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| SITE NUMBER AND NAME: S004 Willow Creek (North of Fort Macleod) | | HIGHWAY & KM: 2:08, 6.284 | PREVIOUS INSPECTION DATE: July 8, 2021 | INSPECTION DATE: May 19, 2022 |
| LEGAL DESCRIPTION: 13/14-20-09-26-W4M | NAD 83 COORDINATES: UTM Northing Easting 12 5514351 320169 | | RISK ASSESMENT: PF: 8 CF: 4 TOTAL: 32 | |
| Average Annual Daily Traffic (AADT): 5460 (north) & 6100 (south) (Reference No. 92080) | | | CONTRACTOR MAINTENANCE AREA (CMA): 26 | |

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| SUMMARY OF SITE INSTRUMENTATION: Three slope inclinometers, five standpipes, and six vibrating wire piezometers are located at the crest of the slide. Instruments located in the slide mass are assumed to be inoperable. LAST READING DATE: July 6, 2022 | | INSPECTED BY: Chris Morgan (KCB) Laura Assaad (KCB) Roger Skirrow (AT) Alex Frotten (AT) |
| PRIMARY SITE ISSUE: Landslide at outside bend of Willow Creek (slope crest retrogressing), possibly due to infiltration from irrigation activities on farmland on the opposite side of Hwy 2. Landsliding has retrogressed into eastbound lane ditch, causing ditch flows to discharge onto the slide surface. | | |
| APPROXIMATE DIMENSIONS: The site is approximately 400 m long and 20 m in height. The head scarp is located approximately 11 m to 12 m from the guardrail. The slope is approximately 4H:1V to 5H:1V. | | |
| DATE OF ANY REMEDIAL ACTION: 2008 – slope stabilization (soil nailing, grading, and bioengineering (live staking)) with longitudinal peaked stone creek bank (LPSTP) armoring to reduce erosion at the toe of the slide. 2014 – installation of a guardrail along the east (northbound) edge of the highway. | | |

| ITEM | CONDITION EXISTS | | DESCRIPTION AND LOCATION | NOTICABLE CHANGE FROM LAST INSPECTION | |
|-------------------|------------------|----|--|---------------------------------------|----|
| | YES | NO | | YES | NO |
| Pavement Distress | | X | Transverse pavement cracking but is not believed to be attributed to the slide. | | X |
| Slope Movement | X | | The head scarp of the slide has been retrogressing into the ditch since 2016. The head scarp has retrogressed over 10 m in the last 9 years. | | X |
| Erosion | X | | Erosion observed on slopes from ditch discharge onto slide area, riprap armoring placed in 2008 is intact. | | X |
| Seepage | X | | N/A – none observed during the 2022 inspection. A wet area was observed in the slide zone during a previous inspection. | | X |
| Culvert Distress | | X | N/A – none observed | | X |

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| COMMENTS |
| There has been minimal change in slope retrogression observed between 2019 and 2022. The head scarp is approximately 11 m to 12 m from the guardrail at the closest point. South of the main slide, the right flank has retrogressed to approximately 16 m from the guardrail. There are four wooden stakes (3 re-installed, 1 existing) present at the head scarp that are used to estimate slide retrogression. It is estimated that there has been 2.3 m to 3.5 m of retrogression into the ditch since 2016. |

The head scarp has retrogressed 3 m to 5 m past the fence line. The slide zone is actively being undermined and material from the topsoil mat is sloughing into the slide zone over time. No significant changes were noted in the slide mass during the 2022 inspection.

The site was well vegetated during the 2022 inspection. However, bare patches of soil were observed near the top of the slide zone.

A buried black utility cable is exposed in the slide area.

The nature of the slide (i.e., back tilting blocks) suggests a combination of rotational and translational failure along a deep weak layer. The right flank of the slide (southeast) appears to be retrogressing faster than the left flank (northwest).

There is a wet area at the head of the slope where ditch flow is discharging onto the slide mass, with possible salt staining downslope of the head scarp. Standing water was present on the lower third of the slope during a previous inspection (WP 20).

The creek armouring completed in 2008 is in good condition. However, continued slope movement is displacing the armouring eastward across creek, straightening a former curved zone of creek bank. The riprap is exposed due to low water levels and needs maintenance to the vanes.

Maintenance/Repair/Monitoring Recommendations:

Short-Term

- The operable instruments should continue to be read twice per year (spring and fall) as part of the Southern Region GRMP.
- At least two data loggers should be installed with at least two of the operable piezometers. The reading frequency (twice per year) may not be sufficient to capture high or low water levels, or changes in response to precipitation events (i.e., freshet, heavy rainfall, or prolonged rainfall).
- Additional survey stakes should be installed to monitor slide retrogression. Existing stakes are vulnerable to disturbance from weather events, maintenance activities (i.e., mowing), and vandalism.
- A desktop study should be completed for the site including review of existing borehole logs, geological maps, reviewing historic air photos, and assessing available LiDAR data for use in change detection.

Long-Term

- A geotechnical site investigation should be completed to assess the subsurface conditions (i.e., stratigraphy and groundwater conditions).
- Preliminary engineering should be completed to assess repair options for the site. Potential repair options for this site include: diverting surface water away from the slide zone; or installing horizontal drains connected to a seepage collection curtain. The seepage collection curtain would need to be assessed for potential impact to the farmland and reservoir on the west side of the highway.

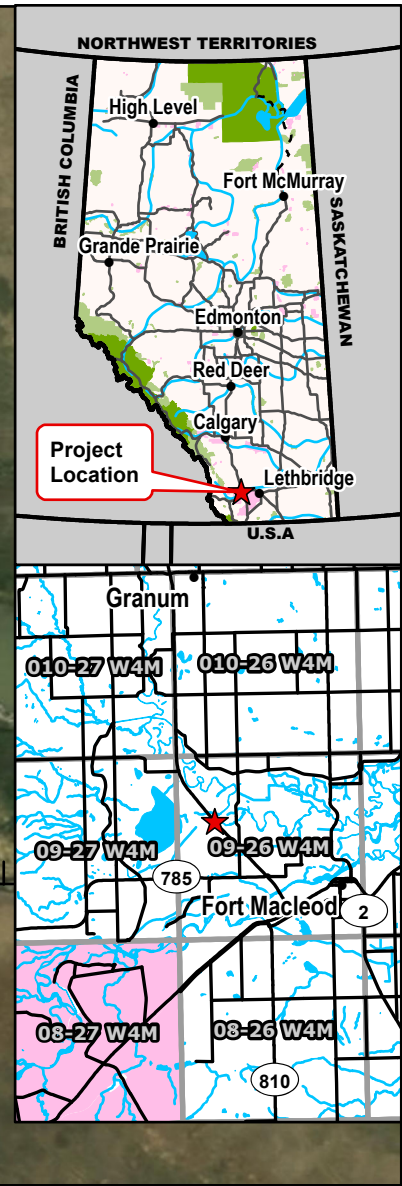
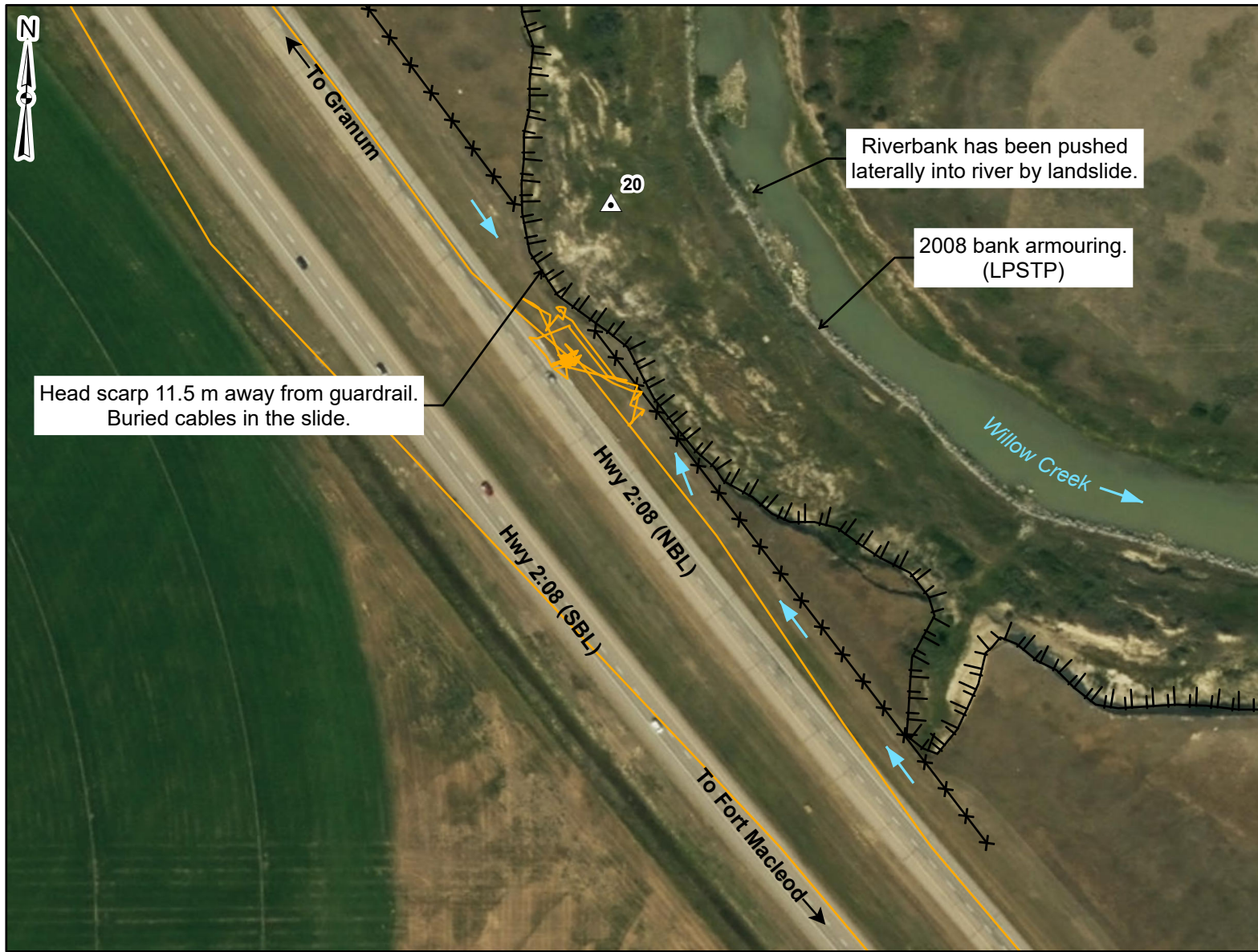
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Chris Gräpel, M.Eng., P.Eng.
Senior Civil Engineer, Associate



Legend

- GPS Waypoint (July 7, 2020)
- GPS Track (May 19, 2022)
- Scarp
- Fence
- Flow Direction

NOTES:
 1. HORIZONTAL DATUM: NAD83
 2. GRID ZONE: UTM ZONE 12N
 3. IMAGE SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS AND THE GIS USER COMMUNITY.

CLIENT

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| PROJECT SOUTHERN REGION GEOHAZARD RISK MANAGEMENT PROGRAM | | |
| TITLE Site Plan S004 - Willow Creek (North of Fort Macleod) Hwy 2.08, km 6.284 | | |
| SCALE 1:2,000 | PROJECT No. A05116A03 | FIG No. 1 |

Inspection Photographs

- Photo 1** An overview of the slide area. Willow Creek is at the toe of the slope (indicated by red arrow) and instruments can be seen in the slide zone (indicated by red circle). Photo taken May 19, 2022 facing north.



- Photo 2** View of Willow Creek and creek armoring from the head of the slide. Back tilting blocks are visible in the slide mass. Photo taken May 19, 2022 facing northeast.



Photo 3 View of the slide from the left (north) flank of the slide. The head of the slide is retrogressing towards the highway. Photo taken May 19, 2022 facing southeast.



Photo 4 The head of the slide is retrogressing towards the highway. Photo taken May 19, 2022 facing south.

