

**ALBERTA TRANSPORTATION AND
ECONOMIC CORRIDORS
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)
2024 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: | June 1, 2023 | 13 9 | 5 4 | 65 – Site 2 36 – Site 1 |
| Current Inspection: | May 8, 2024 | 7 13 9 | 5 3 4 | 35 – Sites 2, 4 at Hwy 39 – Sites 2, 4 D/S of Hwy. 36 – Site 1 |
| Road AADT: | 460 | | Year: | 2023 |
| Inspected By: | Nicole Wilder, Don Proudfoot (Thurber) Rocky Wang, Robert Senior (TEC) | | | |
| Report Attachments: | <input checked="" type="checkbox"/> Photographs <input checked="" type="checkbox"/> Plans <input checked="" type="checkbox"/> Maintenance Items | | | |

| | | |
|---|---|-------------------------------------|
| Primary Site Issue: | Site 2 had a slide scarp that was crossing the highway at 2 locations. There is another slide closer to the arch culvert ~16m downslope of the highway named 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: | In 2023 at the Site 2 slide, the highway embankment was excavated, a subdrain was installed and the highway embankment was rebuilt with lightweight geofoam fill and re-surfaced with pavement, in conjunction with a Highway 726 overlay, to reduce the driving forces acting at the top of the large landslide block. | |
| Maintenance: | Semi-continuous milling, patching and crack sealing prior to the repairs noted above | |
| Observations: | Description | Worse? |
| <input checked="" type="checkbox"/> Pavement Design | After resurfacing a segment that included geogrid placement, in conjunction with the 2023 Hwy 726 overlay, the pavement is in excellent condition with no visible signs of distress. | <input type="checkbox"/> |
| <input checked="" type="checkbox"/> Slope Movement | Slide 2 continues to move at a fast rate further downslope of the highway activated by river erosion at the outside bend of the River. The highway pavement at Site 4 (between Sites 1/2) was good due to the 2023 overlay. Site 1 was unchanged this year. | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> Erosion | West edge of riverbank below Site 2 (severe); Vehicle track ruts and erosion gully alongside new TRM placement on west side of hwy at Site 2 (moderate); Exposed gravel drain outlet formed a slump at Site 1 (moderate); West ditch opposite Slide 1 (slight). | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> Seepage | From the subdrain outlet at Site 2, from the backslope west of the hwy at Site 4, and from the exposed gravel drain at Site 1. | <input type="checkbox"/> |
| <input type="checkbox"/> Bridge/Culvert | | <input type="checkbox"/> |
| <input checked="" type="checkbox"/> Other | Backslope slumps on west cut slope south of Slide 2. | <input checked="" type="checkbox"/> |

Instrumentation:

Last read July 16, 2021 (No Instruments Remaining). 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 extensive and very active, extending all the way up to and through the highway embankment. Prior to 2023 the movements at Site 2 have been dealt with by milling the pavement at the flanks of the slide and adding asphalt patches in the road surface and small earth fills to smooth out dips in the adjacent ditch. However, the additional weight of these fills and the ongoing river erosion at the toe of the slope kept the landslide in motion. In 2023 Hwy 726:02 was overlaid through the Eureka River valley, and as part of this Paving Contract #21542 that was managed by McIntosh Perry Inc., TEC approved modest improvements to the Site 2 slide as was originally outlined in a geotechnical investigation and preliminary design completed by Thurber (dated Nov 21, 2019) consisting of: Excavation/removal to 4 m depth of the existing damaged 2m thickness of existing ACP/GBC and clay subgrade; Installation of a subdrain system draining towards the east; Re-construction of the hwy embankment with 3 layers of Geofoam lightweight fill blocks surrounded by sand then covered with 0.8 m of compacted clay; Installation of a new 0.52 m thick pavement structure reinforced with geogrid; Covering with the ACP overlay; and then completed with Topsoil Replacement, Seeding, and Soil Coverings. It should be noted that these improvements as discussed with TEC were intended to only slightly improve existing conditions by a Factor of Safety (FOS) of about 3% (due to the relative length of the landslide) by reducing some driving weight by removal of the existing ACP, and did not provide the customary minimum FOS of 1.3 requirement through this landslide area. The landslide will still likely creep, but patching could be performed more easily afterwards.

Although there was active slide block movement further down the valley slope closer to the river, there were no signs of distress in the new pavement surface at the time of the inspection. On this basis the risk level has been reduced for the location at the pavement surface but will need to reassessed next year.

The movement at Site 1 has been slower and so far, the landslide has not retrogressed into the highway at that location. The 800 mm drop manhole, AC curb, and half culvert at Site 1 were removed as part of the above referenced paving contract, and replaced with a subdrain running alongside the east edge of the pavement that drains into a catch basin which in turn was connected to a 300 mm diameter SWSP that outlets at the river.

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 past visual observations indicating general crack widening, distortion, and on-going sealing in the last few years, suggested a larger slide is developing and moving towards the river. However, there were no signs of distress in the new pavement overlay at Site 1 or 4 at the time of our spring 2024 inspection.

Recommendations:**Maintenance**

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

The silt fence installed along the outside boundary of the Site 2 repair under the last years aforementioned contract, should either be keyed in the ground surface or removed (perhaps as part of the contract warranty work). Similarly, the vehicle track ruts in the west ditch of Site 2 should be graded and the damaged ditch barriers replaced.

At Site 2, one additional roll (30 m length) of TRM and ditch barriers should be extended northwards along the west ditch to protect it from erosion. Also, the TRM and ditch barriers along the north ditch should be extended a bit further up the west backslope, as bare soil and some erosion from recent surface flow was observed.

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 cracked slope that currently exists.

Ball Park Cost \$30,000

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. TEC 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

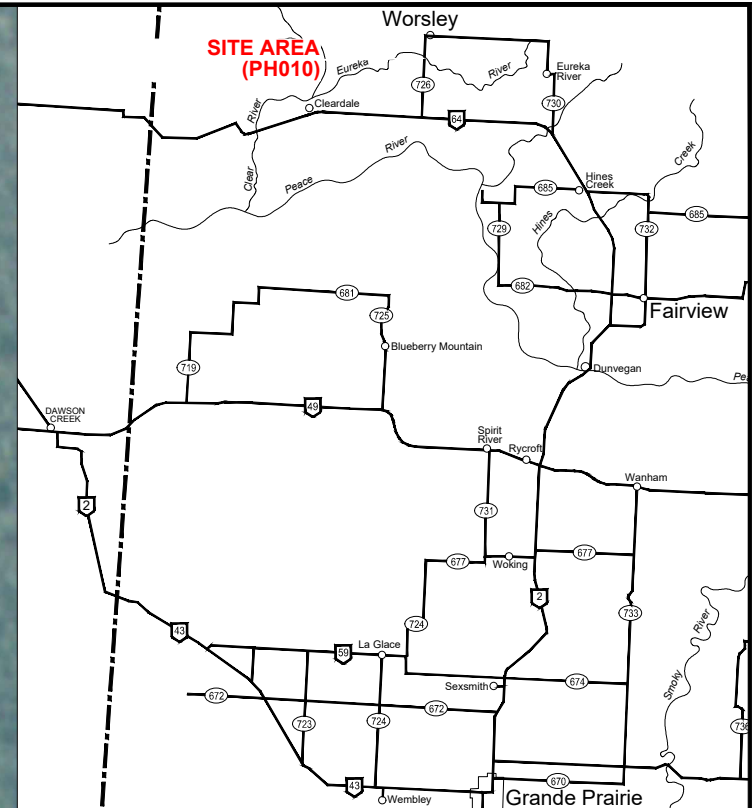
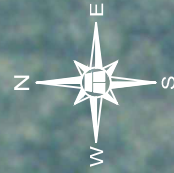
- a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification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



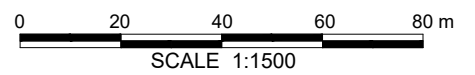
KEY MAP - SCALE 1:1,500,000

NOTES

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

LEGEND

- MOVEMENT DIRECTION
- APPROXIMATE LOCATION OF TEST HOLE WITH SLOPE INCLINOMETER
- DEPTH BELOW GROUND SURFACE OF SHEAR ZONE IN SLOPE INCLINOMETER (7-9m)

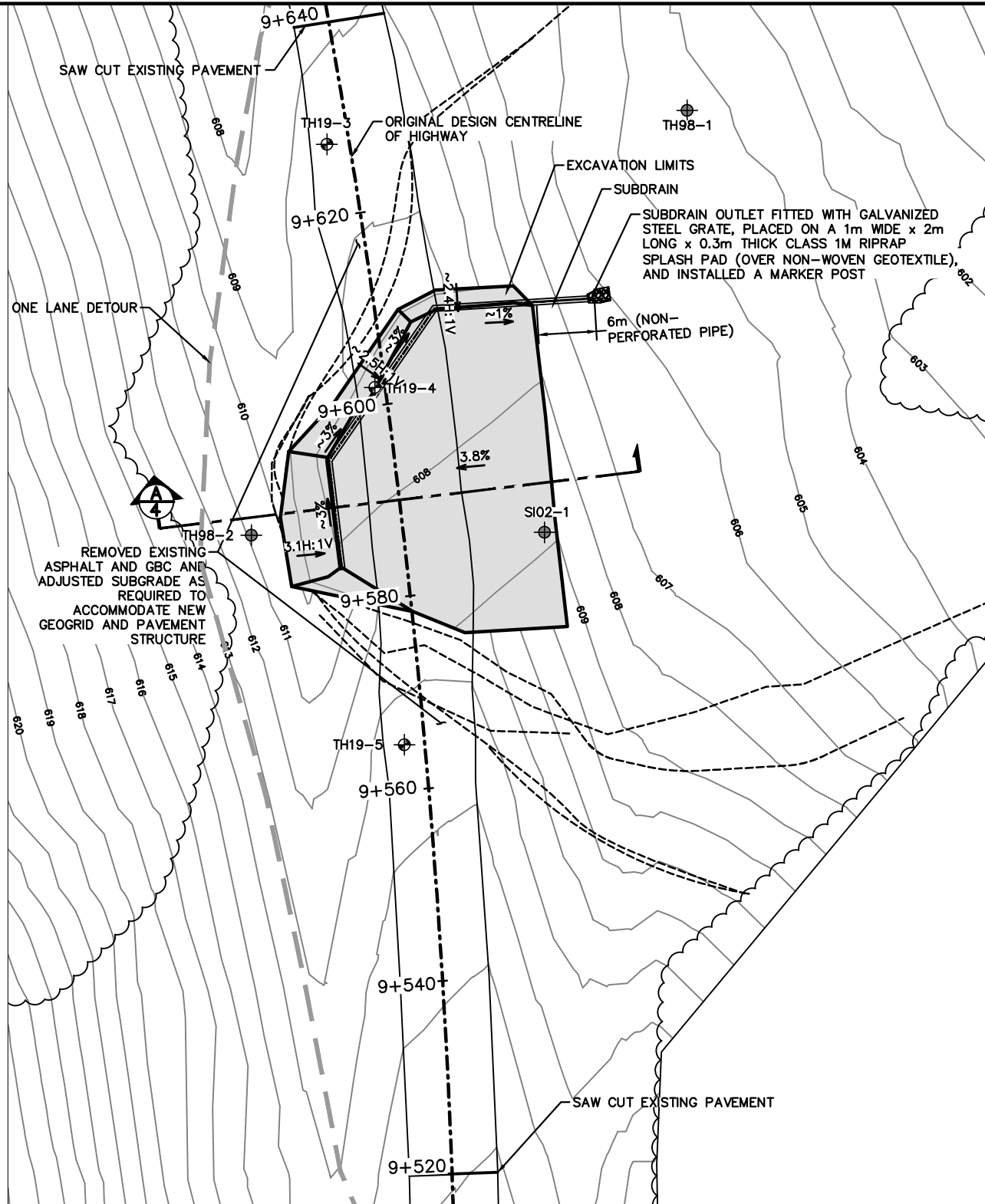


PEACE REGION (PEACE RIVER/HIGH LEVEL)
PH010 HWY 726:02 SOUTH OF WORSELY,
SITES #1, #2 & #4
2024 PH010 INSPECTION PLAN

DWG No. 32123-PH010-1

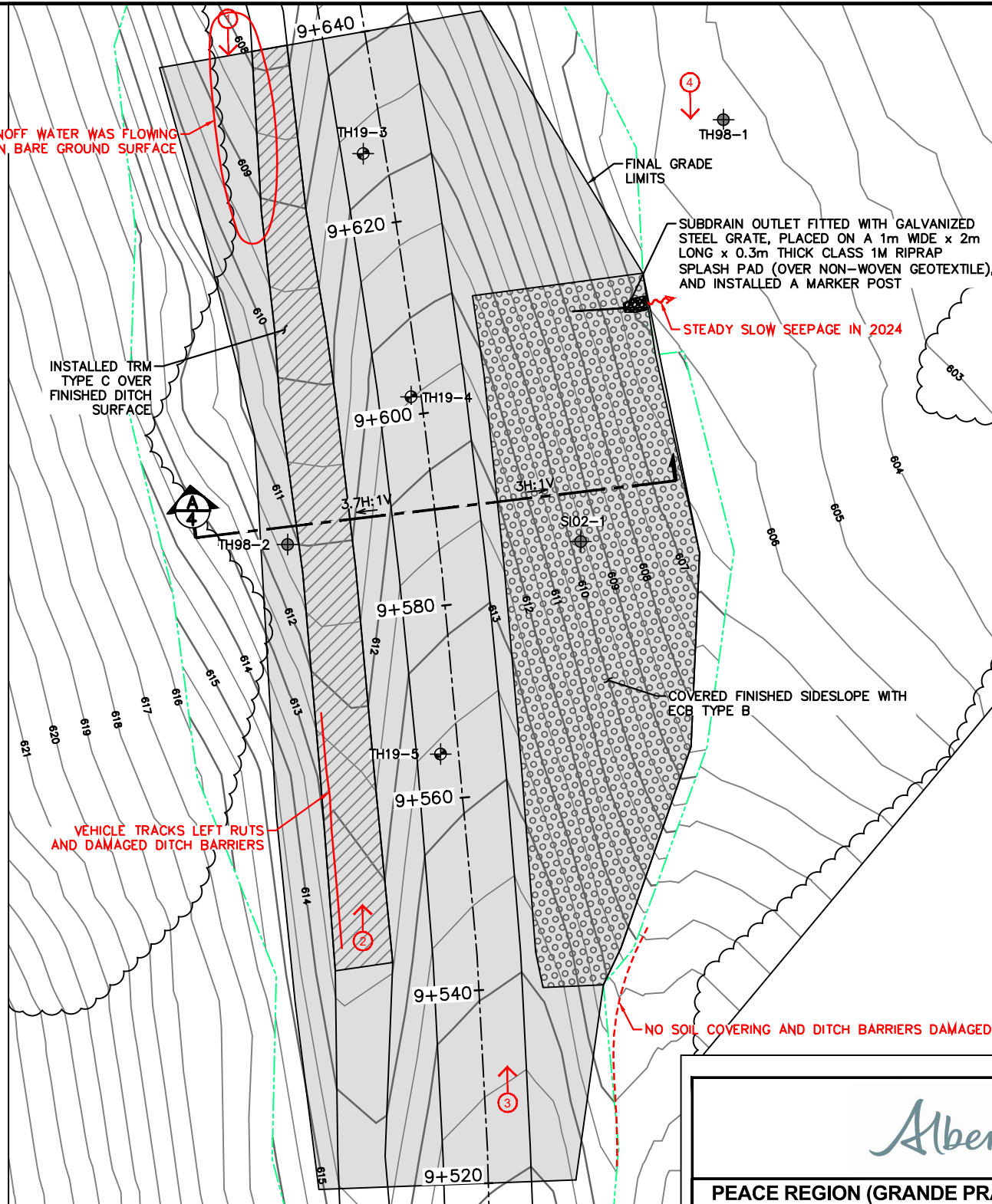
| | |
|-------------|-------------|
| DRAWN BY | ML |
| DESIGNED BY | BDM |
| APPROVED BY | DWP |
| SCALE | 1:1500 |
| DATE | MAY 8, 2024 |
| FILE No. | 32123 |





2023 AS-BUILT EXCAVATION PLAN

1:600



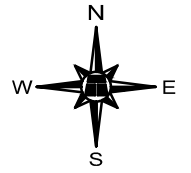
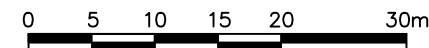
2023 AS-BUILT FINAL PLAN

1:600

- LEGEND**
- APPROXIMATE 2019 TEST HOLE LOCATION
 - APPROXIMATE PREVIOUS TEST HOLE LOCATION
 - SLOPE INCLINOMETER
 - TREE LINE
 - HIGHWAY 726:02
 - APPROXIMATE LANDSLIDE OUTLINES OBSERVED ON SITE
 - GROUND SURFACE CONTOUR IN METRES
 - NON-PERFORATED SUBDRAIN
 - PERFORATED SUBDRAIN
 - PHOTO AND DIRECTION

NOTES:

1. ORIGINAL GROUND SURFACE SURVEYED BY MCINTOSH PERRY ON AUGUST 11, 2019. SITE FEATURES ONLY REFLECT THE SURVEY DATA, AND MAY VARY AT THE TIME OF TENDERING THE PROJECT.
2. AS-BUILT GROUND SURFACE SURVEYED BY MCINTOSH PERRY CONSULTING ENGINEERS LTD. ON SEPTEMBER 14, 2023
3. DETOUR OUTLINE IS APPROXIMATE, DESIGNED BY CONTRACTOR
4. EXCAVATION LIMITS AND OTHER FEATURES ARE APPROXIMATE
5. REPAIRS LOOK GOOD. ROAD SURFACE SMOOTH; NO CRACKS IN NEW PAVEMENT.
6. CONDITIONS ON MAY 8, 2024 SHOWN IN RED



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

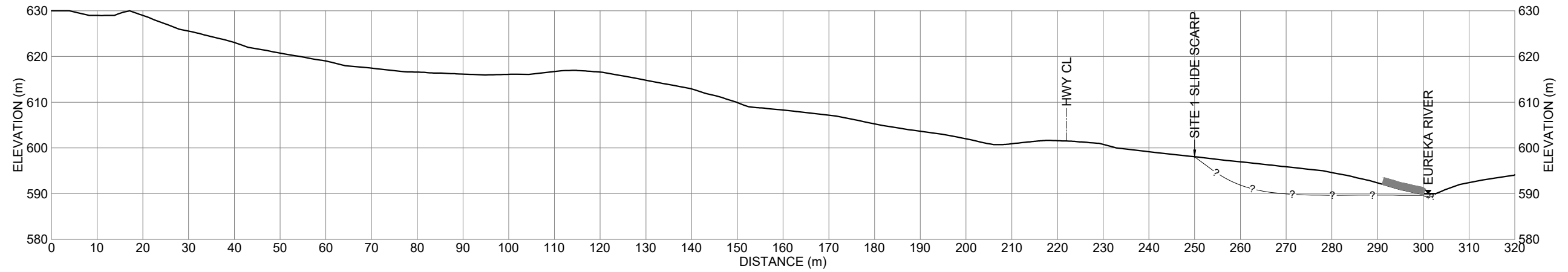
2024 PH010 INSPECTION PLAN

DWG No. 32123-PH010-3

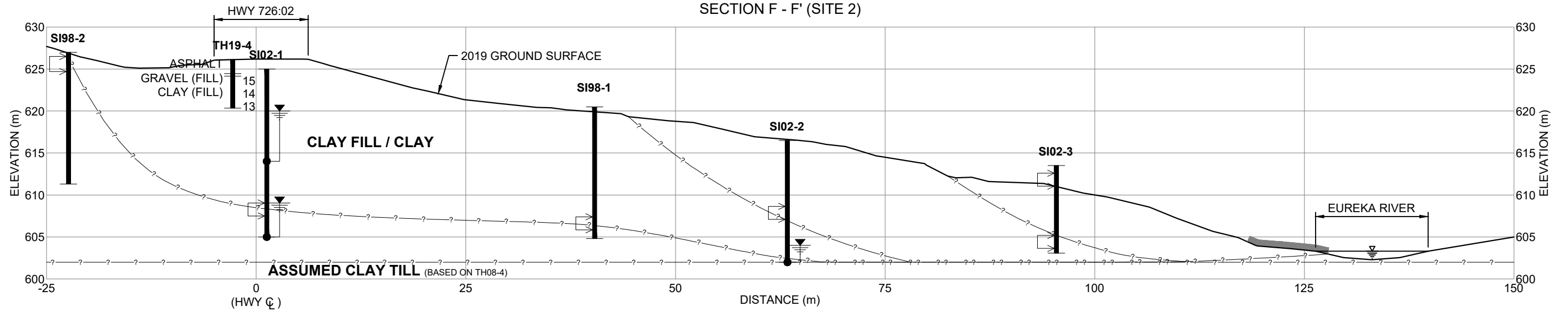
| | |
|-------------|-------------|
| DRAWN BY | ML |
| DESIGNED BY | BDM |
| APPROVED BY | DWP |
| SCALE | 1:600 |
| DATE | MAY 8, 2024 |
| FILE No. | 32123 |



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-PH010-4

| | |
|-------------|-------------|
| DRAWN BY | ML |
| DESIGNED BY | BDM |
| APPROVED BY | DWP |
| SCALE | 1:1000 |
| DATE | MAY 8, 2024 |
| FILE No. | 32123 |





Photo 1 – Looking south along the west ditch at the east end of the TRM placement at Site 2.



Photo 2 – Looking north along the west ditch of Site 2, at vehicle track ruts that caused damage to the ditch barriers.



Photo 3 – Looking north along the freshly paved highway surface that was constructed over Lightweight Geofam fill at Site 2.



Photo 4 – Looking south along the east sideslope at steady seepage from the new subdrain outlet constructed beneath the new Lightweight Geofam fill at Site 2.



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



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



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



Photo 8 – Looking south from the north end of the Site 1 slide at the new surface water catch basin manhole that captures surface runoff from the new subdrain further south along the east edge of the highway, that drains into a smooth-wall steel pipe outletting further east. This replaced the previously existing AC curb/Manhole/Half-Culvert system.



Photo 9 – Looking northwest at the new SWSP outlet (Site 1). Note the re-routed Telus cable at ground surface.



Photo 10 – Looking southeast along the Eureka River from the arch culvert inlet (Site 1).