wheel paths was measured as 190 mm. Asphalt core thicknesses are presented on Figure 2. The existing asphalt was measured at the borehole locations as having a thickness of approximately 170 mm. The boreholes were drilled in the centre of the roadway, between the wheel paths.

Based on visual observations of the asphalt core samples, the following comments are presented for consideration:

- It appears the mix had a nominal aggregate size of approximately 10 mm.
- Voids were noted in the cores taken outside the wheel paths, suggesting poor compaction at time of construction.
- Asphalt binder content may have been high, making the mix more flexible and more susceptible to rutting under heavy loading.

The rutting within the wheel paths was measured using a survey rod and level. Maximum rut depths in each wheel path were measured as 97 mm and 110 mm. It was determined that the rutting is comprised of a combination of compaction within the wheel paths and bulging adjacent to the wheel paths. Survey of the gravel beneath asphalt cores indicated a relatively level gravel surface.

Given that the underlying granular base and bedrock subgrade are providing excellent stability, it appears the asphalt is effectively being forced laterally away from the wheel paths, accumulating on either side.

Based on the above observations, it appears the ACP mix used for the truck lane may not have been suitable. A more rut resistant mix would incorporate a premium asphalt binder. Poor construction may have also played a role, as voids were visible within the core samples.

5.0 PAVEMENT DESIGN RECOMMENDATIONS

5.1 General

All design and construction recommendations presented in this report are based on the assumption that an adequate level of monitoring will be provided during construction and that all construction will be carried out by a suitably qualified Contractor, experienced in earthworks and roadway construction. An adequate level of monitoring for earthworks construction is considered to be full-time monitoring, compaction testing, and laboratory materials analyses.

All such monitoring should be carried out by suitably qualified persons, independent of the Contractor. One of the purposes of providing an adequate level of monitoring is to check that recommendations, based on data obtained at discrete borehole locations, is relevant to other areas along the proposed roadway reconstruction.

The design options are based on a 25 year design life. With all reconstruction options, it is imperative that positive surface drainage of both subgrade and pavement surfacing be maintained. All joints must be sealed to prevent ponding of water and reduce infiltration. Special care and attention should be given to surface grading and sealing of joints where stormwater is directed over the roadway. Recommended minimum grades of 1.0% should be used in hard surfaced areas.

5.2 Design Inputs

All design recommendations are based on information provided in the Terms of Reference (TOR) document issued by Public Works and Government Services Canada (PWGSC), dated August 26, 2015. The traffic loading conditions are based on the 150,000 trucks per year (taken from the TOR document). In addition Alberta Transportation's (AT) Historical Equivalent Single Axle Loading (ESAL) Report (2014 Edition) was also utilized in developing a design traffic loading for the project. No construction drawings were made available for the existing road structures at the time of issuing this report. The following design inputs were calculated using the available information, with assumptions outlined as follows:

- The AT data for the 2014 traffic loading, in terms of ESALs per day per direction for Highway (Hwy) 4:02 at Coutts, identifies 710 ESALs/day/direction which was used for design. This was validated using the 150,000 trucks per year statistic provided in the TOR.
- An assumed annual traffic growth rate of 2.0% was used. Note that review of AT's historical data indicated an average growth rate of 2.2% for the past ten years of data.
- A design period of 25 years was used, as per the TOR.

Based on the above information, the design ESAL was determined to be $8.3x10^6$.

For pavement design the following design inputs were used:

- Assumed reliability of 90%, with Standard Deviation (S_o) of 0.45.
- Assumed Initial Serviceability Index of 4.2, and Final Serviceability Index of 2.5.
- Based on correlation from SPTs conducted in the sandstone bedrock, a Resilient Modulus (Mr) of 90 MPa was used. For the PCCP design, the modulus of subgrade reaction was taken as 200 MPa/m.

The computed Structural Number (SN) required to meet the design ESAL and subgrade support conditions is 101.

5.3 Option 1 – Portland Cement Concrete Pavement [PCCP] Design with Existing Granular Base

The first option, and most likely to meet the 25 year design life, is the plain doweled PCCP option. Upon removal of the existing ACP surface, the underlying granular base materials should be scarified, moisture conditioned, and recompacted to 100% of Standard Proctor Maximum Dry Density (SPD).

The PCCP design for this project was based on the volume of truck traffic loading provided in the TOR document. The design thickness for the PCCP is 230 mm with smooth dowel bars providing load transfer on the transverse joints.

The top of the subgrade is approximately 400 mm below the top of the existing asphalt (measured at the edge of the lane where traffic is minimal). Following removal of the ACP surface and subcut of the granular base to make room for 230 mm thick PCCP, it is anticipated that the remaining granular base will have a nominal thickness of approximately 170 mm. Sufficient thickness of the granular base to act as a buffer between the top of the bedrock and the underside of the concrete is important due to the potential for non-uniform bedrock strengths and support. The expected minimum granular base course thickness of 170 mm is likely sufficient.

Given the existing ACP lane measures 4.0 m in width (based on paint lines), the PCCP should include transverse sawcut contraction joints spaced at 4.0 m. This spacing will provide for square panels which generally perform favourably compared to longer rectangular panels. The proposed PCCP panel width is slightly wider than the existing panel widths observed on the American side of the border crossing (widths varied between 2.3 m to 2.8 m). This difference in panel width should be address in the detailed design.

The termination of the PCCP on the American side of the border is distressed. It has been assumed that repairs to this area are outside the current scope of preliminary design.

Load transfer devices at transverse joints is recommended to reduce faulting. Smooth epoxy coated steel dowels, 32 mm in diameter by 450 mm in length, spaced at 300 mm, placed at mid-depth within the slab are required. Dowels should be placed using a prefabricated dowel baskets to ensure they are oriented perpendicular to the joint and parallel to the pavement surface. Both ends of the PCCP should be thickened by 20% to provide increased strength at the free edges of the pavement.

If more than one truck lane is to be paved, details for the longitudinal joints between panels should be reviewed. Typically, longitudinal joints include 15M tie bars 600 mm in length, spaced 900 mm on centre. The longitudinal tie bars should be installed using gang drills and fixed in place with epoxy. A minimum clearance of 400 mm should be maintained at transverse joints. No longitudinal joints should be placed within wheel paths.

The finished PCCP should be textured by constructing longitudinal grooves to within 75 mm of the edge of the PCCP surface. A curing compound should be applied to the PCCP surface in two successive applications within 20 minutes of completion of finishing operations.

Detailed concrete specifications are beyond the scope of this work; however, the use of a high performance mix is recommended. The design is based on a 28-day flexural strength of 4.5 MPa. This typically requires a compressive strength of 35 MPa at 28 days. In the absence of a performance history, trial batching will be required to confirm flexural strength.

Design and construction should comply with Alberta Infrastructure and Transportation Specifications for Highway Construction, Supplemental Specification Section 3.70 - Portland Cement Concrete Pavement. Section 3.70 is intended for larger paving projects, and special provisions to the contract should be considered based on the relatively small size and duration of this project.

5.4 Option 2 – Asphalt Concrete Pavement [ACP] Design with Granular Base

The second option, which is considered less likely to meet the 25 year design life without significant maintenance, is to replace the existing ACP surface with a more suitable, rut resistant ACP material. The recommended material is a premium mix, Superpave 12.5 mm Nominal Maximum Size (NMS) using PG 70 -34, polymer modified asphalt. A total thickness of 200 mm placed in three lifts is recommended.

Given the top of the bedrock at approximately 400 mm below the top of the existing pavement, the 200 mm thick ACP surface will allow for 200 mm of existing granular base course with a reduced structural contribution. The computed SN for this design was 102.

The existing granular base material may be reused, but should be scarified, moisture conditioned, and recompacted to 100% of SPD. The prepared granular base should be proof-rolled to identify soft areas before paving.

Full removal of the existing bituminous surface is recommended. Recycling the bituminous surfacing material is not recommended. Replacement asphalt should comprise new material only, sourced from a reputable contractor with experience in asphalt pavement construction.

The surface of the granular base course must have an asphalt prime coat of SS 1, or its equivalent, applied prior to the placement of asphalt concrete.

Observation of compaction and asphalt laying operations should be carried out by staff of Tetra Tech EBA. The travel distance from batch plant to site should be considered, and a plan should be in place to keep the asphalt well within its required temperatures upon arrival so that proper compaction can be achieved.

Maintenance for this option will include milling to remove the upper 60 mm, and inlay with the same premium polymer modified ACP at Year 12, and again at Year 22. Periodic crack sealing should also be expected on an as-needed basis.

5.5 Option 3 – Full Depth Reconstruction with Portland Cement Concrete Pavement [PCCP]

This option is similar in design to Option 1, except it includes full removal of the existing structure including all granular base material. The subgrade should be subcut an additional 100 mm to allow for a minimum 270 mm thickness of granular base course to mitigate risk of non-uniform bedrock support which may lead to premature PCCP cracking.

The structure includes 230 mm concrete surfacing, overlying 270 mm of granular base course, overlying shattered sandstone bedrock. All other recommendations from Option 1 apply here.

The weathered sandstone is likely rippable with heavy equipment. The presence of stronger layers requiring the use of a breaker such as a hoe ram is a possibility.

6.0 LIFECYCLE COST ANALYSIS

A cost estimate has been prepared based on unit prices taken from other recent projects in Alberta. The estimate is intended to be used for comparison of the three options only. Detailed estimates from contractor bids may vary greatly from the numbers provided here. It should be noted that the estimates are based on unit prices for projects of varying size which may include some efficiencies gained due to economies of scale on larger projects. As this project is relatively small, the prices may vary. The following summary excludes removal of the existing pavement surfacing, as that cost must be carried for all three options.

Table A: Pavement Cost Comparison

Option	Surfacing	Subcut Subgrade & Replace GBC	Mill & Inlay 60 mm @ Years 12 and 22	Maintenance (Crack Repair)	Total Cost
Option 1 (PCCP Resurface)	$140,000	-	-	$3,000	$143,000
Option 2 (ACP Resurface)	$35,882	-	$17,640	$600	$54,122
Option 3 (PCCP Reconstruction)	$140,000	$17,220	-	$375	$157,595

GBC = Granular Base Course

Note that the above costs are in present day dollars. Future costs for rehabilitation and maintenance have not been discounted to present value and doing so would not significantly change the outcomes.

7.0 DESIGN AND CONSTRUCTION GUIDELINES

General design and construction guidelines are provided in Appendix C, under the following supplemental heading:

- Backfill Materials and Compaction

These guidelines are intended to present standards of good practice. Although supplemental to the main text of this report, they should be interpreted as part of the report. Design recommendations presented herein are based on the premise that these guidelines will be followed. The design and construction guidelines are not intended to represent detailed specifications for the works although they may prove useful in the preparation of such specifications. In the event of any discrepancy between the main text of this report and Appendix C, the main text should govern.

8.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech EBA Inc.

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TETRA TECH EBA INC.
Signature
Date
PERMIT NUMBER: P245
The Association of Professional Engineers and Geoscientists of Alberta

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/tlp

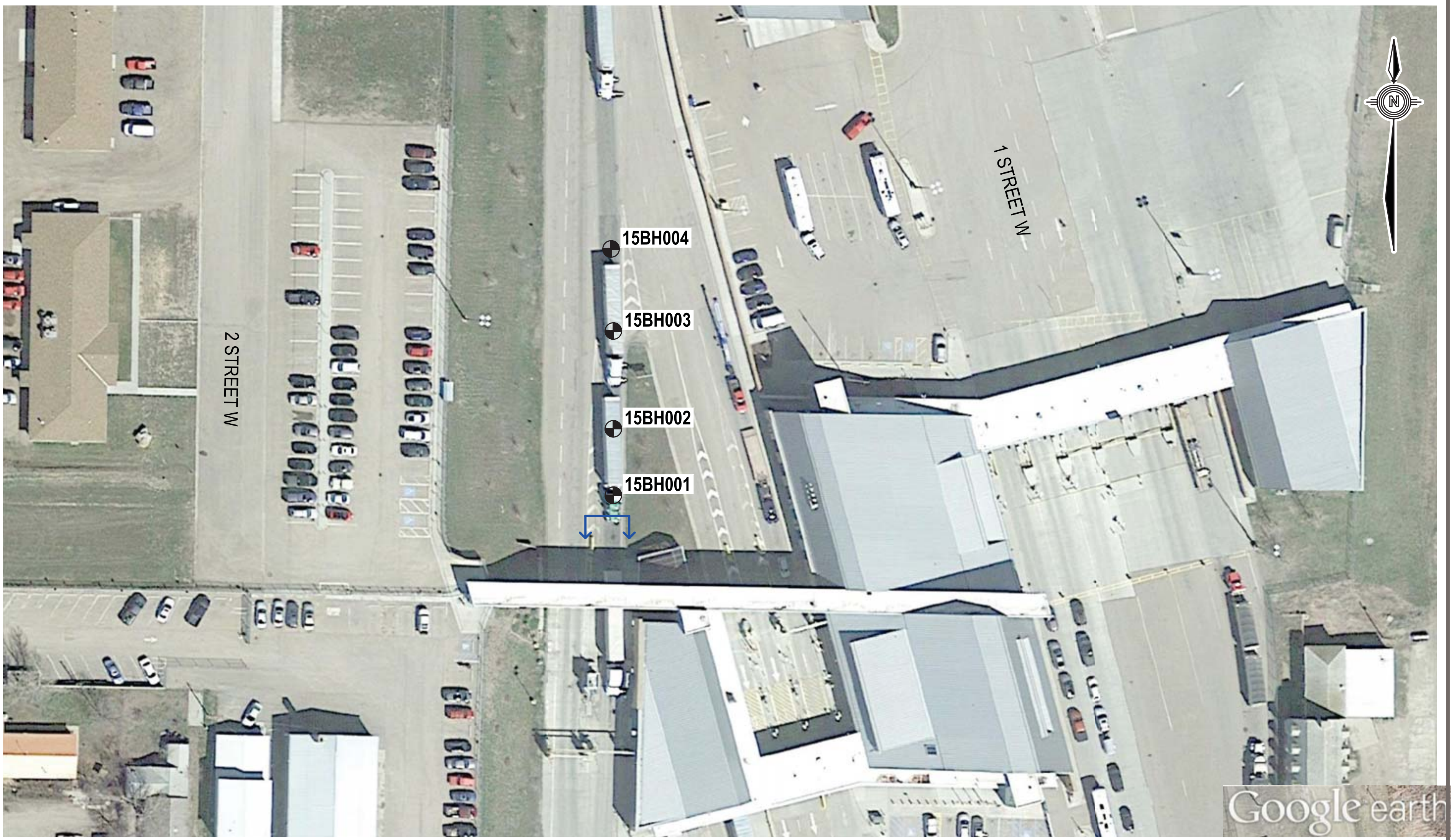
REFERENCES

American Association of State Highway and Transportation Officials Guide for the Design of Pavement Structures 1993 (AASHTO 1993).

Alberta Transportation Pavement Design Manual, Edition 1, 1997, with updates.

FIGURES

C:\Riverbend\Drafting\L121\L12104011\L12104011-01 Figure 1.dwg [FIGURE 1] November 22, 2015 - 8:59:46 pm (BY: HUGHES, LEANNE)



LEGEND

BOREHOLE LOCATION

CROSS SECTION

0 50m

Scale: 1:1,000 @ 8.5"x11"

CLIENT

Associated Engineering Alberta Ltd.

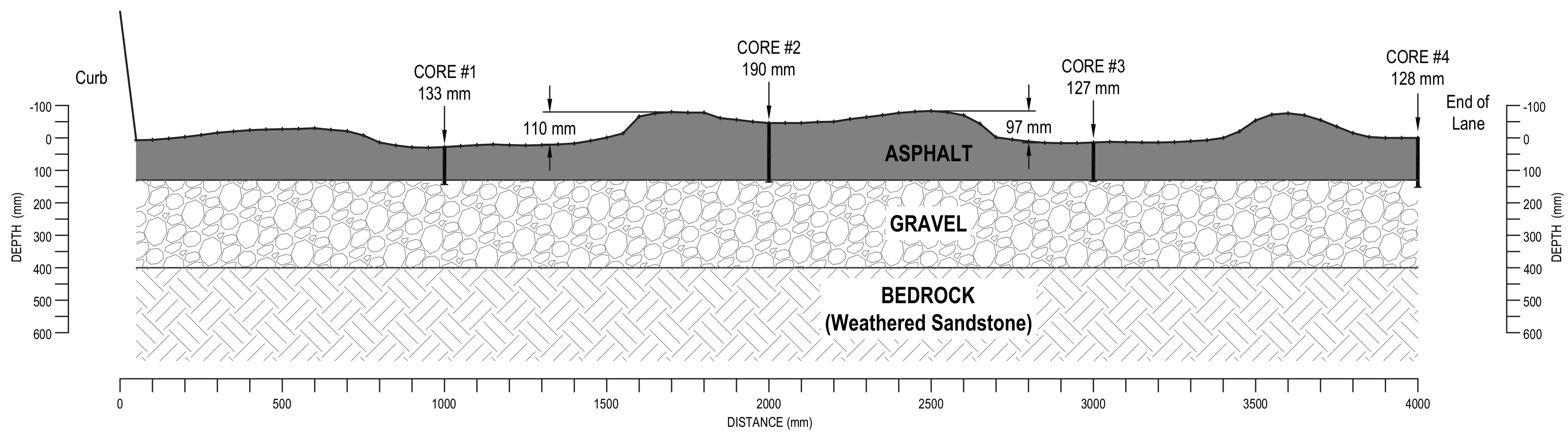
TETRA TECH EBA

LANE REPAIR PORT OF ENTRY COUTTS/SWEETGRASS

BOREHOLE LOCATION PLAN

PROJECT NO.	DWN	CKD	REV
L12104011-01	LCH	TC	0
OFFICE	DATE		
LETHBRIDGE	November 2015		

Figure 1



NOTE
DEPTH ZERO IS REFERENCED TO ASPHALT SURFACE AT END OF LANE.

0 — 1m
Scale: 1:20 @ 8.5"x11"

CLIENT
Associated Engineering Alberta Ltd.

TETRA TECH EBA

LANE REPAIR PORT OF ENTRY COUTTS/SWEETGRASS

ROAD SECTION

PROJECT NO.	DWN	CKD	REV
L12104011-01	LCH	TC	0

OFFICE	DATE
LETHBRIDGE	November 2015

Figure 2

PHOTOGRAPHS

Photo 1 View of the ACP on the Canadian side, and PCCP on the American side. Note rutting in the ACP, and cracking of the PCCP at the transition. The PCCP is otherwise in good condition.

Photo 2 View of the lane cross-section surveyed (Figure 2). Four cores were taken along the white line – two in the wheel paths, one between the wheel paths, and one at the far edge of the lane.

Photo 1: View of the ACP on the Canadian side, and PCCP on the American side. Note rutting in the ACP, and cracking of the PCCP at the transition. The PCCP is otherwise in good condition.

Photo 2: View of the lane cross-section surveyed (Figure 2). Four cores were taken along the white line – two in the wheel paths, one between the wheel paths, and one at the far edge of the lane.

APPENDIX A

GEOTECHNICAL REPORT - GENERAL CONDITIONS

GENERAL CONDITIONS

GEOTECHNICAL REPORT

This report incorporates and is subject to these “General Conditions”.

1.0 USE OF REPORT AND OWNERSHIP

This geotechnical report pertains to a specific site, a specific development and a specific scope of work. It is not applicable to any other sites nor should it be relied upon for types of development other than that to which it refers. Any variation from the site or development would necessitate a supplementary geotechnical assessment.

This report and the recommendations contained in it are intended for the sole use of Tetra Tech EBA’s Client. Tetra Tech EBA does not accept any responsibility for the accuracy of any of the data, the analyses or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than Tetra Tech EBA’s Client unless otherwise authorized in writing by Tetra Tech EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of Tetra Tech EBA. Additional copies of the report, if required, may be obtained upon request.

2.0 ALTERNATE REPORT FORMAT

Where Tetra Tech EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed Tetra Tech EBA’s instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by Tetra Tech EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of Tetra Tech EBA’s instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except Tetra Tech EBA. Tetra Tech EBA’s instruments of professional service will be used only and exactly as submitted by Tetra Tech EBA.

Electronic files submitted by Tetra Tech EBA have been prepared and submitted using specific software and hardware systems. Tetra Tech EBA makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.

3.0 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, Tetra Tech EBA has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

4.0 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. Tetra Tech EBA does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

5.0 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

6.0 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of testholes and/or soil/rock exposures. Stratigraphy is known only at the locations of the testhole or exposure. Actual geology and stratigraphy between testholes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. Tetra Tech EBA does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

7.0 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

8.0 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

9.0 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

10.0 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

11.0 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

12.0 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

13.0 SAMPLES

Tetra Tech EBA will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

14.0 INFORMATION PROVIDED TO TETRA TECH EBA BY OTHERS

During the performance of the work and the preparation of the report, Tetra Tech EBA may rely on information provided by persons other than the Client. While Tetra Tech EBA endeavours to verify the accuracy of such information when instructed to do so by the Client, Tetra Tech EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

APPENDIX B
BOREHOLE LOGS

TERMS USED ON BOREHOLE LOGS

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on 0.075mm sieve): Includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as inferred from laboratory or in situ tests.

DESCRIPTIVE TERM	RELATIVE DENSITY	N (blows per 0.3m)
Very Loose	0 TO 20%	0 to 4
Loose	20 TO 40%	4 to 10
Compact	40 TO 75%	10 to 30
Dense	75 TO 90%	30 to 50
Very Dense	90 TO 100%	greater than 50

The number of blows, N, on a 51mm O.D. split spoon sampler of a 63.5kg weight falling 0.76m, required to drive the sampler a distance of 0.3m from 0.15m to 0.45m.

FINE GRAINED SOILS (major portion passing 0.075mm sieve): Includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as estimated from laboratory or in situ tests.

DESCRIPTIVE TERM	UNCONFINED COMPRESSIVE STRENGTH (KPA)
Very Soft	Less than 25
Soft	25 to 50
Firm	50 to 100
Stiff	100 to 200
Very Stiff	200 to 400
Hard	Greater than 400

NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil.

GENERAL DESCRIPTIVE TERMS

Slickensided - having inclined planes of weakness that are slick and glossy in appearance.
Fissured - containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
Laminated - composed of thin layers of varying colour and texture.
Interbedded - composed of alternate layers of different soil types.
Calcareous - containing appreciable quantities of calcium carbonate.;
Well graded - having wide range in grain sizes and substantial amounts of intermediate particle sizes.
Poorly graded - predominantly of one grain size, or having a range of sizes with some intermediate size missing.

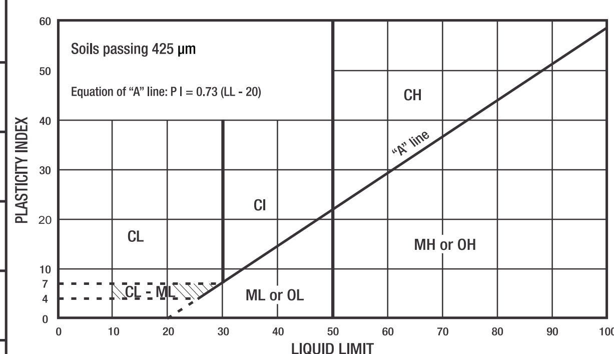
MODIFIED UNIFIED SOIL CLASSIFICATION

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE-GRAINED SOILS More than 50% retained on 75 µm sieve*	GRAVELS 50% or more of coarse fraction retained on 4.75 mm sieve	CLEAN GRAVELS	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	$C_U = D_{60} / D_{10}$ Greater than 4 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines	Not meeting both criteria for GW	
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures	Atterberg limits plot below “A” line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures	Atterberg limits plot above “A” line or plasticity index greater than 7	
	SANDS More than 50% of coarse fraction passes 4.75 mm sieve	CLEAN SANDS	SW	Well-graded sands and gravelly sands, little or no fines	$C_U = D_{60}/D_{10}$ Greater than 6 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			SP	Poorly graded sands and gravelly sands, little or no fines	Not meeting both criteria for SW	
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures	Atterberg limits plot below “A” line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures	Atterberg limits plot above “A” line or plasticity index greater than 7	
FINE-GRAINED SOILS (by behavior) 50% or more passes 75 µm sieve*	SILTS	Liquid limit <50	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands of slight plasticity		
		Liquid limit >50	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts		
	CLAYS Above “A” line on plasticity chart negligible organic content	Liquid limit <30	CL	Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays		
		Liquid limit 30-50	CI	Inorganic clays of medium plasticity, silty clays		
		Liquid limit >50	CH	Inorganic clays of high plasticity, fat clays		
	ORGANIC SILTS AND CLAYS	Liquid limit <50	OL	Organic silts and organic silty clays of low plasticity		
		Liquid limit >50	OH	Organic clays of medium to high plasticity		
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils		

Classification on basis of percentage of fines:
Less than 5% Pass 75 µm sieve — GW, GP, SW, SP
More than 12% Pass 75 µm sieve — GM, GC, SM, SC
5% to 12% Pass 75 µm sieve — Borderline Classification requiring use of dual symbols

For classification of fine-grained soils and fine fraction of coarse-grained soils.

PLASTICITY CHART



*Based on the material passing the 75 mm sieve
Reference: ASTM Designation D2487, for identification procedure see D2488. USC as modified by PFRA

SOIL COMPONENTS				
FRACTION	SIEVE SIZE		DEFINING RANGES OF PERCENTAGE BY MASS OF MINOR COMPONENTS	
	PASSING	RETAINED	PERCENTAGE	DESCRIPTOR
GRAVEL coarse	75 mm	19 mm	>35 %	“and”
GRAVEL fine	19 mm	4.75 mm	21 to 35 %	“y-adjective”
SAND coarse	4.75 mm	2.00 mm	10 to 20 %	“some”
SAND medium	2.00 mm	425 µm	>0 to 10 %	“trace”
SAND fine	425 µm	75 µm		
SILT (non plastic) or CLAY (plastic)	75 µm		as above but by behavior	

OVERSIZE MATERIAL	
Rounded or subrounded	
COBBLES	75 mm to 300 mm
BOULDERS	> 300 mm
Not rounded	
ROCK FRAGMENTS	>75 mm
ROCKS	> 0.76 cubic metre in volume

Tt_Modified Unified Soil Classification.cdr

TETRA TECH

Keysheet

Soil Compactness/Consistency

COARSE GRAINED SOIL

Description	SPT N-Value[1] (blows per 0.3 m)
Very Loose	< 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	> 50

FINE GRAINED SOIL

Description	Undrained Shear Strength (kPa)
Very Soft	< 12
Soft	12 to 25
Firm	25 to 50
Stiff	50 to 100
Very Stiff	100 to 200
Hard	> 200

References: As per Canadian Geotechnical Foundation Engineering Manual 4th Edition, Canadian Geotechnical Society (2006)

Water Level Measurement

- Measured in standpipe, piezometer or well
- Inferred

Sample Types

- A-Casing
- Core
- Disturbed, Bag, Grab
- HQ Core
- Jar
- Jar and Bag
- NQ Core
- No Recovery
- Split Spoon/SPT
- Tube

Backfill Materials

- Asphalt
- Bentonite
- Cement
- Drill Cuttings
- Grout
- Gravel
- Sand
- Slough
- Topsoil Backfill

Lithology - Graphical Legend[2]

- Asphalt
- Bedrock
- Cobbles/Boulders
- Clay
- Coal
- Concrete
- Fill
- Gravel
- Limestone
- Mudstone
- Organics
- Peat
- Sand
- Sandstone
- Shale
- Silt
- Siltstone
- Till
- Topsoil

1. Refer to ASTM D1586 for definition of N. The N-values reported on the logs are the uncorrected (field-measured) values.
2. The graphical legend is an approximation and for visual representation only. Soil strata may comprise a combination of the basic symbols shown above. Particle sizes are not drawn to scale

TETRA TECH EBA

ASSOCIATED ENGINEERING

Borehole No: **15BH001**

Project: LANE REPAIR COUTTS	Project No: 704-L12104011
Location: COUTTS BORDER CROSSING	Ground Elev: 1067.32 m
COUTTS, ALBERTA	Project Engineer: TREVOR CURTIS

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	SPT (N) 20 40 60 80 / Pocket Pen. (kPa) 100 200 300 400	15BH001	Elevation (m)
0		ASPHALT CONCRETE (170 mm)								
		GRAVEL (FILL) - sandy, trace silt, well graded, sizes to 20 mm, subangular and angular, damp, dense, dark brown.		B1		3.4				1067
		BEDROCK - sandstone, silty, fine grained, medium to high strength, dry to damp, yellowish brown, weathered.		B2		10.8				
				D1	50 /127mm			>100		
1				B3		12				1066
				D2	50 /102mm			>100		
2		... fine to medium grained, greyish white.		B4		13.5				1065
				B5		13.7				
3				D3	50 /102mm			>100		1064
		End of Borehole at 3.45 m 25 mm PVC Standpipe Installed to 3.45 m No Seepage or Sloughing Upon Completion Borehole Measured Dry November 13, 2015								
4										

TETRA TECH EBA

Contractor: CHILAKO DRILLING SERVICES LTD.	Completion Depth: 3.5 m
Drilling Rig Type: 150 mm SOLID STEM AUGER	Start Date: 2015 November 09
Logged By: JL	Completion Date: 2015 November 09
Reviewed By: JZ	Page 1 of 1

ASSOCIATED ENGINEERING

Borehole No: **15BH002**

Project: LANE REPAIR COUTTS	Project No: 704-L12104011
Location: COUTTS BORDER CROSSING	Ground Elev: 1067.34 m
COUTTS, ALBERTA	Project Engineer: TREVOR CURTIS

Depth (m)	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)
0	ASPHALT CONCRETE (170 mm)				
	GRAVEL (FILL) - sandy, trace silt, well graded, sizes to 20 mm, subangular and angular, damp, dense, dark brown.	Bulk	B1		3.6
	BEDROCK - sandstone, silty, fine grained, very weak to weak, dry to damp, yellowish brown, weathered.	Bulk	B2		11
		SPT	D1	26	
1		Bulk	B3		11.5
	... weak.	SPT	D2	50 /102mm	
2	End of Borehole at 1.95 m				

25 mm PVC Standpipe Installed to 1.95 m
No Seepage or Sloughing Upon Completion
Borehole Measured Dry November 13, 2015

Plastic Limit — Moisture Content — Liquid Limit (20, 40, 60, 80)

■ SPT (N) ■ (20, 40, 60, 80): >100

▲ Pocket Pen. (kPa) ▲ (100, 200, 300, 400)

15BH002

Elevation (m): 1067, 1066, 1065, 1064

Depth (m): 0, 1, 2, 3, 4

TETRA TECH EBA

Contractor: CHILAKO DRILLING SERVICES LTD.	Completion Depth: 2 m
Drilling Rig Type: 150 mm SOLID STEM AUGER	Start Date: 2015 November 09
Logged By: JL	Completion Date: 2015 November 09
Reviewed By: JZ	Page 1 of 1

ASSOCIATED ENGINEERING

Borehole No: **15BH003**

Project: LANE REPAIR COUTTS	Project No: 704-L12104011
Location: COUTTS BORDER CROSSING	Ground Elev: 1067.08 m
COUTTS, ALBERTA	Project Engineer: TREVOR CURTIS

Depth (m)	Soil Description
0	ASPHALT CONCRETE (170 mm)
	GRAVEL (FILL) - sandy, trace silt, well graded, sizes to 20 mm, subangular and angular, damp, dense, dark brown.
	BEDROCK - sandstone, silty, fine grained, weak, dry to damp, yellowish brown, weathered.
2	... fine to medium grained, greyish white.
	End of Borehole at 3.45 m 25 mm PVC Standpipe Installed to 3.45 m No Seepage or Sloughing Upon Completion Borehole Measured Dry November 13, 2015

Sample Number	SPT (N)	Moisture Content (%)
B1		3.2
B2		11.6
D1	50 /75mm	
B3		11.9
D2	50 /25mm	
B4		12.1
B5		11.9
D3	50 /38mm	

SPT (N): >100 (D1), >100 (D2), >100 (D3)

Plot axes: Plastic Limit – Moisture Content – Liquid Limit (20, 40, 60, 80); SPT (N) (20, 40, 60, 80); Pocket Pen. (kPa) (100, 200, 300, 400)

Depth (m): 0, 1, 2, 3, 4 — Elevation (m): 1067, 1066, 1065, 1064

Contractor: CHILAKO DRILLING SERVICES LTD.	Completion Depth: 3.5 m
Drilling Rig Type: 150 mm SOLID STEM AUGER	Start Date: 2015 November 09
Logged By: JL	Completion Date: 2015 November 09
Reviewed By: JZ	Page 1 of 1

TETRA TECH EBA

ASSOCIATED ENGINEERING

Borehole No: **15BH004**

Project: LANE REPAIR COUTTS	Project No: 704-L12104011
Location: COUTTS BORDER CROSSING	Ground Elev: 1067.15 m
COUTTS, ALBERTA	Project Engineer: TREVOR CURTIS

Soil Description	Sample Number	SPT (N)	Moisture Content (%)	Pocket Pen. (kPa) / SPT (N) plot
ASPHALT CONCRETE (170 mm)				
GRAVEL (FILL) - sandy, trace silt, well graded, sizes to 20 mm, subangular and angular, damp, dense, dark brown.	B1		3.4	
BEDROCK - sandstone, silty, fine grained,weak, dry to damp, yellowish brown, weathered.	B2		12.2	
	D1	50 /76mm		>100
	B3		10.6	
	D2	50 /76mm		>100
End of Borehole at 1.95 m				

25 mm PVC Standpipe Installed to 1.95 m
No Seepage or Sloughing Upon Completion
Borehole Measured Dry November 13, 2015

Depth (m): 0, 1, 2, 3, 4 — Elevation (m): 1067, 1066, 1065, 1064

Plot scales: Plastic Limit / Moisture Content / Liquid Limit 20, 40, 60, 80; SPT (N) 20, 40, 60, 80; Pocket Pen. (kPa) 100, 200, 300, 400

TETRA TECH EBA

Contractor: CHILAKO DRILLING SERVICES LTD.	Completion Depth: 2 m
Drilling Rig Type: 150 mm SOLID STEM AUGER	Start Date: 2015 November 09
Logged By: JL	Completion Date: 2015 November 09
Reviewed By: JZ	Page 1 of 1

APPENDIX C
RECOMMENDED GENERAL DESIGN AND CONSTRUCTION GUIDELINES

CONSTRUCTION GUIDELINE

BACKFILL MATERIALS AND COMPACTION (GENERAL)

1.0 DEFINITIONS

"Landscape fill" is typically used in areas such as berms and grassed areas where settlement of the fill and noticeable surface subsidence can be tolerated. "Landscape fill" may comprise soils without regard to engineering quality.

"General engineered fill" is typically used in areas where a moderate potential for subgrade movement is tolerable, such as asphalt (i.e., flexible) pavement areas. "General engineered fill" should comprise clean, granular or clay soils.

"Select engineered fill" is typically used below slabs-on-grade or where high volumetric stability is desired, such as within the footprint of a building. "Select engineered fill" should comprise clean, well-graded granular soils or inorganic low to medium plastic clay soils.

"Structural engineered fill" is used for supporting structural loads in conjunction with shallow foundations. "Structural engineered fill" should comprise clean, well-graded granular soils.

"Lean-mix concrete" is typically used to protect a subgrade from weather effects including excessive drying or wetting. "Lean-mix concrete" can also be used to provide a stable working platform over weak subgrades. "Lean-mix concrete" should be low strength concrete having a minimum 28-day compressive strength of 3.5 MPa.

Standard Proctor Density (SPD) as used herein means Standard Proctor Maximum Dry Density (ASTM Test Method D698). Optimum moisture content is defined in ASTM Test Method D698.

2.0 GENERAL BACKFILL AND COMPACTION RECOMMENDATIONS

Exterior backfill adjacent to abutment walls, basement walls, grade beams, pile caps and above footings, and below highway, street, or parking lot pavement sections should comprise "general engineered fill" materials as defined above.

Exterior backfill adjacent to footings, foundation walls, grade beams and pile caps and within 600 mm of final grade should comprise inorganic, cohesive "general engineered fill". Such backfill should provide a relatively impervious surficial zone to reduce seepage into the subsoil against the structure.

Backfill should not be placed against a foundation structure until the structure has sufficient strength to withstand the earth pressures resulting from placement and compaction. During compaction, careful observation of the foundation wall for deflection should be carried out continuously. Where deflections are apparent, the compactive effort should be reduced accordingly.

In order to reduce potential compaction induced stresses, only hand-held compaction equipment should be used in the compaction of fill within 1 m of retaining walls or basement walls. If compacted fill is to be placed on both sides of the wall, they should be filled together so that the level on either side is within 0.5 m of each other.

All lumps of materials should be broken down during placement. Backfill materials should not be placed in a frozen state, or placed on a frozen subgrade.

Where the maximum-sized particles in any backfill material exceed 50% of the minimum dimension of the cross-section to be backfilled (e.g., lift thickness), such particles should be removed and placed at other more suitable locations on site or screened off prior to delivery to site.

Excavation and construction operations expose materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration of performance. Unless otherwise specifically indicated in this report, the walls and floors of excavations, and stockpiles, must be protected from the elements, particularly moisture, desiccation, frost, and construction activities. Should desiccation occur, bonding should be provided between backfill lifts. For fine-grained materials the previous lift should be scarified to the base of the desiccated layer, moisture-conditioned, and recompacted and bonded thoroughly to the succeeding lift. For granular materials, the surface of the previous lift should be scarified to about a 75 mm depth followed by proper moisture-conditioning and recompaction.

3.0 COMPACTION AND MOISTURE CONDITIONING

"Landscape fill" material should be placed in compacted lifts not exceeding 300 mm and compacted to a density of not less than 90% of SPD unless a higher percentage is specified by the jurisdiction.

"General engineered fill" and "select engineered fill" materials should be placed in layers of 150 mm compacted thickness and should be compacted to not less than 98% of SPD. Note that the contract may specify higher compaction levels within 300 mm of the design elevation. Cohesive materials placed as "general engineered fill" or "select engineered fill" should be compacted at 0 to 2% above the optimum moisture content. Note that there are some silty soils which can become quite unstable when compacted above optimum moisture content. Granular materials placed as "general engineered fill" or "select engineered fill" should be compacted at slightly below (0 to 2%) the optimum moisture content.

"Structural engineered fill" material should be placed in compacted lifts not exceeding 150 mm in thickness and compacted to not less than 100% of SPD at slightly below (0 to 2%) the optimum moisture content.

4.0 "GENERAL ENGINEERED FILL"

Low to medium plastic clay is considered acceptable for use as "general engineered fill," assuming this material is inorganic and free of deleterious materials.

Materials meeting the specifications for "select engineered fill" or "structural engineered fill" as described below would also be acceptable for use as "general engineered fill."

5.0 "SELECT ENGINEERED FILL"

Low to medium plastic clay with the following range of plasticity properties is generally considered suitable for use as "select engineered fill":

Liquid Limit	= 20 to 40%
Plastic Limit	= 10 to 20%
Plasticity Index	= 10 to 30%

Test results should be considered on a case-by-case basis.

"Pit-run gravel" and "fill sand" are generally considered acceptable for use as "select engineered fill." See exact project or jurisdiction for specifications.

The "pit-run gravel" should be free of any form of coating and any gravel or sand containing clay, loam or other deleterious materials should be rejected. No material oversize of the specified maximum sieve size should be tolerated. This material would typically have a fines content of less than 10%.

The materials above are also suitable for use as "general engineered fill."

6.0 "STRUCTURAL ENGINEERED FILL"

Crushed gravel used as "structural engineered fill" should be hard, clean, well graded, crushed aggregate, free of organics, coal, clay lumps, coatings of clay, silt, and other deleterious materials. The aggregates should conform to the requirement when tested in accordance with ASTM C136 and C117. See exact project or jurisdiction for specifications. This material would typically have a fines content of less than 10%.

In addition to the above, further specification criteria identified below should be met:

"Structural Engineered Fill" – Additional Material Properties

Material Type	Percentage of Material Retained on 5 mm Sieve having Two or More Fractured Faces	Plasticity Index (<400 μm)	L.A. Abrasion Loss (percent Mass)
Various sized Crushed Gravels	See exact project or jurisdiction for specifications	See exact project or jurisdiction for specifications	See exact project or jurisdiction for specifications

Materials that meet the grading limits and material property criteria are also suitable for use as "select engineered fill."

7.0 DRAINAGE MATERIALS

"Coarse gravel" for drainage or weeping tile bedding should be free draining. Free-draining gravel or crushed rock generally containing no more than 5% fine-grained soil (particles passing No. 200 sieve) based on the fraction passing the 3/4-inch sieve or material with sand equivalent of at least 30.

"Coarse sand" for drainage should conform to the following grading limits:

"Coarse Sand" Drainage Material – Percent Passing by Weight

Sieve Size	Coarse Sand*
10 mm	100
5 mm	95 – 100
2.5 mm	80 – 100
1.25 mm	50 – 90
630 μm	25 – 65
315 μm	10 – 35
160 μm	2 – 10
80 μm	0 – 3

* From CSA A23.1-09, Table 10, "Grading Limits for Fine Aggregate", Class FA1

Note that the "coarse sand" above is also suitable for use as pipe bedding material. See exact project or jurisdiction for specifications.

8.0 BEDDING MATERIALS

The "Coarse Sand "gradation presented above in Section 7.0 is suitable for use as pipe bedding and as backfill within the pipe embedment zone, however see exact project or jurisdiction for specifications.

Fin de la modification à la demande de soumissions.