Klohn Crippen Berger

Alberta Transportation

CON0022166 Peace Region (Grand Prairie – South) GRMP

GP017 - Hwy 40:34, km 26.7

Call-Out Report

A05116A01

November 2021

November 29, 2021

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 – South) GRMP
GP017 – Hwy 40:34, km 26.7
Call-Out Report

1 INTRODUCTION

As part of the Geohazard Risk Management Program (GRMP) contract for the Grande Prairie – South region, Klohn Crippen Berger Ltd. (KCB) was requested by Alberta Transportation (AT) to conduct a call-out inspection for the GP017 embankment slide on a landslide near the toe of a mountain slope with ~1.2m high backscarp at km 26.7 on highway 40:34 (the site). The site is located approximately 5 km northeast of Grande Cache, Alberta. The legal land description of the site is SW-12-57-8-W6M. The site location and a site plan is shown in Figure 1. The 2020 annual average daily traffic for this section of Hwy 40.34 is 1450 vehicles per day (AT 2020).

The site was inspected on October 12, 2021 by Chris Gräpel, P.Eng. of KCB, accompanied by Dwayne Lowen of AT (the Maintenance Contract Inspector, MCI), Mike Schiffer and Carter McIntyre of Ledcor (the highway maintenance contractor, HMC), and Darren Handbury of Caylor Contracting Ltd. (subcontractor to Ledcor). The GP017 call-out inspection was conducted at the request of AT after an embankment slide was observed to be worsening by AT. 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.

2 SITE DESCRIPTION

This section of Hwy 40:34 is a paved two-lane roadway that runs north-south between Grande Prairie and Grande Cache. The site is in Contractor Maintenance Area (CMA) 504.

Klohn Crippen Berger Ltd.
Suite 301, 2627 Ellwood Drive SW • Edmonton AB T6X 0P7 • Canada
t 780.444.0706 • f 780.481.2431 • www.klohn.com

The slide is located on a 15-m-high embankment fill and is located immediately adjacent to a previous slide repair constructed in 2002 The embankment slopes are partially vegetated with grass except for where the slide is located. Gravelly embankment fill can be seen in the slide area. There is a small trail near the toe of the embankment which is used for the Great Canadian Death Race. At the bottom of the slope is Grande Cache Lake. A Telus line is located beneath the trail at the toe of the slope.

According to the Alberta Geological Survey (AGS 2013a), the site is a transition zone between moraine till, fluvial and colluvial deposits. Moraine is diamicton (till) deposited directly by glacial ice with deposits of clay, silt, sand, and pebbles, cobbles, and boulders. The soil is characterized by lack of distinctive topography that may contain blocks of bedrock, stratified sediment, or lenses of glaciolacustrine and/or glaciofluvial sediment. Fluvial deposits are sediments deposited by streams and rivers; synonymous with alluvium. Fluvial deposits include poorly to well sorted, stratified to massive sand, gravel, silt, clay, and organic sediments occurring in channel and overbank deposits. Colluvial deposits are sediments that have reached their present position because of gravity-induced movement which is commonly found as slope and slump deposits on valley sides and floors. Colluvium can include both bedrock and surficial materials as well as a significant component of fluvial deposits.

Bedrock in the area consists of a mixture of Dunvegan formation, Smoky group, Bullhead group and Fort St. John group. The formations consist of shales, sandstones, and siltstones from the upper and lower Cretaceous age (AGS 2013b).

Five (5) test pits were previously performed in fall of 1999 and the soil conditions on site were found to consist of a mixture of silt, sand, gravel, and cobbles. Two of the test pits encountered a thin layer of silty clay (GAEA 1999).

Review of a highway gradeline drawing (AT 1967) give to KCB by AT indicated that there was a corrugated metal pipe installed in a centreline arrangement near the GP017 site.

2.1 Previous Work

An embankment slide next was previously repaired in 2002 along this same section of highway, immediately next to the existing slide. Pavement cracking was observed before the slide was repaired (EBA 2002). The initial design of repairs was prepared by GAEA (1999) but the construction was conducted under the supervision of EBA Engineering Consultants Ltd. (EBA 2002). EBA made some revisions to the GAEA design concept during construction. The 2002 repair consisted of:

- Excavation of the slide mass and placing it on the toe of the slope to create a working bench, which allowed gabion basket trenching to be conducted a minimum 2.5 m away from the Telus line below the trail.
- The construction of a gabion retaining wall at the toe of the slope, next to the trail. This wall helped to hold back future material sloughing. The gabion wall was modified to be 2 baskets wide at the bottom from the one-basket-wide gabion wall design proposed by GAEA (1999).
- The installation of three gravel-backfilled finger drains along the side slope within the slide area. The drains were installed to allow quick drainage of the roadway subgrade. The

reconstruction of the embankment slope consisted of coarse gravelly fill and shot rock (sedimentary rock, conglomerate and shale) from a nearby quarry.

The 2002 repair work has been successful in stabilizing the original slide. A cross section of the 2002 repair is included in Appendix II.

3 SITE OBSERVATIONS

The following observations were made on site during the call-out inspection:

- The weather was approximately 5°C, overcast with a light wind. At the end of the site visit, a few flakes of snow were falling.
- The most recent slope failure is understood to have occurred in 2020 to the east of the slope that was repaired in 2002 (Photos 1 through 5).
- The most recent failure appears to be in a sliver fill sloped at approximately 60% (30°) constructed as part of a cut and fill.
- The overall topography is a gentle mountain-side slope above Grande Cache Lake with the highway located approximately 15 m above lake level.
- The backslope upslope of the highway has been excavated into a silty, sandy gravel with some cobbles and occasional boulders.
- The sliver-fill failure extends to approximately 8 to 9 m below edge of pavement.
- A centreline culvert was not seen during the site inspection.
- The portion of the slope that failed is grassed without tree cover (Photo 1). The grassed-portion of the slope extents for approximately 70 m to the east. A few dead trees are present on the sliver-fill surface.
- The slope failure is approximately 15 m wide at the edge of the pavement and 4 to 6 m wide near the gabion wall (the slope failure is wider at top of slope than at bottom, as shown in Photo 2).
- The slope angle of the failure is approximately 60% (30°). The highway embankment adjacent to the failure is a bit steeper at approximately 50% (26°) which matches AT's historic highway gradeline drawings.
- The highway has a crown opposite the slide. Surface water runoff from the pavement appears to be flowing onto the slide and eroding the slide surface (Photo 5). Eroded materials are being carried downslope towards the lake (Photo 2).
- The area where materials have been removed from the slope by sliding and erosion is about 0.5 to 1.0 m deep. A limited amount of material at the base of the slide (zone of accumulation) indicates the initial slide was not large. Most of the material within the slide zone appears to have been removed by surface water erosion.

- The material within the slide/erosion zone was dry. Evidence of seepage was not seen. Outlets of drains required as part of the 1999 repair design were not observed.
- Surface water flow has deposited sand and gravel along the flow path from the bottom of the failure to the edge of the lake.
- The trail at the toe of the slope is located within 5 m of the edge of Grande Cache Lake. KCB understands that this portion of trail is used during the Great Canadian Death Race.
- The trail at the toe is a utility line route containing at least a Telus communications line.
- In reference to EBA's revision to GAEA's design concept of the repair, discussed in Section 2.1 of this report, rockfill was used for slope repair instead of sand and gravel. The rockfill appears to be from the Rodar Pit (the old Savage Rail quarry).
- A berm of fill (or a graded stockpile) appears to have been constructed at the base of the slope below the gabion wall (Photo 2). The trail has been routed up and over the berm of fill. The berm appears to be stable and well-vegetated. Silt fence placed during 2002 construction is partially in place in a deteriorated state at the toe of the berm.
- The trail was followed to the east and west and assessed as a potential construction access route. Caylor Contracting believed they could mobilize a small excavator from the east into the toe of the slope with limited tree cutting. The trail to the east was also a potential excavator access route but involved a steeper and longer climb up the highway embankment.
- Access via the trail to the east started in a broad gently sloping area that could be used for temporary riprap stockpiling and staging/laydown.
- The high-tension cable barrier (HTCB) at the crest of the slope was estimated to be 600 m long or more. Access for repair work will require the HTCB to be de-tensioned and laid down and protected with timbers at the heavy equipment access location.

Photos taken during the call-out inspection are included in Appendix I.

4 ASSESSMENT

KCB's assessment of the site is as follows:

- There may have been an initial slide, but surface water flow over the edge of the pavement now appears to be causing the most removal of material. The mechanism for the initial slide could be highwater table in the sliver fill due to periods of seasonally high groundwater (possibly discharging into the natural slope and sliver fill from or on top of bedrock).
- The centreline culvert indicated on the 1967 AT gradeline drawings was not visible and could either be buried and potentially contributing to the slope stability issues at this site or was removed some time in the past.
- Eroded sediments are being transported into Grande Cache Lake.

- The 2002 repair have addressed the 1999 failure. The repair concept constructed in 2002 appears to be appropriate for the most-recent slope failure (e.g., rockfill slope reconstruction, subsurface drains, low-height retaining wall to allow slope to be reconstructed.
- The slope to the east of the most-recent failure could fail in the future.

From an environmental perspective, the proximity of Grande Cache Lake to the slide is a key environmental sensitivity that will need to be considered in designing and implementing repairs at the site. Grande Cache Lake supports a range of fish species, including sport fish (FWMIS 2021), but none of the potentially occurring species have a designated protective status under the Federal *Species at Risk Act* or the Alberta *Wildlife Act*. As Grande Cache Lake is a fish-bearing lake, the *Water Act* Codes of Practice do not apply and there is no designated restricted activity period (RAP) for works within the lake. The timing of construction would need to consider the potential for effects on both spring and fall spawning fish species, if works within the lake were anticipated.

Stabilization structures encroaching below the high-water level of the lake would require review and approval under the *Water Act*, and the works would be subject to the timing restrictions defined in the approval. Encroachment into the lake would also trigger review under the Federal *Fisheries Act* related to effects on fish habitat, and potentially could require review under the *Canadian Navigable Waters Act*. Designing the stabilization structures to avoid encroachment into the lake and identifying mitigation measures to avoid indirect effects would substantially reduce the permitting requirements for the work.

A review of the disposition boundaries for use of public lands indicated that there is a widened right of way associated with the Highway 40 alignment at the site, which extends down to the edge of Grande Cache Lake. Restricting repair works to within the existing right of way would avoid the need for additional approvals under the *Public Lands Act*.

Review and approval under the Historical Resources Act is expected to be required prior to conducting works on the failed slope.

KCB understand that the HMC will conduct the repair works, as opposed to the work being tendered. KCB would prepare an Environmental Overview Assessment (EOA) to identify environmental sensitivities, potential effects, and required mitigation measures to be followed by the contractor.

Due to the environmental concerns associated with conducting repairs at the GP017 site, AT should consider doing additional work to reduce the possibility of subsequent failure occurring to the east of the most-recent failure.

5 RISK LEVEL

Risk levels for AT GRMP sites (earth slides and debris flow) 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 (safety of public and significant loss of infrastructure facilities or privately owned structures will occur if a slide occurs; slides where rapid mobilization of large-scale slide is possible).

We also considered the consequences of erosion because of our observations that surface water flow is eroding the slide surface and conveying eroded materials to Grande Cache Lake.

The current risk level of the site in the last Section B inspection by Thurber in 2020 is 27 (Probability 9 x Consequences of 3).

Based on our call out observations, KCB recommends the following factors using AT's risk level system for slides and erosion:

- Probability Factor – A rating of 9 was selected for the site because the slope failure/erosion area is an unvegetated steep slope with erodible materials exposed and with rills forming on the lower parts of the slope. The site appears to be actively eroding.
- Consequence Factor – Continued erosion or sliding will eventually cause the edge of the pavement to be affected, possibly resulting in settlement of part of the eastbound lane. Partial closure of the road would result in a consequence rating of 4. However, a rating of 8 was selected for the site because the bottom of the slide is within 10 m of Grande Cache Lake and there is evidence of eroded material flowing directly into fish-bearing waters that supports a recreational fishery. The rating of 8 was selected as the mid-point between a consequence rating of 10 (eroded material flowing into fish-bearing waters) and a consequence rating of 6 (sites within 500 m of a watercourse).

We recommend a Risk Level of 72 for the site based on the erosion/environmental consequences.

6 RECOMMENDATIONS

6.1 Short Term

KCB's short-term recommendations include:

- The Maintenance Contract Inspector (MCI) should continue to monitor the site for further slope movement or erosion after rainfall or snowmelt or settlement of the road surface or pavement cracking that could indicate the slide could retrogress into the highway.

6.2 Long Term

AT will repair the recent (2020) slope failure and erosion area. A conceptual repair is presented in the cross section and plan sketches included in Appendix III and will consist of a rockfill slope reconstruction with buried subdrains and a low height gabion basket retaining wall.

- The need for, and potential extent of, regulatory permitting and supporting studies will need to be assessed. Various wildlife restricted activity periods will need to be considered, as well as the timing of the next Great Canadian Death Race, when scheduling the repair work.
- Line locators shall be contacted to confirm the utility lines buried under the trail. The utility owner(s) should be contacted to obtain permission to place fill on top of the utility.
- The extent of slope disturbance should be limited to what is necessary to complete a uniform width slope reconstruction. This will require excavating some stable material on the lower part of the slope. Stockpiling of materials at the toe of the slope above lake level should be conducted to provide a working platform (like what was done in 2002). Any excess material should be stockpiled along the trail so the thickness of the stockpile is limited to reduce the potential for inducing slope failure at water's edge. This will involve a longer, but thinner stockpile along the trail. The stability of an enlarged berm should be checked as part of a final design. Loose materials should be removed to prepare a competent and intact natural soil base.
- The previous 2002 (EBA) repair concept should be employed, i.e., gabion retaining wall with two baskets wide at the base, buried finger drains, and compacted rockfill slope reconstruction. The previous repair shall be protected from all damage.
  - The existing gabion wall shall not be damaged. Care, including hand excavation where necessary, is required to prevent damage.
  - The new gabions should be extended from the existing gabion wall and shall be connected to the existing gabions.
  - The rockfill placed in the gabion shall be durable rock that meets AT's riprap requirements to reduce the potential for freeze-thaw deterioration of gabion rockfill. The rockfill placed in the reconstructed slope need not meet AT's riprap durability requirements.
  - The gabion rock shall be placed by hand in the baskets using the densest possible arrangement of particles, in accordance with gabion basket manufacturer's requirements.

  - A heavy nonwoven geotextile (16 oz/sq.ft) with coarse clean gravel zone 1.0 m wide upslope of the nonwoven geotextile shall be used as a transition/cushion between the gabions and the rockfill.
  - Three finger drains (100-mm-diameter perforated pipe wrapped in geo-sock) shall be trenched in as finger drains in the lower third of the slope at the west edge, centre, and east edge repair area and shall drain down to behind the gabion wall and be extended to within 2 m of the lake, and discharge on a bed of clean rockfill between the drain outlet and the lakeshore.
  - The rockfill placed to reconstruct the slope shall be bucket tamped to densify the rockfill.
- The trail should be restored using similar slopes over the berm so that long-term trail accessibility is not degraded from current conditions.
- AT should conduct additional work to attempt to limit the potential for future slope failures to the east of the most-recent failure. AT could excavate a shallow trench at edge of pavement and grade the trench so that it drains towards the proposed repair. A subsurface drain (100-mm-diameter) could be placed in the trench, be directed downslope and connected to the east finger drain. This measure could intercept pavement runoff flowing over the crest of the slope and possibly reduce the potential for a follow-up failure to the east of the most-recent failure.
  - Alternatively, AT could install a ridge of sandbags, mulch roll, or other barrier on the slope side of the HTCB, but this would tend to concentrate water flow when it discharges onto the slope, increasing erosion potential. Depending on the highway grades, concentrated water flow might be discharged onto the rockfill-repaired slope which would resist erosion.

The estimated cost of construction services for this work is estimated to be between $100,000 and $150,000. The cost of environmental and engineering services is estimated to be between $35,000 and $50,000 depending on the extent of regulatory permitting, pre-construction support, and duration of construction.

7 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 peace 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.

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.

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

Yours truly,

KLOHN CRIPPEN BERGER LTD.

PERMIT TO PRACTICE
KLOHN CRIPPEN BERGER LTD.
RM SIGNATURE: _____
RM APEGA ID #: 187607
DATE: 30 Nov. 2021
PERMIT NUMBER: P009196
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

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

CG:KB

ATTACHMENTS

Figure	Site Plan
Appendix I	Site Photographs
Appendix II	2002 Repair Cross Section
Appendix III	Plan and Section Sketches

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.

Alberta Transportation. 2020. Traffic Counts Reference No. 70000104. Retrieved on October 13, 2021 from: http://www.transportation.alberta.ca/mapping/

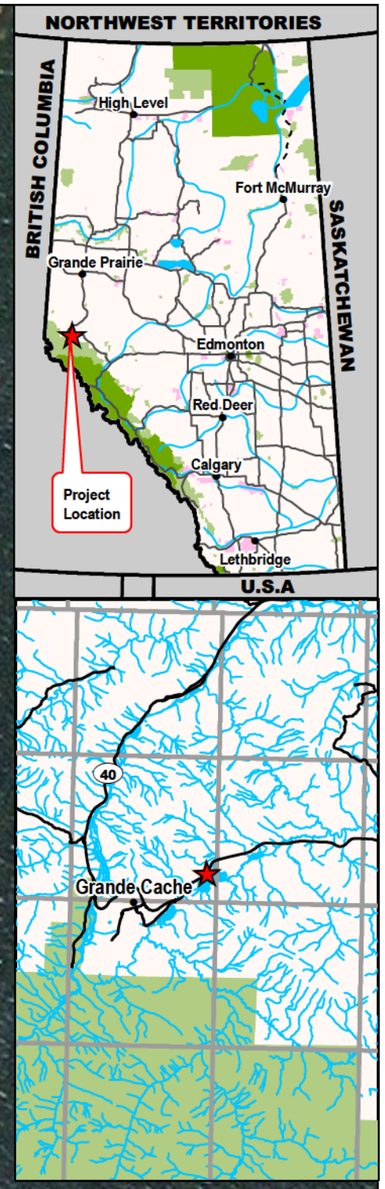
Alberta Transportation. 1967. Grade line drawing W. of Mason Creek – Grande Cache, Sheet 9 and 11.

EBA Engineering Consultants Ltd. 2002. Construction supervision report, Slide remediation works, Grande Cache Lake and Hwy 40, Grande Cache, Alberta.

Thurber Engineering Ltd. (Thurber). 2020. GP017-2 Call Out Report. Prepared for Alberta Transportation Geohazard Assessment Program.

GAEA Engineering (GAEA). 1999. SIDE SLOPE FAILURE BY GRANDE CACHE LAKE ON HIGHWAY 40:34. Geotechnical Report. Prepared for Alberta Transportation.

FIGURE



Legend

2002 Slide Extent — Guardrail

Recent Slide Extent

Metres
0 100

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

CLIENT: Alberta Government

Klohn Crippen Berger

PROJECT: GRANDE PRAIRIE SOUTH REGION GEOHAZARD RISK MANAGEMENT PROGRAM

TITLE: Site Plan
GP017 Grande Cache Lake Slide
Hwy 40:34, km 26.7

SCALE	PROJECT No.	FIG No.
1:1,500	A05116A01	1

Time: 11:49:20 AM
Date: October 29, 2021
File: Z:\AICGY\Alberta\A05116A03 ABT Southern Region GRMP\400 Drawings\2021\GP017_211015mxd.mxd

APPENDIX I

Site Photographs

Appendix I
Site Photographs

Photo 1 **Oblique UAV view of GP017 site showing 2001 repair and recent failure. Photo taken October 12, 2021, facing west. The trail at the toe of the slope is used for the Great Canadian Death Race.**

Photo 2 **Oblique UAV view of GP017 site showing 2001 repair and recent failure. Photo taken October 12, 2021, facing northwest. The slope below the gabion wall appears built up (red circle). Eroded material from the slide mass is being transported across the trail towards the lake.**

Photo 3 **Crest of embankment slope, recent slide area, and 2001 repair. Photo taken on October 12, 2021, facing west.**

Photo 4 **Crest of embankment slope near 2001 repair and recent failure. Photo taken on October 12, 2021, facing east.**

Photo 5 **Rills are forming on the lower portion of the slide from surface water runoff flowing over the edge of pavement and onto the slide mass. Photo taken on October 12, 2021, facing north.**

Photo 6 **Location to the east of site where the trail is close to the highway. Bedrock outcrop in upslope ditch approximately 100 m to the east of the site. Photo taken on October 12, 2021, facing west.**

APPENDIX II

2002 Repair Cross Section

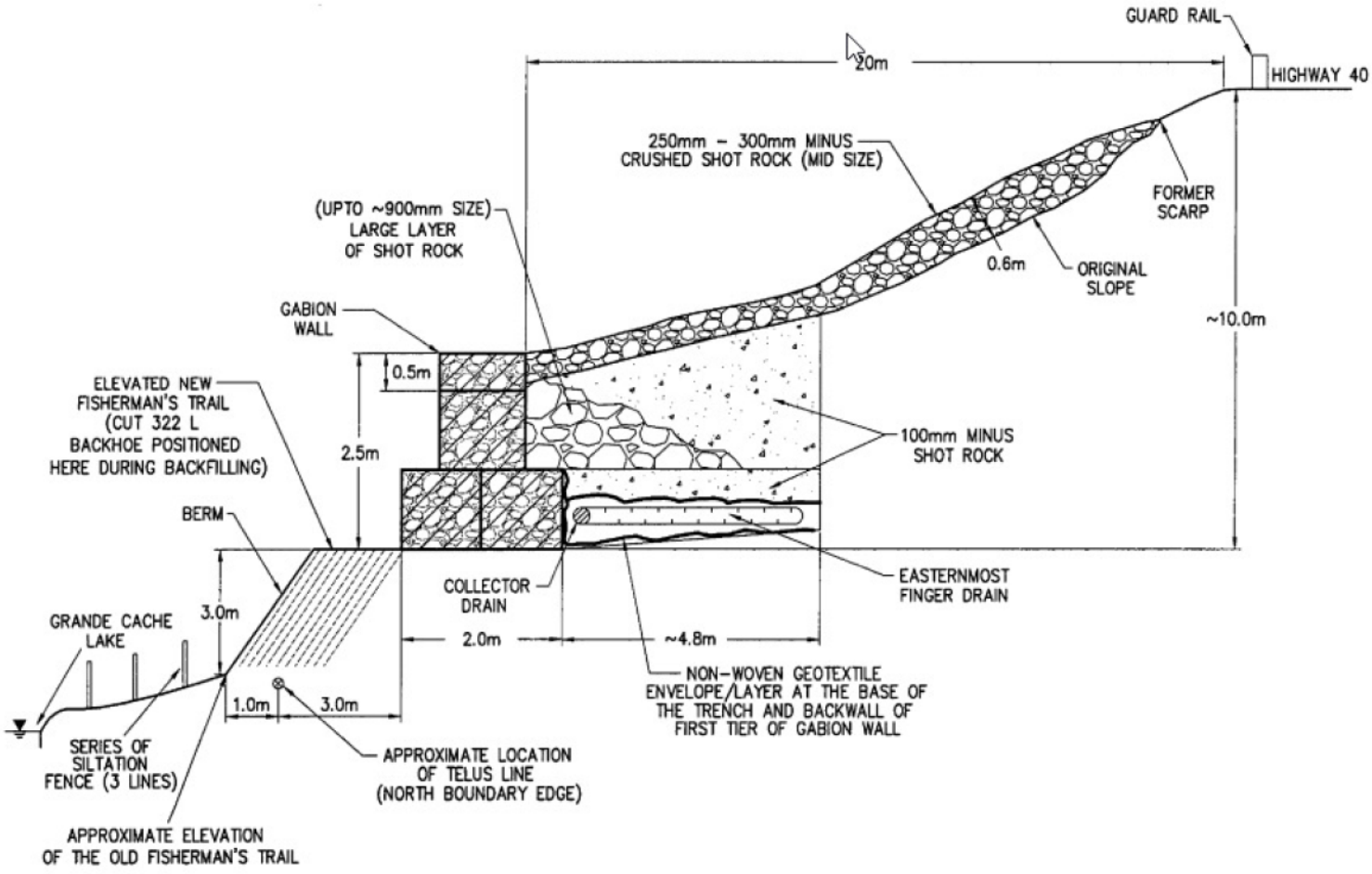


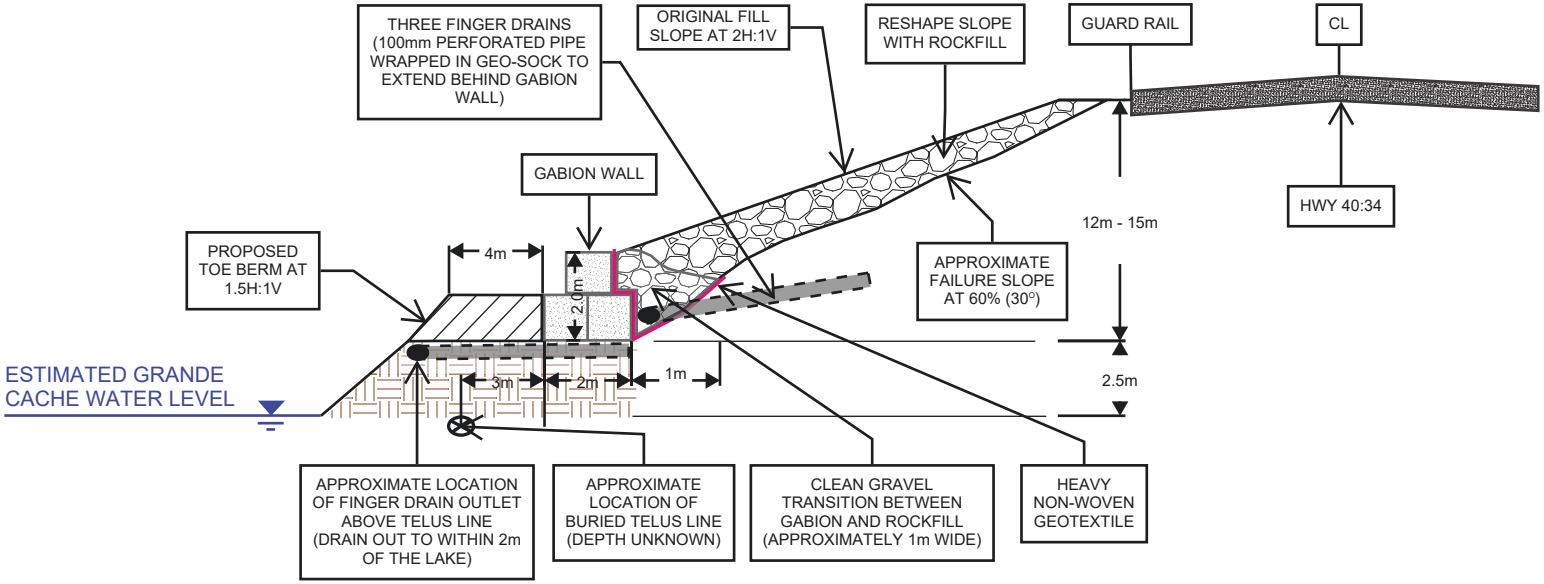
Figure 1
Plan View
As-Built Slope Reconstruction

NOTE: DRAWING NOT TO SCALE

22537Q08b.dwg

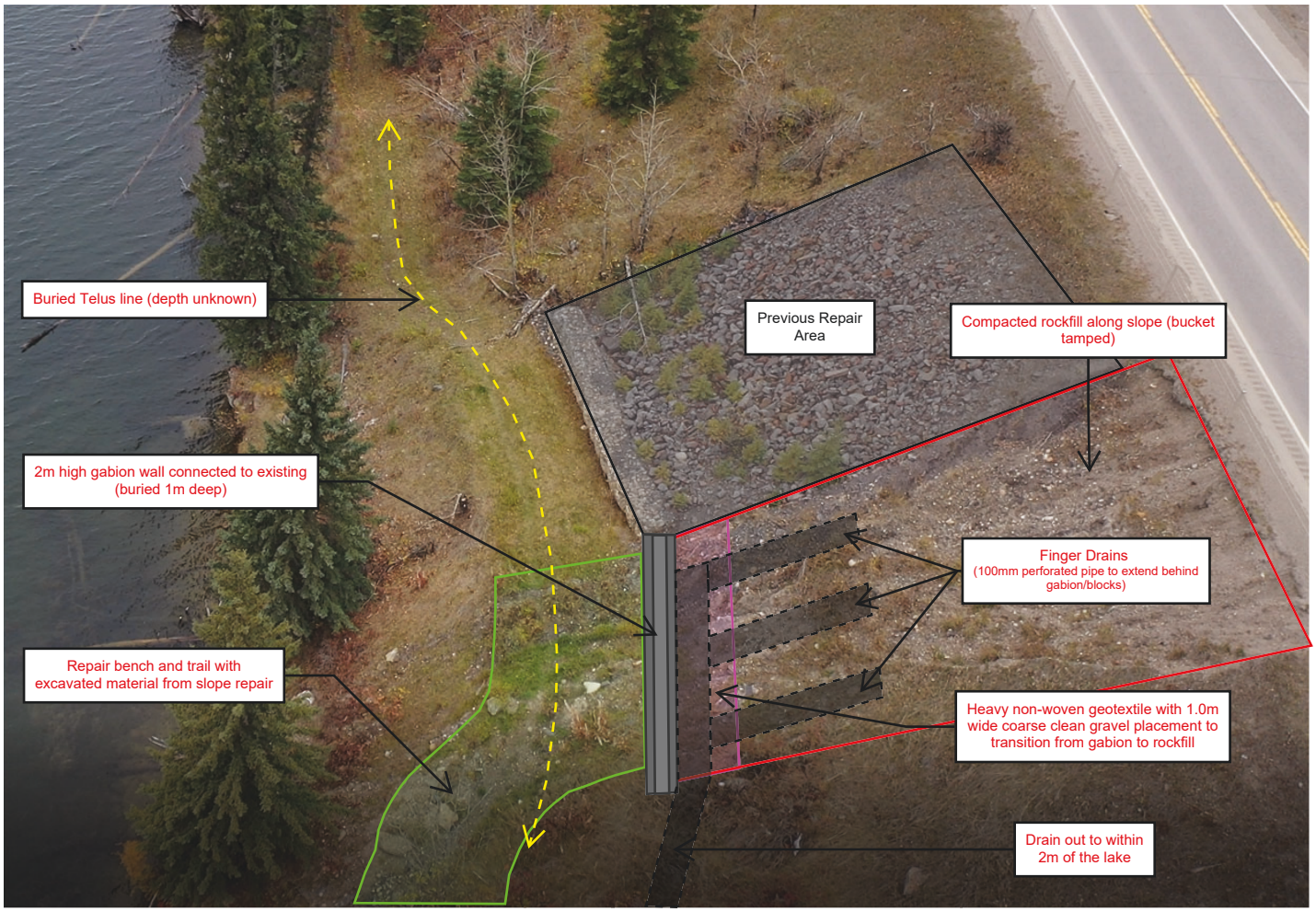
APPENDIX III

Plan and Section Sketches



GP017 CROSS SECTION
SCALE: NTS

Notes:
- Sketch made in reference to Figure 1 - Plan View - As-Built Slope Reconstruction from the 2002 EBA Construction Supervision Report for Grande Cache Lake and Hwy 40
- Original embankment slope estimated based on field observation


Buried Telus line (depth unknown)
Previous Repair Area
Compacted rockfill along slope (bucket tamped)
2m high gabion wall connected to existing (buried 1m deep)
Finger Drains
(100mm perforated pipe to extend behind gabion/blocks)
Repair bench and trail with excavated material from slope repair
Heavy non-woven geotextile with 1.0m wide coarse clean gravel placement to transition from gabion to rockfill
Drain out to within 2m of the lake