Klohn Crippen Berger

Alberta Transportation

CON0022166 Peace Region (Grande Prairie - South) GRMP

GP055; Hwy 674:02, km 15.150

Call-Out Report

A05116A01

October 2022

October 5, 2022

Alberta Transportation
Main Floor, Provincial Building
9621 96 Avenue
Peace River, Alberta
T8S 1T4

Ed Szmata
Construction Technologist

Dear Mr. Szmata:

CON0022166 Peace Region (Grande Prairie District - South) GRMP
GP055; Hwy 674:02, km 15.150
Call-Out Report

1 INTRODUCTION

As part of the Geohazard Risk Management Program (GRMP) contract for the Grande Prairie District - South (Grande Prairie South) region, Klohn Crippen Berger Ltd. (KCB) was requested by Alberta Transportation (AT) to conduct a call-out inspection for a slope instability along Hwy 674:02, km 15.150 (e-mail from AT dated August 12, 2022). The site is located on the south shoulder of Hwy 674 approximately 15 km east of Hwy 2, approximately 3 km north of Sexsmith, Alberta. The approximate UTM coordinates of the site are 6137493 N, 403024 E (UTM Zone 11U, NAD 83) and the legal land description is NW 34-73-04-W6M. After submission of the draft report, the site was assigned the GRMP number GP055. A site plan is presented in Figure 1.

The site was inspected by Mr. Chris Gräpel, P.Eng. and Mr. Taylor Wollenberg-Barron of KCB, Ed Szmata, Max Shannon, and Dwayne Loewen of AT, Carter McIntyre of Ledcor (the highway maintenance contractor, HMC), and a representative of CTR, a contractor that works for Ledcor. The site was inspected on August 31, 2022. This is the first time this site was inspected by KCB. The site inspection was conducted at the request of AT's Maintenance Contract Inspector (MCI), Mr. Dwayne Loewen. An Unmanned Aerial Vehicle (UAV) flight of the site was completed by KCB to capture aerial imagery of the site. Photographs from the site inspection are included in Appendix I.

This call-out report was prepared for AT under Contract No. CON0022166. KCB's site observations, assessments, and recommendations for short-term and long-term remedial actions are presented in this report.

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2 BACKGROUND

AT requested a call-out to the area due to new cracking of the asphalt and formation of a clear backscarp on the pavement surface at on an embankment on Hwy 674:02 km 15.150. Hwy 674:02 is a two-lane paved highway oriented east-west between Sexsmith and Teepee Creek, Alberta and is located within Contractor Maintenance Area (CMA) 5. The 2021 Average Annual Daily Traffic (AADT) for this highway is 1120 vehicles east bound from Traffic Count Station No. 29750 and 570 vehicles west bound from Traffic Count Station No. 30730.

The surficial geology of the site according to the Alberta Geological Survey (AGS 2013a) comprises glaciolacustrine sediments deposited in or along the margins of glacial lakes with laminated to massive fine sand, silt, and clay or near shore sediments comprising massive to stratified, well-sorted silty sand, pebbly sand, and minor gravel. A relatively large area of organic deposits (peat) was identified at lower elevation approximately 1.5 km to the south.

The bedrock in the area is the Wapiti formation which includes varying thicknesses of interbedded fine to coarse grained cross-stratified sandstone with subordinate siltstone and mudstone (AGS 2013b).

A review of the hydrogeology of the area indicated the presence of a spring with unknown flow in the vicinity of the site. The ground water conditions are anticipated to be near surface while flowing towards the southeast (Toth 1977). These findings align with credible accounts from local residents who noted instances of livestock sinking deep into soft sediments, possibly in ‘quick’ condition, at the base of the valley in which the subject embankment is located.

A Telus trench with buried utilities was identified within the road alignment from review of pipeline and utility corridor resources that may impact future remedial work. Other utilities in the area include a decommissioned pipeline to the east and ATCO gas line servicing the local residences north of the highway. The ATCO line and decommissioned pipeline are not anticipated to impact any slope remediation work.

As stated by AT, a local resident recalled construction at this location in the mid-1980’s where the embankment was excavated to a depth of approximately “10 feet” 3 m below natural ground level and backfilled with pit run gravel.

AT reported that the embankment was partially reconstructed with a shallow sub-excavation and replacement with gravel about 1.0 m to 1.2 m deep (below pavement surface) in 2018.

3 SITE OBSERVATIONS

The site was visited on August 31, 2022. The weather during the site visit was approximately 18-20°C, sunny, with light to no wind. Photographs are included in Appendix I and the location of site features are presented in Figure 1. An oblique air photo of the site taken from our UAV video is included as Photo 1.

KCB's observations made during the site visits are as follows:

- The embankment is in a shallow valley that is up to 4 m deep south of the embankment. The valley bottom is approximately 10 m wide. There is no evidence of a permanent creek channel. It is our assessment that the shallow valley in which the embankment is constructed in is an ephemeral drainage gully with flow oriented in the southwesterly direction.
- Vegetation on the slope was trimmed short near the pavement but further downslope on the embankment the grass was tall and limited KCB's ability to observe site features (e.g., ground cracks, slope deformation, etc.).
- KCB did not obtain permission from the landowner(s) to access property next to the highway right of way which impacted KCB's ability to inspect the culvert inlet present approximately 15 m from the highway right-of-way (ROW) boundary, approximately 30 m east of the centre of the embankment slide (Photo 2).
- Asphalt patching was evident extending approximately 70 m east of the slide and 20 m west of the slide backscarp. Asphalt thickness at the slide location had a measured thickness of approximately 1.0 m (Photos 3 and 4).
- The south embankment slope was measured at approximately 3H:1V and extended approximately 4 m vertically to the base of the drainage gully. The north embankment slope was approximately 2.0 m high.
- A smooth-wall, 0.9 m diameter steel culvert outlet is present approximately 12 m downslope of the south embankment and 12 m east of the centre of the slide (Photo 4). The culvert is located up the east abutment of the embankment and appears to have been installed after the embankment was constructed.
- A dugout pond is present to the southwest of the embankment. The water level in the pond could indicate the groundwater level to the southwest of the embankment. The water level in the pond is approximately 2.0 m below the crest of the embankment.
- Several relatively large erosional features, possibly sinkholes, were observed downslope of the culvert outlet. Water was present in the some of these depressions, the largest of which were at least 2 m across and over 1 m deep (Photo 5). Depths of the depressions were not directly measured to limit risk while approaching the edges which were significantly undermined.

- Riprap at the toe (lowest point) of the south embankment slope suggests the potential presence of a decommissioned culvert that may be present within the road embankment (Photo 5). The riprap appears to be located where a culvert would be expected.
- The embankment slide was present through the east bound lane of the highway (south side) with its backscarp extending just past the centre line of the highway and extended approximately 7 m parallel with the highway (Photo 6). AT said that the backscarp used to extend to centreline but was now creeping past centreline into the westbound lane. Pavement cracking and differential settlement up to 75 mm within the slide area was evident. Width of cracking within the asphalt was up to approximately 30 mm.
- The backscarp formed a crescent shape through the asphalt which widened to approximately 15 m at the highway shoulder.
- An approximately 1 m long segment of asphalt along the eastern edge of the backscarp within asphalt has separated from the highway with cracks open to a width of approximately 100 mm (Photo 7).
- Cracking of the embankment fill, open approximately 50 mm, extended approximately 12 m down the south embankment and ended on the eastern side above the outlet of a culvert (Photo 8). The cracking on the western flank of the slide zone on the embankment slope extended beyond shoulder ditch of the highway and terminated at the western slope of the gully (Photo 9).
- A toe bulge approximately 0.3 m high and approximately 10 m long was observed by walking up the embankment slope through the tall grass. The height of grass obscured the toe bulge.

4 ASSESSMENT

KCB's assessment of the site is as follows:

- The embankment appears to have been partially reconstructed and/or repaired in the mid-1980s and in 2018. Neither repair appears to have addressed embankment instability.
- The thickness of asphalt and AT's reports of routine maintenance and patching indicate that the embankment failure has been moving steadily since 2018.
- A high ground water table appears to be present at the site (e.g., standing water in a dugout southwest of the embankment, a reported spring nearby on hydrogeological maps, anecdotal information on livestock sinking into the valley bottom). High groundwater table could be due to an upward gradient which could create quickening conditions causing loss of support underfoot for livestock. High groundwater levels and upward gradients could create adverse foundation conditions which, without drainage, appear to have destabilized the embankment.
- Evidence of a decommissioned culvert present under the highway needs to be reviewed further to confirm its impact on any future construction work to repair the embankment.
- The embankment slope of 3H:1V is not overly steep (nor is the embankment all that high), especially if the embankment is partially constructed with pit run which could indicate that the weakness is in the foundation.
- The MCI's and HMC's observation that the failure surface is extending further past centreline than it has before indicates the embankment failure is retrogressing.

5 RISK LEVEL

The risk level has not been previously prepared for the site. Risk levels for AT GRMP sites are determined according to the following:

Risk Level = Probability Factor X Consequence Factor

Where the AT risk level is defined as follows:

- Probability Factor varies from 1 (inactive, very low probability of slide occurrence) to 20 (catastrophic slide is occurring).
- Consequence Factor varies from 1 (shallow cut slope where slide may spill into ditches or fills where slide does not impact pavement; minor consequence of failure; no immediate impact to driver safety; maintenance issue) to 10 (sites where the safety of public and significant loss of infrastructure facilities or privately owned structures will occur if a slide occurs; sites where rapid mobilization of large scale slide is possible).

The risk level was determined using AT's risk level system and is presented as follows:

- Probability Factor – A rating of 10 was selected because the slide appears actively moving and retrogressing into the westbound lane.
- Consequence Factor – A rating of 4 was selected for the site because failure of the slope will result in a partial closure of the road and require construction of a temporary diversion.

A total Risk Level of 40 was assigned for the site.

6 RECOMMENDATIONS

Recommended short-term and long-term remedial actions for the site are discussed in the following subsections.

6.1 Short-Term

KCB recommends the following short-term actions:

- AT should continue with their plans to patch this section of highway this fall.
- The MCI should continue to monitor the site for further pavement or slope cracking after the pavement patch.
- The existing traffic accommodation measures should be maintained. If the severity of settlement and slope movement increases, additional speed reduction or more frequent patching from could be implemented to reduce the risk to local traffic while a repair is being designed.

6.2 Long-Term

KCB recommends the following long-term actions:

- A geotechnical drilling investigation should be undertaken to assess the state of the embankment and previous repairs. A proposal is being prepared for KCB's services and will be released separately. The investigation should include 2 to 3 boreholes to a depth of approximately 10 m to assess fill and foundation conditions. Due to the repeated embankment repairs conducted at this site, boreholes should be drilled in the eastbound lane, mid-slope on the south embankment slope, and possibly one borehole at the toe. A slope inclinometer and two piezometers should be installed mid-slope on the south embankment slope. The mid-slope instrumentation would allow depth of movement to be recorded and to assess groundwater levels at the base of the fill and bottom of the borehole and indicate if there is an upward gradient. A borehole at the toe, with two piezometers would help in understanding groundwater conditions at the south toe of the embankment.
- Drilling a mid-slope borehole will require a temporary bench to be excavated to provide drill rig access. While an excavator is constructing the temporary bench, a shallow test pit could be excavated at the possible location of an old culvert that appears to have been located at the valley bottom.
- A design should be prepared for repair of the embankment. We anticipate that the repair would include excavating the south embankment slope, installing a gravel shear key and foundation drainage (either perforated pipe laid out on the foundation or in drainage trenches excavated into the foundation), and reconstruction of the south embankment slope with compacted gravel reinforced with geogrid. The asphalt surface would be reinstated using the asphalt thickness design previously used for the 2018 overlay. The design work should include a drilling investigation with instruments installed as well as an

Environmental Overview Assessment and assessment of historical resources. KCB estimates the total project costs, including engineering, environmental, and construction, will be in the range of $600,000 to $800,000. AT has provided input on this cost based on their experience on similar projects in the region.

7 CLOSURE

This report is an instrument of service of Klohn Crippen Berger (KCB). The report has been prepared for the exclusive use of Alberta Transportation (Client) for the specific application to the Peace Region (Grande Prairie South) Geohazard Risk Management Program (Contract No. CON0022166), and it may not be relied upon by any other party without KCB's written consent.

KCB has prepared this report in a manner consistent with the level of care, skill and diligence ordinarily provided by members of the same profession for projects of a similar nature at the time and place the services were rendered. KCB makes no warranty, express or implied.

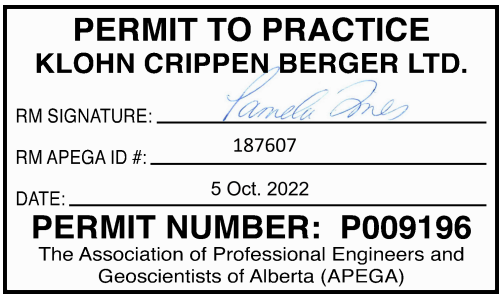
Use of or reliance upon this instrument of service by the Client is subject to the following conditions:

1. The report is to be read in full, with sections or parts of the report relied upon in the context of the whole report.
2. The observations, findings and conclusions in this report are based on observed factual data and conditions that existed at the time of the work and should not be relied upon to precisely represent conditions at any other time.
3. KCB should be consulted regarding the interpretation or application of the findings and recommendations in the report.
4. This report is electronically signed and sealed and its electronic form is considered the original. A printed version of the original can be relied upon as a true copy when supplied by the author or when printed from its original electronic file.

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

Yours truly,

KLOHN CRIPPEN BERGER LTD.



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

CKG: bb

ATTACHMENTS
Figure
Appendix I Site Photographs

REFERENCES

Alberta Geological Survey (AGS), 2013a. Map 601. Surficial Geology of Alberta. Published March 25, 2013.

Alberta Geological Survey (AGS), 2013b. Map 600. Bedrock Geology of Alberta. Published June 17, 2013.

Toth, J., 1977. The Hydrogeological Reconnaissance Maps of Alberta. In: Alberta Research Council Bulletin 35 - Contributions to the Hydrogeology of Alberta, Alberta Research Council Groundwater Division, 1977, p.1-12.

Alberta Transportation (AT). 2021. Traffic Counts Reference No. 29750. Retrieved September 1, 2022 from: Turning Movement Summary Diagram 00029750 (alberta.ca)

Alberta Transportation (AT). 2021. Traffic Counts Reference No. 30730. Retrieved September 1, 2022 from: Turning Movement Summary Diagram 00030730 (alberta.ca)

FIGURE

NOTES:

1. BACKGROUND IMAGERY OBTAINED FROM GOOGLE MAPS ON SEPTEMBER 2, 2022.
2. THE LOCATION OF TELUS UTILITY TRENCH IS APPROXIMATE AND OBTAINED FROM ABADATA ON SEPTEMBER 1, 2022.
3. LOCATION OF SLIDE FEATURES AND OTHER SITE OBSERVATIONS ARE APPROXIMATE AND WERE ESTIMATED FROM KLOHN CRIPPEN BERGER'S (KCB'S) CALL-OUT INSPECTION PHOTOS.

LEGEND

- CULVERT INLET/OUTLET
- GROUND CRACK
- HEAD SCARP
- TELUS UTILITY TRENCH
- GROUND DEPRESSIONS
- SETTLEMENT IN HIGHWAY SURFACE

CLIENT: Alberta

Klohn Crippen Berger

PROJECT: G.P. SOUTH REGION GEOHAZARD RISK MANAGEMENT PROGRAM

TITLE: SITE PLAN
GP055 - NORTH OF SEXSMITH SLIDE
H674:02, KM 15.150

SCALE	PROJECT No.	FIG No.
AS SHOWN	A05116A01	1

APPENDIX I

Site Photographs

Photo 1 **Oblique aerial drone photo of the site, indicating the main site features. Highway impacted by embankment slope failure is indicated by the red highlighted area. Photo taken August 31, 2022, facing northwest.**

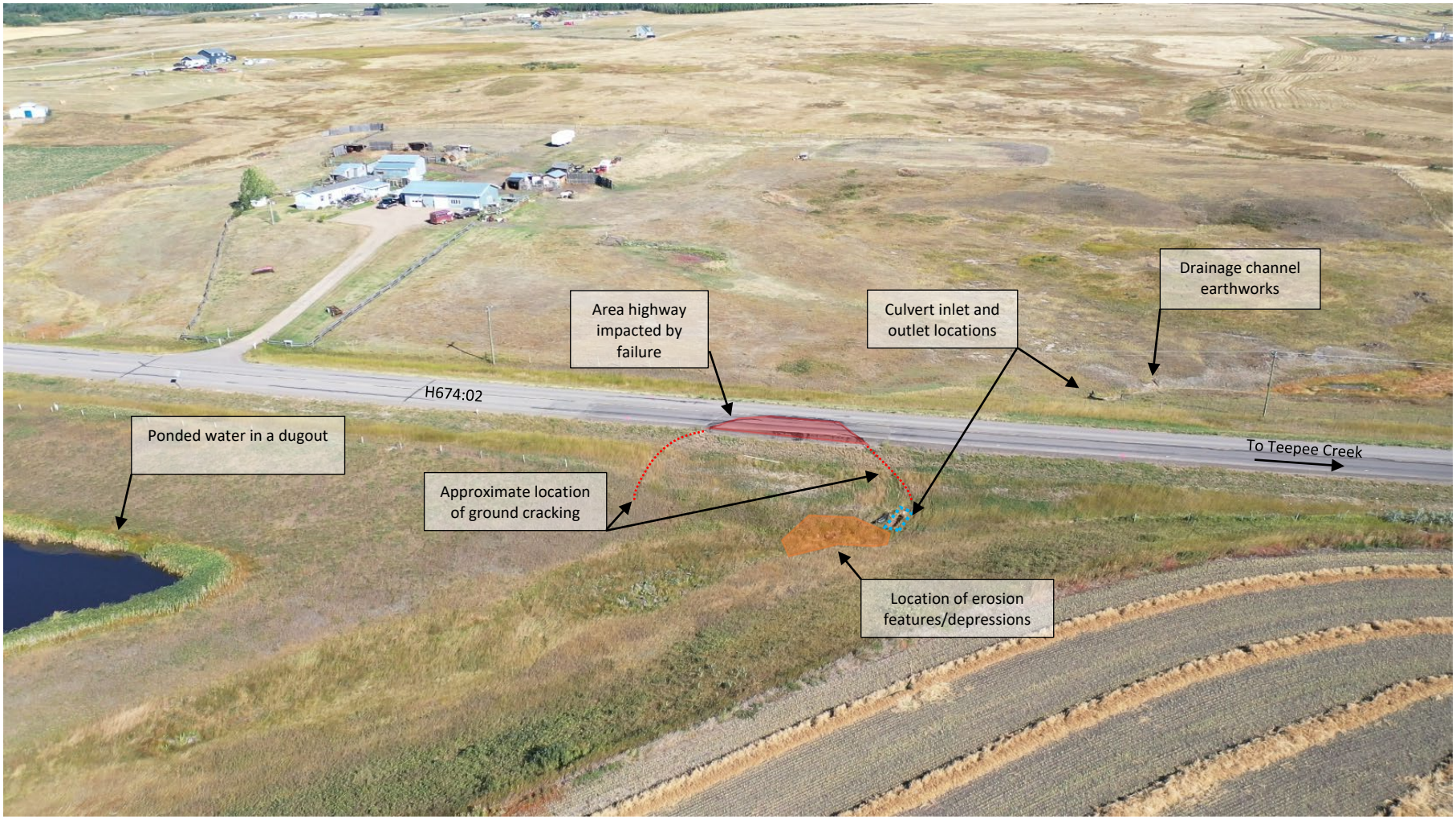


Photo 2 **Culvert inlet north of highway and earthworks to direct flow into inlet of smooth-wall steel culvert. Photo taken August 31, 2022, facing northeast.**

Photo 3 **Thickness of asphalt upwards of 1.0 m at western edge of impacted eastbound lane of the highway. Photo taken August 31, 2022, facing northeast.**

Photo 4 **Smooth-wall steel pipe culvert outlet on south embankment, note erosion below point of discharge. Photo taken August 31, 2022, facing northeast.**

Photo 5 **Large depression approximately 5 m away from culvert outlet at toe of south embankment slope. Note eroded rip rap within depression possibly from decommissioned culvert not visible during inspection. Photo taken August 31, 2022, facing southwest**

Photo 6 **Extent of settlement and cracking observed in east bound lane of highway. Photo taken August 31, 2022, facing west.**

Photo 7 **Cracking and separation of asphalt segment at shoulder of eastbound lane. Note that cracking is extending north past centreline. Photo taken August 31, 2022, facing west.**

Photo 8 **Red circle indicates cracking observed at east side of south embankment slope. Photo taken August 31, 2022, facing north.**

Photo 9 **Red circle indicates cracking observed at west side of south embankment. Photo taken August 31, 2022, facing north.**