

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



| Site # | Location | Name | Hwy | km |
|-------------------|---|--|-----------|----------|
| NC008 | 15.6 Km North of Hwy 63 & 55 Intersection | La Biche River (0.8 to 0.9 km North of Bridge) | 63:02 | 15.6 |
| Legal Description | | UTM Co-ordinates (NAD 83) | | |
| 3-69-17 W4 | | 12 | N 6089536 | E 403480 |

| | Date | PF | CF | Total |
|-----------------------------|--|----|--------------|--------------------|
| Previous Inspection: | June 25, 2020 | 10 | 4 | 40 (New Landslide) |
| Current Inspection: | June 24, 2021 | 10 | 4 | 40 (New Landslide) |
| Road AADT: | 3520 | | Year: | 2020 |
| Inspected By: | José Pineda, Tarek Abdelaziz (Thurber) Arthur Kavulok, Kristen Tappenden, Bernard Ching (Alberta Transportation) | | | |
| Report Attachments: | <input checked="" type="checkbox"/> Photographs <input checked="" type="checkbox"/> Plans <input type="checkbox"/> Maintenance Items | | | |

| | |
|---------------------------|--|
| Primary Site Issue | An Active landslide within the western side slope of the highway southbound lanes, causing severe drop and deterioration to western half of the highway southbound lanes |
| Dimensions: | About 90 m wide (parallel to the highway alignment) and 40 m long (perpendicular to the highway alignment) |
| Site History: | <p>The current landslide area (NC08-2) is to the south of the NC08-1 landslide site, which was repaired in the fall of 1997.</p> <p>Available information suggests that this stretch of the highway (along previous Highway 63 lanes prior to the implementation of the twinning project) has been showing slide movements since 1987. Initial attempts in the year 1990 to improve the highway condition consisted of the installation of a cut-off drain along the east side of the highway with the intention of intercepting the seepage from the swampy area to the east. However, after some time this drain was covered with silt and became non-functional. A subsequent attempt to repair the slide consisted of the installation of a centre line culvert in 1996 to allow runoff water from the east swampy area to drain out toward the Oxbow Lake.</p> <p>During the fall of 1997, additional repairs were conducted at the NC08-1 site. The repair consisted of (a) excavating and replacing a 100 m long section of the roadway with compacted clay and granular backfill, (b) placing a 600 mm thick granular drainage layer below replacement zone to reduce pore pressure build up, (c) constructing a 230 m long toe berm along the toe of the slope to the south of the ALPAC road, (d) regarding the east ditch and installing a 900 mm diameter culvert across ALPAC road to the north of the site, and (e) abandoning centre line culverts below original highway 63.</p> <p>The highway was twinned between 2014 and 2015 and the old highway, where previous and current instabilities took place, became the new southbound lanes of the current highway. There is a new</p> |

| | | |
|---|--|--------------------------|
| | <p>centerline culvert (Culvert C2) below the southbound lanes that may have been installed during the highway twinning projects. It also appears that the OH powerlines may have been relocated to the west side of the southbound lanes during the implementation of the highway twinning project.</p> <p>A geotechnical investigation, consisting of drilling three test holes along with the installation of a slope inclinometer and four piezometers, was completed in 2020. The test holes indicated that the stratigraphy within the slope consists of 3 to 4 m of high plastic clay fill underlain by a high plastic firm clay foundation to 21 m depth. The native clay was noted to be stiffer 14 to 16 m below existing ground surface.</p> | |
| Maintenance/Repairs: | Cracks were spray patched by AT in 2020; the beaver dam to the north of the culvert C1 outlet location and beaver dam 1 to the east of the culvert inlet location were cleared by the County in 2020 | |
| Observations: | Description | Worse? |
| <input checked="" type="checkbox"/> Pavement Distress | <p>New landslide (NC08-2): Up to 60 mm drop in the western half of the highway south bound lane for a distance of about 90 m; potholes up to 2.2 m long x 400 mm wide x 120 mm deep near the south end of the landslide</p> <p>Old landslide repaired in 2007 (NC08-1): up to 100 mm wide x 60 mm deep reflective cracks with no significant drop in pavement; multiple potholes on highway driving lanes</p> | <input type="checkbox"/> |
| <input checked="" type="checkbox"/> Slope Movement | New landslide (NC8-2): Multiple open head scarp cracks (up to 500 mm between closely spaced cracks) with up to 50 mm drop across the crack surfaces; toe bulge in the oxbow lake and the side slope | <input type="checkbox"/> |
| <input type="checkbox"/> Erosion | | <input type="checkbox"/> |
| <input checked="" type="checkbox"/> Seepage | Oxbow channel downslope of the highway. | <input type="checkbox"/> |
| <input type="checkbox"/> Bridge/Culvert Distress | | <input type="checkbox"/> |
| <input checked="" type="checkbox"/> Other | <p>Three beaver dams were previously noted within the Oxbow Lake. Beaver dam 1 was cleared in 2020; beaver dam 2 was exposed; beaver dam 3 was still submerged under water.</p> <p>Previously submerged Culvert C1 below the ALPAC road was visible due to the removal of the beaver dam to the north of the culvert outlet location. Water was free flowing into the culvert to drain the Oxbow Lake and flooded area noted in 2020; continuous heavy flow from culvert C2 below highway 63 south bound lanes.</p> <p>Power poles and buried phone cables flags were noted within the active landslide area</p> | <input type="checkbox"/> |

Instrumentation Readings (2SIs, 2 SPs, 2VWs; Spring 2021):

SI1B showed a rate of movement of 1.5 mm/yr over 4.8 m to 8.4 m depth since the fall of 2020 readings. SI20-2 showed a rate of movement of 2.0 mm/yr over 3.8 m to 7.4 m depth between March 9, 2021, and June 25, 2021.

Standpipe piezometers SP20-1 and SP20-3 showed groundwater depths of 1.52 m and 2.64 m, respectively, corresponding to increases in groundwater level of 0.29 m and 0.68 m since the piezometers were last read in March 2021.

Vibrating wire piezometers VW20-2A and VW20-2B showed groundwater depths of 2.62 m and 2.65 m, respectively, corresponding to increases in groundwater level of 0.53 m and 0.40 m, respectively, since they were last read in March 2021.

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

The highway surface condition did not change significantly since the 2020 site visit.

Although the highway cracks were spray patched last year after the 2020 site visit, they opened again, and multiple potholes were also visible on the highway surface. This created rough driving conditions on the highway surface.

At the new landslide location, the drop noted on the highway most western lane continues to create rough driving conditions and constitutes a safety hazard to motorists.

Fill placement on the top of the weak high plastic clay foundation and high groundwater levels within the clay fill and native clay are the main triggers for the new landslide movement. The presence of beaver dams within the Oxbow resulted in high ground water levels within the landslide mass and aggravated the situation.

Although the new landslide is currently creeping, accelerated landslide movement may occur in the future resulting in partial road closure and a major detour. Power and phone services may also get impacted by additional landslide movements.

The flooded area, noted in 2020 within the northern limit of the site, drained through Culvert C1 after the removal of the beaver dams. This should help reducing water levels within the Oxbow Lake and the likelihood of flooding the ALPAC road. If the beaver dams are not kept under control, progressive rise in water levels in future years could result in washout of the ALPAC road and saturation of highway 63 embankment fills (depending on the beaver dam's height and water levels in the lake).

Recommendations:

This site should be visited again in the spring of 2021.

In the short term, the local MCI should:

- (a) Monitor the highway periodically for signs of distress and watch closely for the development of additional cracks and highway dip (particularly after prolonged rainfall events). The highway surface cracks at NC08-1 and NC08-2 locations should be sealed to prevent surface water infiltration into the landslide masses. The potholes along the highway surface should also be filled with ACP to prevent further deterioration to the highway surface conditions.
- (b) ACP patch should be placed within the limits of the NC08-2 (new landslide) location to eliminate existing hazard and provide a smooth ride to motorists.
- (c) Place speed reduction signs, as needed, prior to the placement of the ACP patch at NC08-2 location.
- (d) Consider removing all beaver dams within the Oxbow Lake to reduce water levels within the highway embankment.

The long-term repair may include any of the following options:

- a) Reinforce the slip surface of the landslide by constructing a cast-in-place pile wall within the SBL west side slope. The estimated cost of a pile wall would be in the range of \$ 2,000,000.
- b) Re-align the highway to the east of its current location outside the limits of the active landslide and excavate the current embankment at NC08-2 location to unload the active landslide mass. The estimated cost of this option would be in the range of \$1,000,000 (excluding engineering, assuming 250 to 300 m of new alignment and including extension of centerline culvert). However, this option would need to be investigated further because two horizontal curves would need to be established in a short distance at a travelling speed of 110 Km/hr.
- c) Unload the landslide through partial removal and replacement of the highway fill with lightweight fill (e.g., EPS foam). A drainage blanket along with subdrains will need to be installed below the foam to prevent flotation. The estimated cost of this option would range of \$2,000,000 (excluding Engineering) and this may require one lane closure or a temporary detour to complete the construction.

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.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

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.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

5. INTERPRETATION OF THE REPORT

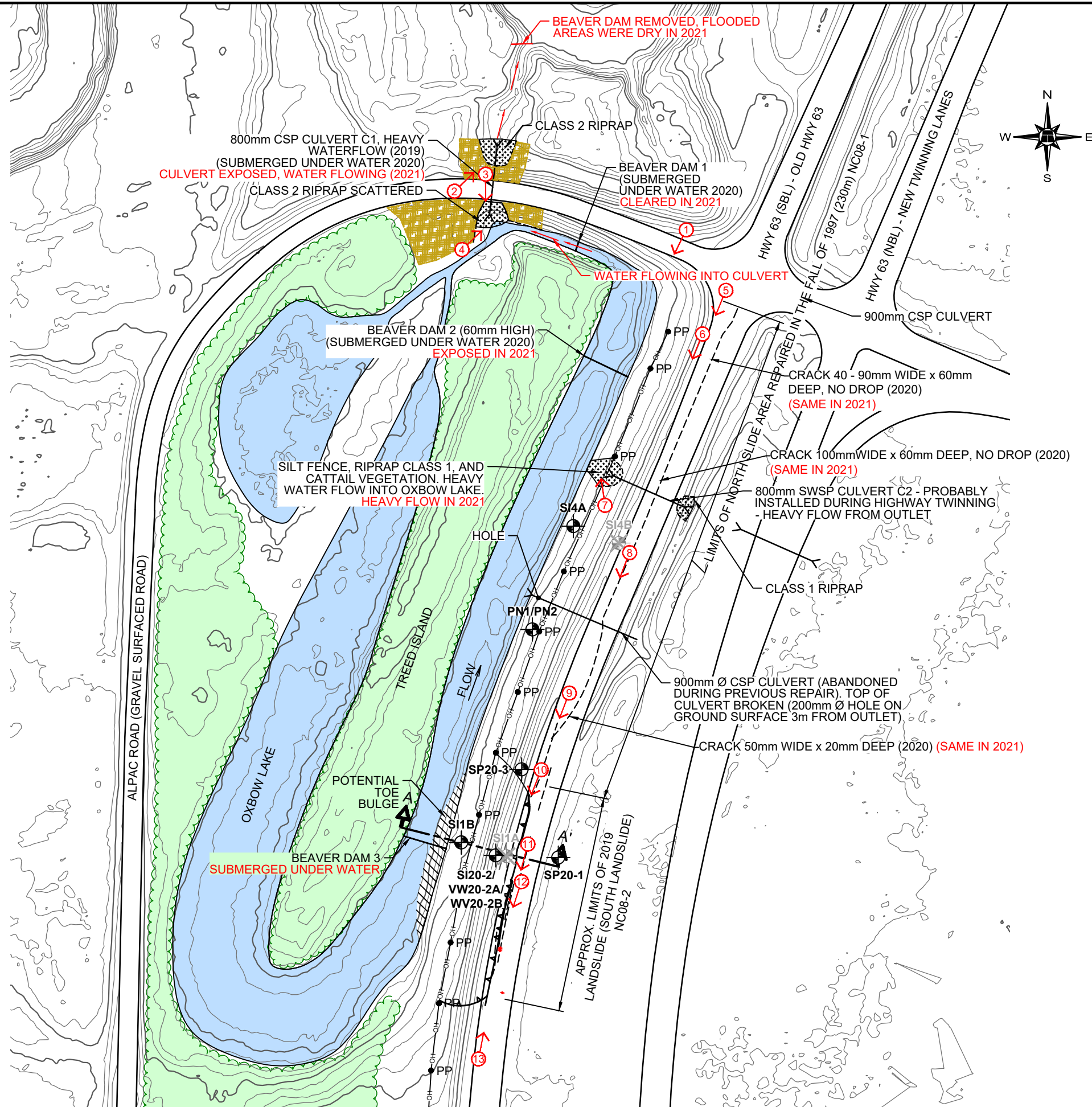
- a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification 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

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

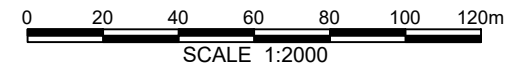


LEGEND

- APPROXIMATE TEST HOLE LOCATION
- SLOPE INCLINOMETER
- VIBRATING WIRE PIEZOMETER
- STANDPIPE PIEZOMETER
- DESTROYED INSTRUMENT
- ACTIVE LANDSLIDE SCARP CRACK
- CRACK
- 540 GROUND SURFACE CONTOUR
- OVERHEAD POWERLINE
- POWER POLE
- CULVERT
- EROSION CONTROL BLANKET
- APPROXIMATE DIRECTION AND NUMBER OF PHOTO

NOTES:

1. SITE FEATURES ARE APPROXIMATE
2. TOPOGRAPHY IS BASED ON 2008 LIDAR DATA
3. **JUNE 24, 2021 OBSERVATIONS SHOWN IN RED**
4. OVERHEAD POWERLINES WERE RELOCATED TO THE WEST SIDE OF THE OLD HIGHWAY 63 DURING HIGHWAY TWINNING PROJECT



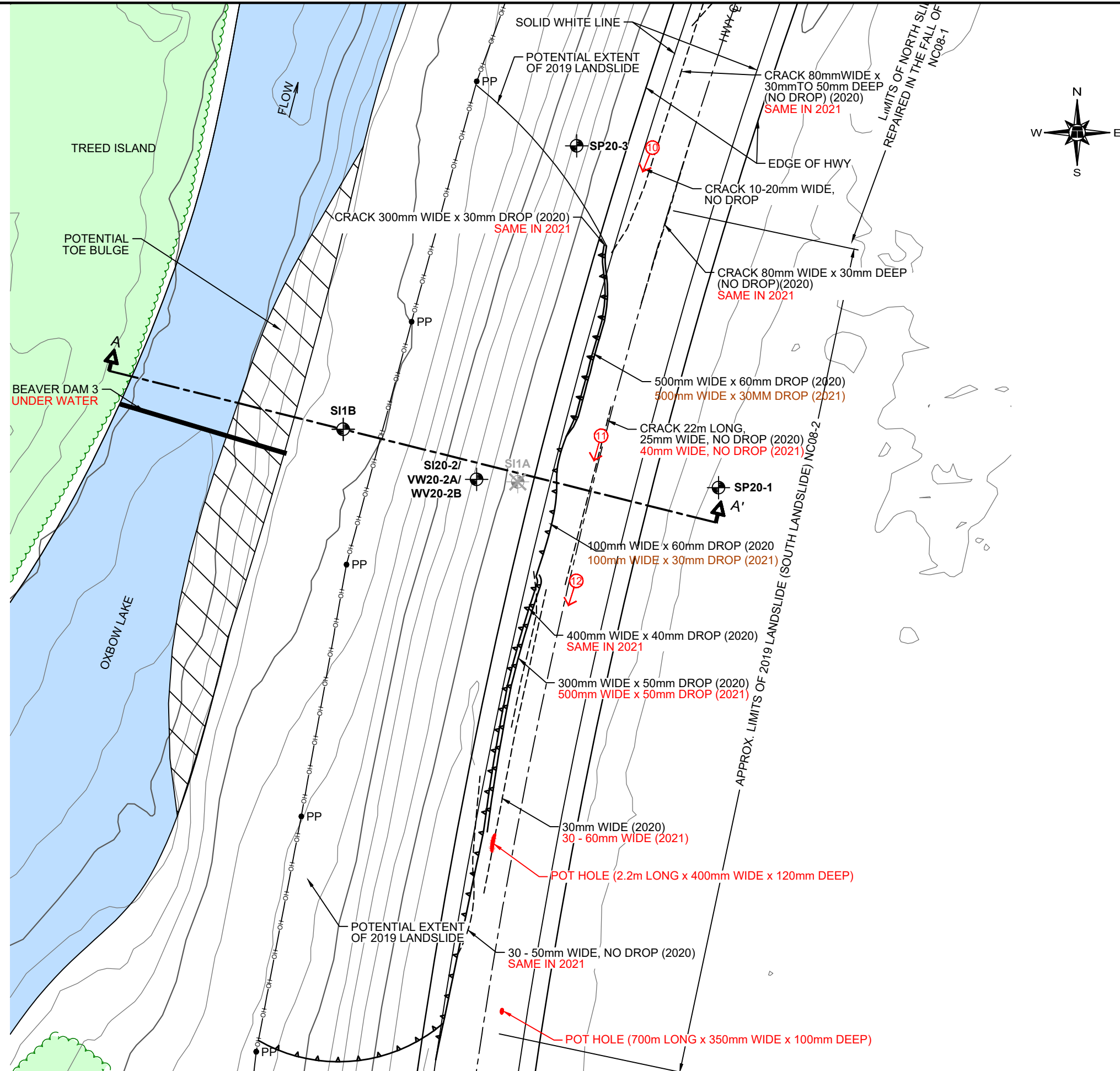
NORTH CENTRAL REGION
(ATHABASCA AND FORT McMURRAY DISTRICTS)
2021 GEOHAZARD ASSESSMENT

NC008: HWY 63:02 LA BICHE RIVER (km 15.6)
SITE PLAN SHOWING EXISTING FEATURES

FIGURE NC008-A

| | |
|-------------|-------------|
| DRAWN BY | ML |
| DESIGNED BY | JGP |
| APPROVED BY | TSA |
| SCALE | 1:2000 |
| DATE | AUGUST 2021 |
| FILE No. | 32122 |

THURBER ENGINEERING LTD.

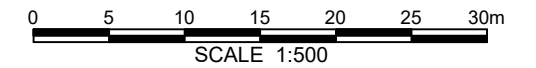



LEGEND

- APPROXIMATE TEST HOLE LOCATION
- SLOPE INCLINOMETER
- VIBRATING WIRE PIEZOMETER
- STANDPIPE PIEZOMETER
- DESTROYED INSTRUMENT
- ACTIVE LANDSLIDE SCARP CRACK
- CRACK
- GROUND SURFACE CONTOUR
- OVERHEAD POWERLINE
- POWER POLE
- APPROXIMATE DIRECTION AND NUMBER OF PHOTO

NOTES:

1. SITE FEATURES ARE APPROXIMATE
2. TOPOGRAPHY IS BASED ON 2008 LIDAR DATA
3. JUNE 24, 2021 OBSERVATIONS SHOWN IN RED
4. OVERHEAD POWERLINES WERE RELOCATED TO THE WEST SIDE OF THE OLD HIGHWAY 63 DURING HIGHWAY TWINNING PROJECT
5. CRACKS WERE SPRAY PATCHED IN 2020.






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

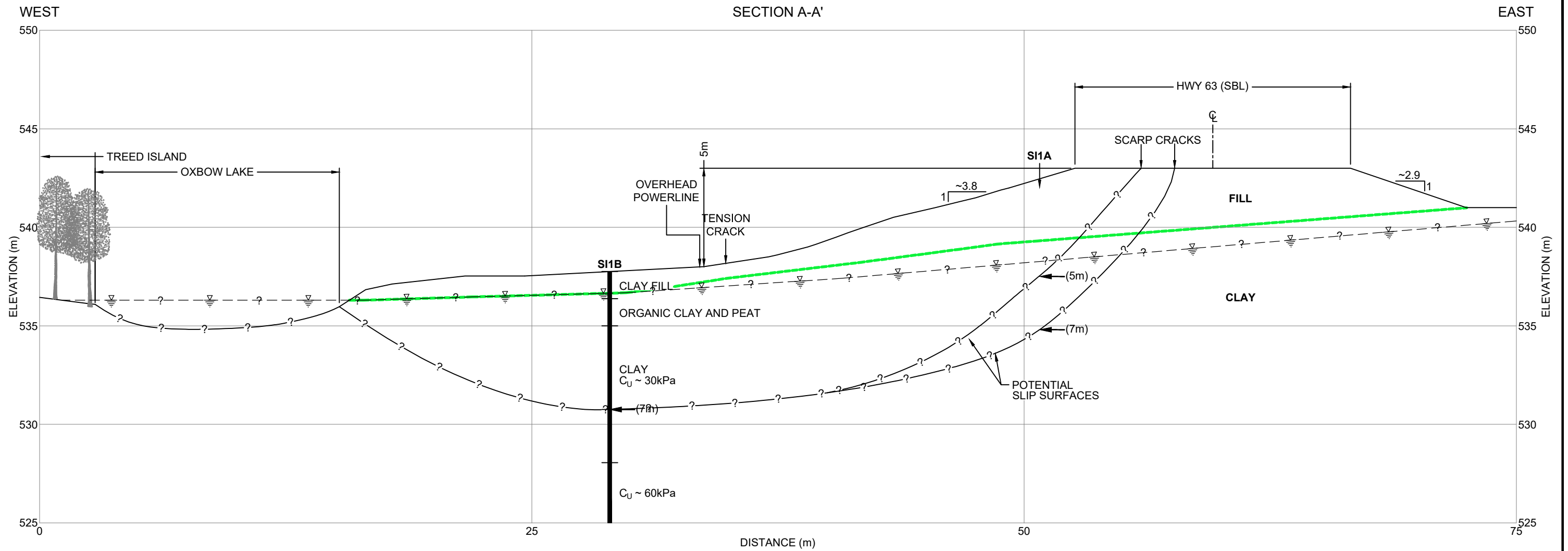
**NC008: HWY 63:02 LA BICHE RIVER (km 15.6)
SITE PLAN SHOWING THE SOUTH SLIDE AREA**

FIGURE NC008-B

| | |
|-------------|-------------|
| DRAWN BY | ML |
| DESIGNED BY | JGP |
| APPROVED BY | TSA |
| SCALE | 1:500 |
| DATE | AUGUST 2021 |
| FILE No. | 32122 |



THURBER ENGINEERING LTD.



LEGEND

- C_u UNDRAINED SHEAR STRENGTH BASED ON POCKET PENETROMETER
- ←(7m) ZONE OF MOVEMENT IN SLOPE INCLINOMETER (DEPTH)
- ▽ - ? POTENTIAL PIEZOMETRIC SURFACE

NOTES:

1. CROSS-SECTION IS APPROXIMATE, BASED ON 2008 LIDAR DATA AND JULY 3, 2019 OBSERVATIONS
2. S11A STRATIGRAPHY IS NOT AVAILABLE



**NORTH CENTRAL REGION
(ATHABASCA AND FORT McMURRAY DISTRICTS)
2021 GEOHAZARD ASSESSMENT
NC008: HWY 63:02 LA BICHE RIVER (km 15.6)
CROSS-SECTION A-A'**

FIGURE NC008-C

| | |
|-------------|-------------|
| DRAWN BY | ML |
| DESIGNED BY | JGP |
| APPROVED BY | TSA |
| SCALE | 1:200 |
| DATE | AUGUST 2021 |
| FILE No. | 32122 |





Photo No. 1 – Looking south at the Oxbow Lake. Beaver dam 2, which was submerged under water in 2020, was visible during the 2021 site visit



Photo No. 2 – Looking northeast at Culvert C1 outlet. Note that beaver dam, located downstream of the culvert outlet, was cleared so water was flowing freely along the channel



Photo No. 3 – Looking south towards CSP culvert C1 outlet; note that this area was submerged under water in 2020



Photo No. 4 – Looking north at Culvert C1 inlet location



Photo No. 5 – Looking south at highway open cracks within the limits of the repaired area in 1997 (previously known as NC08-1)



Photo No. 6 – Looking south at highway open cracks and potholes within the limits of the NC08-1 repaired area



Photo No. 7 – Looking north at 900 mm diameter SWSP Culvert C2 outlet; heavy flow in 2021



Photo No. 8 – Looking south at highway open cracks within the limits of the repaired area in 1997 (NC08-1)



Photo No. 9 – Looking south at the southern flank cracks of the NC08-1 repaired landside. Note that cracks were spray patched in 2020



Photo No. 10 – Looking south at the northern flank of the new landslide (previously known as NC08-2); note exiting drop within the highway lane



Photo No. 11 – Looking south at highway cracks at the central portion of the south landslide (NC08-2)



Photo No. 12 – Looking south at highway cracks near the southern flank of the south landslide (NC08-2)



Photo No. 13 – Looking north at highway cracks near the south flank of the south landslide (NC08-2)