CENTRAL REGION GRMP
SITE INSPECTION FORM

SITE NUMBER AND NAME: **C018-1 and -2**	HIGHWAY & KM: 837:02, 2.1	PREVIOUS INSPECTION DATE: June 26, 2023	INSPECTION DATE: **June 18, 2024**
LEGAL DESCRIPTION: 27-29-21 W4M	NAD 83 COORDINATES: UTM 12 Northing 5708478 Easting 369823	RISK ASSESSMENT: Debris Flows > 0.5 m^3 PF: 15 CF: 7 TOTAL: 105 Debris Flows < 0.5 m^3 PF: 15 CF: 6 TOTAL: 90 Earth slide PF: 10 CF: 6 TOTAL: 60	
AVERAGE ANNUAL DAILY TRAFFIC (AADT): 280 (north) (Reference No. 106230)		CONTRACT MAINTENANCE AREA (CMA): 517	

SUMMARY OF SITE INSTRUMENTATION:	INSPECTED BY:
A weather station was installed by KCB at the crest of the slope west of H837:02. LAST READING DATE: N/A	Chris Gräpel (KCB) James Lyons (KCB) Tony Penney (TEC) Rocky Wang (TEC)

PRIMARY SITE ISSUE: Natural slope instability along a section of the west valley slope along Hwy 837 (C018-2) and highway embankment instability (C018-1). On May 22, 2018, an earthflow slide deposited approximately 500 m^3 of material on the highway. Ongoing sliding and expansion of the 2018 slide area has occurred since 2018, and new slides on the highway embankment have developed since 2021.

APPROXIMATE DIMENSIONS: Total length of the geohazard site is approximately 400 m. C018-1 includes three slope failures along the east highway embankment slope (approximately 20 m to 70 m in length and 6 m high). For C018-2, the areas of slope instability include shallow slope failures that vary in depth from 0.5 m to 1.0 m and extend 10 m to approximately 40 m above the highway.

DATE OF ANY REMEDIAL ACTION: C018-1: Embankment repairs (including geogrid-reinforced granular fill, placing a Turf Reinforcement Matt (TRM) on the slope surface, and armouring the toe of the slope with riprap) have been completed in 2000, 2002, and 2005. C018-2: Following the earthflow slide that occurred in May 2018, TEC installed jersey barriers along the centerline of the west (southbound) lane and traffic cones to keep traffic away from the barrier and guardrail. The traffic through the highway below the C018-2 site is one way. Traffic control is via stop sign because batteries were repeatedly stolen from the one-way-traffic signal-light system initially set up at the site. TEC's Highway Maintenance Contractor (HMC) regularly removes deposited material from behind the jersey barriers. New jersey barriers were installed in 2020.

ITEM	**CONDITION EXISTS**		**DESCRIPTION AND LOCATION**	**NOTICABLE CHANGE FROM LAST INSPECTION**	
	YES	NO		YES	NO
Pavement Distress	X		Longitudinal pavement cracking along the east (northbound) shoulder	X	
Slope Movement	X		C018-1: Slope failures along the east (northbound) highway embankment slope. C018-2: Active slide areas depositing rockfall material onto the highway surface from the west valley slope	X	
Erosion	X		C018-2: Evidence of rill erosion on the valley slope	X	
Seepage	X		Seepage observed at various locations along the toe of the valley slope above the highway		X
Culvert Distress		X	N/A – none observed during the 2024 inspection.		X

COMMENTS

Previous Work and Inspections:

- The C018 site has been inspected by KCB since 2000 (annual inspections, call-out inspections, and as part of an ongoing study with the University of Alberta (UofA)).
- There have been previous repairs at the C018-I site constructed from 2000 to 2005. The repair work included rebuilding the slope with geogrid-reinforced granular full, placing turf reinforcement matting on the slope surface, seeding, riprap installation at the base of the embankment slope, and grading of the embankment slopes. The extents of the early 2000s repair work are indicated by Waypoints 355 and 356.
- Between 2017 and 2021, there have been various topographic surveys and aerial drone surveys/mapping completed at the site.
- Following the May 2018 inspection, KCB recommended that TEC shut down the highway until the unstable rock mass was removed, and provisions were made to reduce rockfall risk to the public. The unstable ledge of rock was believed to be at risk of failure during a heavy rainfall or under the effect of gravity without rain. KCB completed an analysis of various rockfall mitigation options including the installation of jersey barriers (with and without an empty ditch), a rockfall catchment net, and a two-lock-block retaining wall. The effectiveness of these measures is presented in the letter dated June 20, 2018 that was sent to TEC. The current arrangement of jersey barriers at the centre of the west (southbound) lane does not address the risk of collapse of the rock mass, nor offer enough catchment for the rockfall hazard at this site.
- In October 2021, a geotechnical investigation and laboratory testing program was completed to support design work for the C018-2 site. In 2022, KCB received approval from TEC to begin a conceptual assessment for potential design repairs and the final report was issued on August 30, 2022.
- In 2022, KCB began a Conceptual Engineering Assessment (CEA) to assess repair options for the C018 site. The options assessed in the CEA report include re-routing traffic around the site, installation of a rockshed, installing a barrier wall in the upslope ditch and re-aligning the highway, and automated monitoring. The assessment included quantity and cost estimates and the Preliminary Engineering Report (PER) was issued to TEC on June 14, 2022 for review and comment. In a review meeting held between KCB and TEC on July 8, 2022, TEC indicated that their preferred options for the site that should proceed to preliminary design were a crest-of-backslope ditch to improve drainage to the highway backslope, an automated monitoring system, and an alternate route around the site. The final CEA report was issued to TEC on August 30, 2022.
- In February 2023, KCB submitted a proposal to TEC to complete design work for the C018-1 site. TEC approved the proposal in February 2023. KCB began design work and issued the final design report to TEC on June 28, 2023. On June 26, 2023, during the 2023 Section B Inspection, TEC requested a rockfall barrier design be completed for the C018-2 subsite. The design work was completed on March 19, 2024.
- In late-2023 and early-2024, KCB prepared a tender (Tender No. TND0022533) that includes the repair of the C017-1, C017-3, C018-1 and C018-2 sites. The final tender was issued to TEC in early-May 2024, advertised on May 22, 2024, a pre-tender meeting was held on May 31, 2024, and the tender closing date was July 5, 2024.The tender was awarded in early-September, a pre-construction meeting is to be scheduled, and construction is anticipated to be completed in summer or fall 2024.

C018-1:

- Longitudinal pavement cracking north of the C018-1 slide was observed in the shoulder of the east (northbound) lane (Photo 6). Longitudinal pavement cracking has been regularly and is the most severe upslope of the slide failures near the south extent of the site. Increased traffic loading on the east (northbound) lane due to jersey barriers in the west (southbound) lane along C018-2 may be attributing to slope movements that are impacting the pavement surface (i.e., pavement settlement and cracking). Ground cracks were also observed further north, closer to the length of riverbank repaired in the early 2000s (Photo 7).

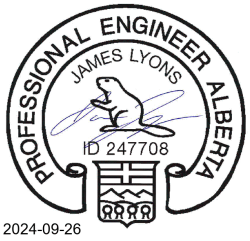
- Dispersive soil voids were observed on the east side of the highway along the length of the site (Photos 8 through 10). The sinkholes were concentrated near the left (northwest) and right (southeast) extent of the previous riverbank repair. Between 5-10 voids were observed during the 2024 inspection.
    - Waypoint 378: Four sinkholes up to approximately 0.8 m in diameter and 1.5 m deep.
    - Waypoint 379: Location where surface water runoff from the highway flows into a sinkhole.
    - Waypoint 380 and 381: Two sinkholes up to approximately 0.7 m in diameter and 1 m deep.
- Between 2023 and 2024, no significant change to the slope failure on the east (northbound) highway embankment slope (first observed during the 2021 inspection) was observed (Photo 11). KCB and TEC believe that the failure occurred in spring 2021.The failure expanded between the 2022 and 2023 inspections (likely due to wet weather) and is approximately 20 m wide and 3 m high, with ground cracks observed approximately 5 m to 10 m on either side of the failure.
- Material (soil and coal fragments) from the C018-2 site was observed on the east side of the guardrail, indicating that material falling down the slope is not being completely contained with the concrete jersey barriers (Photo 12). The larger blocks deposited behind the guardrail appear older (weathered) and were generally less than approximately 0.5 m x 0.5 m x 0.5 m.
- There are two above ground utility lines just east of the guardrail (at the crest of the highway embankment) that run the entire length of the site. One appears to be severed while the other appears intact.

C018-2:

- In general, there was less material deposited behind the jersey barriers than previous years inspections, particularly along the southeast portion of the site (Photo 1).
- Near the middle of the site, failed material has been deposited into the west (southbound) lane between the 2023 and 2024 inspections (Photo 2). The material was deposited approximately 35 m along the base of the slope and the area of instability extends approximately a quarter of the way up the slope.
- Near the north extent of the site, failed material has been deposited into the ditch and west (northbound) lane between the 2023 and 2024 inspections (Photo 3). The volume of failed material was approximately 480 cubic meters (15 m long, 8 m deep, and 4 m tall). The area of instability extends approximately one third of the way up the slope.
- A new pavement crack (approximately 25 mm to 50 mm wide and 20 m long) was observed in the west (southbound) lane behind the jersey barriers at the north extent of C018-2 (Photo 4 and 5). The crack extends across both lanes (Photo 5). The crack was near the north extent of the previous riverbank repair completed in the early 2000s and could indicate movement is outflanking the previous repair and the rate of movement has increased between the 2023 and 2024 inspections.
- In more active zones and beneath the two areas where material was deposited into the west (southbound) lane between 2023 and 2024, seepage was observed at the base of the failed material (Waypoint 382). At the southeast extent of the site, there is evidence of surface water flowing across the highway surface (sediment deposited in ditch and across the highway surface).

Maintenance/Repair/Monitoring Recommendations:

- The site should be regularly inspected by TEC's Maintenance Contract Inspector (MCI), especially after precipitation events.
- When required, material deposited behind the jersey barriers should be regularly removed by TEC's HMC.
- The site should continue to be inspected annually as part of the Central Region Section B Inspections.
- Th C018-1 slide should be repaired and the C018-2 rockfill barrier should be installed in summer of fall of 2024 as described in TND0022533. If the movement near the northeast extent of the site continues to get worse, near the previously repaired riverbank slide, TEC should consider completing repair work (as an Extra Work Order) as part of TND0022533. The repair could potentially include rebuilding a portion of the highway embankment with geogrid reinforced granular fill, with a shear key, like the C018-1 repair.



James Lyons, P.Eng.
Civil Engineer

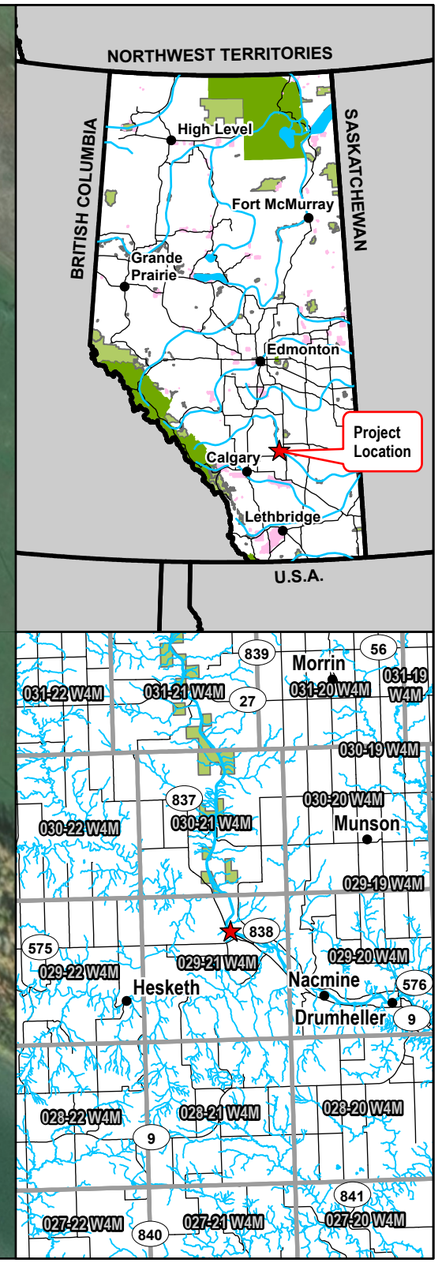
PERMIT TO PRACTICE
KLOHN CRIPPEN BERGER LTD.

RM SIGNATURE: _____

RM APEGA ID #: 187607

DATE: 26 Sep. 2024

PERMIT NUMBER: P009196
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)



Legend

- Waypoint
- Flow Direction
- Jersey Barrier
- Culvert
- Scarp
- Crack

0 100 Metres

NOTES:
1. HORIZONTAL DATUM: NAD83
2. GRID ZONE: UTM ZONE 12N
3. IMAGE SOURCE: 2024 MICROSOFT CORPORATION, MAXAR, CNES DISTRIBUTION AIRBUS DS.

CLIENT: Alberta

Klohn Crippen Berger

PROJECT: CENTRAL REGION GEOHAZARD RISK MANAGEMENT PROGRAM

TITLE: Site Plan
C018 - Red Deer Riverbank Slide
Hwy 837:02, km 2.100

SCALE 1:2,500 | PROJECT No. A05116A02 | FIG No. 1

File: C:\Users\equine\Desktop\TWINS\A05116A02 ABT Central Region GRMPAT_CentralRegion_Section\BAT_CentralRegion_SectionB.aprx Date: Time: Creator: : EQuine

Photo 1 **Southeast extent of where the jersey barriers are installed along the C018-2 site. Photo taken June 17, 2024, facing northwest.**

Photo 2 **Failed material deposited into the west lane behind the jersey barriers, near the middle of the site, between the 2023 and 2024 inspections. Photo taken June 17, 2024, facing southeast.**

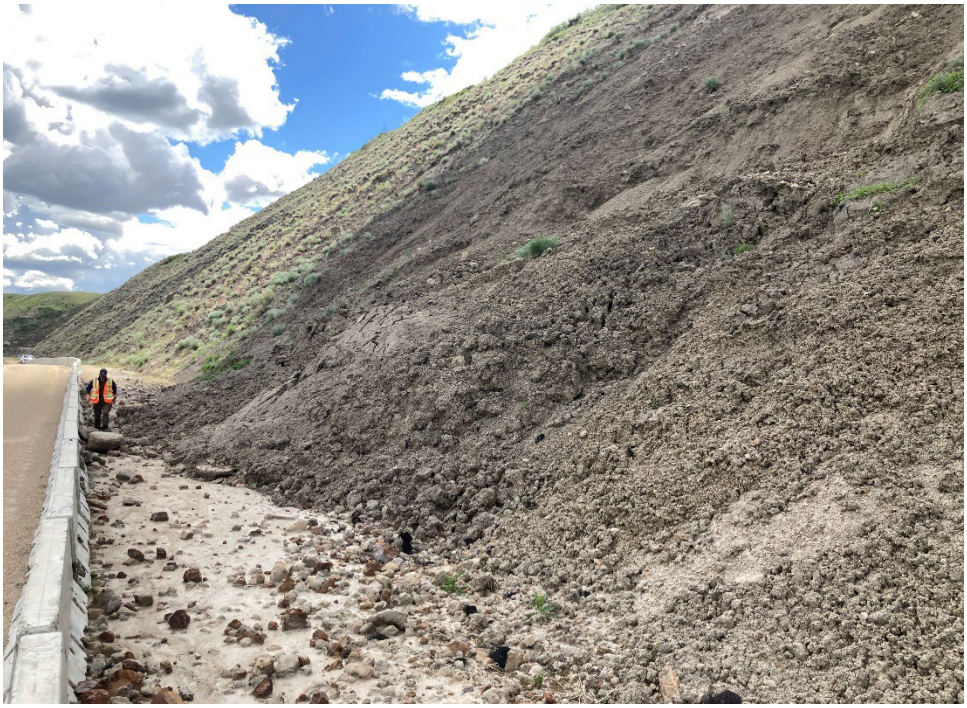


Photo 3 **Failed material deposited into the west lane behind the jersey barriers, near the northwest extent of the site, between the 2023 and 2024 inspections. Photo taken June 17, 2024, facing southeast.**

Photo 4 **New pavement crack (approximately 25 mm wide and 20 m long, indicated by red arrow) that extends across both lanes near the northwest extent of the C018-2 site (northwest of the previous riverbank slide repair). Photo taken June 17, 2024, facing northwest.**

Photo 5 **New pavement crack extending across the east and west lanes (indicated by red arrows). Photo taken June 18, 2024, facing northwest.**

Photo 6 **Pavement cracking at the edge of the east lane northwest of the C018-1 slide. Photo taken June 18, 2024 facing southeast.**

Photo 7 **Ground cracking observed just southeast of the previous riverbank slide repair completed in the early 2000s. Photo taken June 18, 2024, facing northwest.**

Photo 8 **Sinkhole observed in the highway embankment slope downslope of C018-2. Photo taken June 18,2024, facing north.**

Photo 9 **Sinkholes observed in the highway embankment slope downslope of C018-2. Photo taken June 18,2024, facing north.**

Photo 10 **Sinkhole observed in the highway embankment slope downslope of C018-2. Photo taken June 18,2024, facing north.**

Photo 11 **No significant changes were observed at the C018-1 slide between the 2023 and 2024 inspections. Photo taken June 18, 2024, facing southeast.**

Photo 12 **Material (soil and coal fragments) have been deposited across the highway surface. Photo taken June 18, 2024, facing southeast.**