



THURBER ENGINEERING LTD.

October 13, 2022

File No.: 32121

Alberta Transportation
Provincial Building
9621 – 96 Avenue
Peace River, Alberta
T8S 1T4

Attention: Mr. Max Shannon

**GEOHAZARD RISK MANAGEMENT PROGRAM (CON0022164)
PEACE REGION (PEACE RIVER DISTRICT)**

**SECTION D CALL-OUT REPORT
EAST OF MANNING: HWY 691:02 km 4.14 to 4.18**

Dear Mr. Shannon:

This report presents the results of a call-out for the above-noted site located on Hwy 691:02 between km 4.14 and 4.18, which is about 4 km south of the intersection with Highway 35 on the south side of the Town of Manning. The legal description of this site is NW24/SW25-91-23-W5M. The AADT (average annual daily traffic) on the highway is 379 vehicles per day (verified in September 2022).

Mr. Ken Froese, P.Eng., and Mr. Mark Gallego, P.Eng., of Thurber Engineering Ltd. (Thurber) undertook a callout inspection on June 3, 2022, in the presence of Messrs. Rishi Adhikari, P.Eng., Max Shannon, Ed Szmata, and Erwin Kurz (Maintenance Contractor Inspector, MCI) of Alberta Transportation (AT).

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

1. BACKGROUND

This site was patched 3 to 4 years ago (likely 2017 or earlier) when the distress appeared to be rutting in the outer wheel path of the west-bound lane (WBL). However, the "rutting" has increased in extents to the center of the lane indicating there might be a landslide occurring. The site was scheduled for additional patching in the summer of 2022 to maintain a safe traveling surface. The MCI requested a callout on April 27, 2022, to assess the site to see if additional remedial measures should be considered. This site was added to the annual Geohazard Risk Management Program (GRMP) tour for late May and early June 2022 when the team was already going to be in the area.

A brief review of publicly available mapping indicates that the bedrock at this site is in the order of 140 m deep (Alberta Geological Survey DIG 2020 0023) and consists of marine clay shale of the Shaftesbury Formation (Alberta Geological Survey Map 236). The bedrock surface slopes southwest toward a localized low area; however, the regional trend is sloping downward to the



east (Alberta Geological Survey Digital Map DIG_2020_0022, 2020) toward the pre-glacial valley thalweg that approximately underlies the present-day Peace River valley (about 19 km distant). A surficial geology map indicates that the uplands in this area consist of an extensive glaciolacustrine plain (clay, silt, and sand) which is intersected by fluvial deposits (stratified gravel, sand, and silt) in the river and creek valleys. The site is situated on the south edge of the fluvial deposits of the Notikewin River valley (Alberta Geological Survey Digital Map DIG_2004_0038, 2004). The Notikewin River is highly meandering, with an overall valley width in the area between about 2.4 km and 2.8 km and containing numerous oxbows and meander scars.

AT Maps information indicates that the pavement structure consists of 260 mm of ACP over 250 mm of GBC and that the foundation soils are low to medium plastic clays, which would indicate the highway embankment may be on the glaciolacustrine plain rather than the fluvial deposits of the adjacent river valley.

2. OBSERVATIONS

Observations made during the site visit are illustrated in DWG No. 32121-HWY 691:02 CALLOUT-1, attached. Selected photographs of the site visit are also included at the end of this letter.

The highway embankment measures about 1.4 m in height on the south side with a sideslope of 3.7H:1V. The farmland beyond was relatively flat with no obvious drainage pattern. On the north side, the sideslope was about 2.5H:1V and the roadway surface was 8 m to 9 m above the lower-lying, flat farmland at the toe. There is a culvert under the south approach located about 80 m east of the site and an 800 mm dia. CSP centerline culvert about 120 m to the west of the site (km 4.017). A patch was planned for the summer of 2022, which was marked out by spray paint and stakes spanning a length of about 49 m of the west-bound lane (WBL).

At the time of the callout inspection, the main crack pattern was located within the area delineated by the planned patch. The main crack was in the outer wheel path of the WBL and extended about 24 m within the planned patch. The western portion of this crack pattern was about 150 mm in overall width with individual crack widths of up to 20 mm and a slight differential down to the north of about 50 mm. In the central portion, the crack deviated to the center of the lane and was about 30 mm without differential. The eastern portion was about 200 mm in overall width with individual crack widths of also about 20 mm and 50 mm differential. West of the main crack, and to the end of the planned patch, there were two roughly parallel cracks on either side of the slight outer wheel path rut that are likely related to the distress. To the east of the main crack, there was a single crack roughly in the center of the outer wheel path (OWP) that continued beyond the planned patch.

Observations at the toe of the slope noted a potential toe roll at the level of the adjacent field, although thick bush somewhat obscured the slope. This possible toe roll was between 200 mm and 400 mm high and spanned a distance of about 50 m and was in line with the main crack noted on the highway. There was another potential toe roll noted about 45 m east of the proposed patch but was only 100 mm in height and could be the result of previous farming disturbance. There was no obvious corresponding crack and differential in the highway surface at this location.



A power pole near this area had a 4° lean towards the highway but as this was the first observation, it is not known if this indicates movement or is unchanged since installation.

3. INSTRUMENTATION

There is no instrumentation at this site.

4. ASSESSMENT

Based on satellite imagery, the site is located at the top of the south end of an abandoned meander scar. This particular series of meander scars is located above a terrace as the river has downcut a new channel about 1.8 km to the north. It would be expected that the slopes above the meander bend would have been over steepened when the river was at the toe and actively eroding the banks. With sufficient time, the slope should reach equilibrium but might be susceptible to reactivation depending on changes in the groundwater table, stress regime (eventually loss of cohesion), and slope loading (such as the construction of a highway embankment). It is possible that the construction of the highway so close to the crest of the slope has, over time, changed this balance such that the slope is no longer stable, particularly given the rain fall levels in the last few years seem to be higher than average. This may be a phase of creep movement leading to the development of a failure surface sufficient for larger-scale displacement. The depth of failure is likely near or at the base of the slope. It is anticipated that the distress will continue until there is a significant drop in the highway surface.

5. RISK LEVEL

Based on the AT's Risk level rating system, the risk level for this site has been assessed as follows:

$$\text{Risk (40)} = \text{PF (10)} \times \text{CF (4)}$$

This risk level was based on a Probability Factor (PF) of 10 (between “active with moderate but steady or decreasing” and “active but increasing rate of movement”) and a Consequence Factor (CF) of 4 (as associated with “high fills” and “where partial closure of the road or significant detours would be a direct and unavoidable result of slide occurrence”). Although the height of fill is only about 1.4 m, the overall slope height involved in the movement is 8 m.

6. RECOMMENDATIONS

There have been several similar slumps of this nature in the area (such SH030, SH031, East of Gunn's Creek, and the East of Arcadia callout on Hwy 2:50) and there are four typical options presented for the repair of these sites. Both slope flattening or a toe berm would be suitable at this Hwy 691:02 site although right-of-way acquisition will be required. A pile wall would also be a potential solution but is likely too expensive for this low-volume highway unless the other options prove unacceptable. Gravel replacement of the slide mass is not suitable at this location given the potential depth of the failure surface. Another option that was not suitable at those other sites but may be acceptable here is a short realignment south around the slide area. There would be additional right-of-way requirements for this option as well and it might not be acceptable from a



geometric or aesthetics perspective as the highway on either side is quite straight. Also, the driveway to the property on the south would need to be shortened or relocated so as not to be located on a curve. On that basis, a toe berm is recommended as the portion of the farmland closest to the highway is not being actively farmed, which may be due to the softer nature so subexcavation and replacement below the footprint or a gravel shear key may be required. Subexcavation of the slide mass might require the removal of significant material – it may be more economical to just construct the toe berm and use routine patching to maintain the highway surface until the slide “tightens up.” The secondary area to the east of the main distress could be repaired in the same manner or left untreated to see if any distress develops.

On a preliminary basis, the recommendations for the main repair are:

- The topsoil from the embankment and ditch bottom should be stripped and stockpiled for later reuse
- All soft or organic material should be removed from below the toe berm footprint
- The fill should be low- to medium-plastic clay or clay till
- The berm should be constructed up to about half the height of the embankment and extend into the ditch 4 m with a 4H:1V slope; and
- The ditch regraded to ensure flow
- The width of the toe berm should extend at least the width of the proposed patch, which is about 50 m.
- The highway sideslope above the berm should be flattened from the current 2.5H:1V to at least 3H:1V.
- All topsoil should be removed from below the footprint of the toe berm and stockpiled for reuse.
- All soft or organic material should be removed from below the toe berm.
- The edges of the toe berm against the highway and natural slopes should be armoured to minimize the potential for erosion.
- Low- to medium-plastic clay or clay till or pitrun gravel are acceptable for the berm construction. If granular material is used, a non-woven geotextile should be used for separation.
- Consideration should be given to placing a drainage layer (granular or synthetic behind the berm to facilitate groundwater flow.

A geotechnical investigation is required to confirm soil properties and groundwater levels particularly at the base of the slope where there is the potential for soft and/or organic soils. Stability analyses will need to be undertaken to determine the appropriate size and slopes of the toe berm.

The estimated cost to construct the toe berm repair described above will be in the order of \$350,000. These costs do not include resurfacing of the highway.



7. CLOSURE

We trust that this information is sufficient for your present requirements. We would be pleased to answer any questions that you may have regarding this letter report.

Yours very truly,
Thurber Engineering Ltd.
Renato Clementino, Ph.D., P. Eng.
Review Principal

Ken Froese, M.Eng., P. Eng.
Geotechnical Engineer
/jf

Attachments:

- Statement of Limitations and Conditions
- DWG No. 32121-HWY 691:02 CALLOUT-1
- Selected Photos



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.

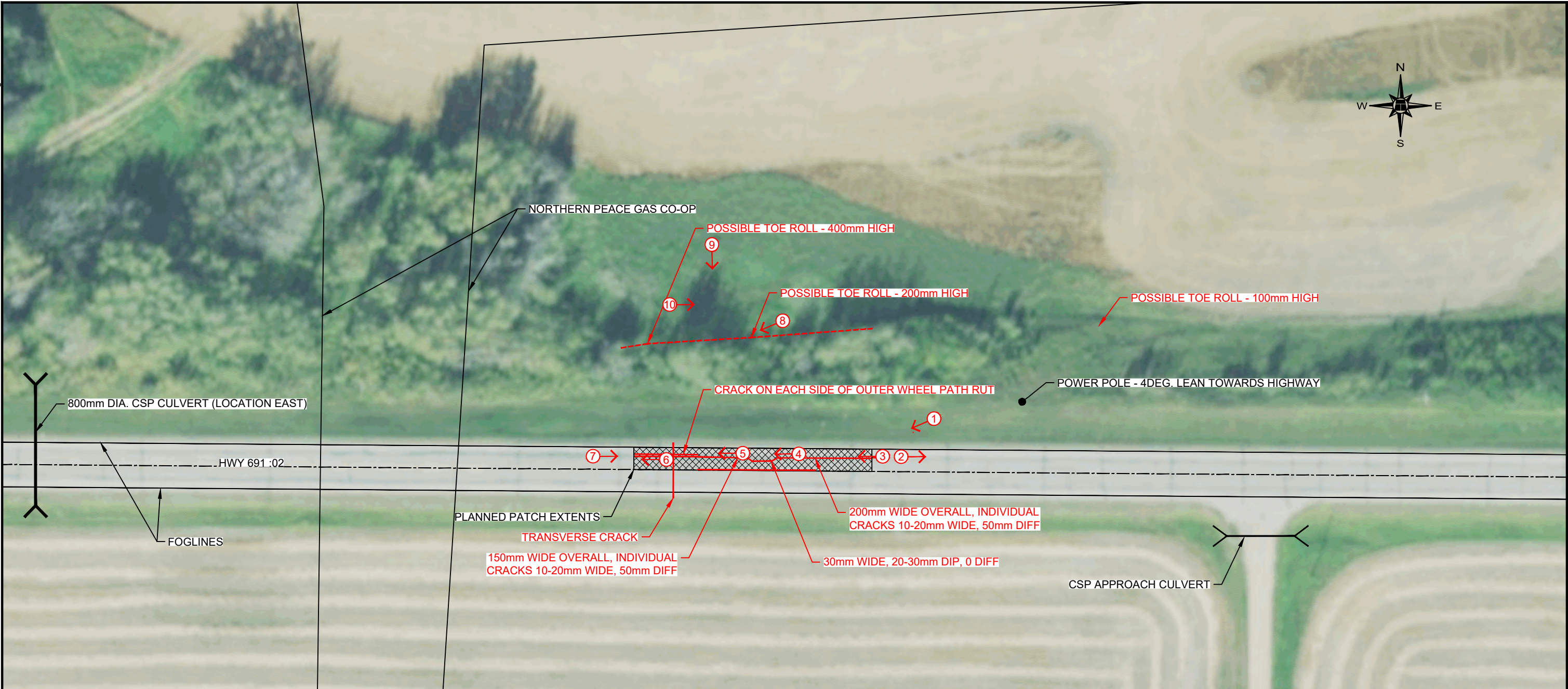
6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

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.

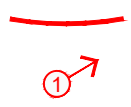
7. INDEPENDENT JUDGEMENTS OF CLIENT

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.

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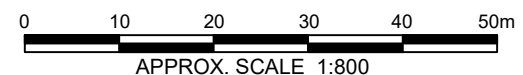


LEGEND



CRACK
 PHOTOGRAPH NUMBER, AND APPROXIMATE DIRECTION AND LOCATION

NOTE:
 FEATURES WERE MEASURED IN FIELD USING APPROXIMATE METHODS (PACING, MEASURING WHEEL, TAPE MEASURE, AND CLINOMETER)



2013 SATELLITE IMAGE OBTAINED FROM VALTUS IMAGING



PEACE REGION (PEACE RIVER DISTRICT)

**HWY 691:02 km 4.14 - km 4.18 GRAVINA CREEK
 SW 25-91-23-W5M
 2022 CALL - OUT**

DWG No. 32121-HWY 691:02-CALLOUT-1

DRAWN BY	ML
DESIGNED BY	KEF
APPROVED BY	RVC
SCALE	APPROX. 1:800
DATE	OCTOBER 2022
FILE No.	32121





Photo 1 – Looking west over distressed area where dip is visible in the roadway surface and the stakes mark the planned patch.



Photo 2 – Looking east beyond the area of distress.



Photo 3 – Looking west at east of the proposed patch over the distressed area.



Photo 4 – Looking west at the central portion of the crack forming in the area of distress.



Photo 5 – Looking west at the main crack (taken west of Photo 4).



Photo 6 – Looking west at end of proposed patched and beyond the area of distress.



Photo 7 – Looking east from near the west end of the area of distress.



Photo 8 – Possible toe roll below the area of distress.



Photo 9 – Looking south at the meander bend scar slope with overhead powerline and the highway beyond.



Photo 10 – Looking east along the toe of the slope.