

**ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)
2022 INSPECTION**



| Site Number | Location | Name | Hwy | km |
|-------------------|-------------------------|---------------------------|----------|-----|
| PH010 | Eureka River South Hill | Sites 1, 2 and 4 | 726:02 | 9.8 |
| Legal Description | | UTM Co-ordinates (NAD 83) | | |
| NW12/SW13-86-8-W6 | | 11 N 6258319 | E 368453 | |

| | Date | PF | CF | Total |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|--------------|----|-------------|
| Previous Inspection: | July 13, 2021 | 13 | 5 | 65 – Site 2 |
| | | 9 | 4 | 36 – Site 1 |
| Current Inspection: | May 16, 2022 | 13 | 5 | 65 – Site 2 |
| | | 9 | 4 | 36 – Site 1 |
| Road AADT: | 420 | Year: | | 2021 |
| Inspected By: | Barry Meays, Don Proudfoot (Thurber) Ed Szmata, Kristin Tappenden, Max Shannon (AT) | | | |
| Report Attachments: | <input checked="" type="checkbox"/> Photographs <input checked="" type="checkbox"/> Plans <input checked="" type="checkbox"/> Maintenance Items | | | |

| | | |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|
| Primary Site Issue: | Slide scarp (Site 2) crossing highway at 2 locations. Another slide ~16m downslope of highway at Site 1. These 2 slides may be linked by a large slide developing between them (called Site 4). | |
| Dimensions: | Main slide Site 2 about 140 m long by 80 m wide. | |
| Date of any remediation: | | |
| Maintenance: | Semi-continuous milling, patching and crack sealing. | |
| Observations: | Description | Worse? |
| <input checked="" type="checkbox"/> Pavement Distress | Last year's patch covering cracks, tears, differential settlement; and sunken west ditch at Slide 2. Cracks/distortion at Site 4 slowly enlarging. Separation/settlement 4 m long above Site 1. | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> Slope Movement | Slide 2 continues to move at a fast rate, damaging and distorting the pavement (activated by toe sliding at the outside bend of the River). The distortion and cracks in the highway at Site 4 had not changed much this year. A 50m long likely scarp crack with a dip on the east side straddles the center of the highway at Site 4 (between Sites 1/2). Site 1 was unchanged this year. | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> Erosion | West edge of riverbank below Site 2 (severe); Exposed gravel drain outlet formed a slump at Site 1 (significant); East highway embankment below AC curb breach (moderate-significant); West ditch opposite Slide 1 (slight). | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> Seepage | From a crack in the pavement at Site 2, and from the exposed gravel drain at Site 1. The 10m long subgrade failure observed in 2014 in the SB Lane just north of Site 2 was patched in 2015. | <input type="checkbox"/> |
| <input type="checkbox"/> Bridge/Culvert Distress | | <input type="checkbox"/> |
| <input checked="" type="checkbox"/> Other | Backslope slumps on west cut slope south of Slide 2. | <input type="checkbox"/> |
| Instrumentation: | | |
| Last read July 16, 2021. SI08-4: Damaged in 2020 (was reading 8 mm/yr at 9m depth); SI98-1: Destroyed in 2014 (Prev. Move. Zone at 14m depth, at a slow rate of <2mm/yr but SI not deep enough); SI98-2 Sheared off at 3 m depth in 2010 (was reading ~40 mm/yr); SI02-1 Sheared off at 17m depth (checked/correct) in 2003 (was reading about 60 mm/yr); SI02-2: Sheared off at 10m depth in 2003 | | |

(was reading about 70 mm/yr); SI02-3: Damaged in 2011 (was reading 9 mm/yr at 10m depth). The water levels in the piezometers were: PN08-4 at 11.5m BGS [damaged in 2021]; PN02-1 at 4m BGS [damaged in 2003]; PN02-1A at 15m BGS [damaged in 2003]; PN02-2 at 14.4m BGS [damaged in 2011].

Assessment (Refer to Figures):

The landslides at the PH010 site were triggered by river erosion along the base of a river valley slope that has been subject to historic landslide movement. The slide movements are occurring in high plastic clay deposits. The landslide at Site 2 is more extensive and mobile than at Site 1, extending all the way up to and through the highway embankment. To date the movements at Site 2 have been dealt with by milling the pavement at the flanks of the slide and adding asphalt patches and small earth fills to smooth out dips in the road surface and the adjacent ditch. However, the additional weight of these fills and the ongoing river erosion at the toe of the slope keeps the landslide in motion. The movement at Site 1 has been slower and so far, the landslide has not retrogressed into the highway at that location.

Inclinometer SI08-4 located between Sites 1 and 2 at Site 4 (damaged prior to 2020 readings) was indicating ongoing movements (latest ~8 mm/yr) at 7 to 9 m depth. Patching of the dip and cracks on the pavement in 2015, a more defined slide crack about 50 m long with a dip on the east side of it was observed in 2016, and visual observations indicating general crack widening, distortion, and on-going sealing in the last few years, suggests a larger slide is developing and moving towards the river. Based on the SI08-4 rate plot, the average rates of movement before and after the fall of 2016, were about 3 mm/year and 6 mm/year respectively, which suggests a slowly accelerating rate of movement from 2016 to 2020.

Recommendations:

Maintenance

Repair the AC curb that was breached along the east edge of the highway above Slide Site 1 to prevent channelized surface runoff. Repair the erosion rilling that formed below the breach on the highway embankment sideslope, and which now fully extends across the paved northbound shoulder, using compacted crushed gravel (and new ACP on the shoulder).

Replace the damaged lid to the 800 mm drop manhole in the edge of the pavement (that leads to the half culvert).

Continue to patch and mill the highway at Sites 2 and 4 as required.

Short Term

Periodically re-grade the slope below Site 2 to seal the cracks and provide a smoother, more uniform slope from the broken, uneven, and crack infested slope that currently exists.

Ball Park Cost \$50,000

A geotechnical investigation and preliminary design were completed by Thurber at the Site 2 slide (dated Nov 21, 2019) as part of Paving Contract #20531 to assess the asphalt thickness through the middle of this dip. AT selected the following repair option, for which a detailed design and tender input were performed by Thurber for McIntosh Perry as part of Contract 21542 (slated for construction in 2023):

- Excavate the highway to a 3.5 m depth across the dip to remove a 2m thickness of exist ACP and some underlying subgrade. Replace these excavated materials with 2m of Lightweight Fill + 1m Clay + 0.5m new pavement structure. This would smoothen out the slide area and reduce some driving weight by removal of the existing ACP. The drainage will also be improved to eliminate intermittent water ponding in the west ditch by the addition of a small amount of fill as required during final grading.

It was indicated to AT that this repair option only improves the factor of safety for this Site 2 slide by an additional 3 percent from existing conditions (due to the relative length of this slide). The landslide will still likely creep, but patching could be performed more easily afterwards.

C-Estimate Cost of \$500,000 (Excl. engineering and contingencies).

Long Term

Thurber performed a preliminary geotechnical investigation and design (see Report dated July 17, 2009), which outlined various remediation alternatives/costs consisting of three major highway re-alignment options (two of which utilize the existing crossing), a minor highway re-alignment, or constructing pile walls at each site individually. TRANS is considering which alternative to pursue in respect of costs and future planning (a functional planning study was completed by Morrison Hershfield Ltd. in 2012, which recommended Option #1B be adopted – i.e., a Major Re-alignment that utilizes the existing crossing and is perpendicular to the river and raises the crossing grade elevation but passes through the farmyard). Separate recommendations for armouring the river along the downstream toe of Slide Sites 1 and 2 for the minor re-alignment, for only armouring Slide Site 1 for two of the major hwy re-alignments, and individual site repair options, were also provided.

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

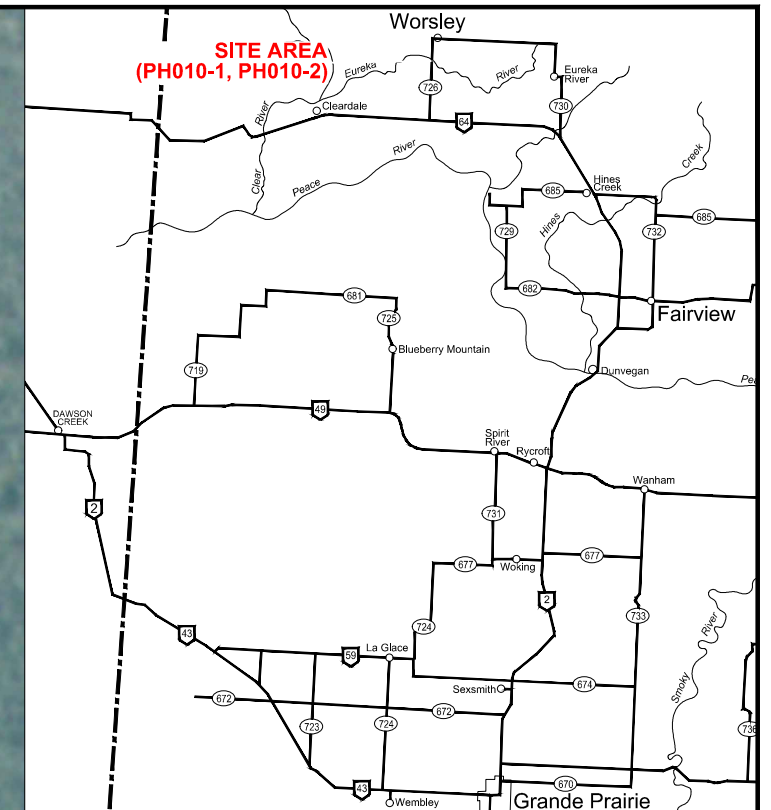
- a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification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



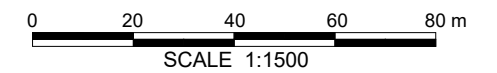
KEY MAP - SCALE 1:1,500,000

NOTES

1. LOCATIONS OF TEST HOLES SI02-1 & SI02-2 ARE APPROXIMATE.
2. SLIDE FEATURES RECORDED USING A HAND HELD GPS.

LEGEND

- MOVEMENT VECTOR (SCALE 1:2,500,000)
- APPROXIMATE LOCATION OF TEST HOLE WITH SLOPE INCLINOMETER
- DEPTH BELOW GROUND SURFACE OF SHEAR ZONE IN SLOPE INCLINOMETER (7-9m)



**PEACE REGION (PEACE RIVER/HIGH LEVEL)
PH010 HWY 726:02 SOUTH OF WORSELY,
SITES #1, #2 & #4**

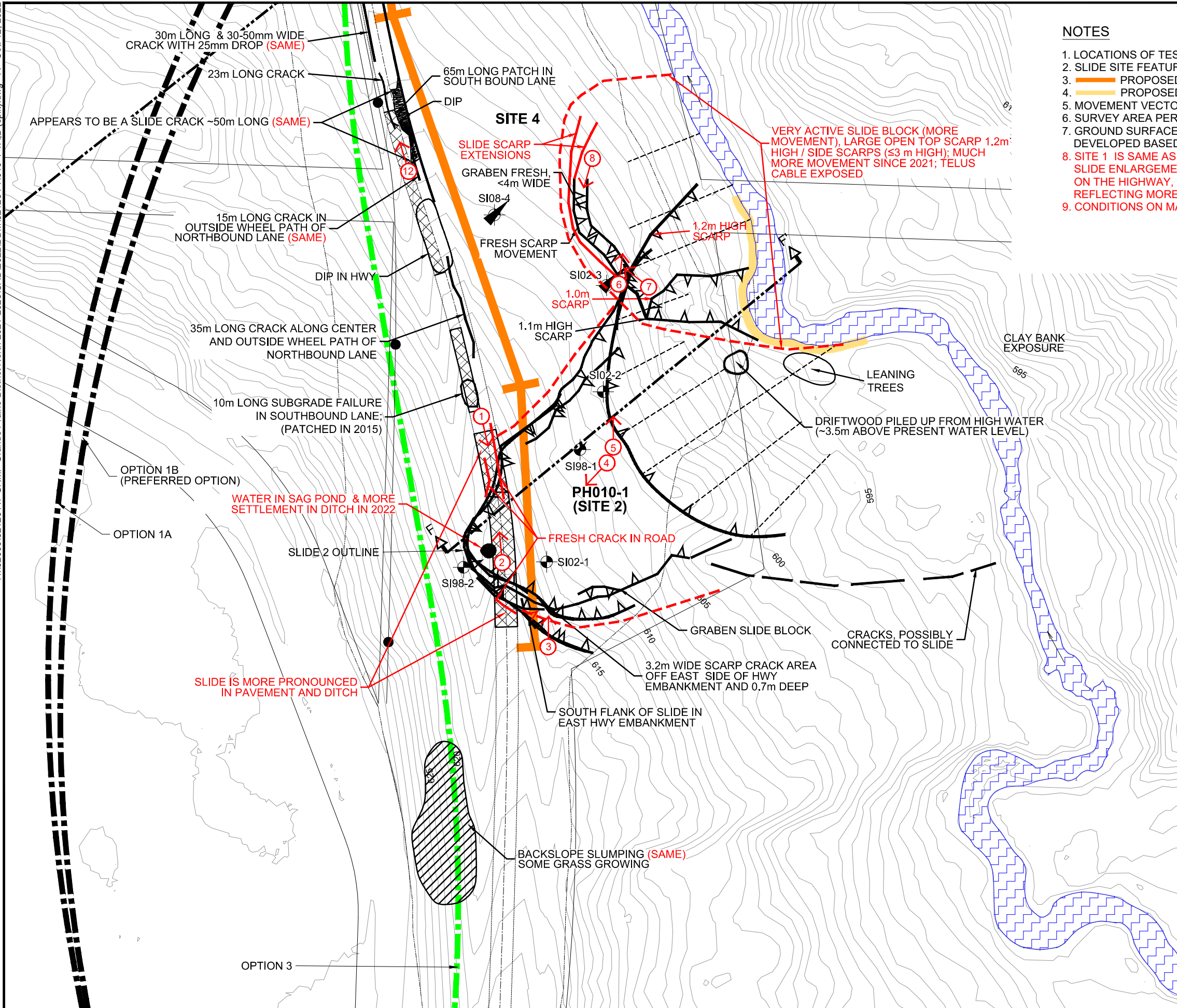
2022 PH010 INSPECTION PLAN

DWG No. 32123-PH010

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| DRAWN BY | KLP |
| DESIGNED BY | BDM |
| APPROVED BY | DWP |
| SCALE | 1:1500 |
| DATE | MAY 16, 2022 |
| FILE No. | 32123 |

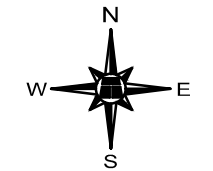


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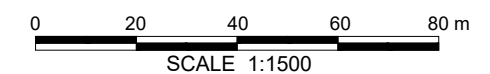
NOTES


1. LOCATIONS OF TEST HOLES SI02-1 & SI02-2 WERE APPROXIMATED ONLY.
2. SLIDE SITE FEATURES RECORDED USING A HAND HELD GPS.
3. PROPOSED PILE WALL LOCATIONS.
4. PROPOSED RIP RAP ARMOUR.
5. MOVEMENT VECTORS 1:3,000 mm/yr.
6. SURVEY AREA PERFORMED BY MCINTOSH PERRY (MP) IN AUGUST 2019.
7. GROUND SURFACE CONDITIONS OUTSIDE MP'S AUGUST 2019 SURVEY WERE DEVELOPED BASED ON 2007 LIDAR DATA.
8. SITE 1 IS SAME AS LAST YEAR. SUBSTANTIALLY MORE CHANGE IN MOVEMENT AND SLIDE ENLARGEMENT AT SITE 2 CLOSER TO RIVER WITH MORE CRACKING / SLUMPING. ON THE HIGHWAY, THE CRACK PATTERNS ARE THE SAME, BUT SOME ARE A BIT WIDER REFLECTING MORE MOVEMENT.
9. CONDITIONS ON MAY 16, 2022 SHOWN IN RED.



LEGEND

- TEST HOLE LOCATIONS
- CRACKS
- SLIDE SCARP / CRACK
- PHOTO AND DIRECTION
- PONDED WATER
- OVERHEAD POWER LINE
- DRAINAGE
- MOVEMENT VECTOR
- HIGHWAY PATCH






**PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)
PH010-1 HWY 726:02 SOUTH OF WORSLEY,
SITES #1, #2 & #4**

2022 PH010-1 INSPECTION PLAN

DWG No. 32123-PH010-1-1A

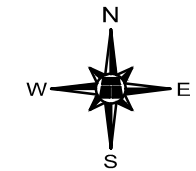
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| DESIGNED BY | BDM |
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| DATE | MAY 16, 2022 |
| FILE No. | 32123 |



THURBER ENGINEERING LTD.

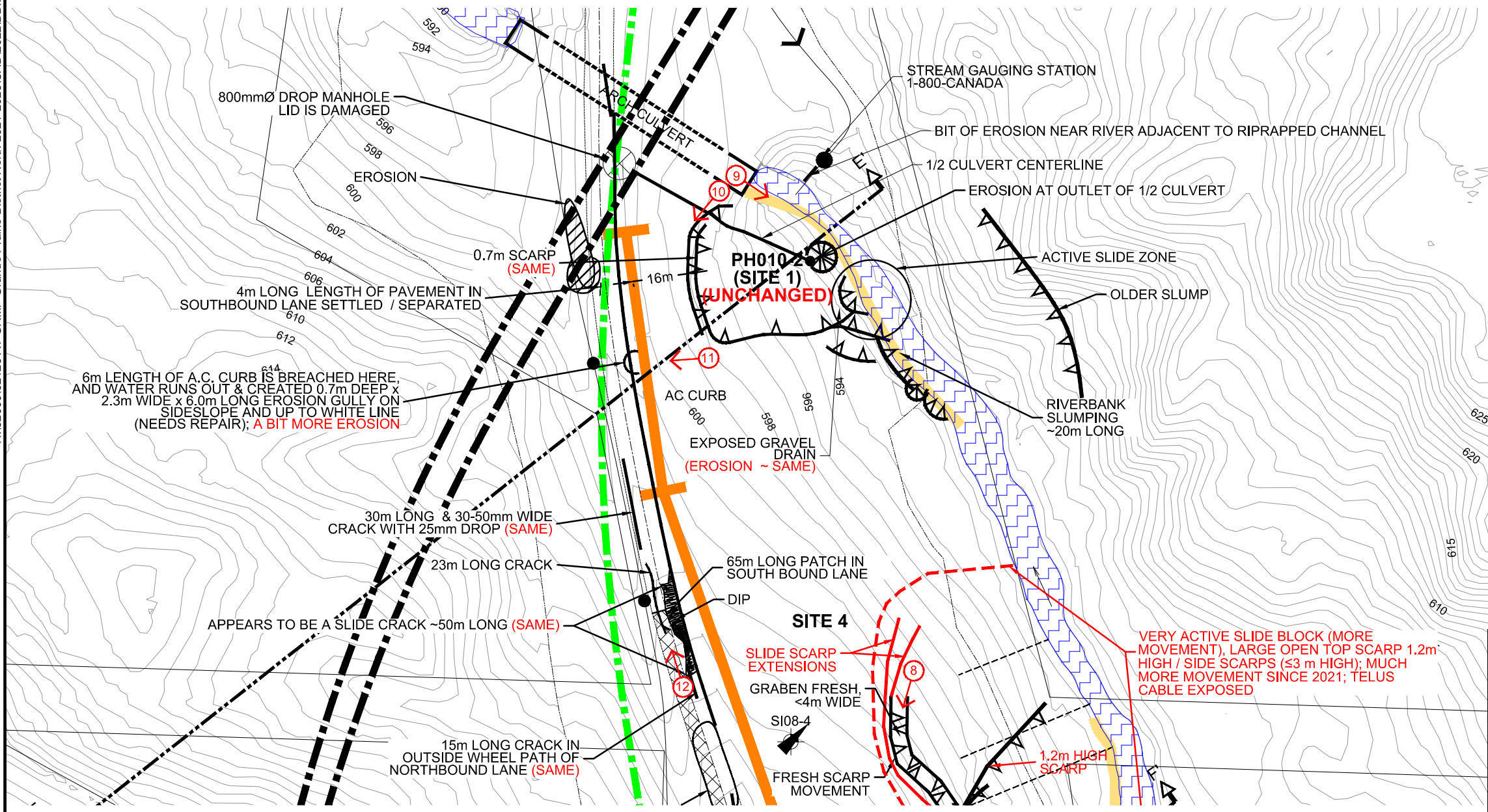
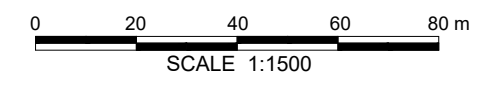
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9. CONDITIONS ON MAY 16, 2022 SHOWN IN RED.



LEGEND

- TEST HOLE LOCATIONS
- CRACKS
- SLIDE SCARP / CRACK
- PHOTO AND DIRECTION
- PONDED WATER
- OVERHEAD POWER LINE
- DRAINAGE
- MOVEMENT VECTOR
- HIGHWAY PATCH



Alberta

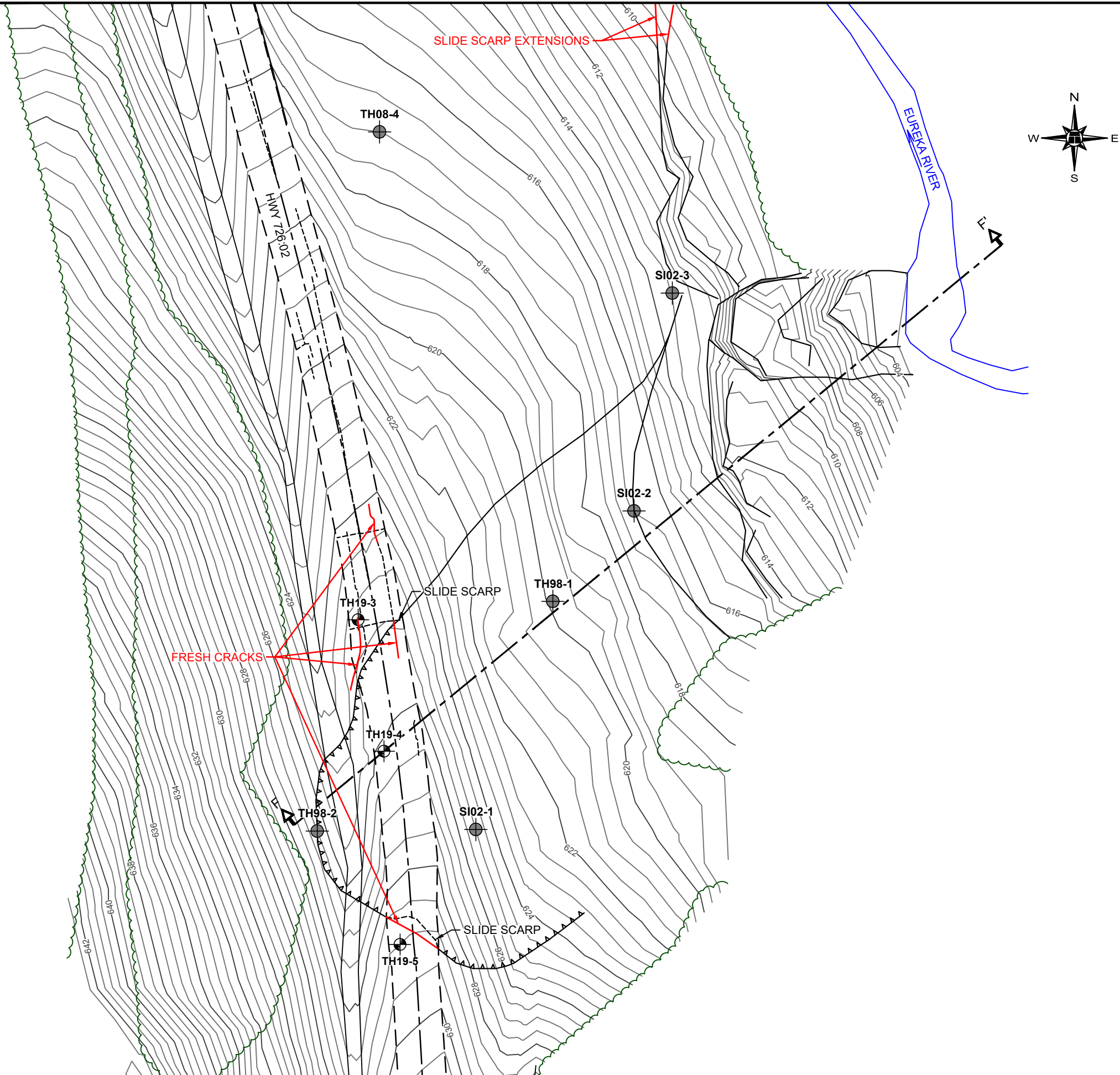
PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)
PH010-1 HWY 726:02 SOUTH OF WORSLEY,
SITES #1, #2 & #4

2022 PH010-1 INSPECTION PLAN

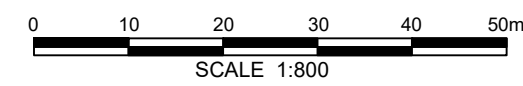
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| DESIGNED BY | BDM |
| APPROVED BY | DWP |
| SCALE | 1:1500 |
| DATE | MAY 16, 2022 |
| FILE No. | 32123 |


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- LEGEND**
- APPROXIMATE 2019 TEST HOLE LOCATION
 - APPROXIMATE PREVIOUS TEST HOLE LOCATION
 - SLOPE INCLINOMETER
 - CONTOUR LINE (0.5m INTERVAL)
 - TREE LINE
 - CRACK IN PAVEMENT
 - LANDSLIDE TENSION CRACK
 - BACKSCARP OF LANDSLIDE BASED ON THURBER'S PREVIOUS GEOHAZARD INSPECTIONS
 - FRESH CRACKS DURING MAY 16, 2022 SITE INSPECTION



PLAN BASED ON MCINTOSH PERRY'S AUGUST 2019 TOPOGRAPHIC SURVEY




**PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)
PH010-1 HWY 726:02 SOUTH OF WORSLEY,
SITES #1, #2 & #4**

**DETAILED SITE PLAN OF SITE 2
(PH010)**

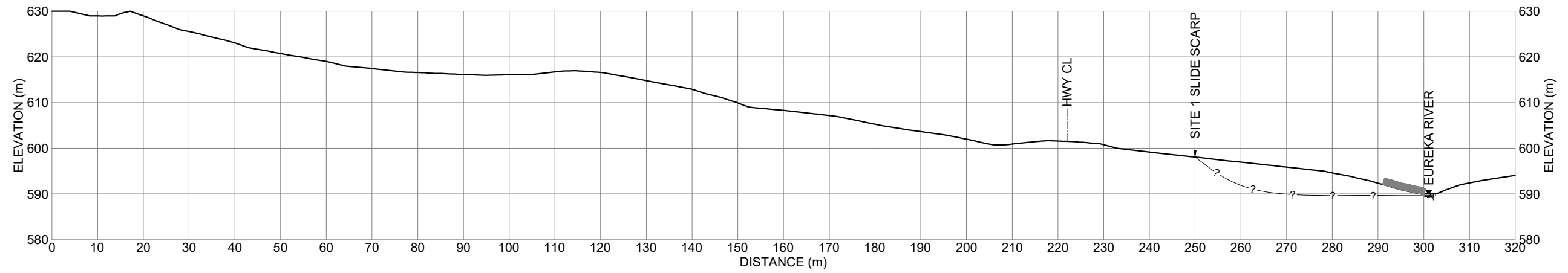
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| FILE No. | 32123 |

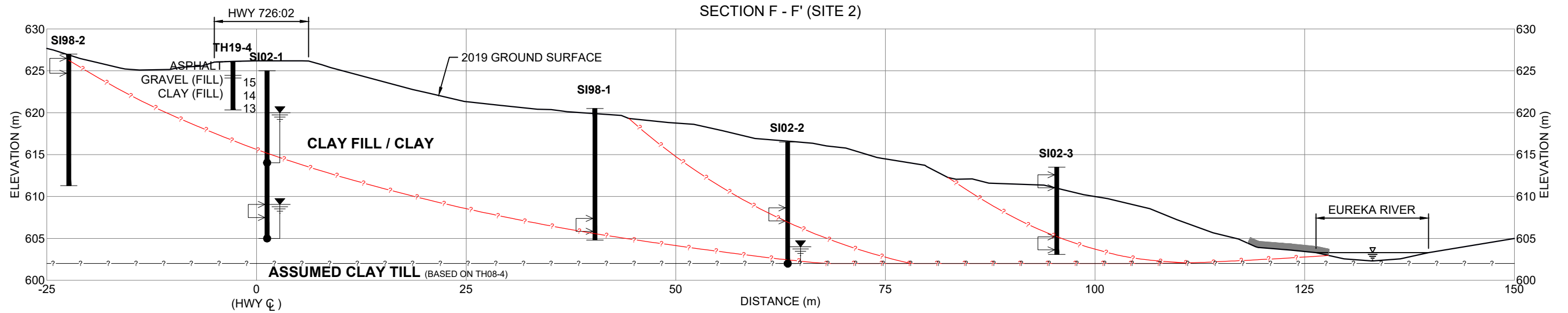


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SECTION E - E' (SITE 1)



SECTION F - F' (SITE 2)



LEGEND

- SPT N VALUE
- HISTORIC GROUNDWATER LEVEL IN PIEZOMETER
- PNEUMATIC PIEZOMETER TIP LOCATION
- ASSUMED MOVEMENT ZONE
- HISTORIC INCLINOMETER MOVEMENTS
- PROPOSED RIPRAP ARMOUR
- INFERRED SLIDE SURFACE

NOTES

1. DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT THE TEST HOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN TEST HOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.
2. CROSS SECTION E - E' IS BASED ON OCTOBER 2007 LIDAR INFORMATION.
3. CROSS SECTION F - F' IS BASED ON MCINTOSH PERRY'S AUGUST 2019 SURVEY (=12.5m HIGHER THAN 2007 LIDAR).
4. OLD ELEVATIONS IN CROSS - SECTION F - F' WERE CORRELATED TO MCINTOSH PERRY'S SURVEY GRID (WHERE APPLICABLE).



**PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)
PH010-1 HWY 726:02 SOUTH OF WORSELY,
SITES #1, #2 & #4**

CROSS-SECTIONS E-E' & F-F'

DWG No. 32123-PH010-1-3

| | |
|-------------|--------------|
| DRAWN BY | KLP |
| DESIGNED BY | BDM |
| APPROVED BY | DWP |
| SCALE | 1:1000 |
| DATE | MAY 16, 2022 |
| FILE No. | 32123 |





Photo 1 – Looking south at the slide scarp crossing the highway at Site 2. Note the dip in the highway, and the extended slide crack reflecting through the patch along edge of the NB driving lane.



Photo 2 – Looking north from the Slide Site 2 at the fresh milled/patched pavement. Note the fresh, well-defined reflective north end scarp crack extending across the SB driving lane/shoulder.



Photo 3 – Looking north across the south end of slide Site 2 and the slide scarp extension along the east highway embankment.



Photo 4 – Looking southwest towards the highway at the main body of the slide scarp at Site 2 where it crosses the hwy.



Photo 5 – Looking north along the east highway embankment from the south end of Slide Site 2.



Photo 6 – Looking southeast at the outside bend of the river, which is causing the most active slumping area at Site 2.



Photo 7 – Looking northwest along the fresh extended slide scarp/crack of Site 2, from just north of the most active portion of the slide.



Photo 8 – Looking south along the north end of the slide scarp between Sites 2 and 4.



Photo 9 - Looking south along the River at the toe of Slide Site 1. Note in the background the piping erosion from the eroded gravel drain that has developed into a slump at the river toe.



Photo 10 - Looking southwest across the Site 1 Slide from northeast of the river (Site 4 is on the left-hand side). Note the grassed over slide scarp parallel to the highway.



Photo 11 – Looking west towards the highway near the north end of Slide Site 1 where the AC curb has been breached, and runoff is causing erosion on the highway embankment and the edge of the pavement.



Photo 12 – Looking north from Site 4 at the cracking/distortion along the highway towards the Site 1 slide.