

**ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
NORTH CENTRAL REGION – ATHABASCA &
FORT MCMURRAY DISTRICTS
2021 SITE INSPECTION**



Site Number	Location	Name	Hwy	km
NC100	35 km Northwest of the Junction of Hwy 2:46 and Hwy 44:04	BF76193 OTAUWAW RIVER	2:46	38.76
Legal Description		UTM Co-ordinates (NAD 83)		
S.W.14-72-4-W5M		11 N 6123853	E 659514	

	Date	PF	CF	Total
Previous Inspection:	June 19, 2020	13	5	65
Current Inspection:	June 23, 2021	14	5	70
Road AADT:	2000	Year:	2020	
Inspected By:	José Pineda, Tarek Abdelaziz (Thurber) Gordon Wolters, Arthur Kavulok, Kristen Tappenden, Bernard Ching, Brent Herrick (Alberta Transportation)			
Report Attachments:	<input checked="" type="checkbox"/> Photographs <input type="checkbox"/> Plans <input type="checkbox"/> Maintenance Items			

Primary Site Issue:	Deep-seated landslide in the WBL embankment above the bridge culvert outlet location, resulting in the formation of multiple open tension cracks within the side slope (upper crack is about 5.6 m from edge of pavement) and highway north shoulder, and culvert distress 27 to 30 m from the outlet location.
Dimensions:	The landslide is approximately 11 to 20 m wide (parallel to the highway) and 40 m long (perpendicular to the highway).
Site History:	<p>Embankment side slope failure and highway surface dip were first noted by AT's MCI in May 2020.</p> <p>The following summarizes existing information:</p> <ul style="list-style-type: none"> (a) The culvert was constructed in 1966 over the Tributary to Otauwau River. The culvert records indicate a total length of 87.8 m, a span of 1724 mm and a rise of 1901 mm. (b) A 2.5 to 3 m wide 1 m deep ditch was dug by AT on the north side of the highway to convey surface runoff to a natural gully located to the east of the culvert outlet location. The mouth of the gully is in the immediate vicinity of the culvert outlet location. (c) A gully was noted above the culvert outlet location during the bridge inspections conducted in 2011, 2016 and 2018 (i.e., prior to the development of the side slope failure). This is believed to be a localized slump above the culvert outlet. Refer to Photos No. 5a, 5b. and 5c. (d) The June 3, 2020 bridge inspection report indicated that the north embankment side slope above the culvert outlet location failed, and the failure area was approximately 12 m wide, 40 m long, and 3 m deep. The culvert was noted to

	<p>have deformed significantly approximately 27 to 30 m from the culvert outlet locations and recommendations were provided to replace the distressed section of the pipe. Based on the 2020 report, underground telephone lines were located on the north right-of-way and three overhead power lines were located on the south right of way.</p> <p>(e) Geotechnical instrumentation installed by Wood in 2021.</p>
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Observations:	Description	Worse?
<input checked="" type="checkbox"/> Pavement Distress	A 50 to 100 mm dip in the highway WBL shoulder above the landslide area; 15 m long, 200 to 270 mm deep open cracks within the dip area	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Slope Movement	1.4 m deep head scarp crack on the north embankment side slope; heads carp crack located approximately 3.6 m from the edge of pavement; previously noted four tension cracks (Cracks A to D) above the head scarp crack of the landslide mass as shown on Figure 1 were buried under excess cuttings of the drilling program completed by Wood.	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Erosion	Eroded natural gully (3 to 7 m wide and up to 2 m deep) surrounded by fallen trees/deadfall is located northeast of the culvert outlet; heavy flow from the mouth of the gully	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Seepage	Landslide mass was noted a bit drier than during the 2020 inspection. Water ponding 300 mm downstream of the culvert outlet.	<input type="checkbox"/>
<input checked="" type="checkbox"/> Bridge/Culvert Distress	The bridge inspection reports indicated that the culvert had bolts cracked near the inlet, the roof was damaged at rings 29, 30, and 31 with a reverse curvature close to the outlet. Silt accumulated at the bottom of these rings, but the inspector was unable to take measurements at these locations. The report also indicates that the culvert outlet heaved by about 300 mm.	<input type="checkbox"/>
<input checked="" type="checkbox"/> Other	Two-third of the landslide area is covered with falling trees; two beaver dams were noted upstream of the culvert inlet location; scattered riprap at culvert inlet and outlet locations; water ponding zone increased at outlet location	<input type="checkbox"/>

Instrumentation:

As part of the preliminary engineering assessment completed at this site, Wood installed three vibrating wire piezometers and one slope inclinometer outside the limits of the landslide. Wood also installed survey pins at several locations. Based on the Wood's readings between May and June 2021, the depth to groundwater level ranged between 2.1 to 9.9 m (i.e., Elev. ~ 629.5 to 635.4). The slope inclinometer appears to have shown 1 mm movement at an approximate depth of 4.5 m below ground surface.

Observations and Assessment (Refer to attached Figures and Photos):

The site observations indicate the presence of a deep-seated landslide on the north side of the highway. The landslide is about 40 m long (perpendicular to the highway alignment) x 14 to 20 m wide (parallel to the highway alignment) x 9 m deep and is toeing out at the culvert outlet location. The landslide resulted in the development of a dip in the highway shoulder and impacted the integrity of the 2 m diameter bridge size culvert.

Previous bridge inspection records indicate that a localized toe erosion/gully was noted in the vicinity of and above the culvert outlet location. Progressive loss of toe support may have resulted in the

development of the current landslide within the 14 m high embankment fill. It is possible that the culvert continued to overflow during spring seasons, resulting in progressive erosion and saturation of the toe of the embankment fill. The flow from the natural gully, located to the east of the culvert outlet, and may have also contributed to the saturation of the fill at the bottom of the embankment.

The 2020 bridge inspection report indicated reverse curvatures and silt accumulation on in rings 29 to 31, potentially indicating that the culvert has failed or excessively deformed.

The landslide appears to be very active and is retrogressing quickly to the highway surface. Accelerated movement of the landslide may result in partial or full closure of the highway lanes, failure of the bridge culvert, and underground telephone line(s).

Recommendations:

It is recommended to get the landslide repaired in the near future. This site should be visited again in 2022.

Short-Term Measures

In the short term, the MCI should periodically monitor the highway for additional movement or cracking. Speed reduction and landslide warning signs should be placed along the highway at this location. If the dip becomes severe, minimal ACP patch should be placed on the highway surface to provide a smooth surface to motorists. This is to avoid excessive loading of the crest of the slope at the landslide location.

The underground telephone utility owner should be notified of the existing hazard and temporary above ground lines may need to be placed until the landslide is repaired.

Long-Term Measure:

Wood completed the preliminary engineering assessment for this site and recommended the following:

- (a) excavation and replacement of the landslide mass with a stronger material (either gravel or geo-grid reinforced fill),
- (b) construction of a gravel shear key at the base of the slope,
- (c) installation of a bigger diameter SWSP culvert to replace the existing one, and
- (d) shaping and armoring eroded gully to the east of the landslide mass

Wood's cost estimate for the repairs ranged from about \$2,000,000 to \$2,500,000 (excluding contingencies and engineering).

Closure

It is a condition of this letter report that Thurber's performance of its professional services will be subject to the attached Statement of Limitations and Conditions.

Yours very truly,
Thurber Engineering Ltd.
Tarek Abdelaziz, Ph.D., P.Eng.
Principal | Senior Geotechnical Engineer

José Pineda, M.Eng., P.Eng.
Senior Geotechnical Engineer



STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

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3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

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5. INTERPRETATION OF THE REPORT

- a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.
- b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.
- c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.
- d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

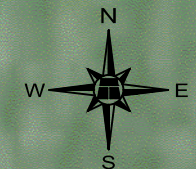
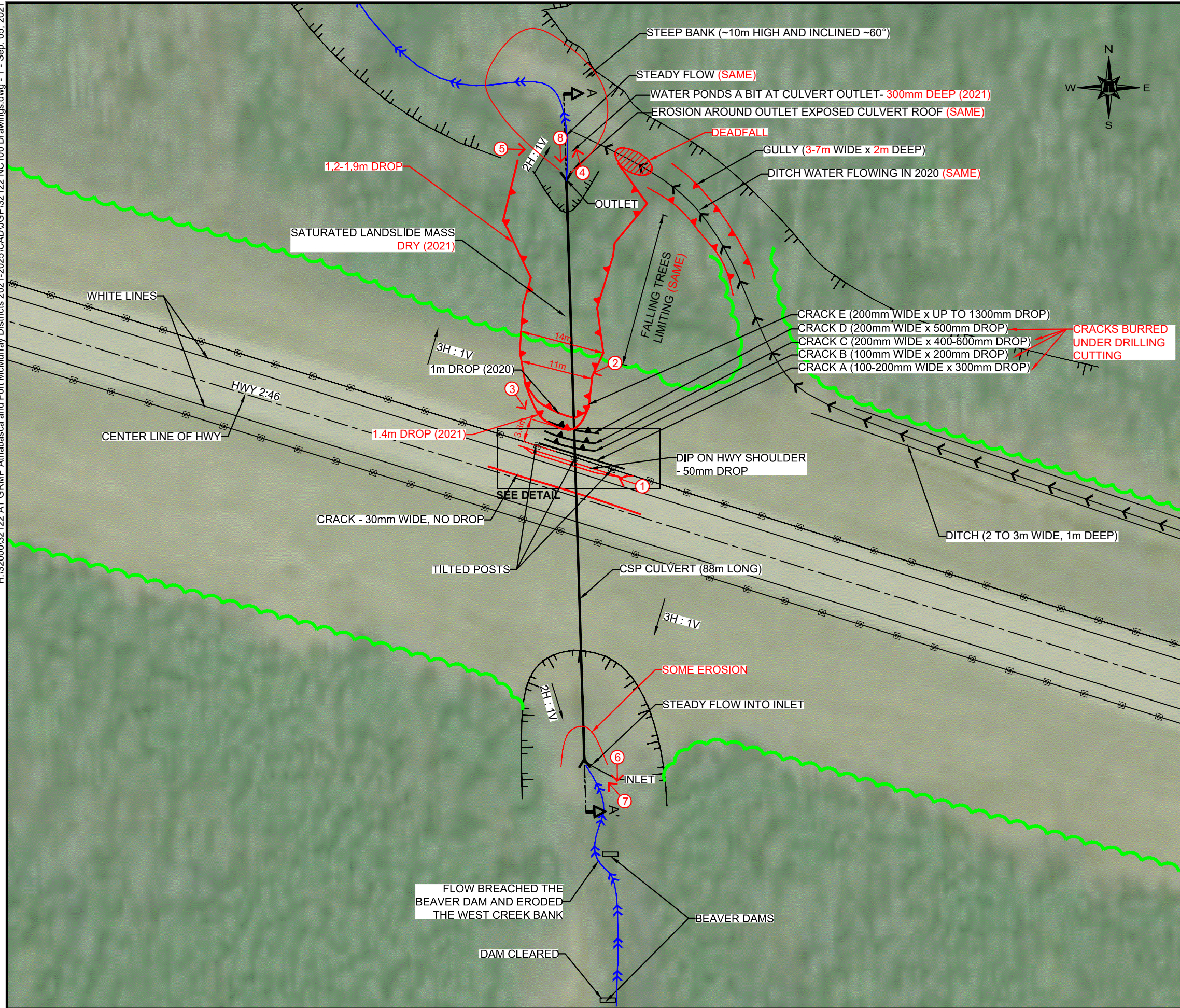
6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

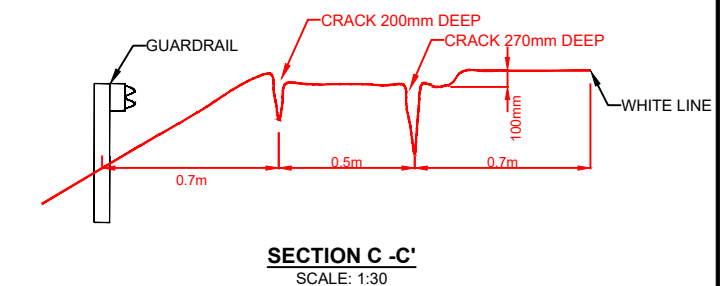
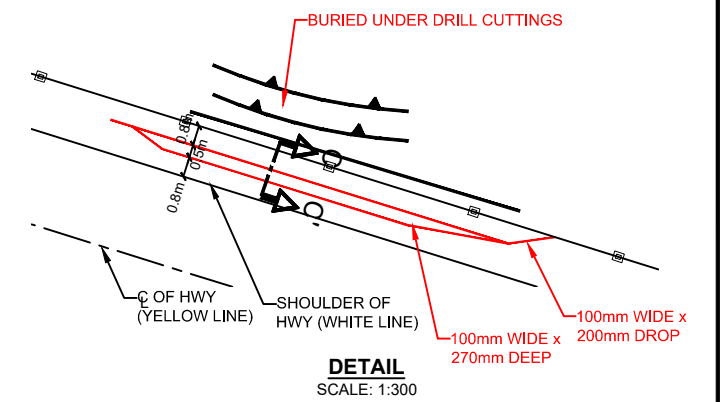
7. INDEPENDENT JUDGEMENTS OF CLIENT

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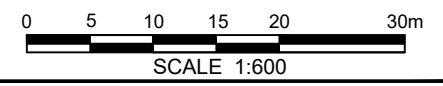
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- LEGEND**
- ACTIVE SCARP CRACK (APPROXIMATE)
 - CREEK
 - DITCH WATER FLOW
 - HIGH TENSION CABLE BARRIER (HTCB)
 - TREE LINE (APPROXIMATE)
 - PHOTOGRAPH NUMBER, AND APPROXIMATE DIRECTION AND LOCATION



- NOTES:**
1. JUNE 23, 2021 OBSERVATIONS ARE SHOWN IN RED.
 2. GEOTECHNICAL INSTRUMENTS INSTALLED BY OTHERS ARE NOT SHOWN ON THIS DRAWING.



Alberta

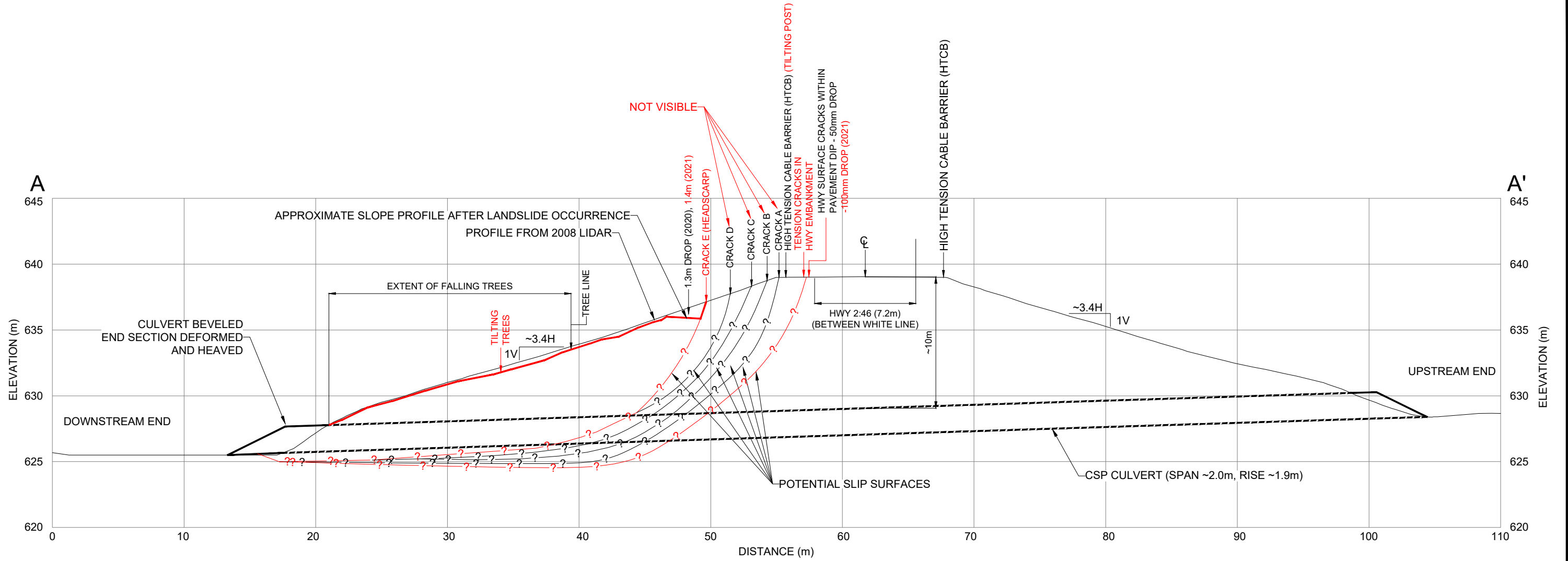
**NORTH CENTRAL REGION
(ATHABASCA AND FORT McMURRAY DISTRICTS)
2021 GEOHAZARD ASSESSMENT**

**NC100: HWY 2:46 BF76193
OTAUWAWU RIVER (km 38.7)**


FIGURE 1

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	1:600
DATE	SEPTEMBER 2021
FILE No.	32122





NOTE:
 GROUND PROFILE AFTER LANDSLIDE OCCURRENCE WAS OBTAINED THROUGH SIMPLE FIELD MEASUREMENTS. HENCE, THE ACCURATE GROUND PROFILE MAY VARY FROM WHAT IS PRESENTED IN SECTION A - A'.




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NC100: CROSS - SECTION A - A'

FIGURE 2

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	1:300
DATE	SEPTEMBER 2021
FILE No.	32122



THURBER ENGINEERING LTD.



Photo No. 1 – Looking at WBL landslide; note the presence of open tension cracks on the highway shoulder; main head scarp crack of landslide is about 3.6 m north from the edge of pavement



Photo No. 2 – Looking southwest at the north embankment landslide's head scarp and western flank; landslide mass was noted to drier than in 2020.



Photo No. 3 – Looking southeast at the landslide’s head scarp and eastern flank; multiple tension cracks noted between the head scarp and the guardrail during the previous inspection were buried under drill cuttings



Photo No. 4. Looking northwest at the CSP culvert outlet; note water ponding near the culvert outlet



Photo No. 5 – Looking east; water ponding a bit around culvert outlet location



Photo No. 6 – Two beaver dams noted upstream of the culvert inlet



Photo No. 7 – Looking at CSP Culvert Inlet (1.9 m diameter); scattered riprap was noted at inlet location



Photo No. 8 – Looking inside CSP Culvert outlet; note reverse curvature in the roof (Photograph was taken by AT during bridge culvert inspection completed on June 3,2020). This is approximately 27 to 30 m from the culvert outlet location.