

**ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION –
GRANDE PRAIRIE DISTRICT – NORTH
2023 INSPECTION**



Site Number	Location	Name	Hwy	km
PH037	Dunvegan	Dunvegan South 1+250 to 2+000	2:68	15.674
Legal Description		UTM Co-ordinates		
NW¼ 06-080-04 W6M		11U E 398514	N 6197340	

	Date	PF	CF	Total
Previous Inspection:	May 20, 2022	10	7	70
Current Inspection:	June 2, 2023	10	7	70
Road WAADT:	2,491		Year:	2022
Inspected By:	Rishi Adhikari, TEC Max Shannon, TEC		José Pineda, Thurber	
Report Attachments:	<input checked="" type="checkbox"/> Photographs	<input checked="" type="checkbox"/> Plans	<input checked="" type="checkbox"/> Maintenance Items	

Primary Site Issues:	<p>Flow slides and shallow slumps occur along gullies eroded below the highway where ditch drainage is directed downslope towards Dunvegan Creek at Sta. 2+000.</p> <p>There is a large deep-seated landslide which crosses the highway between Sta. 1+650 and Sta.1+850 (Photos 5, 6, and 7).</p> <p>There are several slides downslope of the SBL shoulder between Sta. 1+350 and 1+650, the largest of these being at Sta. 1+400, with a backscarp that has retrogressed into the highway shoulder (Photos 11, 12, 13, and 14).</p> <p>There are old rotational features further downslope at Sta. 1+860 and at Sta. 1+600 to 1+700, with a sag pond.</p> <p>There are several shallow slumps upslope of the NBL at Sta. 1+455, 1+610, 1+860, 1+900 and 1+985.</p>
Dimensions:	<p>The 1+800 slide is 160 m to 200 m wide at the downslope road shoulder, and the backscarp appears to be along the upslope ditch.</p> <p>The 1+400 slide is 40 wide at the SBL shoulder, with the backscarp crack on the highway shoulder between the guardrail and the white line about 0.3 m from the white line.</p>
Maintenance:	<p>An ACP patch was placed over the dip and ruts in the ACP at the south end of the 1+800 slide in October of 2017 and at the north end of the 1+800 slide in 2019. ACP patch was also placed in the summer of 2020 on the northbound lane at the south flank of the 1+800 landslide.</p>

Observations:	Description	Worsened?
<input checked="" type="checkbox"/> Pavement Distress	Dips across road at 1+690 and 1+820 associated with both ends of slide. Cracks and loss of the edge of the paved road in the shoulder of the pavement at 1+400 landslide	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Slope Movement	Additional slope movement downslope of Sta. 2+000 to 1+900 indicated by cracking at crests of gullies further downslope. Backscarp cracks were noted in the upslope ditch at the Sta. 1+800 landslide. Slight movement in the slide feature below the highway in the sideslopes. The slide at 1+860 has a backscarp that is at 0.8 m from the guardrail (Photo 4). On-going movement in the sliding zone below the highway between Sta. 1+400 to 1+490. The backscarps at this location range between 5 to 7 m high and the slide is impacting the southbound shoulder with cracks at 0.3 m from the white line and eight guardrail posts impacted (four posts are hanging and four posts are partially exposed).	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Erosion	Up to 3.3 m wide by 0.8 m deep erosion gullies in the upslope ditch between 1+350 and 2+000.	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Seepage	Some seepage and tension cracks have been observed below the highway between Sta. 1+540 and 1+600	<input checked="" type="checkbox"/>
<input type="checkbox"/> Bridge/Culvert Distress		<input type="checkbox"/>
<input checked="" type="checkbox"/> Other	Concrete jersey barriers placed along the shoulder white line at the 1+400 slide.	<input type="checkbox"/>
<p>Instrumentation:</p> <p>Fifteen slope inclinometers, 23 piezometers (21 pneumatic and 2 standpipe) were read on 25, 2023.</p> <p>Overall, the slope inclinometers showed an increasing rate of movement compared to the fall of 2022 with readings ranging from -9.7 mm/yr in SI-58 in the backslope at Station 1+600 to 31.7 mm/yr in SI-54 near the 1+500 slide. SI18-6 located on the side slope at the north flank of the 1+800 slide sheared off at a depth of 34.7 m between the Fall 2022 and the current readings. No new zones of movements have been observed since the fall of 2022.</p> <p>Standpipe piezometer SP09-6 showed a water level at 26.6 m below ground surface. SP09-8 continued to be dry. The change in water levels on the pneumatic piezometers from the Fall of 2022 readings ranged from an increase of 0.23 m in PN18-8A to a decrease of 0.04 m in PN18-4.</p>		

Assessment:

Ongoing slide activity was observed at the Sta. 1+400 slide in 2016 right through 2023. Soil below the matting and around the soil nails, installed in 2010, has failed superficially, with more substantial failure extents below the surface treated area. It is anticipated that the rate of retrogression will likely accelerate above the areas where the soil nails have been bent downward due to a combination of confining soil loss and slope movement. The backscarp located at the shoulder of the SBL ranges between 5 to 7 m high. The SI's installed within the footprint of the 1+400 slide had rapid rates of movement in the spring and summer of 2018 (50 to 700 mm/yr.) and sheared off at a depth of 2 m as a result of a mud flow after the fall of 2018.

The 1+800 slide is a deep-seated slide that is currently affecting all three lanes of the highway over a 200 m length with the backscarp likely within the NBL ditch bottom. Based on the ongoing slope inclinometer monitoring, the 1+800 slide plane depth varies within the embankment of the highway from about 18 m near the SBL shoulder to a depth of 28 m below the NBL shoulder with the toe of the landslide is likely situated some 300 m further downslope towards Dunvegan Creek. Rates of movement in the 1+800 slide SI's typically vary from small creep movements to 11 mm/yr. and have accelerated to about 20 mm/yr. in recent years. The 1+800 slide continues to exhibit moderate rates of movement up to 13 mm/yr; however, its footprint currently affects the entire highway embankment whereby a complete closure of the highway could result from a sudden increase in slide activity.

The 1+400 slide is retrogressing rapidly and is impacting the SBL shoulder. When considering the existing smaller slide features to the south, this suggests that the expansion of this slide further to the south should be anticipated.

Thurber provided a preliminary engineering assessment report with three remedial options with ballpark "A" cost estimates to address the features affecting the highway through the site in July of 2018.

Shallow surface movement elsewhere is expected to continue, with the possibility of further shallow surface failures developing. This is likely a function of the soil type at this location and is triggered by rainfall or snowmelt and gradual loss of cohesion in the surface due to weathering.

Erosion and slope movement downslope of the highway near Sta. 2+000 are a function of water flows in the ditch and are expected to worsen.

Recommendations:**Cost****Short Term**

Extend the climbing lane closure with Jersey barriers from the boat launch turn off to approximately Sta. 1+500. Reduce the posted speed to 80 km/hr. Widen the shoulder of the northbound lane and adjust the jersey barriers further into the southbound climbing lane when required to maintain at least 2 lanes of safe traffic.

Maintenance

Continue to monitor visually for signs of activity at both slides and close the outer SBL at the 1+400 slide should tension cracks or dips appear in the roadway surface. Apply small asphalt patches at each end of the 1+800 slide to smooth out the dip when required for traffic safety.

Intermediate Term

Install driven steel pile walls at the Sta. 1+400 landslide location to temporarily maintain the climbing lane until a more permanent repair is implemented.

\$800,000

Long Term

Thurber's preliminary engineering assessment provided three remedial options ranging from a realignment further to the east to completely circumvent the landslide features to maintaining the existing alignment with pile walls built at the 1+400 to 1+800 slides.

\$45 million to \$110 million

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.
Partner | Senior Geotechnical Engineer

José Pineda, 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.

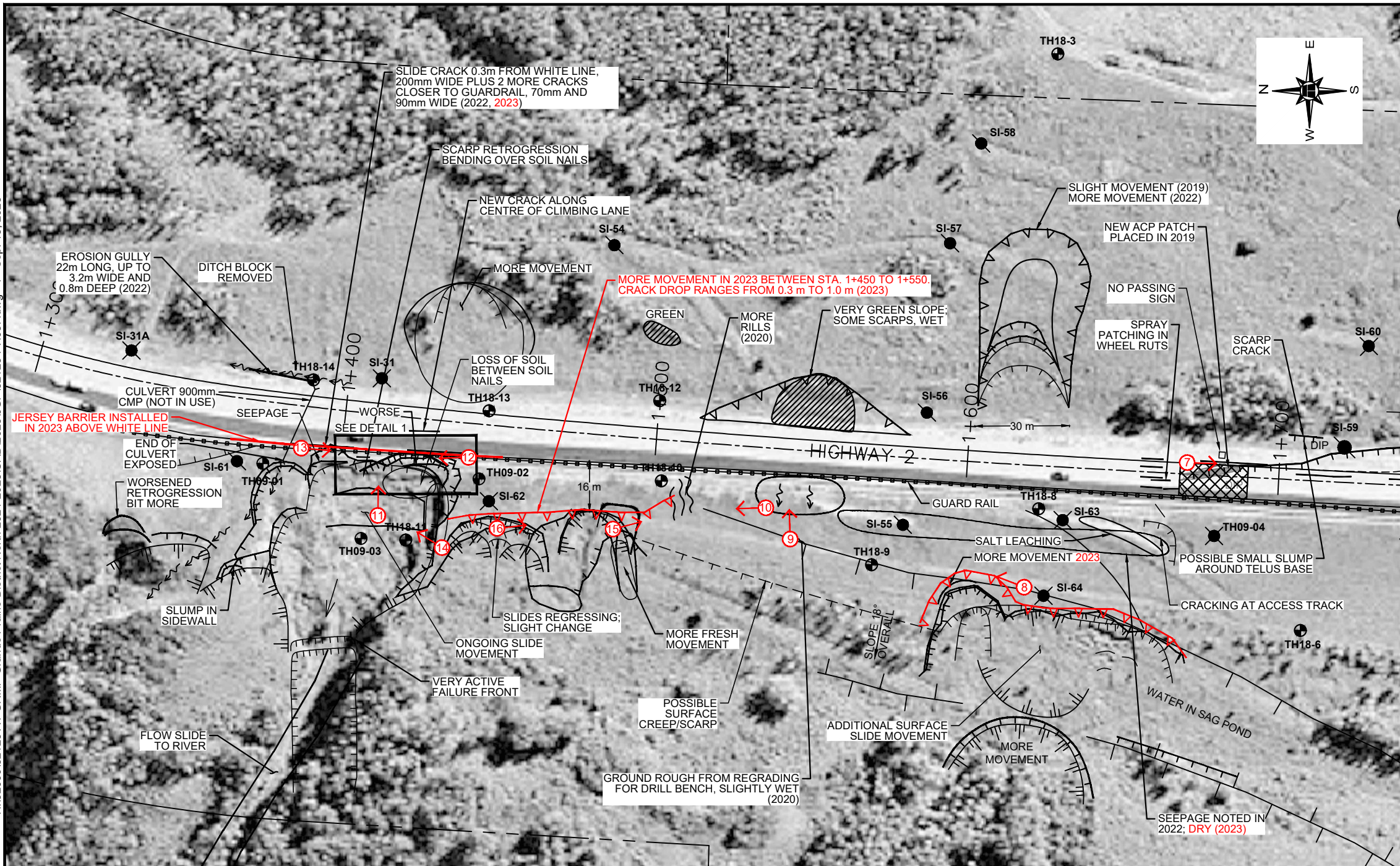
6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

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

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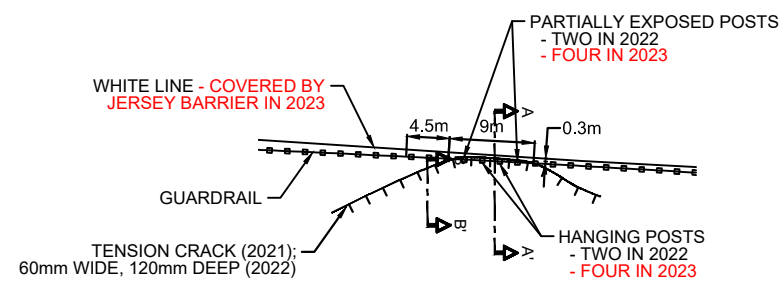
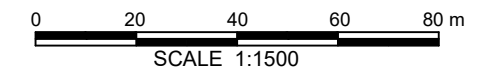


LEGEND

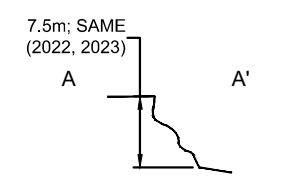
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- SLOPE INDICATOR (INACTIVE/DESTROYED)
- TEST HOLE LOCATION
- SCARP CRACK
- DIRECTION AND NUMBER OF PHOTO

NOTES:

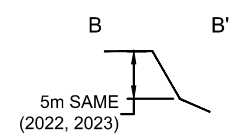
1. LOCATION DATA RECORDED USING HAND HELD GPS RECEIVER. ALL LOCATIONS ARE APPROXIMATE AND ARE FOR ILLUSTRATIVE PURPOSES ONLY.
2. JUNE 2, 2023 OBSERVATIONS SHOWN IN RED



DETAIL 1
SCALE:1:800



CROSS - SECTION A - A'
SCALE:1:800



CROSS - SECTION B - B'
SCALE:1:800



**PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)
PH037 DUNVEGAN SOUTH - 1+250 TO 2+000**

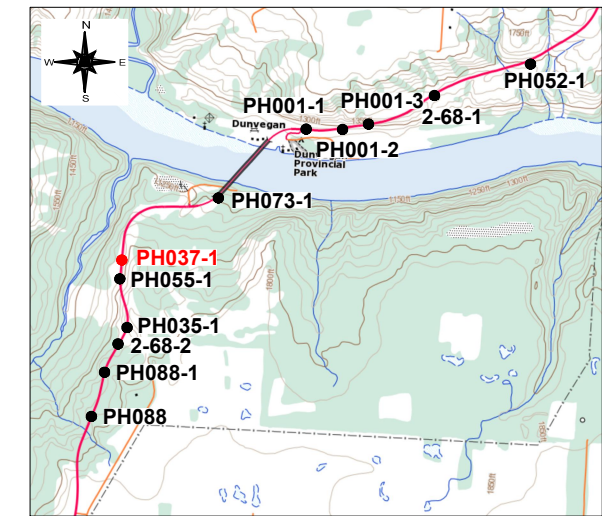
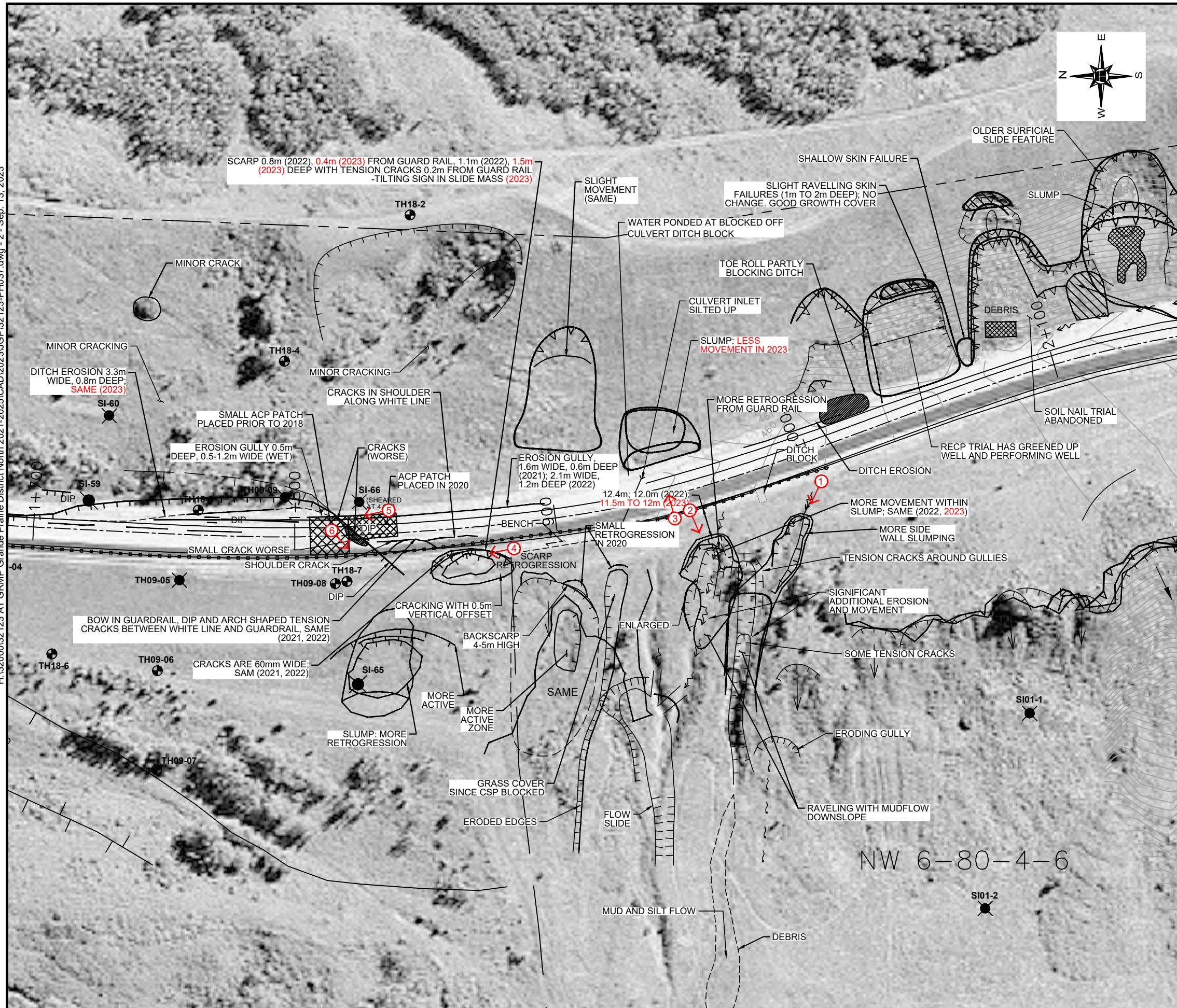
2023 PH037 INSPECTION PLAN

FIGURE 1

DRAWN BY	KLP
DESIGNED BY	JGP
APPROVED BY	DWP
SCALE	1:1500
DATE	SEPTEMBER 2023
FILE No.	32123



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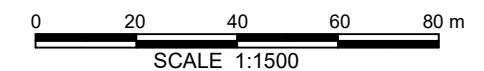
KEY PLAN
SCALE: 1:75 000

LEGEND

- SLOPE INDICATOR
- SLOPE INDICATOR (INACTIVE/DESTROYED)
- TEST HOLE LOCATION
- SCARP CRACK
- DIRECTION AND NUMBER OF PHOTO

NOTES:

1. LOCATION DATA RECORDED USING HAND HELD GPS RECEIVER. ALL LOCATIONS ARE APPROXIMATE AND ARE FOR ILLUSTRATIVE PURPOSES ONLY.
2. JUNE 2, 2023 OBSERVATIONS SHOWN IN RED



**PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)
PH037 DUNVEGAN SOUTH - 1+250 TO 2+000**

2023 PH037 INSPECTION PLAN

FIGURE 2

DRAWN BY	KLP
DESIGNED BY	JGP
APPROVED BY	DWP
SCALE	1:1500
DATE	SEPTEMBER 2023
FILE No.	32123



NW 6-80-4-6



Photo 1: Looking northwest from Sta. 2+000 at erosion gully in SBL ditch south of ditch block



Photo 2: Looking west from Sta. 1+980 below the SBL highway. More movement noted in 2023



Photo 3: Looking east at backslope skin failure at Sta. 1+900 (Less movement since 2022).



Photo 4: Looking north from Sta. 1+890 at the slump in the sideslope of the SBL. More movement since 2022. The scarp is 1.5 m high and 0.4 m from the guardrail.



Photo 5: Looking north from Sta. 1+800 at the erosion gully developed on the ditch up to 5 m wide and 0.8 m deep. Erosion gully wider and deeper than noted at the 2022 inspection.



Photo 6: Looking south across the dip in the highway at the south end of the 1+800 slide.



Photo 7: Looking from the shoulder of the SBL at Sta. 1+670 across the dip in the highway at the north end of the 1+800 slide.



Photo 8: Looking north near Sta. 1+670 at slumping occurring on the highway side slope approximately 20 m from the edge of pavement. More movement noted since 2022



Photo 9: Looking east near Sta. 1+550 at fresh erosion rills and gullies developed on the highway side slope. Erosion became worse in 2023



Photo 10: Looking north near Sta. 1+560 at rough area (drill access bench) with some seepage and tension cracks



Photo 11: Looking east at failed soil matting and nails which were installed in August 2010 at Sta. 1+450 slide.

Backscarp (5 m to 7.5 m high) continues retrogressing and impacting the highway. Four guardrail posts are hanging and other four posts are partially exposed.



Photo 12: Looking north from Sta. 1+450 backscarp. New Jersey Barrier installed in 2023



Photo 13: Looking south from Sta. 1+390 at the backscarp of the 1+400 slide which is impacting the highway shoulder. Slide cracks are wider and closer to the driving lane



Photo 14: Looking north towards the 1+400 slide. The slide has further retrogressed towards the highway, is wider than in 2022 and there is a 5 m to 7.5 m drop below the guardrail.



Photo 15: Looking south at the north end of slumping occurring from Sta. 1+450 to 1+550. Photo showing a drop of about 0.3 m



Photo 16: Looking south at the middle portion of slumping occurring from Sta. 1+450 to 1+550. Photo showing a drop of about 1 m.