January 19, 2022

Alberta Transportation
2nd Floor, Willowglen Business Park
803 Manning Road NW
Calgary, Alberta
T2E 7MB

Alex Frotten, E.I.T.
Construction Engineer – Delivery Services Division (Southern Region)

Dear Mr. Frotten:

CON0022161 Southern Region GRMP
Call-Out Report – S068 Background Data Review

Please find enclosed a Section D report relating to the S068 site, located on Forestry Trunk Road 25001 (FTR 25001), formerly called Highway 940, south of the Highwood House rest stop junction.

This report includes a summary of background information for the site, which has multiple subsites. Following a review of background information, KCB visited the site and documented the current conditions. The 2021 site visit did not include an update to the risk rankings.

We appreciate the opportunity to continue providing our services to Alberta Transportation. Please contact the undersigned or Mr. Chris Gräpel, P.Eng. if you have any questions regarding this report.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

Chris Morgan, P.Eng.
Senior Geotechnical Engineer

LA:ap

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TABLE OF CONTENTS

List of Tables

List of Appendices

1 INTRODUCTION

As part of the Geohazard Risk Management Program (GRMP) contract for the southern region, Klohn Crippen Berger Ltd. (KCB) was requested by Alberta Transportation (AT) to conduct a call-out inspection for an existing GRMP site along Forestry Trunk Road 25001 (FTR 25001), formerly called Highway 940. This call-out report was prepared for AT under Contract No. CON0022161.

The FTR 25001 corridor is an unpaved, two-lane gravel road with an alignment of northwest/ southeast. A winter closure of FTR 25001 south of Cataract Creek is in place from December 1 to April 30. The 2020 annual average daily traffic (AADT) for this section of highway is 210 vehicles per day (AT 2020).

The identified geohazard "site" is:

- S068 Wilkinson Creek Erosion and Landslide Hazards – The contract reference for the site is 25001:02 C1 17.236. AT Maps indicates that this S number consists of six subsites.

Site S068 was included in the 2021-2025 GRMP contract; however, the site was previously identified and inspected by other consultants during previous contract cycles.

The S068 subsites (other than Wilkinson Creek Bridge) were previously inspected by AMEC Earth & Environment (AMEC [now Wood]) and Dr. D.M. Cruden from the University of Alberta between August 2008 and September 2008 (the inspection report was issued to AT in April 2009). Subsites S068-2, S068-3, and S068-5 were inspected by AMEC on June 10, 2009. Multiple subsites were re-inspected by AMEC between July 9, 2013 and July 31, 2013 following the 2013 Alberta floods (the inspection report was issued to AT on February 20, 2014). KCB completed a Section A report in 2017 that included S068-2, S068-3, and S068-5, and S068-5 was inspected by KCB in July 2021 during the annual Section B tour.

AT requested that KCB review the historic documentation for S068 and evaluate the current site conditions, to determine whether the sites should remain a part of the GRMP. An overview of the S068 subsite locations is shown on Figure 1. Photographs from the 2021 site inspections are included in Appendix I.

2 S068 WILKINSON CREEK EROSION AND LANDSLIDE HAZARDS

2.1 Overview

The Wilkinson Creek Erosion and Landslide Hazards sites (S068) are located on Forestry Trunk Road 25001. The area of interest is defined by Bridge 77508 at the north end (on FTR 25001), and the three-way junction with Highway 532 and Highway 40 at the south end. The subsites are located on a section of highway that has a seasonal road closure in place between December 1 and April 30.

This S number has six subsites, as summarized in Table 2.1 and shown on Figure 1.

Table 2.1 S068 Subsites Location Summary

Site No. and Name[1]	Linear Reference[2]	Latitude[2]	Longitude[2]	Other Names	Geohazard[1]
S068-1 Upper Wilkinson Creek Valley	25001:02 C1 7.489	50.197757	-114.563828	Named Hwy 940 km 81.4 by AMEC in April 2009.	General
S068-2 Upper Wilkinson Creek Valley	25001:02 C1 8.713	50.197801	-114.577299	Hwy 940 km 82.2 – 82.4 visited by AMEC on June 10, 2009. Referenced as S35 – km 82.2 in 2017 KCB Section A.	General (creek erosion)
S068-3 Upper Wilkinson Creek Valley	25001:02 C1 9.668	50.198905	-114.591593	Hwy 940 km 82.2 – 82.4 visited by AMEC on June 10, 2009. Referenced as S35 – km 82.4 in 2017 KCB Section A.	Rockfall (cut slope)
S068-4 Upper Wilkinson Creek Valley	25001:02 C1 8.631	50.198103	-114.575625	Named Hwy 940 km 82.5 by AMEC in April 2009.	General
S068-5 Upper Wilkinson Creek Valley Slide	25001:02 C1 17.236	50.268404	-114.591592	Hwy 940 Wilkinson Creek Bridge Area visited by AMEC in June 2009. Referenced S35 – km 90.9 in 2017 KCB Section A	Erosion
S068-6 Dry Creek Colluvial Farm	25001:02 C1 3.893	50.181871	-114.523462	Named Hwy 940 Dry Creek Colluvial Fan (km 77.8) by AMEC in April 2009.	Debris Flow

Notes:
[1] Location information, ID, and descriptions provided by AMEC in Table B1 Highway 940 Corridor – Corridor Features and Geohazard Sites – Listed from south to north risk level spreadsheet supplied to AT.
[2] Location information taken from AT Maps.

2.2 Geological Setting

The geological setting has been estimated using published geological maps and is summarized in Table 2.2.

Table 2.2 S068 Geological Setting

Site No.	Bedrock Geology (estimated)
S068-1 (25001:02 C1 7.489)	Pennsylvanian Spray Lakes Group (undivided).
S068-2 (25001:02 C1 8.713)	Jurassic Fernie Formation: dark grey to black shale; dark grey siltstone and sandstone; dark grey, platy silty, argillaceous limestone; brown, limonitic, quartz sandstone.
S068-3 (25001:02 C1 9.668)	Cretaceous Blairmore Group (undivided).
S068-4 (25001:02 C1 8.631)	Jurassic Fernie Formation: dark grey to black shale; dark grey siltstone and sandstone; dark grey, platy silty, argillaceous limestone; brown, limonitic, quartz sandstone.
S068-5 (25001:02 C1 17.236)	Cretaceous Blairmore Group (undivided).
S068-6 (25001:02 C1 3.893)	Jurassic Fernie Formation: dark grey to black shale; dark grey siltstone and sandstone; dark grey, platy silty, argillaceous limestone; brown, limonitic, quartz sandstone.

2.3 Background Data

The background data presented in this section has been taken from historic inspection reports prepared by AMEC between 2008 and 2014, together with a Section A report for S068-2, S068-3, and S068-5 prepared by KCB in 2017. The reviewed documents are listed in the references section.

The available information relevant to S068 has been reviewed and is summarized in Tables 2.3 to 2.9.

Table 2.3 S068-1 Summary of Historic Documentation (25001:02 C1 7.489)

Summary of Historic Documentation
AMEC 2008 (Hwy 940 km 81.4) S068 subsite 1 was reported by AMEC to be located approximately 81 km north of the junction between Hwy 3 and Hwy 940 at Coleman, AB, and approximately 8 km north of the junction between Hwy 940 and Hwy 532. AMEC reported the site to be a short distance north of the low pass between the Wilkinson Creek valley and the Dry Creek valley to the south. In 2008, subsite 1 consisted of an 8 m high back slope on the south side of the highway. The back slope was angled at approximately 30° to 33° and composed of glacial till / rocky soil. AMEC reported the road surface as approximately 9 m wide, with no effective ditch along the back slope toe. AMEC noted an accumulation of gravel to cobble-sized rocks along the toe of the back slope, which appeared to have eroded out from the back slope. Surface runoff was observed flowing through debris along the toe of the slope. AMEC reported that the accumulation of rocks along the south edge of the highway was a hazard to vehicles and that surface water could accumulate on the road surface due to the lack of a ditch. Rocks that weathered out of the slope did not appear to roll on to the road. The risk ranking given to the site in 2008 was 14 due to active erosion of the cut slope and the possibility of material spilling onto the road. AMEC recommended a continuation of routine maintenance, including grading. In the medium- to long-term, AMEC recommended that a ditch could be established; however, they also noted that the road was narrow and the effort required to steepen the back slope could outweigh the benefits of a ditch.

Summary of Historic Documentation
AMEC 2013 (Site #181, WPT 181 km 24.5) Following the 2013 floods, AMEC reported a full washout of the highway for a 30 m segment, and creek erosion impacting the toe of the highway embankment for approximately 200 m length. A creek is located at the downslope toe of the highway embankment. AMEC recommended rebuilding the highway embankment and the ditch and noted that channel diversion / training may be required, possibly including Class 2 riprap slope armoring.

Table 2.4 S068-2 Summary of Historic Documentation (25001:02 C1 8.713)

Summary of Historic Documentation
AMEC 2008 (Hwy 940 km 82.2) S068 subsite 2 was reported by AMEC to be located approximately 82 km north of the junction between Hwy 3 and Hwy 940 at Coleman, AB, and approximately 9 km north of the junction between Hwy 940 and Hwy 532. AMEC reported the site to be in the upper portion of the Wilkinson Creek valley, a short distance north of the low pass between the Wilkinson Creek valley and the Dry Creek valley to the south. At this location, the highway is located on a rock fill embankment. In 2009, subsite 2 was reported by AMEC to consist of a 5 m to 6 m high bedrock back slope on the northeast (upslope) side of the highway, generally angled at about 1H:1V. A ditch was present along the toe of the back slope, estimated as approximately 1 m to 1.5 m wide and 0 m to 0.5 m deep. AMEC noted cobble sized rocks in the ditch that had eroded out from the back slope. AMEC believed the ditch was undersized for the height of the back slope. Wilkinson Creek was reported to run along the toe of the highway embankment, oriented parallel to the highway. AMEC reported that the toe of the highway embankment was at risk of being undermined by Wilkinson Creek. In 2008, the site was given two risk rankings: • A risk level of 10 was calculated for the risk of damage to the highway due to creek erosion, because although the road was not currently undermined by creek flows, it could be in the future. • A risk level of 13 was calculated for the rockfall hazard due to signs of periodic rockfalls and an undersized ditch (PF = 13 and CF = 1). AMEC recommended ditch cleaning was carried out during routine maintenance.
AMEC 2009 (Hwy 940 km 82.2, June 2009 Inspection) A follow-up inspection was carried out by AMEC on June 10, 2009. AMEC appeared to have reported the 10 m wide section of embankment slope armoring that was previously described at km 82.4 as present at the km 82.2 subsite. Overall, AMEC noted that the site appeared to be in the same condition as was observed in September 2008. The risk ranging given to this site in 2009 was 10 based on the risk of Wilkinson Creek undermining the highway embankment toe and potentially causing slope instability. AMEC recommended no further inspections at the site unless requested by the MCI. Portions of the report seem to have mixed up observations between the km 82.2 site and the km 82.4 site; therefore, the 2008 report has been used as a benchmark.

Summary of Historic Documentation
AMEC 2013 (Site #170, WPT 170 km 23.9) Following the 2013 floods, AMEC reported full washout of the road over a section approximately 600 m long and indicated that the creek had encroached from the south side. AMEC recommended rebuilding the highway and conducting a hydrotechnical study. AMEC noted that the creek bank would likely require armoring with Class 2 riprap, and that AT could consider moving the road alignment slightly up the valley side.
KCB 2017 (S35 – km 82.2) The site is described as S35 – km 82.2 Creek Bank Erosion. The Section A report includes a summary of the AMEC 2009 inspection report, and appears to have mixed up portions of the site description when compared to the original AMEC site inspection in 2008. The Section A report provides no new information for S068-2.

Table 2.5 S068-3 Summary of Historic Documentation (25001:02 C1 9.668)

Summary of Historic Documentation
AMEC 2008 (Hwy 940 km 82.4) S068 subsite 3 was reported by AMEC to be located approximately 82 km north of the junction between Hwy 3 and Hwy 940 at Coleman, Alberta, and approximately 9 km north of the junction between Hwy 940 and Hwy 532. At this location, the highway is located on a rock fill embankment, and Wilkinson Creek runs at the toe of the embankment, oriented parallel to the highway. Downslope of the highway is the creek channel and upslope of the highway is a back slope that has been excavated into original ground. In 2009, the highway embankment was reported by AMEC to be approximately 6 m high with a downslope side slope inclined at about 38°. The subsite was located just downstream of a bend in the creek channel. At the time of inspection, AMEC noted fresh cobble to boulder-sized rock fill on the downslope side of the highway embankment (from the edge of the road to the creek) for a length of approximately 10 m. AMEC assumed that the fresh area of rock fill represented slope armoring to reduce creek erosion at the embankment toe (assumed as placed in early 2008). The risk ranging given to this site in 2008 was 14 based on the concern relating to erosion in the right creek bank leading to instability at the outside edge of the highway. If erosion were to undermine the road, warning signs and lane reduction would be required to conduct repairs. AMEC recommended ongoing monitoring of the site during the annual inspection tour.
AMEC 2009 (Hwy 940 km 82.4, June 2009 Inspection) A follow-up inspection was carried out by AMEC on June 10, 2009. In 2009, AMEC reported the highway embankment as 5 m to 6 m high, with a downslope side slope of between 48° and 50°. Vegetation was reported as abundant, including willows. Crest erosion was noted due to surface water runoff from the highway. AMEC reported that the toe of the embankment appeared stable with no significant erosion from Wilkinson Creek. Overall, AMEC noted that the site appeared to be in the same condition as was observed in September 2008. The risk ranging given to this site in 2009 was 10 based on the risk of Wilkinson Creek undermining the highway embankment toe and potentially causing slope instability. AMEC recommended no further inspections at the site unless requested by the MCI. Portions of the report seem to have mixed up observations between the km 82.2 site and the km 82.4 site; therefore, the 2008 report has been used as a benchmark.

Summary of Historic Documentation
AMEC 2013 (Site #170, WPT 170 km 23.9) Following the 2013 floods, AMEC reported full washout of the road over a section approximately 600 m long, and indicated that the creek had encroached from the south side. AMEC recommended rebuilding the highway and conducting a hydrotechnical study. AMEC noted that the creek bank would likely require armoring with Class 2 riprap, and that AT could consider moving the road alignment slightly up the valley side.
KCB 2017 (S35 – km 82.4) The site is described as S35 – km 82.4 Creek Bank Erosion. The Section A report includes a summary of the AMEC 2009 inspection report and appears to have mixed up portions of the site description when compared to the original AMEC site inspection in 2008. The Section A report provides no new information for S068-3.

Table 2.6 S068-4 Summary of Historic Documentation (25001:02 C1 8.631)

Summary of Historic Documentation
AMEC 2008 (Hwy 940 km 82.5) S068 subsite 4 was reported by AMEC to be located approximately 82 km north of the junction between Hwy 3 and Hwy 940 at Coleman, Alberta, and approximately 9 km north of the junction between Hwy 940 and Hwy 532. AMEC reported the highway to be about 9 m wide at this location. In 2008, subsite 4 was reported by AMEC to consist of a back slope along the upslope side of the road. The height of the back slope was not estimated but the slope angle was reported to be between 30° and 32°. The back slope was sparsely vegetated and composed of rocky soil/colluvium including cobble to boulder-sized material. AMEC noted a surface runoff erosion gully on the back slope, running from the crest to the toe. Surface runoff was causing erosion of the back slope and washing out of coarser particles which were creating a debris fan at the toe of the slope, along the edge of the highway. AMEC noted that the ditch at the toe of the back slope was negligible to very small and was prone to infilling. Routine grading of the highway would be necessary to keep the road surface clear of rockfall materials. AMEC reported that Wilkinson Creek was immediately downslope of this subsite; however, no further details were given. AMEC noted that the road was relatively narrow in this location and that there was minimal room to widen the highway downslope due to the creek. AMEC noted that the back slope could be steepened; however, this would likely create stability and maintenance issues. The risk ranking given to the site in 2008 was 18 due to ongoing erosion along the gully and the limited capacity of the ditch. AMEC recommended ditch cleaning was part of routine maintenance.
AMEC 2013 (Site #160, WPT 160 km 23.4) Following the 2013 floods, AMEC reported creek encroachment and partial washout of the highway for a 100 m segment. AMEC also reported a back slope earth slide that partially covered the road. AMEC recommended rebuilding the road and clearing the slide debris. AMEC also recommended conducting a hydrotechnical study to evaluate mitigation options. AMEC recommended armoring the toe of the highway embankment to reduce creek erosion.

Table 2.7 S068-5 Summary of Historic Documentation (25001:02 C1 17.236)

Summary of Historic Documentation
AMEC 2009 Hwy 940 Wilkinson Creek Bridge Area The first inspection of the Wilkinson Creek Bridge was carried out by AMEC on June 10, 2009. S068 subsite 5 was reported by AMEC to be located approximately 13 km south of Hwy 40/Hwy 940/Hwy 541 junction at Highwood House, Alberta. The inspection report included an annotated air photo and a figure showing the site location and layout. AMEC reported that the creek flows from south to north. AMEC reported that based on discussions with AT, the creek had flooded and washed out a section of the highway approximately 100 m to 200 m south of the bridge three times since 1996. Washouts were repaired by importing suitable fill material by truck and rebuilding the highway. AMEC reported that the highway washouts had not previously impacted the bridge or bridge abutments. AMEC noted that in this area the creek was generally relatively straight, with the exception of a pronounced east to west channel meander starting roughly 150 m to 170 m upstream of the bridge and rejoining the overall north/northeast bearing channel roughly 20 m downstream of the bridge. AMEC reported that the highway south of the bridge consists of a relatively thin fill embankment, constructed on the relatively flat creek floodplain on the valley floor. On June 20, 2009, AMEC estimated the water elevation in the creek as less than a metre below the highway surface elevation. The AMEC observations indicated that there was a low levee on the left bank (west side) of the creek that was prone to overtopping during high creek flows, allowing the creek to overtop the highway on the left bank and flow northwards on the floodplain on the west side of the highway, effectively cutting off the meander and the bridge. The risk ranking given to the site in 2008 was 54 (PF = 9 and CF = 6). The ranking was based on the knowledge that the highway had been washed out at least three times in previous years, and that washouts caused a full closure of the highway, with a lengthy detour required by road users while the highway was repaired. AMEC provided three potential options to AT to reduce the risk of future washouts: 1. Bank protection and channel training to reduce the risk of channel overtopping during high creek flows. 2. Realignment of the highway and repositioning of the bridge crossing to a location with less risk of future flood events and creek channel shifts. 3. Accept the risks of future washouts and possible erosion at the existing bridge, and promptly repair washouts as they occur in the future. AMEC recommended Option 3 since the highway is a secondary highway in a relatively remote area of the province. The highway was reconstructed on roughly the original alignment.
AMEC 2013 (Site #40, WPT 40 km 14.7) Following the 2013 floods, AMEC reported a partial washout of the highway for 280 m and a potential debris flow fan offset from the road by 10 m. AMEC noted that the creek had altered its channel and bypassed the bridge meander, now occupying a fairly straight channel alignment. The bridge had remained intact; however, the old channel was noted to be infilled with sediment. AMEC noted that approximately 500 m of road rebuild would be required and that given the extent of the creek channel changes, restoration of the channel at the old bridge location might not be viable. AMEC reported that the bridge was constructed of old PE girder, near the end of its service life.

Summary of Historic Documentation
AMEC recommended rebuilding the road, excavating ditches, and constructing a new bridge crossing. AMEC also recommended a hydrotechnical assessment and bridge planning exercise so that relocation of the bridge could be evaluated. A replacement bridge 90 m to the south was suggested as an option.
KCB 2017 (S35 – km 90.9 (Wilkinson Creek Bridge)) The site is described as S35 – km 90.9 (Wilkinson Creek Bridge). The Section A report includes a summary of the AMEC 2009 inspection report. The Section A report provides no new information for S068-5.
KCB 2021 (Unreported annual inspection visit to S068-5 Wilkinson Creek Bridge) The site was visited during the 2021 annual inspection but not reported. AT reported that the site had washed out during the 2013 flooding and been subsequently repaired. In general, there were no significant changes to the site layout when compared to previous AMEC site observations.

Table 2.8 S068-6 Summary of Historic Documentation (25001:02 C1 3.893)

Summary of Historic Documentation
AMEC 2008 (Hwy 940 Dry Creek Colluvial Fan [km 77.8]) S068 subsite 6 was reported by AMEC to be located approximately 78 km north of the junction between Hwy 3 and Hwy 940 at Coleman, AB, and approximately 4 km north of the junction between Hwy 940 and Hwy 532. AMEC reported the site to be at the location where Hwy 940 crossed over the lowermost portion of a colluvial fan along an unnamed tributary creek flowing into the Dry Creek valley from the south side of Plateau Mountain. In 2009, AMEC noted that the lower portion of the fan, angled at 10° from horizontal, was sparsely vegetated and had no active surface channels. AMEC believed the area where the fan originally tapered out had likely be regraded during construction of the highway. AMEC reported that there had been no significant accumulation of material in the fan. The risk ranking given to the site in 2008 was 4. A debris flow was considered improbable, and if a flow did occur then maintenance crews would be able to clear the road. AMEC recommended no further work at this site.
AMEC 2013 (Site #220, WPT 220 km 28.2) Following the 2013 floods, AMEC reported a full road washout and road blockage due to multiple debris flows (landslides) from the north mountain. The debris flows from Plateau Mountain accumulated on the road and affected the flow in the creek (Dry Creek) that runs east to west (parallel to the road). An oil and gas facility is located adjacent to the highway. AMEC recommended rebuilding the road and the ditches. In the long-term AMEC suggested moving the road to the south valley wall and armoring the toe.

Table 2.9 S068 Risk Rankings

Site No.	Linear Reference	Probability Factor	Consequence Factor	Risk Level	Ranking Date
S068-1	25001:02 C1 7.489	7	2	14	2008
S068-2	25001:02 C1 8.713	5	2	10	2009
S068-3	25001:02 C1 9.668	5	2	10	2009
S068-4	25001:02 C1 8.631	7	2	18	2008
S068-5	25001:02 C1 17.236	9	6	54	2009
S068-6	25001:02 C1 3.893	1	4	4	2008

2.4 2021 Site Evaluation

Following a review of background data, KCB carried out site visits on October 22, 2021, to evaluate current site conditions. Observations are documented in Table 2.10. Recommendations are included in Section 3.

Table 2.10 Site Visit Observations

Site No.	2021 Observations (Changes since 2008)
S068-1 (25001:02 C1 7.489)	S068-1 consists of an unvegetated back slope on the west side of the highway. The back slope was estimated to be at least 8 m high. There is no ditch at this site. A creek is located downslope of the highway. The back slope was excavated into glacial till/rocky soil. Erosion rills were noted across the back slope due to surface runoff erosion and weathering. There is an accumulation of granular material at the toe of the slope which forms a small vertical step due to road grading. Erosion at the crest of the slope has created overhanging vegetation mats and there is a risk of trees falling onto the highway. S068-1 was damaged due to the 2013 flooding but appears to have been repaired to approximately the original road geometry. In general, there were no significant changes noted in 2021 when compared to observations reported in the AMEC 2008 geohazard review for the Highway 940 corridor.
S068-2 (25001:02 C1 8.713)	S068-2 consists of a 5 m to 6 m high bedrock back slope on the north side of the road, adjacent to a curve in the highway. A shallow rockfall ditch is present on the upslope side of the highway, estimated to be approximately 1.5 m wide and less than 0.5 m deep. Bedrock appears to be sedimentary with visible bedding planes. The bedrock is dipping towards the highway and the geometry of the back slope allows weathered bedrock to roll downslope into the ditch. At the time of inspection, eroded bedrock particles appeared tabular with limited capacity to roll. Erosion at the crest of the slope has created overhanging vegetation mats. KCB also noted cobbles and boulders weathering out of the soil portion of the back slope which overlies bedrock, possibly capable of reaching the highway. Wilkinson Creek is located at the toe of the highway embankment and appeared to be less than 0.2 m deep at the time of the inspection. The creek bank / highway embankment toe was approximately 1.5 m high, angled at 1H:1V, and vegetated with shrubs. Erosion riling was observed along the edge of the road embankment due to surface water runoff. S068-2 was damaged due to the 2013 flooding but appears to have been repaired to approximately the original road geometry. In general, there were no significant changes noted in 2021 when compared to

Site No.	2021 Observations (Changes since 2008)
	observations reported in the AMEC 2008 geohazard review for the Highway 940 corridor, and the 2009 site inspection.
S068-3 (25001:02 C1 9.668)	S068-3 consists of a section of highway with an earth back slope on the upslope side and a creek channel at the toe of the highway embankment. The back slope varies in height but was up to approximately 6 m high in places. At the toe of the embankment is Wilkinson Creek. The creek channel is relatively narrow and approximately 2 m deep. At the time of the inspection the creek appeared to be less than 0.3 m deep. Parts of the creek channel were noted to have cut or been blasted into bedrock, and parts of the channel were cut through soil. Overhanging root mats were observed on the west bank. The downstream slope of the highway embankment was approximately 1H:1V. The channel appeared to be stable and in good condition. S068-3 was damaged due to the 2013 flooding but appears to have been repaired to approximately the original road geometry. In general, there were no significant changes noted in 2021 when compared to observations reported in the AMEC 2008 geohazard review for the Highway 940 corridor, and the 2009 site inspection.
S068-4 (25001:02 C1 8.631)	S068-4 consists of a 1H:1V back slope cut into the existing hillside. In 2021, KCB estimated the back slope to be up to 10 m high. The back slope consisted of rocky soil / colluvium type material. A creek channel is located downslope of the highway, at the toe of the highway embankment. AMEC had reported an erosion gully in 2008, and in 2021 the gully appeared to be inactive with very little change since 2008. A cone of debris was noted at the toe of the slope which had infilled the existing shallow ditch. Overhanging root mats were observed at the crest of the back slope. Wilkinson Creek is located at the toe of the embankment and the creek appeared to be less than 0.2 m deep at the time of the inspection. S068-4 was damaged due to the 2013 flooding but appears to have been repaired to approximately the original road geometry. In general, there were no significant changes noted in 2021 when compared to observations reported in the AMEC 2008 geohazard review for the Highway 940 corridor.
S068-5 (25001:02 C1 17.236)	S068-5 is located at the Wilkinson Creek bridge. At the time of KCB inspection, the highway washout from the 2013 flooding had been repaired and the creek restored to the former channel alignment prior to the 2013 flood. AMEC had noted that the original channel had been infilled with sediment during the 2013 flood, therefore it appears that the channel has been re-excavated. The bridge was intact after the 2013 flooding and no obvious geotechnical issues were observed relating to the bridge in 2021. Repairs appear to have included riprap armoring along the banks, including the outside of the bends. On the west side of the highway, the floodplain area that becomes the new creek channel alignment each time the highway washes out (reportedly at least four times since 1996) is visible and has not been infilled. At the time of inspection, standing water was present in the floodplain area and overhanging root mats were observed along the bank.

Site No.	2021 Observations (Changes since 2008)
	S068-5 was damaged due to the 2013 flooding but was repaired and the creek channel reinstated. Therefore, in general, there were no significant changes noted in 2021 when compared to observations reported in the AMEC 2008 geohazard review for the Highway 940 corridor, and the 2009 site inspection.
S068-6 (25001:02 C1 3.893)	S068-6 consists of a colluvial debris fan, south of Plateau Mountain. The site is located immediately east of a pipeline booster station; a pipeline warning delineator was spotted nearby, warning of sour gas. S068-6 was damaged due to the 2013 flooding but appears to have been repaired to approximately the original road geometry. In general, there were no significant changes noted in 2021 when compared to observations reported in the AMEC 2008 geohazard review for the Highway 940 corridor, and the 2009 site inspection.

3 SUMMARY AND RECOMMENDATIONS

As requested by AT, KCB reviewed the available information for GRMP "site" S068, first inspected in 2008 and last inspected in 2013. This site was not visited during the last contract cycle.

In total, six subsites were evaluated through a review of the historic site inspection reports from previous consultants, followed by a site visit in 2021 to evaluate whether site conditions had changed significantly. Based on the available information, KCB has made recommendations on whether the sites should remain a part of the GRMP, or whether they should be returned to the MCI for ongoing management.

All six sites were damaged during the 2013 flooding; however, they appear to have subsequently been repaired and reinstated to approximately the original highway geometry as prior to flooding. Therefore, in general, there were no significant changes when compared to previous inspections. Any changes observed were typically due to natural site degradation, such as surface runoff erosion or back slope weathering.

Based on the available information, KCB has made the following recommendations:

- S068-1, S068-2, S068-3, S068-4, and S068-6 should be removed from the GRMP, unless the MCI has specific concerns relating to certain sites, or other sites along this stretch of highway. The MCI should manage short-term risks to road users at individual locations using routine highway maintenance.
- The S068-5 should remain a part of the GRMP and be visited once per contract cycle.
- A preliminary engineering assessment including a hydrotechnical assessment and environmental evaluation should be conducted for the S068-5 site. Options to provide additional discharge capacity should be assessed (e.g., longer-span bridge, construction of a side channel and large diameter culvert, channel realignment, and alternate bridge location).

4 CLOSING

This report is an instrument of service of Klohn Crippen Berger Ltd. (KCB). The report has been prepared for the exclusive use of Alberta Transportation (Client) for the specific application to the Southern Region GRMP, 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.

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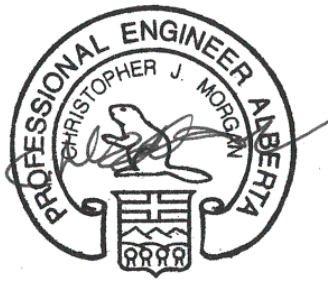
Please contact the undersigned if you have questions or comments about this report.

Yours truly,

KLOHN CRIPPEN BERGER LTD.



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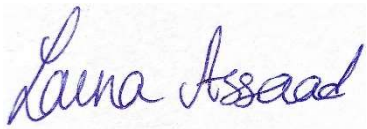

Chris Morgan, P.Eng.
Senior Geotechnical Engineer

Laura Assaad, EIT
Geotechnical Engineer-in-Training

PERMIT TO PRACTICE
KLOHN CRIPPEN BERGER LTD.

RM SIGNATURE: _____

RM APEGA ID #: 187607

DATE: 19 Jan. 2022

PERMIT NUMBER: P009196

The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

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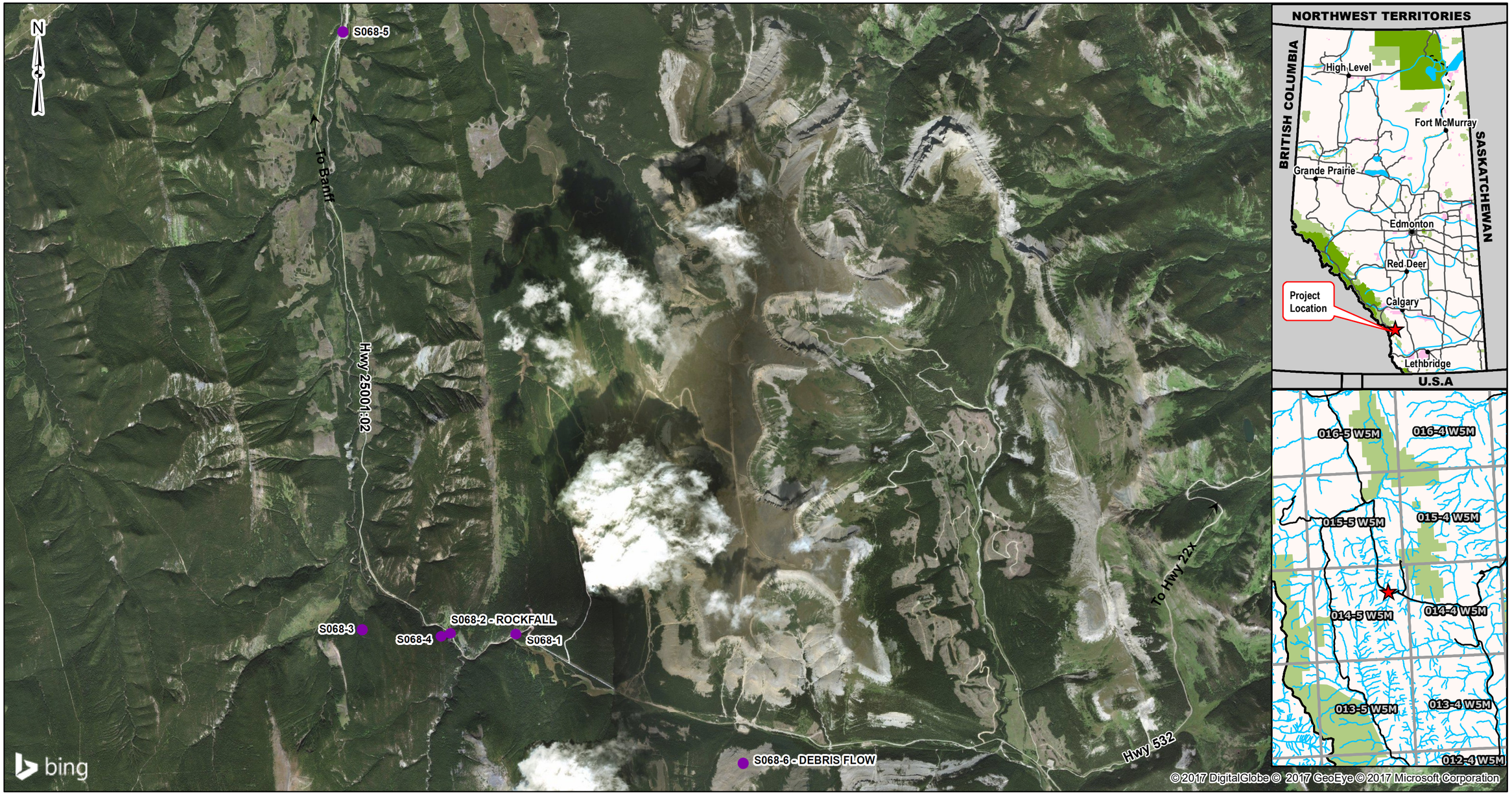
FIGURE



Legend

- S068 (6 sub-sites)

Meters
0 1,000

NOTES:
1. HORIZONTAL DATUM: NAD83
2. GRID ZONE: UTM Zone 11N
3. IMAGE SOURCE: Microsoft BING Basemap

CLIENT
Alberta
Klohn Crippen Berger

PROJECT
SOUTHERN REGION GEOHAZARD RISK MANAGEMENT PROGRAM

TITLE
Site Plan
S068 - Geohazards Call-Out

SCALE	PROJECT No.	FIG No.
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APPENDIX I

S068 Site Walkover Photos

Appendix I
S068 Site Walkover Photos

Photo I-1 S068-1: Back slope upslope of the highway. Photo was taken facing north on October 22, 2021.

Photo I-2 S068-1: Accumulation of gravel at the back slope toe due to surface erosion and weathering. Photo was taken facing east on October 22, 2021.

Photo I-3 S068-1: Erosion at the brow of the slope leading to overhanging topsoil mats. Photo taken facing north on October 22, 2021.

Photo I-4 S068-2: Bedrock slope on the north side of the highway. Photo was taken facing west on October 22, 2021.

Photo I-5 S068-2: Toe of backslope was clear of debris at time of inspection. Photo was taken facing west on October 22, 2021.

Photo I-6 S068-2: Creek at toe of highway embankment. Photo was taken on October 22, 2021.

Photo I-7 S068-3: Right bank of Wilkinson Creek repaired following the 2013 floods. Photo was taken facing east on October 22, 2021.

Photo I-8 S068-3: Right bank of Wilkinson Creek repaired following the 2013 floods. Photo was taken facing west on October 22, 2021.

Photo I-9 S068-4: Back slope on the upslope side of the highway. Photo was taken facing north on October 22, 2021.

Photo I-10 S068-4: Surface runoff leading to a debris cone at toe of back slope that reduces the available ditch capacity. Photo taken facing north on October 22, 2021.

Photo I-11 S068-4: Creek at toe of highway embankment. Photo taken on October 22, 2021.

Photo I-12 S068-5: Bridge at Wilkinson Creek. Photo was taken on July 9, 2021.

Photo I-13 S068-5: The creek jumped its banks during the 2013 flooding and washed out the road. Photo was taken on July 9, 2021.

Photo I-14 S068-5: Repaired and riprap lined bank of Wilkinson Creek after 2013 washout. Photo was taken facing northwest on July 9, 2021.

Photo I-15 S068-6: Debris flow path at the toe of Plateau Mountain. Photo was taken facing north on October 22, 2021.

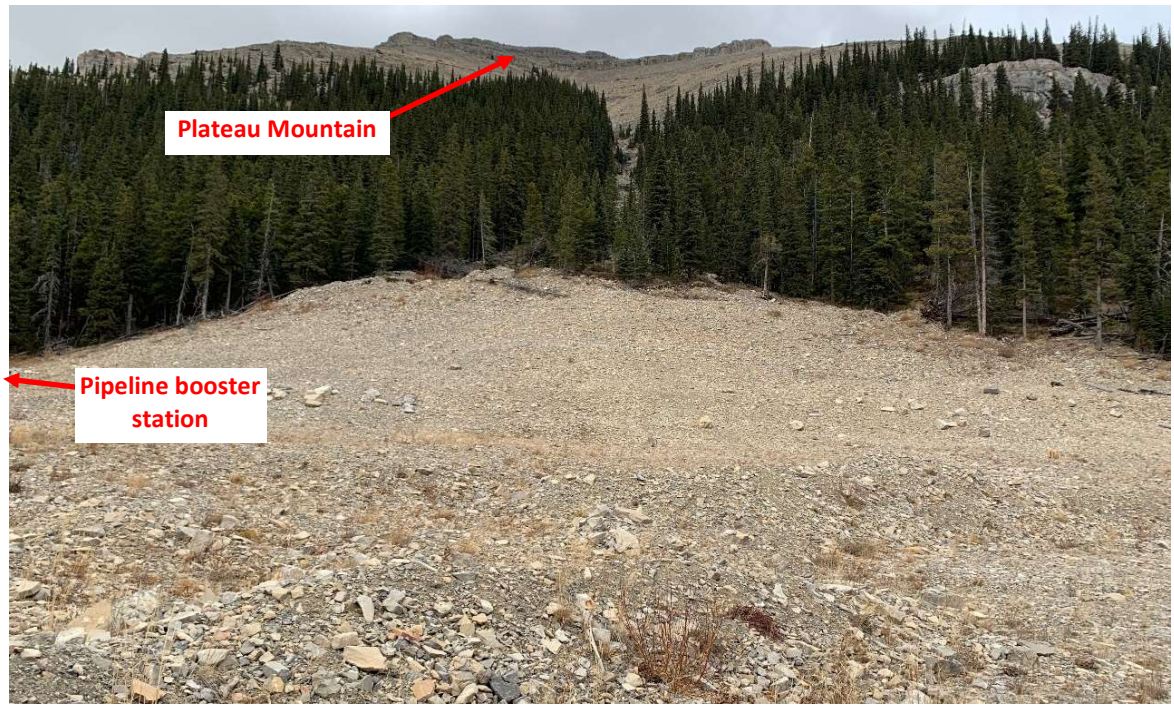

Photo I-16 S068-6: East side of debris fan. Photo taken facing east on October 22, 2021.