

**ALBERTA TRANSPORTATION AND
ECONOMIC CORRIDORS
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION (PEACE RIVER DISTRICT)
2024 INSPECTION**



Site Number	Location	Name	Hwy	km
SH004-1	South of Little Smoky River	Little Smoky River (South of Bridge)	49:12	2.3-2.6
Legal Description		UTM Co-ordinates		
W33-074-21-W5M		11 E 489,224	N 6,145,128	

	Date	PF	CF	Total
Previous Inspection:	7-Jun-2023	13	6	78
Current Inspection:	3-Jun-2024	13	6	78
Road AADT:	1530		Year:	2024
Inspected By:	Rishi Adhikari, TEC Robert Senior, TEC		Ken Froese, Thurber Roger Skirrow, Thurber	
Report Attachments:	<input checked="" type="checkbox"/> Photographs		<input checked="" type="checkbox"/> Plans	<input type="checkbox"/> Maintenance

Primary Site Issue:	The highway traverses the 120 m deep Little Smoky River valley over an easterly-oriented 35 m deep-seated retrogressive landslide. There are persistent widespread creep movements over most of the entire valley slope. The movements are partly due to erosion at the bottom of the valley by the Little Smoky River. This site is related to Geohazard sites SH003 and SH016.
Dimensions:	At least 300 m length of highway affected by several intersecting scarps resulting in uneven riding surface. Approx. 1.3 km of the highway crosses this unstable west valley slope.
Date of Remediation:	1960's: Surface drainage improvements intended to drain sag ponds. 1972: Minor road realignment to accommodate new climbing lane. 1987: Subdrain installed in backslope ditch. 1998: Overlay including building up downslope shoulder with gravel fill buttress and raising of the guardrail. 2006: Repair of erosion damage and installation of surface drains to nearby sag pond.
Maintenance:	There is a repeated cycle of patching and milling and guardrail adjustments that extends to the original construction of the highway at this location. 2016: Patch placed in August, milled in late September 2017: Patch and milled in August/September 2018: Milling removed up to about 60 mm of asphalt Fall 2019: Milling both sides of valley for about \$172,000 2020: Pavement overlay and guardrail replacement 2022: Milling 2023: Milling 2024: Patching

Observations:	Description	Worsened?
<input checked="" type="checkbox"/> Pavement Distress	Cracking and uneven roadway surface requires ongoing patching and milling especially at the landslide scarp cracks.	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Slope Movement	Overall slope movement continues resulting in cracks at scarps and sags in the graben blocks.	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Erosion	Rilling between riprap channel and beyond P01-6. Lesser riling near north end of patch.	<input type="checkbox"/>

<input checked="" type="checkbox"/> Seepage	Evidence of seepage observed near culvert outlet at north end of site.	<input type="checkbox"/>
<input checked="" type="checkbox"/> Bridge/Culvert	Separation of plastic culvert.	<input type="checkbox"/>
<input type="checkbox"/> Other		<input type="checkbox"/>
Instrumentation (Spring 2024):		
VW07-2, VW07-2A, VW07-3, VW07-3A	Relatively stable and slightly decreasing over the last three years.	
Destroyed/Lost	VW07-2B and -3B (damaged Fall 2014); SI4A, SI01-6, SI01-7, SI01-2, SI07-3B, SI01-9, SI07-2B, PZ01-6, PZ01-2 (discontinued)	
Assessment:		
<p>The west and east valley slopes are prime examples of large scale, deep-seated retrogressive translational landslides. The overall west valley slope is moving as several separate slide blocks with numerous intermediate and main scarps, sag ponds, and differential movement zones. The highway alignment intersects these features which results in well established cracks crossing the highway and associated an uneven and tilted highway surface. The driving mechanism appears to be toe erosion by the Little Smoky River; a high ground water table may also be contributing. Based on GPS survey of the InSAR points conducted by Alberta Geological Survey (AGS Open Report 2013-14), this portion of the highway is located on landslide blocks moving relatively slower (5 mm to 40 mm per year) as compared to the eastside (SH003) or the bridge site (SH016). Drawing 32121-SH004-1-1 shows some of the local slide features that have been interpreted from the 2008 LiDAR imagery. Regrading of the slopes at this site has obscured the scarps of the larger slide blocks that are likely present beneath the highway alignment.</p> <p>The ongoing movement of the valley slope results in continued deformation of the highway surface that requires frequent widespread patching. An overlay was placed in the summer of 2020 to maintain the smoothness of the highway. Reportedly, the crack pattern in the highway started reflecting through the overlay in less than 24 hours. As the crack pattern became fully established, the increasing differential across the cracks required milling in 2021, 2022, and 2023. Patching was required in 2024 and, as shown on the Drawings, the crack pattern quickly became re-established: there are three main sets of scarp cracks crossing the highway on a NW-SE orientation and likely represent retrogressive movements of the valley-scale landslide blocks.</p> <p>The areas of rilling have slowly stabilized over the last two years. The new erosion gully that formed at the south end of the site at the end of guardrail in 2023 has deepened somewhat.</p> <p>There is a break in the plastic culvert that handles downslope ditch flow from the south that creating a sinkhole up to the ground surface. The sinkhole has not changed in size significantly in the last few years. A second gap at a culvert joint was observed in 2019 about 25 m further north. Both of these gaps in the culvert were slightly wider in 2023 and again in 2024.</p> <p>The slope below an approach located at the south end of the site started to deteriorate in 2019. There was increased displacement and extension of the tension and scarp cracks on this slope and the gully in the centre of the feature continued to deepen. This area seems to have stabilized in 2023 and 2024. This area warrants continued monitoring as retrogression of the features toward the highway could occur relatively rapidly.</p>		
Recommendations:		
Short-term:		
<ul style="list-style-type: none"> ▪ Road maintenance consisting of milling and patching should continue as necessary (once or twice annually) to maintain the roadway surface in a safe condition. Crack sealing of the ACP should be done to limit infiltration of rain fall and snow melt into the extensive crack network. The bare areas on the downslope side of the highway to the north of the riprap apron have the potential to deteriorate further. This area could be regraded and covered with topsoil and seed, and further secured with an erosion control blanket or seed-impregnated compost blanket. The second rill area near the north end of the site and the new gully at the south end of the guardrail could be repaired at the same time with the same methodology. 		

- The break in the culvert should be excavated and repaired to limit infiltration into the slope which could potentially result in slope movement or significant erosion. Alternatively, this culvert could be replaced with an above-ground half-culvert or welded steel pile.

Long-Term:

The two alternatives for this location are: realign the highway using the existing bridge, or; construct a new alignment and bridge on more stable ground. If the existing bridge location option is preferred, additional extensive riverbank protection could be installed to control river erosion at the toe of the slope. This would augment the effectiveness and life of the existing bridge alignment option. It is understood that AMEC (now WSP) prepared a report under the 2013 High Water Related Mitigation Works program providing recommendations for erosion control at the toe and drainage measures on the slope to reduce the number and size of the sag ponds. In a previous study, Thurber identified a more-stable road alignment option going up a deep cut in the valley slope straight west off the end of the bridge.

Ongoing Investigation:

- It is recommended that the annual Geohazard inspection and twice-annual instrumentation readings should continue as scheduled.
- This is a large and complex slide area with limited spatial distribution of slope indication data. Since there are no longer any operable SI's on site, consideration should be given to adding two to three slope inclinometers if there are other investigation projects in the area such that drilling costs could be shared so that the rate of creep can be monitored.
- Consideration should also be given to re-surveying the InSAR (interferometric synthetic aperture radar) targets, perhaps annually, to supplement the work done by the AGS as this will provide an overall view of ground movements. Restoration of the InSAR study could be undertaken as most of the InSAR targets are still in-place.
- A GPS real-time ground movement system (SparkFun or Geocube based), that is less expensive than the current systems, may be an option worth considering at this site particularly for identifying lower-movement rate zones for potential realignment. It is understood that a conventional terrestrial survey program is being considered for the west abutment of the bridge and this site could be included for minimal additional cost.

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.

Roger Skirrow, M.Sc., P.Eng.
Senior Geotechnical Engineer

Ken Froese, P.Eng.
Associate | 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.

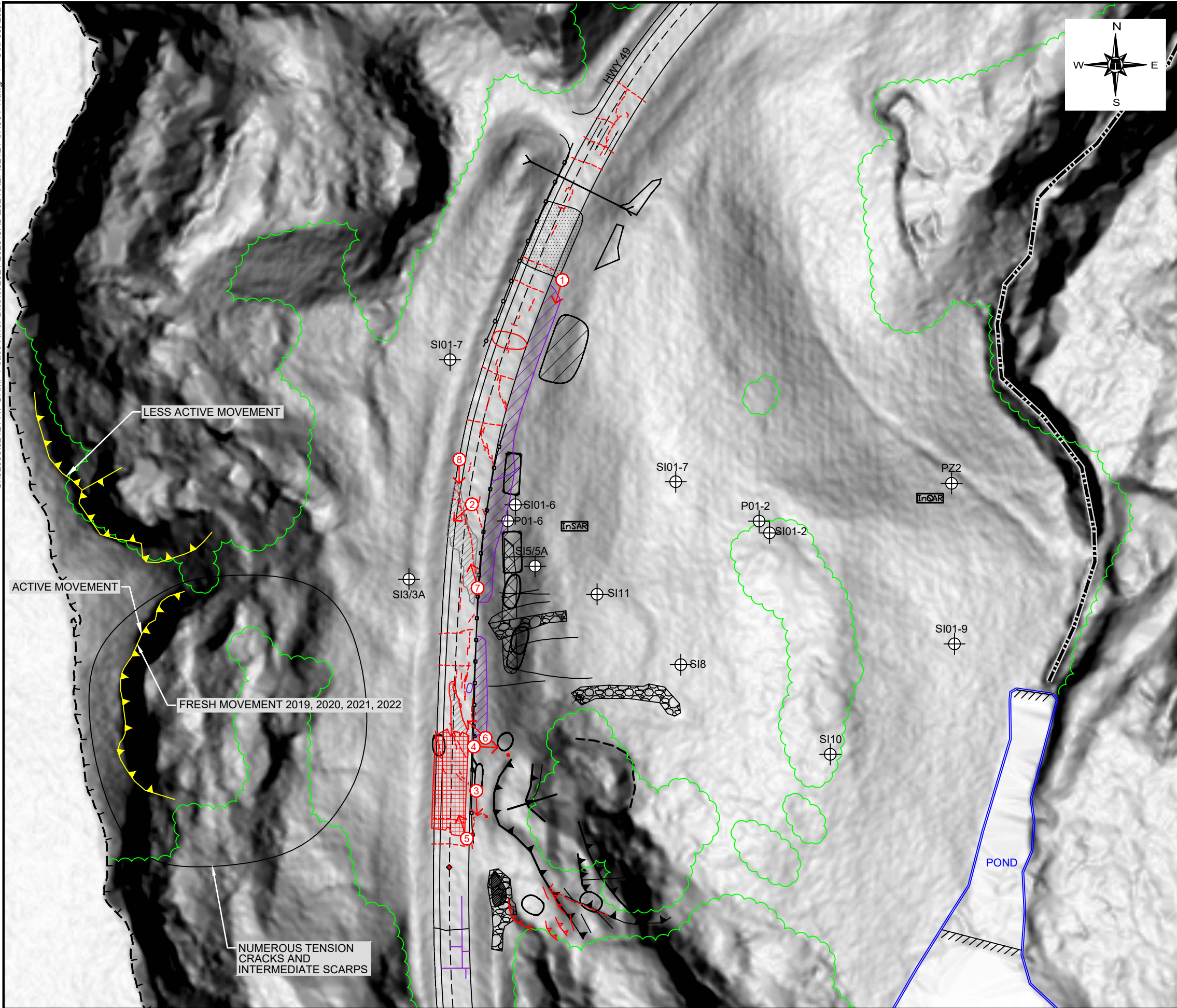
6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

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.

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LEGEND

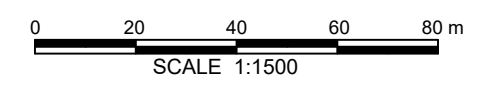
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- SI SLOPE INCLINOMETER
- P PNEUMATIC PIEZOMETER
- INSAR INSAR CORNER REFLECTOR
- MAJOR SCARP
- VALLEY CREST
- TREE LINE
- GUARDRAIL
- LANDSLIDE SCARP CRACKS
- RIPRAP APRON
- PAVEMENT OR TENSION CRACK
- MILLING AREA
- RED TEMPORARY HAZARD SIGN
- DIRECTION AND NUMBER OF PHOTO

NOTES

1. FEATURE LOCATIONS ARE APPROXIMATE.
2. SOME HISTORICAL OBSERVATIONS FROM AMEC FIGURE 1, PROJECT EG10030, PROVIDED BY ALBERTA TRANSPORTATION.
3. JUNE 2024 OBSERVATIONS SHOWN IN RED.
4. SITE OVERLAID IN 2020. CRACK PATTERN REDRAWN USING UAV IMAGERY ACQUIRED BY THURBER IN MAY 2022 AND UPDATED FROM NEW IMAGERY ACQUIRED MAY 2024.

REFERENCE

1. 2008 LIDAR PROVIDED BY ALBERTA TRANSPORTATION. SHADED BY SLOPE ANGLE FROM WHITE AT 0° TO BLACK AT ≥30°.



PEACE REGION (PEACE RIVER DISTRICT)

**SH004-1: HWY 49:12 LITTLE SMOKY RIVER SOUTH OF BRIDGE
2024 SITE INSPECTION PLAN - OVERALL**

DWG No. 32121-SH004-1-1

DRAWN BY	KLP
DESIGNED BY	KEF
APPROVED BY	DWY
SCALE	1:1500
DATE	OCTOBER 2024
FILE No.	32121



LESS ACTIVE MOVEMENT

ACTIVE MOVEMENT

FRESH MOVEMENT 2019, 2020, 2021, 2022

NUMEROUS TENSION CRACKS AND INTERMEDIATE SCARPS

POND

HWY 49

SI01-7

SI01-7

PZ2

INSAR

P01-2

SI01-2

SI01-6

P01-6

INSAR

SI5/5A

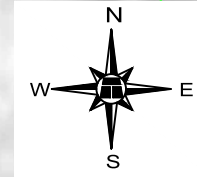
SI3/3A

SI11














SI8

SI01-9

SI10



LEGEND

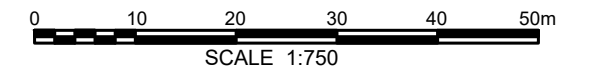
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-  P PNEUMATIC PIEZOMETER
-  INSAR INSAR CORNER REFLECTOR
-  MAJOR SCARP
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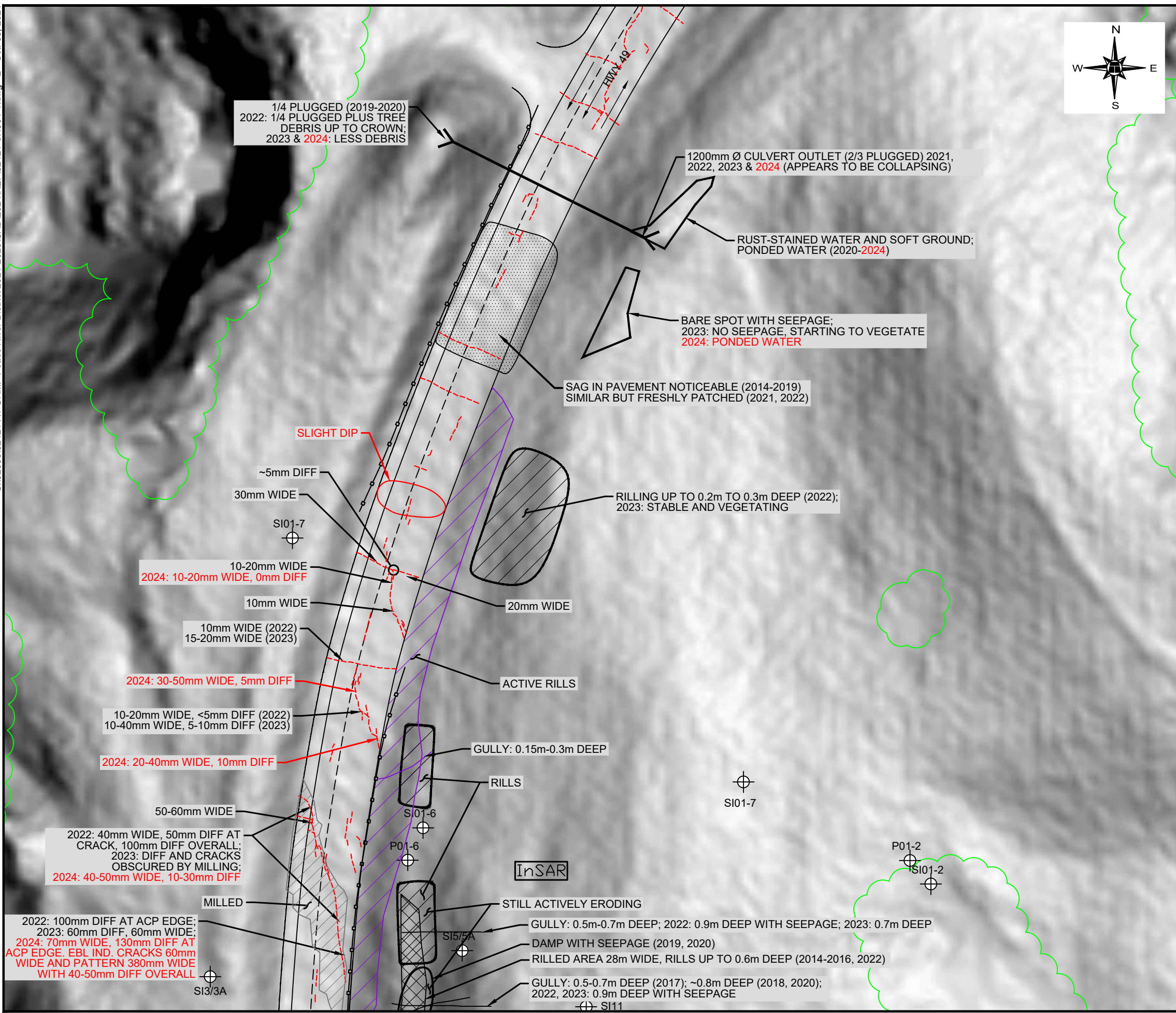


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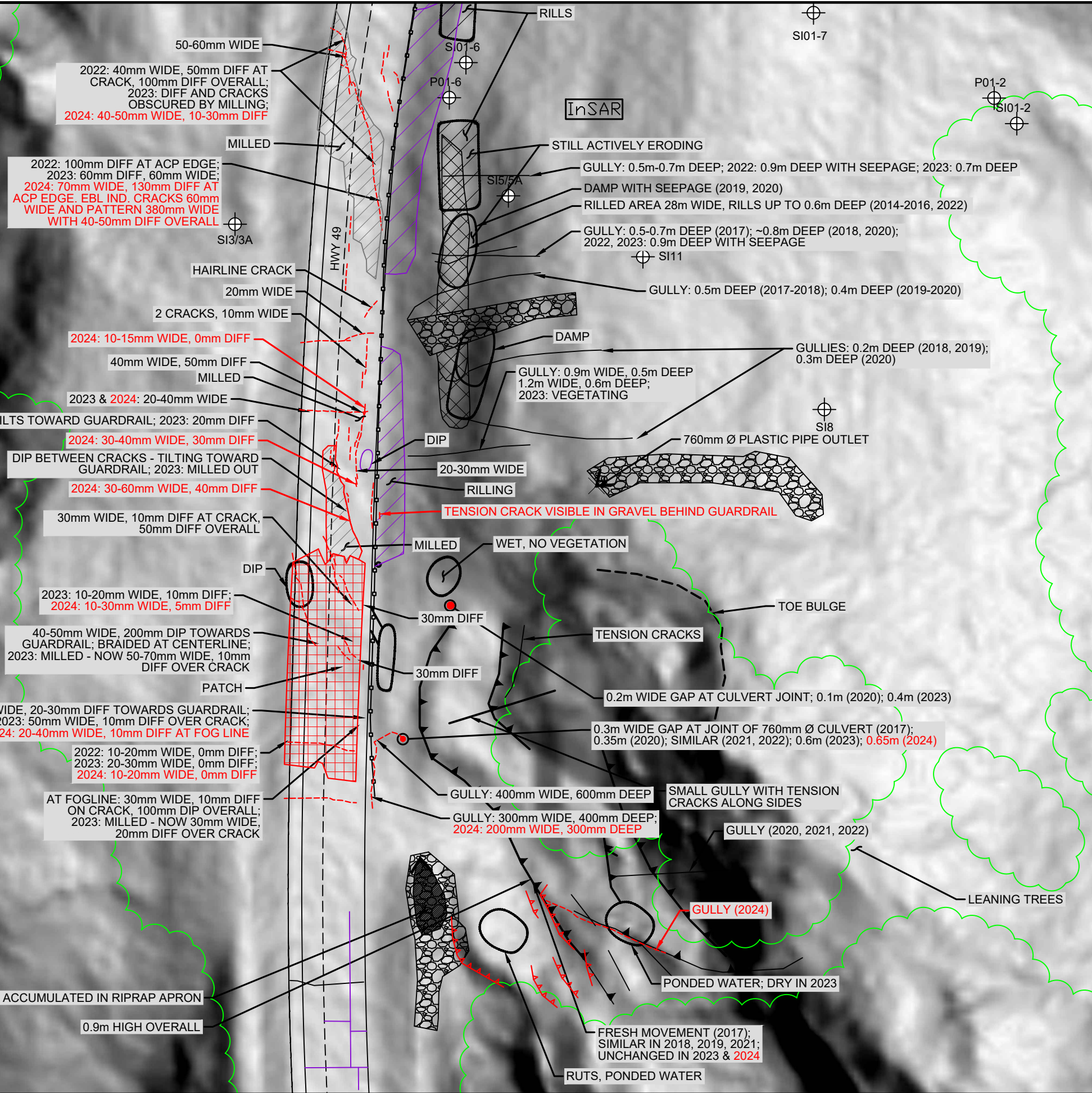
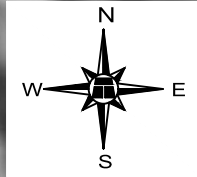
**SH004-1: HWY 49:12 LITTLE SMOKY RIVER
SOUTH OF BRIDGE
2024 SITE INSPECTION PLAN - NORTH PORTION**

DWG No. 32121-SH004-1-2

DRAWN BY	KLP
DESIGNED BY	KEF
APPROVED BY	DWP
SCALE	1:750
DATE	OCTOBER 2024
FILE No.	32121



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- LEGEND**
- APPROXIMATE INSTRUMENT LOCATION
 - SLOPE INCLINOMETER
 - PNEUMATIC PIEZOMETER
 - INSAR CORNER REFLECTOR
 - MAJOR SCARP
 - VALLEY CREST
 - TREE LINE
 - GUARDRAIL
 - LANDSLIDE SCARP CRACKS
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Alberta

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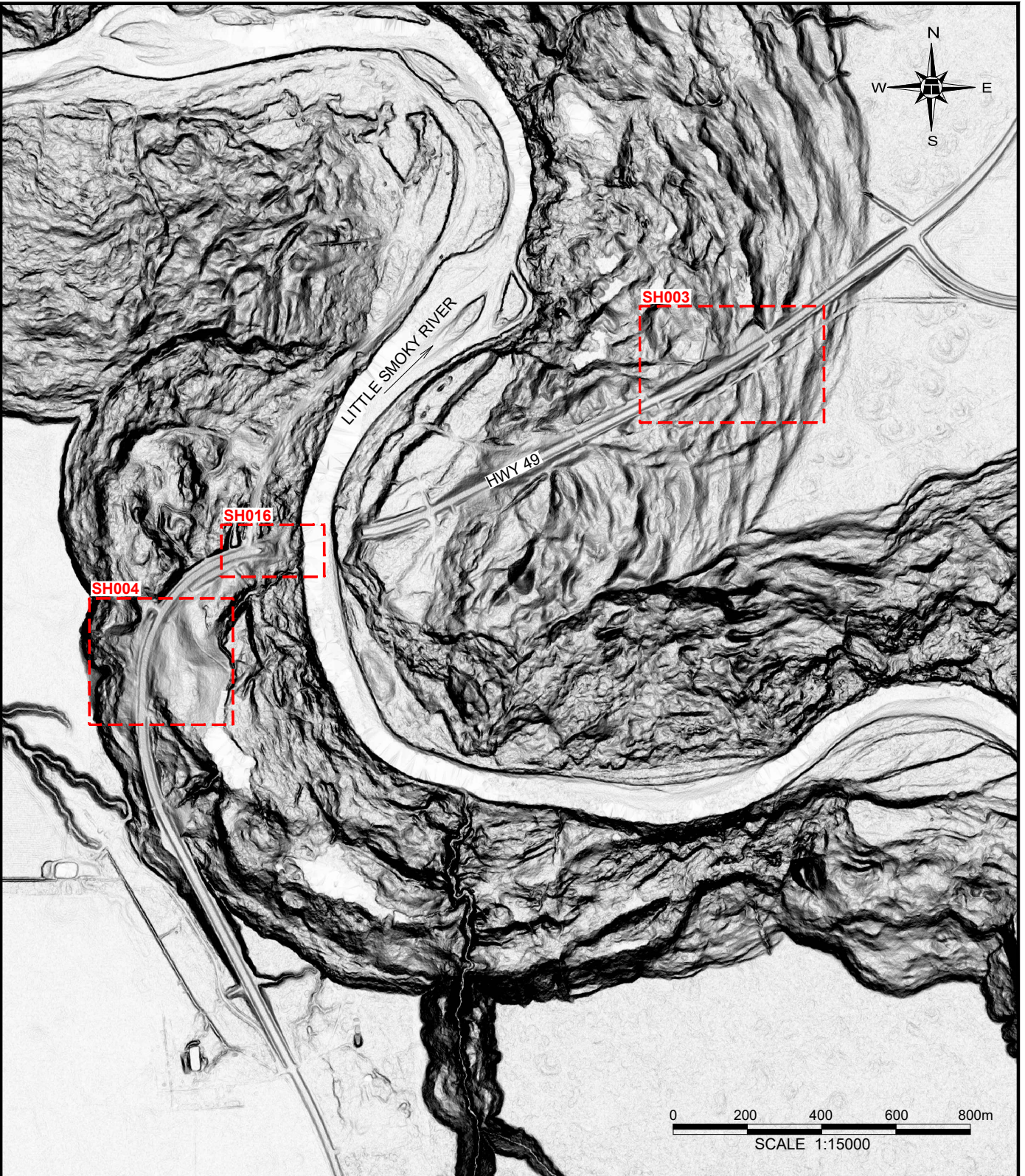
**SH004-1: HWY 49:12 LITTLE SMOKY RIVER
SOUTH OF BRIDGE
2024 SITE INSPECTION PLAN - SOUTH PORTION**

DWG No. 32121-SH004-1-3

DRAWN BY	KLP
DESIGNED BY	KEF
APPROVED BY	DWP
SCALE	1:750
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FILE No.	32121

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H:\32000\32121 AT GRMP Peace River District 2021-2025\CAD\2021\MG\32121 Figure 1 - SH003, SH004, SH016 Key Map.dwg - Layout1 - Oct. 05, 2021



2008 LIDAR PROVIDED BY ALBERTA TRANSPORTATION.

PEACE REGION (PEACE RIVER DISTRICT)

SH003-1, SH004-1, SH016-1 KEY MAP

FIGURE 1



DRAWN BY	KLW
DESIGNED BY	MG
APPROVED BY	DWP
SCALE	1:15000
DATE	OCTOBER 2021
FILE No.	32121



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Photo 1 – Looking south at downslope side of highway from the north end of the site.



Photo 2 – Looking at the southwest slide movement in the backslope above the highway.



Photo 3 – Looking south at an erosion gully that has formed at the south end of the guardrail.



Photo 4 – Looking at 760 mm culvert joint separation. The gully in the foreground is the one shown in Photo 3.



Photo 5 – Looking north at the first set of scarp cracks at south end of the site.



Photo 6 – The second set of scarp cracks just north of Photo 5.



Photo 7 – The third set of scarp cracks further north of the second set and near the north end of the east guardrail.



Photo 8 – Looking north back across all three sets with the third set in foreground.