May 9, 2018

Sturgeon County
9613 100 Street
Morinville, Alberta
T8R 1L9

**Abid Malik, P.Eng.**
**Corporate Capital Projects Officer**

Dear Mr. Malik:

**Range Road 261A Initial Slope Assessment**
**Call – Out Report**

# 1 INTRODUCTION

Klohn Crippen Berger Ltd. (KCB) was requested by Sturgeon County to conduct a call-out inspection of a slope erosion site on Range Road 261A. The project site is located immediately to the east of Range Road 261A approximately 105 m northwest of Meadowview Drive in Sturgeon County, Alberta. The site is the location where river erosion of an embankment slope has affected the east shoulder of Range Road 261A. The site coordinates are 5944452 N, 320265 E (UTM Zone 12) and the legal land description is 8-35-53-26 W4. A site plan is presented in Figure 1.

The site was inspected on April 20, 2018 by Messrs. Hanh Hong, P.Eng. and Chris Gräpel, P.Eng. of KCB with Messrs. Jordan Kluthe and Brad Montgomery, C.Tech. of Sturgeon County. Photographs from the site inspection are included in Appendix I.

This call-out report was prepared as per KCB's proposal to Sturgeon County dated March 23, 2018. KCB's site observations, assessments and recommendations for short-term and long-term remedial actions are presented herein.

# 2 BACKGROUND

## 2.1 Site Description

The slope failure at Range Road 261A is located approximately 105 m north of Meadowview Drive. The site is a steep eroded slope approximately 5.5 m high that is eroded into the range road. The slope below the highway varies between 2H:1V and 1.2H:1V. Near-vertical sections of the slope are present at the recently failed portion, 1.0 to 2.0 m high, below the crest of the slope.



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The site is on the outside bend of the Sturgeon River. The Sturgeon River meanders with several bends near the subject site. A previous report from the Meadowview Drive functional-planning study (Thurber, 2013) states that an old scarp was visible along the crest of the steep bank upstream of the bridge location, indicating that minor sloughing should be expected on the steeper erosional stream-banks of a meandering river.

Sturgeon County (2018) reports that bank erosion occurred in 2007 or earlier. Oblique air photos provided by the Sturgeon County in an erosion report (Sturgeon County, 2018) show the site as being covered with shrubs and small trees in 2007 with a limited area of exposed soil. By 2012, the area of exposed soil had expanded. Comparisons between the 2007 and 2018 photos are complicated by the two photos (2007 and 2012) being taken at different times of the year. The 2007 photo was taken in late spring to late summer and showed vegetation with leaves on the vegetation, whereas the 2012 photo appears to have been taken in early spring, and therefore showed no leaves on the vegetation. Since 2012, photos taken in 2014 and 2016, also believed to be in early spring, show that the lateral extent of instability did not change much.

The geotechnical report for the Meadowview Drive function-planning study (Thurber, 2013) indicates that the subject site is underlain by glacio-lacustrine silt and clay.

The available borehole data described in Thurber (2013) consists of one 9.3 m deep stick log for a borehole drilled at the Sturgeon River bridge pier location in October 1958. The stick log showed 0.5 m of water over sandy silt with some gravel and boulders extending to a depth of 5.5 m overlying sand and gravel to a depth of 5.9 m. On the stick log the sand and gravel was followed by hard clay to a depth of 8.7 m, over soft sandstone to the termination depth of 9.3 m below the stream bed. Thurber (2013) reports it is likely that the soft sandstone is rafted bedrock since the estimated depth to bedrock is about 30 m based on the available geology map. Thurber (2013) reported that the river banks and slopes are expected to be covered by alluvium and glacio-lacustrine silt, clay and sand of varying thicknesses.

Thurber (2013) reports that groundwater conditions are expected to be relatively high within the glacio-lacustrine deposits.

The Sturgeon River within the vicinity of the project is a Class C watercourse with a restricted activity period (RAP, i.e., period to avoid instream work) of April 16 to June 30 (ESRD, 2012). This RAP is intended to restrict instream construction activities during the sensitive spawning and incubation period for spring spawning resident fish species such as northern pike and white sucker. The subject site is approximately 2.3 km upstream from Big Lake.

## 2.2 Previous Repairs

KCB reviewed a Sturgeon County erosion report dated March 2018 and met with Sturgeon County staff on March 28, 2018 to understand the actions taken by Sturgeon County at the subject site. A w-beam guardrail was erected after 2007. By 2012, the guardrail had been undermined by slope instability and was replaced by a barricade consisting of jersey barriers, which was erected at the edge of the pavement. In late March 2018, the jersey barriers were undermined by slope failure that

retrogressed into the edge of the pavement over a 1 to 2 m width. Sturgeon County subsequently shifted the jersey barriers 2 m away from the east edge of pavement, closing the northbound lane over a 40-m length.

## 3 SITE OBSERVATIONS

The following conditions were observed at the site:

- By the time of our site visit, the site was covered with low height vegetation with dense shrubs, bushes and small trees present on the flanks of the slide area.
- The jersey-barrier is approximately 40 m long, and long enough to limit vehicle access to the crest of the failed slope. The north end of the jersey-barrier barricade (see Photo 1) is indicated at waypoint 587, shown on Figure 1. The south end of the jersey-barrier barricade (see Photo 2) is indicated at waypoint 588, shown on Figure 1.
- The slope failure has retrogressed past the eastern edge of pavement in spring of 2018 (see Photo 3.
- Parts of the slope were still covered with snow and high water in Sturgeon River inundated the toe of the slope, precluding inspection of the toe for erosion (see Photo 4 and Photo 5).
- The slide area is expanding to the north (see Photo 6). An 8-m long tension crack, partially infilled with leaf litter and vegetation was observed to the north of the active slope instability area. The north end of the tension crack is at waypoint 585, shown on Figure 1. The tension crack is located approximately 2 m behind the crest of the slope. The 8-m long section of slope that is failing is behind the jersey-barrier barricade
- The slide appears to be expanding to the south due to erosion caused by pavement and ditch runoff flowing over the crest of the slope. Erosion to the south of the active slope instability is located at waypoint 584, shown on Figure 1. As erosion continues to the south of the active slide area, erosion will extend past the southern edge of the jersey-barrier barricade.
- The near surface soils, based on a hand auger located at waypoint 583 (shown on Figure 1) consisted of medium - to high -plastic lacustrine clay, greyish brown in color, with fine sand and silt.
- The slide area appears to be an older slope failure that has been re-activated, as indicated by the eroded slope upstream of Sturgeon River bridge (see Photos 4 and 8)
- Surface water runoff from the range road onto the slope appears to be triggering the slope failure by saturating the slope, and causing erosion of the upper portion of the slide, undermining the pavement (see Photos 6 and 7, reference waypoint 582 on Figure 1)

## 4 ASSESSMENT

The slope erosion appears to be due to runoff from the range road discharging over the steep slope combined with toe erosion from the Sturgeon River. If the erosion is not addressed, the slope and

toe will continue to erode, causing further slope movement and instability. Mitigating erosion at the toe will require rock armoring and instream work. Additional mechanisms exacerbating slope instability include high groundwater table (Thurber, 2013) and weak glacio-lacustrine soils.

# 5 RISK LEVEL

The risk levels for the Range Road 261A site was determined using Alberta Transportation's (AT's) geohazard risk level rating system for earth slides. The AT risk level rating system is appended in Appendix II for ease of reference.

The risk level was 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 occurring).
- Consequence Factor varies from 1 (minor consequence, no impact to driver safety, maintenance issue) to 10 (safety of public at risk, loss of infrastructure, rapid mobilization of large slides).

The risk level determined using AT's risk level factors is presented as follows:

- Probability Factor – A rating of 9 was selected because the embankment-slope failure is active with slope movements and erosion occurring at moderate-steady or decreasing rate of movement and impacting road embankment and ditches.
- Consequence Factor – A rating of 10 was selected for the site because partial closure or full closure of the road will be an unavoidable result of continued erosion and slope movement and because the eroded material could directly flow into fish bearing rivers or affect water quality and aquatic resources.

A total Risk Level of 90 was assigned for the subject site using AT's risk-rating scale.

# 6 RECOMMENDATIONS

The following subsections discuss the recommended short- and long-term remediation works for the subject site.

## 6.1 Short-Term

Short-term remediation works are discussed below and include extending the jersey-barrier barricade, shifting the road over and installing a sheet pile wall.

### 6.1.1 Extending Jersey-Barrier Barricade

The slide appears to be expanding to the south and as erosion continues, the slide will eventually extend past the southern edge of the jersey-barrier barricade. As an immediate short-term mitigation, we recommend extending the southern edge of the jersey-barrier barricade approximately 20 m south of the active slide.

### 6.1.2 Shifting Road West

The road could be shifted about 1.7 m to the west with guardrails installed on both sides of the road and reducing the amount of drainage flowing towards the slide area. Based on our discussion during the site inspection, Sturgeon County have developed a conceptual plan to shift the road. When the final design drawings are prepared, Sturgeon County should use w-beam guardrails and install deeper guardrail posts near the area where the erosion and pavement loss have occurred to provide more structural strength. An asphalt curb should be constructed behind the guardrail on the slope side to divert water away from the slope. A catch basin and slope drain should be considered to convey drainage down the slope without causing further erosion.

Clearances from the adjacent power poles to the western edge of pavement need to be considered. We measured a horizontal distance of about 3.7 m from the existing power pole to the existing edge of pavement on the west side of the road. According to the roadside design guide (Alberta Infrastructure and Transportation, 2007), a clear zone distance of 2.0 m to 3.0 m from the edge of the pavement will need to be maintained (based on a design speed of 60 km/hr, assumed average annual daily traffic [AADT] of 750 vehicles or less, and a fill slope of 4H:1V or less). The actual AADT of Range Road 261A is unknown to KCB.

The rough-order-of-magnitude, cost estimate to shift about 40-m length of the road 1.7 m to the west is between $30,000 to $70,000. The cost estimate is based on rough-order-of-magnitude quantities, volume and prices from AT's 2018/2017 weighted unit-price averages for the North Central Region. The slope should also be stabilized with vegetation using hydro seed mulch or bonded-fiber matrix.

If requested, KCB could prepare a cost estimate to provide construction monitoring during road construction.

### 6.1.3 Sheet-Pile Wall

A sheet-pile wall could be installed along the eastern edge of pavement and the slope face stabilized with vegetation. The sheet pile wall will require a geotechnical site investigation consisting of one to two hollow stem auger boreholes drilled about 17 m deep to assess foundation (e.g., soil and bedrock) conditions. Disturbed and undisturbed samples should be taken to complete an index and strength testing laboratory program. The laboratory test results would be used to develop material parameters that would be used to design the sheet-pile-wall.

The rough order of magnitude, cost estimate for a geotechnical site investigation is between $20,000 to $30,000 for two boreholes, which includes traffic accommodation. The rough order of magnitude, cost estimate for the construction of the sheet-pile wall is between $320,000 to $750,000, depending

on the findings from the geotechnical investigation. Our cost estimate is based on unit costs for a sheet-pile wall project in Southern Alberta that KCB is currently providing construction oversight and contract administration. The cost estimate is based on a 40-m long sheet-pile wall embedded 17 m below the ground surface. The sheet-pile wall will also require surface water diversion, and if river erosion is not addressed, continued river erosion will eventually remove the wedge of soil that is supporting the sheet pile, causing deflection. Anchoring will eventually be required to maintain wall stability at extra cost.

If requested, KCB could prepare a cost estimate for completing a site investigation, assessing and preparing design options for the sheet-pile wall, including preparing a set of drawings, a Class C cost estimate, tendering, construction and post-construction services.

## 6.2 Long-Term

Long-term remediation works are discussed below and include relocating the road entirely further to the west, providing rock armoring at the toe and stabilizing the slope with vegetation.

### 6.2.1 Relocating Road

The entire road could be relocated further to the west as part of the Meadowview Drive improvement work. Based on our discussion with Sturgeon County, this option is being considered as part of the county's capital improvement project.

### 6.2.2 Toe Armoring

Erosion protection on the flank of the slope could be provided with vegetation (eg., using hydro seed mulch or bonded fiber-matrix) and at the toe of the slope using rock armoring (eg., Class II rock riprap). The installation of a rip-rap armoured toe within the Sturgeon River will require review under the Water Act, Public Lands Act, Fisheries Act, and potentially the Heritage Resources Act. Sturgeon County will need to conduct a fish and fish habitat assessment with site visits and a limited assessment of potential for effects on terrestrial resources in order to support these regulatory submissions. KCB could prepare and submit the applications on behalf of Sturgeon County. Water Act review would take about 3-6 months and could constrain the potential for constructing in 2018. Public Lands Act review would likely require an application for amendment of the permanent roadway disposition and application for a temporary field authorization. This process typically occurs simultaneously with the Water Act review. KCB could evaluate rock armouring design options that could limit 'serious harm' to fish as defined under the Fisheries Act and that authorization would not be required. If only a request for review application is required, Fisheries Act review is typically less than 3 months. Full authorization is typically closer to 6 months. In terms of cost, the full scope of work to support application submittals and permitting for rock armoring at the toe is around $35,000, assuming that authorization under the Fisheries Act is not required.

A rough-order-of-magnitude, cost estimate to install rock armoring at the toe of the slope and stabilizing the flank of the slope (eg., using hydro seed mulch or bonded fiber-matrix) for a 40-m length is between $60,000 to $135,000. The cost estimate is based on rough-order-magnitude

quantities, volume and prices from AT's 2018/2017 weighted unit-price averages for the North Central Region.

If requested, KCB could prepare a detailed cost estimate to submit the required applications and permits for regulatory approval, assessing and preparing design options for the toe armoring and slope stabilization, including preparing a set of drawings, a Class C cost estimate, tendering, construction and post-construction services.

## 7 CLOSING

This report is an instrument of service of Klohn Crippen Berger Ltd. The report has been prepared for the exclusive use of Sturgeon County (Client) for the specific application to the Range Road 261A slope failure site. The report's contents may not be relied upon by any other party without the express written permission of Klohn Crippen Berger. In this report, Klohn Crippen Berger has endeavored to comply with generally-accepted professional practice common to the local area. Klohn Crippen Berger makes no warranty, express or implied.

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

Yours truly,

**KLOHN CRIPPEN BERGER LTD.**


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HNH/CKG:kc

**Attachments**
Figures
Appendix I Site Photographs
Appendix II Alberta Transportation Risk Rating System

## REFERENCES

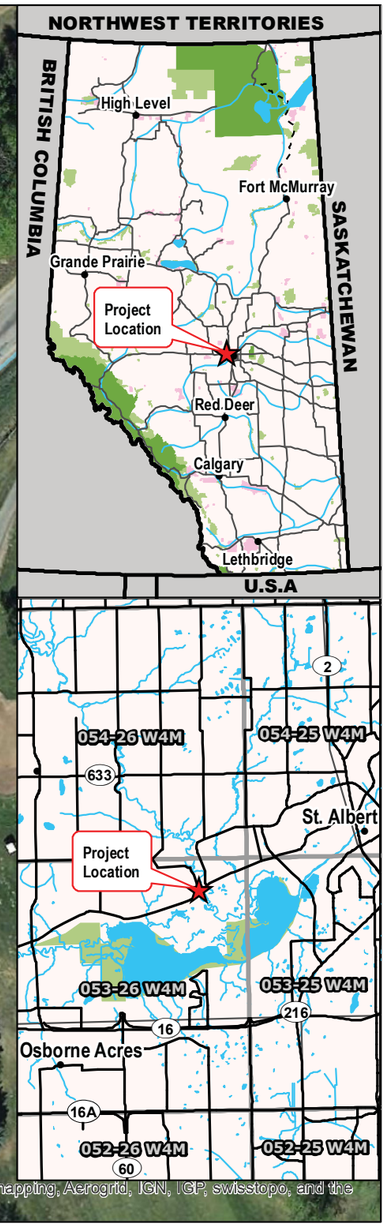
Alberta Environment and Sustainable Resource Development (ESRD), 2012. Code of Practice - St. Paul Management Area Map.

Alberta Infrastructure and Transportation, 2007. Roadside Design Guide, November 2007.

Sturgeon County, 2018. Rge Rd 261A – North of Meadowview Dr., Erosion Status Report, March 14, 2018.

Thurber Engineering Ltd. (Thurber), 2013. Meadowview Drive from Ray Gibbon Drive to Highway 44, Functional Planning Study, Geotechnical Desktop Study, Report to ISL Engineering and Land Services Ltd., February 1, 2013.

# FIGURES


## Legend

- ① Photo Location and Direction
- GPS Waypoints (April 20, 2018)
- GPS Track (April 20, 2018)

Meters
0 25

NOTES:
1. HORIZONTAL DATUM: NAD83
2. GRID ZONE: UTM Zone 12N
3. IMAGE SOURCE: Wold Imagery from ESRI ArcGIS Online. City of Edmonton 2015

CLIENT: **Sturgeon County**

Klohn Crippen Berger

PROJECT: RANGE ROAD 261A SLOPE ASSESSMENT

TITLE: SITE PLAN

| SCALE | PROJECT No. | FIG No. |
|---|---|---|
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# APPENDIX I

## Site Photographs

# Appendix I
# Site Photographs

**Photo 1** **View of site from north. Photo taken on April 20, 2018 looking south.**


**Photo 2** **View of site from the south. Photo taken on April 20, 2018 looking north west.**

**Photo 3** **Slope failure retrogressed past edge of pavement in spring of 2018. Photo taken on April 20, 2018 looking north.**


**Photo 4** **Portions of the slope with a north facing aspect were still covered with snow at the time of KCB's site visit. Note highwater in Sturgeon River that precluded inspection of the toe of the slope at normal water level. Photo taken on April 20, 2018 looking south east.**

**Photo 5** **Northern portion of slope on flanks of slope failure area. Note highwater in Sturgeon River causing flooding of farmland to north of site. Photo taken on April 20, 2018 looking east.**


**Photo 6** **A portion of the slope to the north of the active failure zone is in the process of failing, and will enlarge the slide area. Red arrow shows location of ground cracking associated with expansion of slope failure area. Photo taken on April 20, 2018 looking north.**

**Photo 7** **View of slide area with Meadowview Drive bridge over Sturgeon River in the background. Red arrow shows former location of jersey-barrier barricade. Photo taken on April 20, 2018 looking east.**


**Photo 8** **View of site from Meadowview Drive bridge over Sturgeon River. Photo taken on April 20, 2018 looking west.**

# APPENDIX II

## Alberta Transportation Risk Rating System

**Risk Level (RL) = (Probability Factor, PF) x (Consequence Factor, CF)**

**Geohazard Risk Level Factors – Earth slides and debris flow**

| **Probability Factor (ranked on a scale of 1 to 20)** | |
|---|---|
| **1** | Inactive, very low probability of slide occurrence. |
| **3** | Inactive, low probability of remobilization |
| **5** | Inactive, moderate probability of remobilization, uncertainty level moderate, or active but very slow rate of movement or indeterminate movement pattern. |
| **7** | Inactive, high probability of remobilization or additional hazards, uncertainty level high, or active with perceptible movement rate and defined zone(s) of movement. |
| **9** | Active with moderate steady, or decreasing, rate of ongoing movement. |
| **11** | Active with moderate but increasing rate of movement. |
| **13** | Active with high rate of movement, steady or increasing. |
| **15** | Active with high rate of movement with additional hazards. |
| **20** | Catastrophic slide is occurring. |

| **Consequence Factor (ranked on a scale of 1 to 10)** | |
|---|---|
| **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 |
| **2** | Moderate fills and cuts, not including bridge approach fill or headslopes, loss of portion of the roadway or slide onto road possible, small volume. Shallow fills where private land, water bodies or structures may be impacted. Slides affecting use of roadways and safety of motorists, but not requiring closure of the roadway. |
| **4** | Fills and cuts associated with bridges, intersectional treatments, culverts and other structures, high fills, deep cuts, historic rock fall hazards areas. Sites where partial closure of the road or significant detours would be a direct and unavoidable result of a slide occurrence. |
| **6** | Sites where closure of the road would be a direct and unavoidable result of a slide occurrence. |
| **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 |