June 9, 2017

Alberta Transportation
4th Floor, Provincial Building
4920 51 Street
Red Deer, Alberta
T4N 6K8

Tony Penney, P.Eng.
Construction Engineer

Dear Mr. Penney:

CON0017608 Central Region GRMP Instrumentation Monitoring
Site C061; H20:02, km 12.212 Frost Heave
Section C – 2017 Spring Readings
DRAFT

1 GENERAL

One vibrating wire piezometer (VW40482) and one thermistor cable (TS4286) were read at geohazard site C061 on May 11, 2017 by Ms. Courtney Mulhall, E.I.T. and Mr. Lekan Mitchell, E.I.T. of Klohn Crippen Berger Ltd. (KCB). The site is located on Hwy 20:02, km 12.212, approximately 10 km north of Sylvan Lake, Alberta. The site coordinates are 52°23.564' N, 114°4.592' E (NAD 83). A site plan is presented in Figure 1.

The geohazard at C061 is frost heave. Each winter, heaving of frost susceptible materials in the highway embankment results in an approximate 400 m long section of Hwy 20 heaving, predominately in the northbound lane. Heaving at C061 is prominent in late February to early March, and is significant enough to have caused vehicle damage. Previous remedial actions include drainage redirection to the west ditch, and a series of gravel drains in the embankment in 2008. The maintenance contractor also fills in the depressions between heaves during the winter, and then cuts the asphalt when the heaves subside in spring.

In December 2016, KCB conducted a geotechnical site investigation at 0C61. Drilling was completed by Mobile Augers and Research Ltd. Based on the findings of the investigation, the stratigraphy was determined to consist of fill (silty sand) overlying medium plastic clay and silt and bedrock (siltstone). The silty sand fill is considered frost susceptible based on subsequent laboratory testing completed after the drilling.

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1.1 Instrumentation

Instrumentation installation details are tabulated in Table 1.1. Instrument locations are shown in Figure 1.

In December 2016, KCB installed one vibrating wire piezometer (VW) and one thermistor string (TS) to monitor groundwater and ground temperature conditions. The TS has eight thermistor nodes that are spaced every 1 m from ground surface and to an approximate depth of 8 m below ground surface. The instruments are installed in the same borehole on the north shoulder of Hwy 20.

The VW and TS were read using a Slope Indicator VW Data Recorder (Model No. 52613500).

Table 1.1 Instrumentation Installation Details

Instrument ID	Coordinates[1]		Date Installed	Depth Below Ground Surface (m)	Condition
	Northing (m)	Easting (m)			
VW40482	5808665	699110	Dec. 06, 2016	4.6	Operational
TS4286	5808665	699110	Dec. 06, 2016	Every 1 m from 0 m to 8 m	Operational

[1]Coordinates were determined with a handheld GPS during installation.

2 INTERPRETATION

2.1 General

For VW40482, the water level data was plotted relative to ground surface elevation and the instruments tip elevation. For TS4286, the ground temperature data was plotted against depth. The VW and TS plots are appended in Appendix I, and discussed in the following subsections.

2.2 Interpretation of Monitoring Results

A summary of the instrumentation data is provided in Table 2.1 and Table 2.2.

Water level data from VW40482 indicates that the groundwater table is approximately 3 m to 4 m below ground surface during the winter months, when frost heave was active at C061. The water level recorded in VW40482 has increased 0.8 m since March 2017 and is currently 1.6 m below ground surface. This increase is likely in response to springtime runoff.

The ground temperature data from TS4286 indicates that the ground surface froze to an approximate depth of 2 m, or 1 m below the frost-susceptible fill.

Frost heave requires frost susceptible soils, a free supply of water, and freezing temperatures to occur. Based on the findings of the 2016 geotechnical site investigation and current instrumentation data, it is evident that the conditions at C061 are favorable for the formation of frost heave. That is, there is a sufficient supply of water in the underlying unfrozen soil for moisture transfer to the freezing front, and the formation of ice lenses in the frost-susceptible fill.

Table 2.1 VW Reading Summary

Instrument ID	Date Installed	Date of Previous Reading	Tip Depth (mbgs[1])	Ground Surface El. (m)	Previous Water Level (mbgs[1])	Current Water Level (mbgs[1])	Change from Previous Reading (m)
VW40482	Dec. 06, 2016	May 11, 2017	4.6	901.5	2.4	1.6	0.8

[1]meters below ground surface (mbgs)

Table 2.2 Thermistor Cable Reading Summary

Instrument ID	Date Installed	Date of Previous Reading	Depth of Node (mbgs[1])	Highest Recorded Temperature (°C)	Lowest Recorded Temperature (°C)	Current Temperature (°C)
TS4286	Dec. 06, 2016	May 11, 2017	0.0	15.8	-13.0	15.9
			1.0	10.1	-4.3	10.1
			2.0	3.3	0.3	3.3
			3.0	4.3	2.2	2.5
			4.0	5.8	2.5	2.5
			5.0	6.4	4.0	4.0
			6.0	7.0	4.5	4.5
			7.0	7.1	5.2	5.2
			8.0	6.9	4.7	5.6

[1]meters below ground surface (mbgs)

3 RECOMMENDATIONS

3.1 Future Work

All instrumentation should continue to be read during the winter months when frost heave is active.

Repair options are currently being assessed by KCB and Alberta Transportation, and may include drainage improvement, reconstruction of the existing ditch, and frost heave repair where a culvert was removed. The site should continue to be inspected by the Maintenance Contract Inspector (MCI) and as part of the annual GRMP inspection program (Section B).

3.2 Instrument Repairs

None required.

4 CLOSING

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Please contact the undersigned if you have any questions or comments regarding this report.

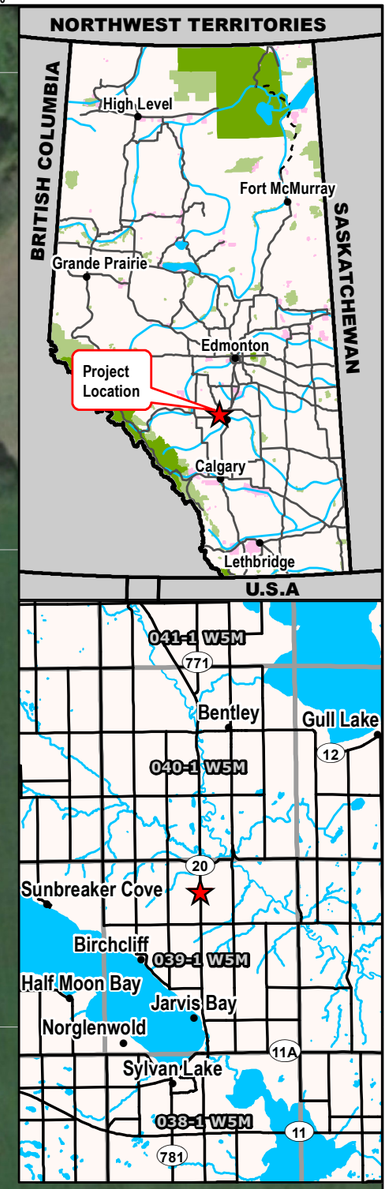
KLOHN CRIPPEN BERGER LTD.

Chris Gräpel, M.Eng., P.Eng.
Senior Civil Engineer, Associate

CF&CM:kc

Attachment
Figure
Appendix I Instrumentation Plots

FIGURES



Legend

- Culvert
- Thermistor (TS)
- Vibrating Wire Piezometer (VW)

Meters
0 50

NOTES:
1. HORIZONTAL DATUM: NAD83
2. GRID ZONE: UTM Zone 11N
3. IMAGE SOURCE: Bing Maps 2016, Microsoft Corporation. Image dated September 2013
4. Location of instruments is approximate (not surveyed)

CLIENT: Alberta Transportation

Klohn Crippen Berger

PROJECT: CENTRAL REGION GEOHAZARD RISK MANAGEMENT PROGRAM

TITLE: Site Plan
C061 - Frost Heave
Hwy 20:02, km 12.212

SCALE	PROJECT No.	FIG No.
1:1,250	A05115A02	1

Time: 10:18:20 AM
Date: June 06, 2017
File: Z:\AIEDM\A05115A02 ABT Central Region GRMP\400 Drawings\201713_Section C Instrumentation\C061\170601 C61.mxd

APPENDIX I

Instrumentation Plots