

**ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION – GRANDE PRAIRIE DISTRICT NORTH
2021 INSPECTION**



Site Number	Location	Name	Hwy	km
PH083	6.1 km W Cleardale	Golf Course Slides	64:02	29.0
Legal Description		UTM Co-ordinates (NAD 83)		
SE1-85-11-W6		11V N 6246600	E 340300	

	Date	PF	CF	Total
Previous Call Out:	June 16, 2020	10	3	30
Current Inspection:	July 14, 2021	10	3	30 [East Slide]
		10	4	40 [West Slide]
Road AADT:	260		Year:	2020
Inspected By:	Don Proudfoot, Barry Meays (Thurber) Ed Szmata, Max Shannon, Roger Skirrow, Rocky Wang, Ken Szmata (AT)			
Report Attachments:	<input checked="" type="checkbox"/> Photographs <input checked="" type="checkbox"/> Plans <input checked="" type="checkbox"/> Maintenance Items <input checked="" type="checkbox"/> Statement of Limitations and Conditions			

Primary Site Issue:	Two Landslides – one on each of the north (PH083-1) and south (PH083-2) highway sideslope embankments, both associated with separate SWSP cross-culverts.	
Dimensions:	Slide 1 (east, downstream ~5H:1V embankment) is 20 m wide by 30 m long; and Slide 2 (west, upstream ~4H:1V embankment) is 15 m wide by 30 m long.	
Date of any remediation:	In 2017 at Slide 1, a 900 mm diameter SWSP was bored alongside the previously existing 1.2 m diameter CSP culvert which had separated.	
Maintenance:	Gravel fill placed over the slide scarps in 2018 for safety reasons.	
Observations:	Description	Worse?
<input checked="" type="checkbox"/> Pavement Distress	Slide 2 has affected a 10 m length of pavement in the EB shoulder, with a 13 m long tension crack observed in the EBDL about 1.2 m from the white line. At Slide 2, a dip exists in the pavement overtop the SWSP. Pavement structure at Slide 2 = 350mm ACP over 300mm GBC.	<input type="checkbox"/>
<input checked="" type="checkbox"/> Slope Movement	The 2 slides were basically unchanged in size this year - however, the slides continue to move downslope taking the previously placed gravel with them, resulting in increased scarp heights and toe roll distances. Also, some cracks observed in the steep, embankment slope immediately above the 900 mm SWSP inlet of Slide 1.	<input checked="" type="checkbox"/>
<input type="checkbox"/> Erosion		<input type="checkbox"/>
<input type="checkbox"/> Seepage		<input type="checkbox"/>
<input checked="" type="checkbox"/> Bridge/Culvert Distress	The inlet of the 900 mm SWSP cross-culvert of Slide 2, which had previously been covered in slide debris, was dug out to partially expose it and allow flow. The SWSP outlet of Slide 2 was below ground and was also dug out to partially expose it.	<input type="checkbox"/>

<input type="checkbox"/> Other		<input type="checkbox"/>
Instrumentation: None		
Assessment: Both landslides appear to be based in high plastic clay. It is postulated that the failures are due to a gradual loss of cohesion due to weathering, combined with high groundwater conditions, which has dropped the resistive forces below what is needed to maintain stability. The slides were relatively unchanged in size this year, however there were some additional movements. The scarp height dropped through the previously placed gravel to 1.8 m (from 1.7 m last year) at Slide 2 and was about the same as last year (1.1 m) at Slide 1. The previously placed gravel overtop of the slide scarp portions is likely adding a surcharge to the top of the slide and causing additional slide body movements. The scarp at slide 2 had enlarged into the edge of the pavement since first observation and was 0.8 m from the white shoulder line. Information from the MCI indicated there used to be a 1.2 m diameter CSP culvert located under the Slide 1 area, which had apparently separated and created a sink hole. This culvert was attempted to be lined, but debris infill prevented success. Subsequently, a bored 900 mm SWSP was installed (located on the east side of the slide). There were a few cracks observed on the steeper sloping ground around the inlet to this new SWSP (a longer inlet would have allowed flatter sloping ground to be formed around the inlet). The 900 mm diameter SWSP culvert at Slide 2 appears to drain south highway ditch runoff, as well as a swale draining from the golf course. Both the inlet and the outlet of the 900 SWSP at Slide 2 had been dug out to partially expose the pipe and allow flow (the inlet had been covered from previous slide debris, and the outlet appears to be too low and was below ground). The landslides will continue to grow in size if not dealt with. In particular, Slide 2 has a 13 m long tension crack located near the center of the EBDL, which suggests that it could retrogress further into the driving lane in the future. The previously blocked Slide 2 inlet with toe debris created a potential for water to pond at the landslide mass and likely accelerated movements.		
Recommendations		
Maintenance: Monitor further movements or enlargement at both slide locations. A barricade and delineators were set up to mark the scarp retrogression into the paved shoulder at Slide 2, but it should be enhanced with warning signage until highway repairs are undertaken. A barricade was also placed at slide 1, but if it encroaches further into the edge of the highway pavement, it should similarly be marked with additional warning signage. Short Term: Spread out the existing gravel that was placed over the slide headscarps more evenly and level with the outside ground to reduce the load on top of the slide. If the cracking around the slopes of the new 900 mm SWSP culvert at Site 1 begin to threaten the integrity of the upstream highway embankment, the existing bevelled end of SWSP could be cut off, an additional length of SWSP with a bevelled end welded onto the cut, and new, flatter slopes constructed with compacted clay around the new inlet. Consideration could also be given to training all of the south highway ditch runoff across the south approach road, so that all of this water is concentrated into one culvert instead of two (effectively eliminating the east culvert). Medium to Long Term: A preliminary engineering assessment was performed by Thurber for repair of these two landslides (File #29186 dated March 23, 2021), and two options were presented for mitigating each of the slides: <ol style="list-style-type: none"> 1) Excavate each slide and rebuild the slope with compacted clay and a toe berm, or 2) Over-excavate each slide and rebuild the slope with granular fill. 		

Details for Options 1): Partially excavate each slide mass (removing the old CSP culvert at Site 1 where required); Stockpile this excavated material on stable ground near the site; Extend the 900 mm dia. SWSP culverts by welding on extensions to daylight at the toe of the new flattened slopes (an elbowed extension is required at the inlet of the Slide 2 site to meet the ditch to the west of the repair area and in line with the swale that drains from the golf course); Install a subdrain at Site 1; Construct a toe berm over the culvert extension to span between the highway embankment sideslope and the backslope; Reconstruct the upper part of the sideslope with additional clay fill to a flattened inclination of about 4.5H:1V; Extra right of way will be needed for these Option 1 slide repairs.

Ballpark Cost \$400,000.

Details for Options 2): Excavate each slide mass and additional clay over a 15 m length extending back to the highway centreline to a level below the highway ditch (removing the old CSP culvert at Site 1 where required); Construct a gravel filled shear key below the highway ditch at Site 2; Install a subdrain at Site 1; Reconstruct the embankment with granular fill (Des. 6 Cl. 80), to inclinations of 4H:1V at Site 1, and to 3H:1V at Site 2, benching the fill into the existing clay; Install a guardrail at Site 2; Extend the 900 mm dia. SWSP culvert at Site 2 by welding an elbowed extension at the inlet of the Slide 2 site to meet the ditch to the west of the repair area and in line with the swale that drains from the golf course; Cap the outer surface of the embankment with clay; Place riprap around the culvert inlet.

Ballpark Cost \$450,000.

Other considerations for both options 1) or 2) which have been included in the above costs where applicable, include: a) Closure of 1 lane of the highway is required at both sites during construction; b) Presence of the Telus cable (that was surveyed and crosses through the work zones of both slide sites) that would need relocation; c) Overhead power lines present near both slide sites - the contractor would need to confirm adequate clearance from these lines for his equipment and obtain permission from the power company; d) Topsoil and seed the final surface of the embankment sideslope (and toe berm); e) Place riprap and construct riprap channels beyond the new culvert extensions; f) Repair the culvert inlet area at Site 1 by flattening the slope with compacted clay fill, and adding riprap; g) Repairing the culvert outlet area at Site 2 by constructing a riprap outlet bowl extending to the fenceline.

Total ballpark cost to fix both landslides at the same time between \$400,000 to \$500,000.

Based on discussions on site AT and Thurber prefer Option 2) for both slides, to avoid obtaining extra right of way. Option 2 for each of the two landslide sites are shown on the plan/section schematic details (Figures D-2 and D-4, attached).

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.

Don Proudfoot, P.Eng.
Principal | Senior Geotechnical Engineer

Barry Meays, 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




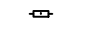




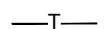


Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, 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.

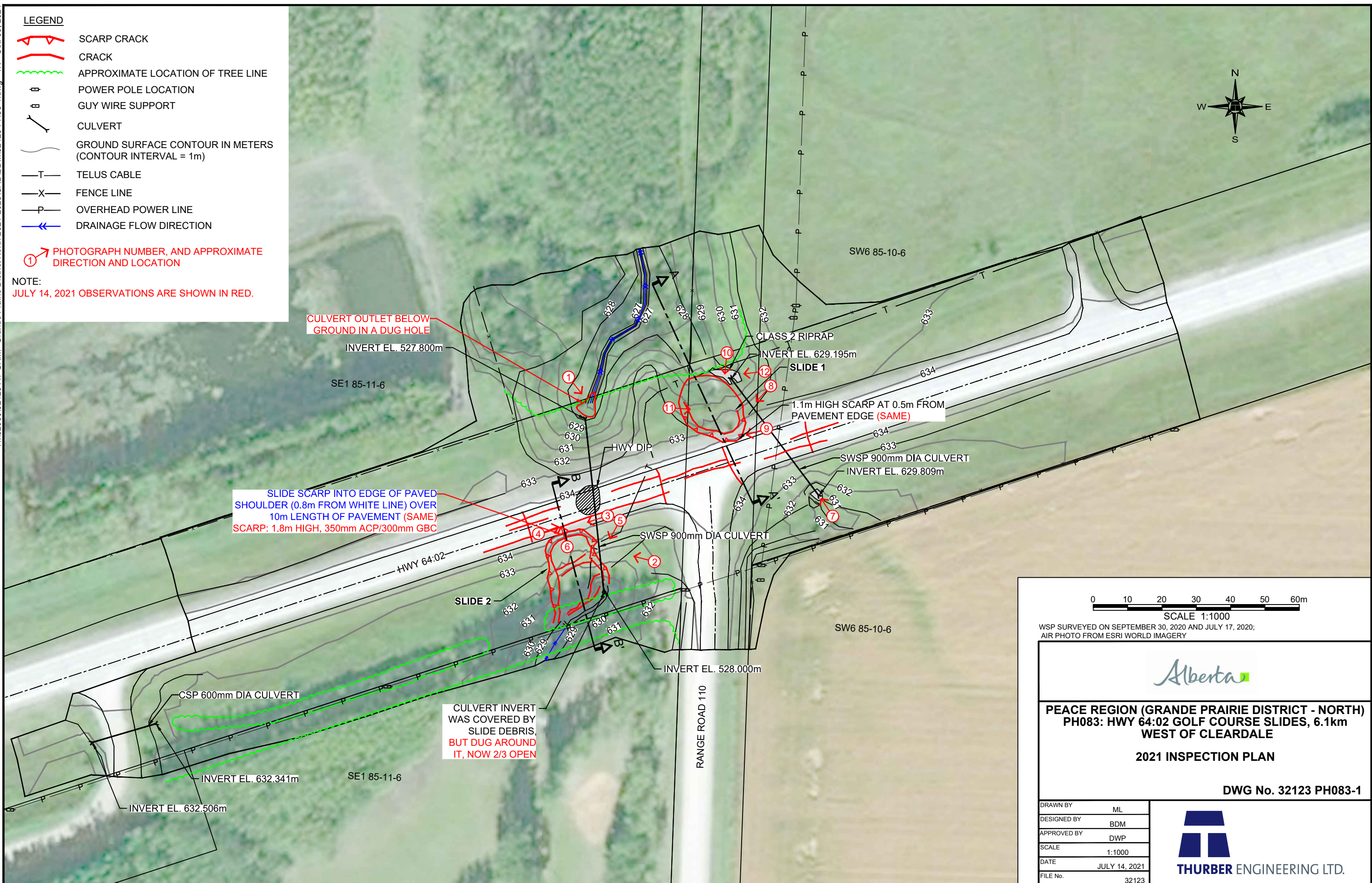
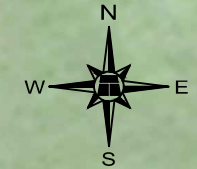
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LEGEND

-  SCARP CRACK
-  CRACK
-  APPROXIMATE LOCATION OF TREE LINE
-  POWER POLE LOCATION
-  GUY WIRE SUPPORT
-  CULVERT
-  GROUND SURFACE CONTOUR IN METERS (CONTOUR INTERVAL = 1m)
-  TELUS CABLE
-  FENCE LINE
-  OVERHEAD POWER LINE
-  DRAINAGE FLOW DIRECTION

 PHOTOGRAPH NUMBER, AND APPROXIMATE DIRECTION AND LOCATION

NOTE:
JULY 14, 2021 OBSERVATIONS ARE SHOWN IN RED.



CULVERT OUTLET BELOW GROUND IN A DUG HOLE
INVERT EL. 527.800m

CLASS 2 RIPRAP
INVERT EL. 629.195m
SLIDE 1

1.1m HIGH SCARP AT 0.5m FROM PAVEMENT EDGE (SAME)

SWSP 900mm DIA CULVERT
INVERT EL. 629.809m

SWSP 900mm DIA CULVERT

SLIDE SCARP INTO EDGE OF PAVED SHOULDER (0.8m FROM WHITE LINE) OVER 10m LENGTH OF PAVEMENT (SAME)
SCARP: 1.8m HIGH, 350mm ACP/300mm GBC

SLIDE 2

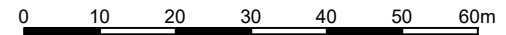
INVERT EL. 528.000m

CSP 600mm DIA CULVERT

INVERT EL. 632.341m

INVERT EL. 632.506m

CULVERT INVERT WAS COVERED BY SLIDE DEBRIS, BUT DUG AROUND IT, NOW 2/3 OPEN



SCALE 1:1000

WSP SURVEYED ON SEPTEMBER 30, 2020 AND JULY 17, 2020;
AIR PHOTO FROM ESRI WORLD IMAGERY



**PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)
PH083: HWY 64:02 GOLF COURSE SLIDES, 6.1km
WEST OF CLEARDALE**

2021 INSPECTION PLAN

DWG No. 32123 PH083-1

DRAWN BY	ML
DESIGNED BY	BDM
APPROVED BY	DWP
SCALE	1:1000
DATE	JULY 14, 2021
FILE No.	32123





Figure D-2: Slide 1 - Option 2

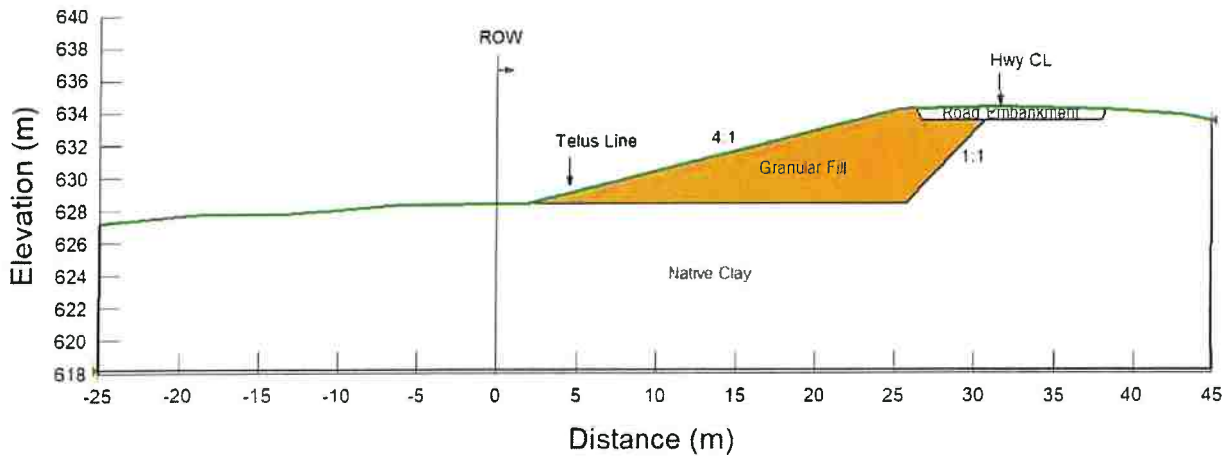
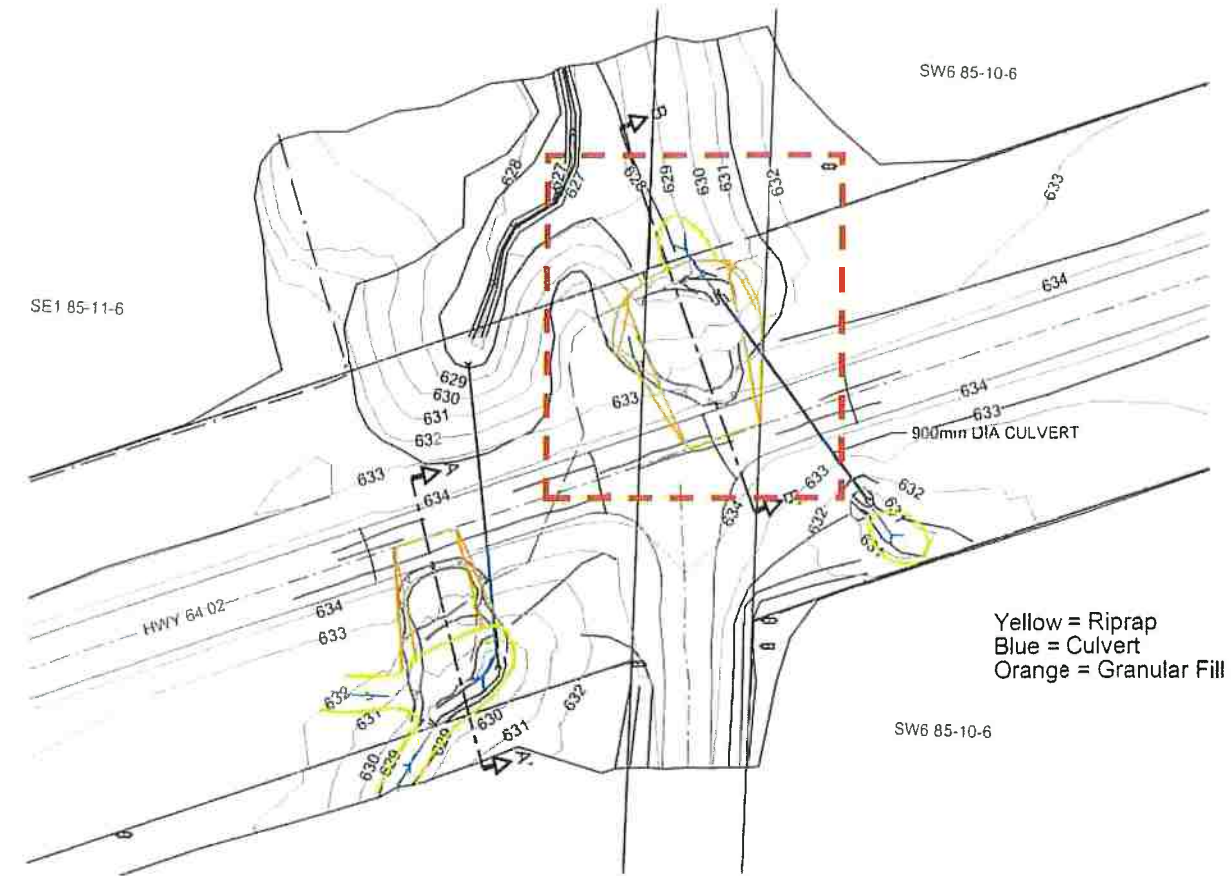




Figure D-4: Slide 2 - Option 2

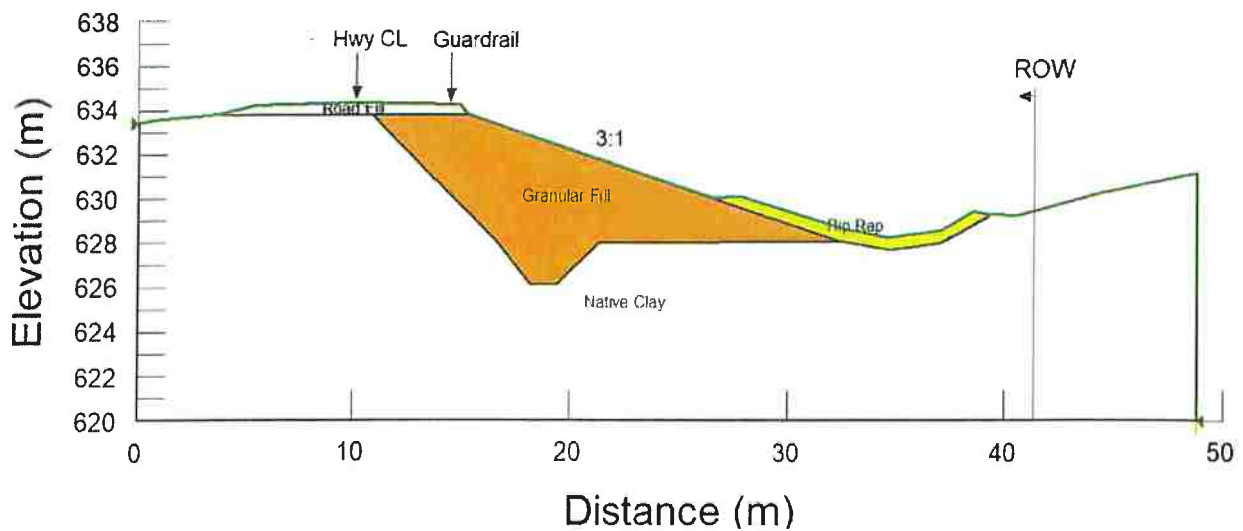
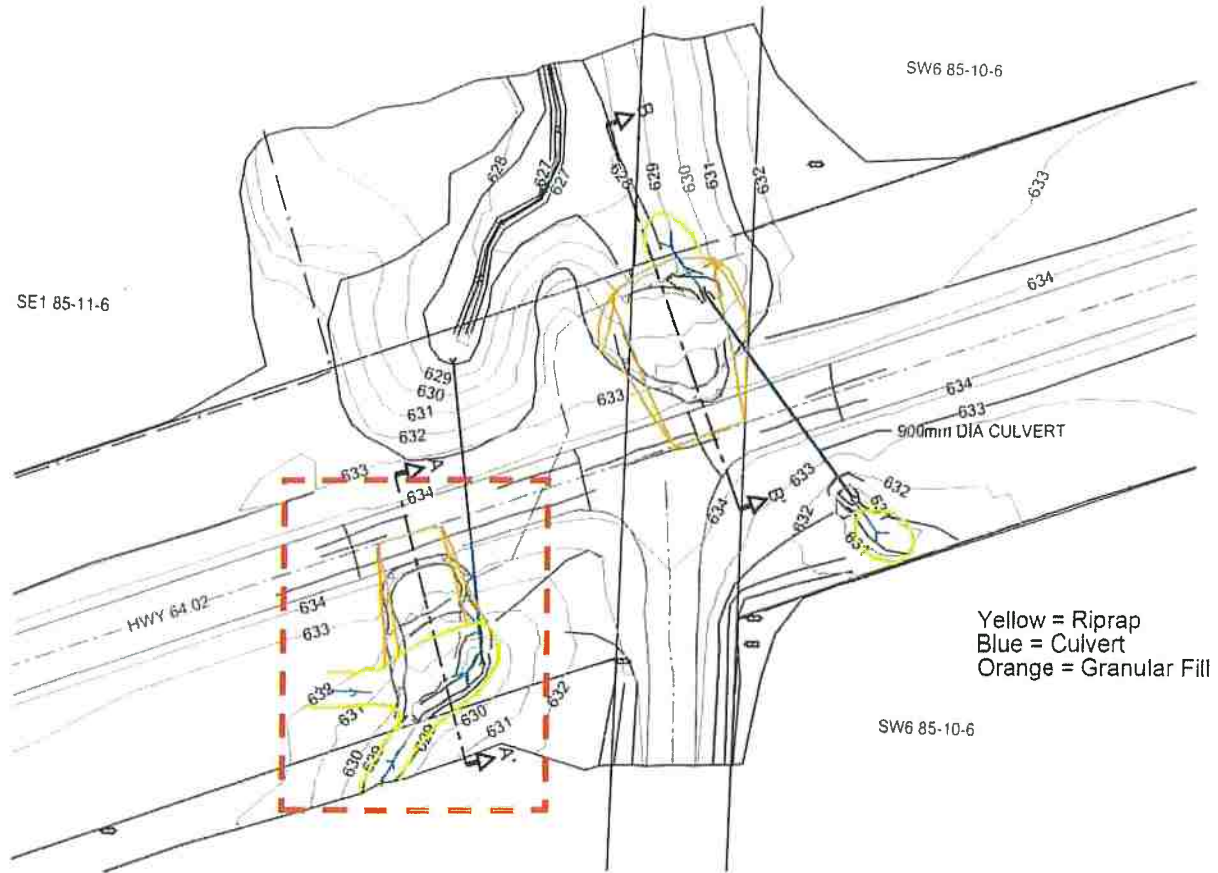




Photo 1 – Looking south at the outlet of the 900 mm diameter SWSP culvert of Slide 2 north of the hwy. The outlet is below ground, and somebody had dug around it to open it up.



Photo 2 – Looking northwest across Slide 2.



Photo 3 – Looking west along the highway embankment and scarp of Slide 2. Note the pitrun gravel that was placed overtop of the slide scarp adjacent to the highway continues to settle and move downslope.



Photo 4 – Looking east along the crack in the highway EB lane OWP adjacent to the Slide 2 scarp.



Photo 5 – Looking west across the culvert inlet area, where Slide 2 debris squeezed around and covered it, before it was excavated and partially opened.



Photo 6 – Looking north at the slide scarp that has bit into the highway shoulder over Slide 2.



Photo 7 – Looking north at the 900 mm culvert inlet area on the opposite (south) side of the highway from Slide 1. A few cracks formed around the steeply sloping embankment surface around the inlet.



Photo 8 – Looking southwest towards the highway across Slide 1.



Photo 9 – Looking west adjacent to the hwy at the Slide 1 slide scarp. Note the dip in the hwy overtop the culvert crossing at Slide 2 (in the background).



Photo 10 – Looking south at the 900 mm dia. SWSP outlet of Slide 1. Note the edge of the slide has moved right up to the edge of the culvert.



Photo 11 – Looking southeast across the Slide 1 body towards the highway.



Photo 12 – Looking northwest at the outlet and downstream erosion gully of Slide 1.