

**ALBERTA TRANSPORTATION  
GEOHAZARD ASSESSMENT PROGRAM  
PEACE REGION (GRANDE PRAIRIE DISTRICT-NORTH)  
2023 INSPECTION**



**THURBER ENGINEERING LTD.**

Site Number	Location	Name (Old Site 5)	Hwy	km
PH023	12 km W. Cleardale	Clear River East Hill-Twin Pipes	64:02	23.4-24.1
Legal Description		UTM Co-ordinates (NAD 83)		
NE28/NW27-84-11-W6		11 N 6244273	E 335460	

	Date	PF	CF	Total
<b>Previous Call Out:</b>	July 9, 2020	17	8	136
<b>Previous Inspection:</b>	May 17, 2022	10	8	80 Slide Risk Rating
		20	4	80 Erosion Risk Rating
<b>Current Inspection:</b>	May 31, 2023	10	8	80 Slide Risk Rating
		20	4	80 Erosion Risk Rating
<b>Road AADT:</b>	160	<b>Year:</b>	2022	
<b>Inspected By:</b>	Don Proudfoot, Barry Meays (Thurber). Ken Szmata, Rishi Adhikari, Max Shannon (TEC).			
<b>Report Attachments:</b>	<input checked="" type="checkbox"/> Photographs <input checked="" type="checkbox"/> Plans <input checked="" type="checkbox"/> Maintenance Items			

<b>Primary Site Issue:</b>	Active erosion and slumping along the creek has re-activated a large ancient landslide. There are also active slides in the highway sideslopes.		
<b>Dimensions:</b>	Large ancient landslide blocks have linked together and affected a length of 750 m along the highway. Active slumping and erosion is occurring along the creek, located approximately 40 m below the highway level.		
<b>Date of any remediation:</b>	1986-Road realignment uphill; 1988-Drainage measures; 1996-Toe Buttress/berm fill covering twin SWSP culverts; 1997-Armoured Channel; winter 1998-Non perf. CSP culvert at north channel bank.		
<b>Maintenance:</b>	Asphalt overlay in August 2008. Chip seal in 2017. Frequent milling/patching the last several years; extensive in 2020 after hwy closure.	<b>Worsened?</b>	
<b>Observations:</b>	<b>Description</b>	<b>Yes</b>	<b>No</b>
<input checked="" type="checkbox"/> Pavement Distress	Numerous dips, distortion, and cracks. Reflective cracking through the 2020 patches.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/> Slope Movement	Re-activation of a large ancient slide movement has cut completely across the highway at both ends, with numerous movement-induced intermediate cracks, settlements, and slumps in between. Continued and enlarged slumping downslope of highway adjacent to creek channel edges. Continued regression in 1 of the 3 south highway embankment slumps.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/> Erosion	Very severe along the creek, former toe berm, and north ditch access.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/> Seepage	Significant/steady seepage from base of enlarged piping slump (north side of creek channel).	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Bridge/Culvert Distress	The twin culverts installed in the creek below the toe berm are ineffective due to silt build-up and channel erosion. The trash rack is toppling due to loss of support.	<input checked="" type="checkbox"/>	<input type="checkbox"/>

**Instrumentation:** Last read June 23, 2023 - The inclinometer movement zones, and piezometer tip depth measurements are shown on the cross-sections attached (Drawings PH023-4 to -6).

**INCLINOMETERS** – The last remaining old operational inclinometer (88-09 near west end below hwy) sheared off at 5.5m.

**20-1:** 17mm/yr @ 4 to 5.5m; & 3mm/yr @ 50 to 54m. **20-2:** Sheared off at 33.2m (but former movement zones @ 32 to 34m & 42 to 43m). **20-3:** Sheared off at 21.0m (former movement zone @ 19.5 to 21m). **20-4:** Sheared off at 7.6m (but former movement zones @ 6 to 8m & 60 to 62m). **20-5:** Sheared off at 11.6m (but former movement zones @ 9 to 12m & 31 to 36m). **20-6:** Sheared off at 20.1m, (but former movement zones @ 18 to 20m & 28 to 31m). **20-7:** 8mm/yr @ 18 to 20m; & 3mm/yr @ 32 to 34m. **20-8:** Sheared off at 36.2m (former movement zone @ 34 to 37m).

**PIEZOMETERS** - 2 Pneumatic Tips were installed in each of the eight 2020 test holes, taped to the outside of the inclinometer casing (A=Upper Tip; B=Lower Tip). TH20-3B, 20-4B & 20-5B are inoperable and will not be read any more. Groundwater Elevations (m): 20-1A=506.0; 20-1B=488.6; 20-2A=505.5; 20-2B=496.30; 20-3A=491.7; 20-4A=510.8; 20-5A=485.6; 20-6A=474.2; 20-6B=460.4; 20-7A=484.5; 20-7B=447.7; 20-8A=475.2; 20-8B=466.0. In general, the piezometers showed decreases in groundwater levels up to 2.0 m since last fall.

### **Assessment** (Refer to Drawings PH023-1 to -6):

During the July 2020 Call Out, the slide spanned an approximate 750 m length of highway, with the scarp crack areas at both ends extending completely across the highway, with frequent intermittent cracking, scarp cracks, and numerous dipped pavement and shoulder embankment areas existing in-between. This indicated that the slide had moved along ancient landslide paths. Many of the observed cracked and dipped areas were reflecting through older patched areas, which indicated there had been past movements at localized areas, but not to the degree and extent of this more sudden movement. Information provided during the Call Out indicated that the majority of movement and highway damage occurred over an approximate 4 to 10 hour time frame on July 8/9, 2020, which resulted in closure of the highway by TEC. Heavy rainfall accumulations (it was indicated that in the order of 240 mm of rainfall had fallen in this area between June 28 and July 9, 2020), likely contributed to both creek runoff/erosion, subsoil saturation, and landslide formation/transgression.

Sliding has also been aggravated by severe creek erosion at the toe of the valley slope over the years. There appears to be a recent large slide block that has moved towards the creek on the north side, centered about 300 m west of the drainage trench erosion area at the east end of the site. The large slump below the east end of the site is a result of the toe buttress fill blocking off the drainage trenches, causing erosion and earth flows that are retrogressing back towards the highway. The original twin culverts in the creek were not big enough to pass storm flows and to handle large amounts of silt and debris coming into the channel. As a result, channel lining/gabions below the east end of the site have eroded away and are ineffective. Recent creek erosion has completely eroded the gabion weirs and exposed the twin pipe outlets, rendering them ineffective. This creek erosion has also displaced the large riprap laid in the channel, and has caused the trash rack piles to lean and bend.

At the time of the 2020 Call Out, the main scarp crack that crossed into the highway at the east end of the site exposed a pavement structure consisting of between 0.4 m to 0.5 m of ACP (likely that thick due to several previous patches), overlying between 0.15 m to 0.2 m of saturated GBC. The exposed scarp on the north side of the highway at a location near the west end of the site exposed a wet, medium plastic, silty clay that contained some sand.

A preliminary geotechnical investigation consisting of drilling eight test holes between 32 to 66 m in depth with instrumentation installed (locations shown on Drawings PH023-1 to -3) was initiated in the fall of 2020 to assist in assessing the soil/groundwater conditions and the depth of movements of this slide. The soil conditions were found to consist of predominant medium to highly plastic clay, with some near surface sand, and possible clay shale bedrock at depth. All of the inclinometers installed in 2020 were registering movements below the present tributary level, and all except for SI20-3 and SI20-8 were registering two movement zones (with the upper zone generally indicating faster rates than the lower zone). Six of these eight inclinometers have now sheared off (leaving only SI's 20-1 and 20-7 still intact). The rates of

movement in both SI20-1 and SI20-7 have significantly decreased since the last readings, varying between 3 and 17 mm/yr. Over the last few years, the movements recorded in the inclinometers have not yet been observed to translate onto the highway surface since the more severe highway scarp cracks and dips were graded/milled/levelled/patched shortly after the July 2020 Call Out.

The landslide movements are expected to have cycles of subsidence and re-initiation as new equilibrium modes are reached due to the upper part of the landslide body settling and separating from the intact ground at the backscarp as the lower part of the slide body pushes into and constricts the creek. However, over time the creek will continue to erode and undermine the support at the toe of the landslide mass and keep the slide in motion until some permanent stabilization and creek erosion protection measures are constructed.

## **Recommendations:**

### **Maintenance:**

To date the slide movements have been mitigated by the maintenance contractor by milling and patching the road. To reopen the road following the big slide movement in 2020, the east flank of the slide was cut down along the highway and patched with a thin asphalt layer, but this area is continuing to distort, and the asphalt is breaking up.

The speed through the landslide area has been posted at a slower speed of 30 km/hr to improve traffic safety through this uneven zone.

### **Short Term:**

The maintenance repairs are temporary measures until a more permanent repair could be designed and implemented. Due to the size and complexity of the landslide the cost to permanently repair this site is substantially higher than first anticipated; therefore, TEC are considering removing the asphalt and turning the affected portion of the highway back to gravel so that it can be maintained by grading the gravel surface until a more permanent repair can be implemented. This work is currently scheduled to be completed in 2023 and will consist of:

- Remove and salvage the existing W-Beam guardrail. After road work is complete, install a new Cable barrier a sufficient distance off the edge of the road, as directed/agreed by TEC.
- Remove the road sand that had accumulated from underneath the guardrail.
- Strip and salvage topsoil
- Remove the road asphaltic concrete pavement (ACP) between Sta. 23+615 and 24+215 and an existing stockpile of ACP that exists north of the hwy, to an approved disposal site.
- Remove some of the existing granular base course (GBC) road gravel only where required to facilitate the new finished grades.
- Drain existing pond in north ditch.
- Remove approach on north side of Hwy (once all temporary stockpiling work is completed but prior to draining the ponded water and regrading the ditch).
- Regrade and compact the existing GBC surface, adding new GBC material where required to provide uniform grades.
- Place and compact 100 mm of ACP millings obtained from a department stockpile over the compacted GBC surface.
- Grade, shape, and compact the highway ditches from approximately 24+135 to 23+980 and 23+700 to 23+625
- Topsoil placement and broadcast seeding all disturbed areas.
- Install Permanent Erosion Control Soil Covering with synthetic ditch barriers on all regraded ditch sections.

**Medium to Longer Term:**

A geotechnical investigation and preliminary engineering assessment was completed by Thurber for this site dated April 8, 2022. The following recommendations were provided:

- Carry out a large-scale grading scheme to raise the tributary creek bed over a 1.15 km length to create a buttress to the toe of the landslide mass. This infill will begin about 180 m upstream of the tributary split location in both the north and south branches, then increase in height at a 0.5% downward surface gradient to a location about 100 m west of Section A, where it reaches the full infill height of 18 m. Downstream of this point, the top of the 18 m high fill will extend at a 4% downward gradient to a point about 200 m west of Section C, where it will transition down to the natural creek bed through a 4H:1V stepped gabion dissipation structure.
- Install a sub-drainage system to maintain the groundwater table at a position as was assumed under pre-construction conditions. This will consist of a 500 mm diameter subdrain pipe enveloped in clean filter gravel and non-woven geotextile, that extends along the entire length of the tributary bottom (having 4 maintenance manholes), that outlets downstream of the fill in the gabion dissipation structure. This subdrain will be continuously joined to 0.3 m thick filter gravel/sand blankets overlying non-woven geotextile placed in intimate contact with the stripped tributary channel walls and at strategic fill areas further upslope.
- Fill to raise the tributary creek bed will be obtained from cutting back the valley slope north of the highway, while flattening critical areas to improve the overall stability factor of safety.
- Line the completed buttress fill (that slopes towards) a channel indented into the fill that can pass the creek flows. The upper 0.5% gradient channel can be armoured with a 0.3 m thick, clean filter gravel, while the steeper 4% gradient channel will need to be armoured with 0.8 m thick Class 2 riprap. The grouted gabion dissipation structure will consist of 19 steps (each step 1m high x 4m long x 10m wide), flanked by steel sheet piles driven along the outside edges, and a 12 m long Class 1 riprap apron at the downstream toe where it meets grade.
- At Section A (near the east end), two additional measures include: a) Lowering the water table by 2 to 3 m over a 100 m wide x 250 area long area by installing a series of closely spaced trench (slot) drains that drain into the base of the tributary fill; and b) Reconstructing a 200 m length of slide compromised highway with lightweight fill by excavating a 5 m thickness of ACP, GBC, and clay fill.

As a minimum, AEP and DFO will need to be contacted prior to these measures being undertaken.

**Ballpark cost ~\$25 million.**

**Long Term:**

Also, a large highway re-alignment is being considered by AT as part of an on-going functional planning study headed up by CIMA Canada Inc., that bypasses all of the slide sites through the Clear River valley over a new crossing. This alternative will be compared to the costs and risks of remediating and maintaining the existing highway at all of the current geohazard sites.

## **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.

Renato Clementon, Ph.D., 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.

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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.

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- 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.

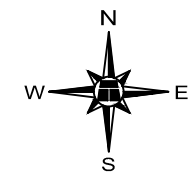
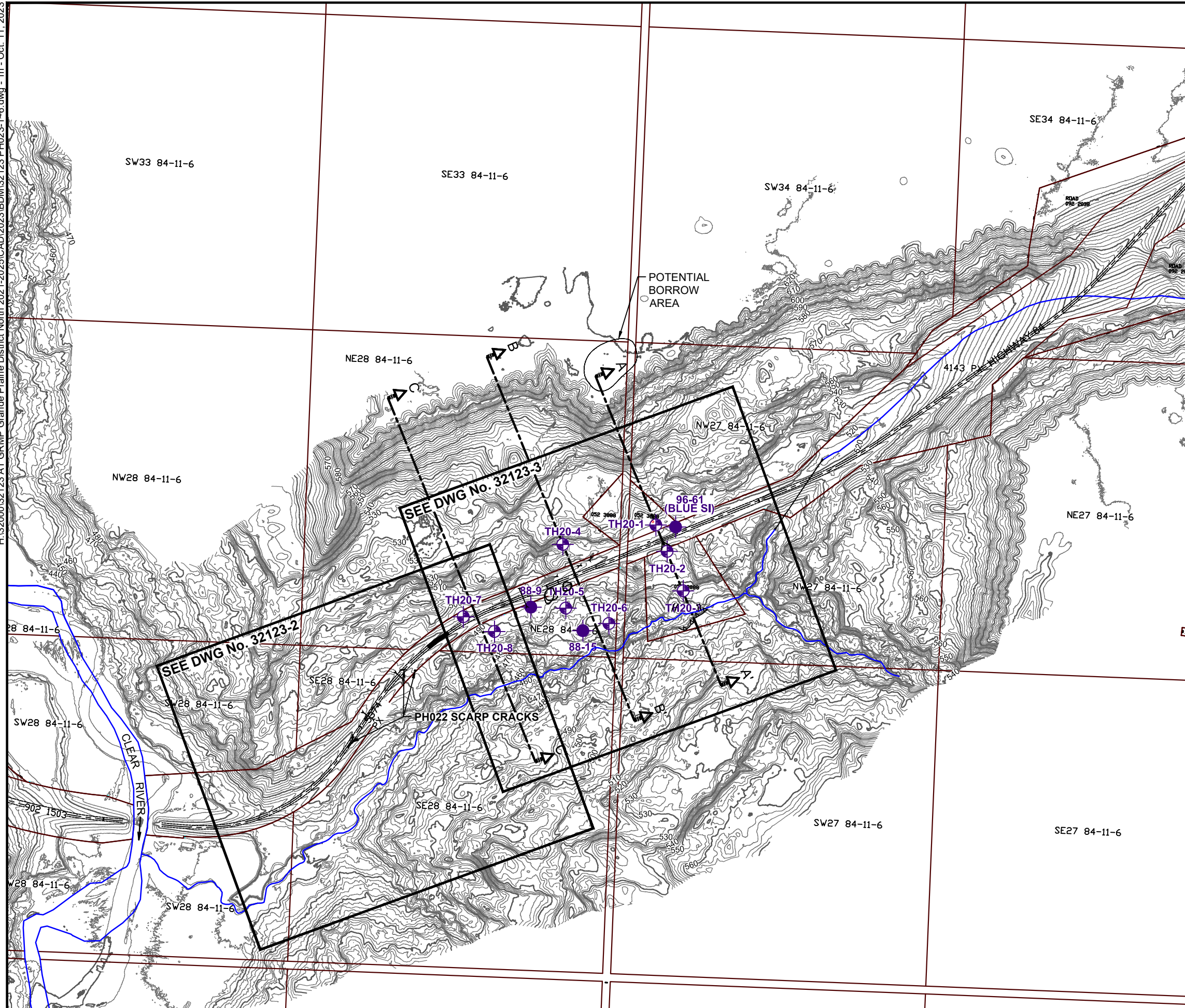
### 6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

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**LEGEND**

-  APPROXIMATE TEST HOLE LOCATION
-  APPROXIMATE TRIBUTARY CENTERLINE



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BASE PLAN PROVIDED BY WSP (LIDAR UAV FLOWN SEPT 29/30, 2020)



**PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)  
PH023: HWY 64:02 CLEAR RIVER EAST HILL**

**SITE PLAN**

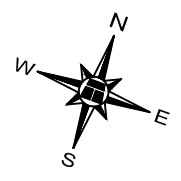
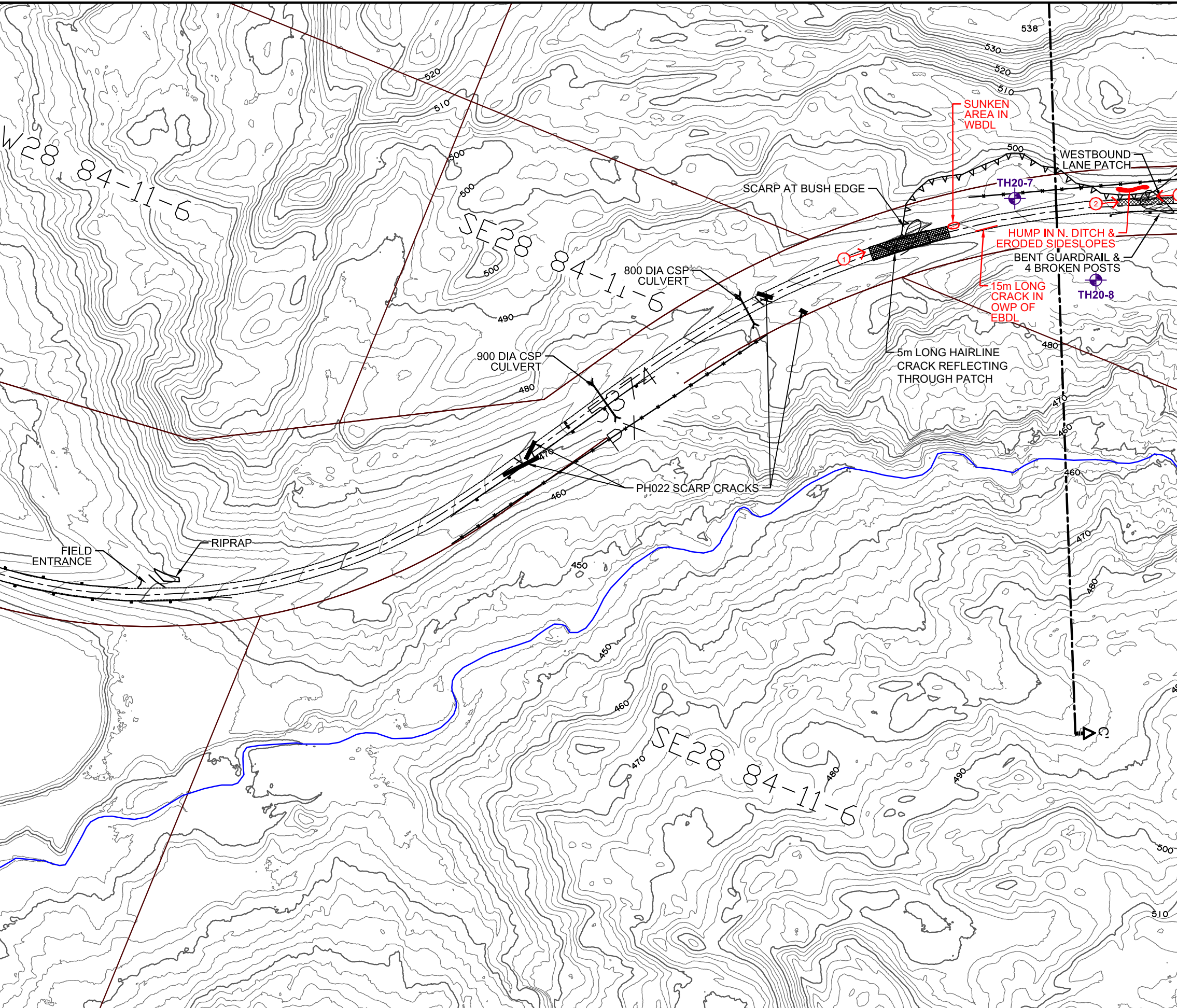
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DESIGNED BY	BDM
APPROVED BY	DWP
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DATE	MAY 31, 2023
FILE No.	32123



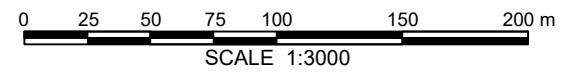
**THURBER ENGINEERING LTD.**

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- LEGEND**
- APPROXIMATE 2020 TEST HOLE LOCATION
  - FENCE LINE
  - GUARD RAIL
  - SETTLEMENTS (JULY 9, 2020)
  - CRACKS (JULY 9, 2020)
  - SLIDE SCARP
  - APPROXIMATE TRIBUTARY CENTERLINE
  - DIRECTION AND NUMBER OF PHOTO
  - ACP PATCH

**NOTE:**  
 1. MAY 31, 2023 OBSERVATIONS SHOWN IN RED



BASE PLAN PROVIDED BY WSP (LIDAR UAV FLOWN SEPT 29/30, 2020)



**PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)  
 PH023: HWY 64:02 CLEAR RIVER EAST HILL**

**DETAILED SITE PLAN - WEST**

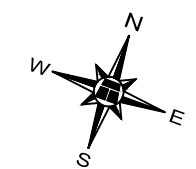
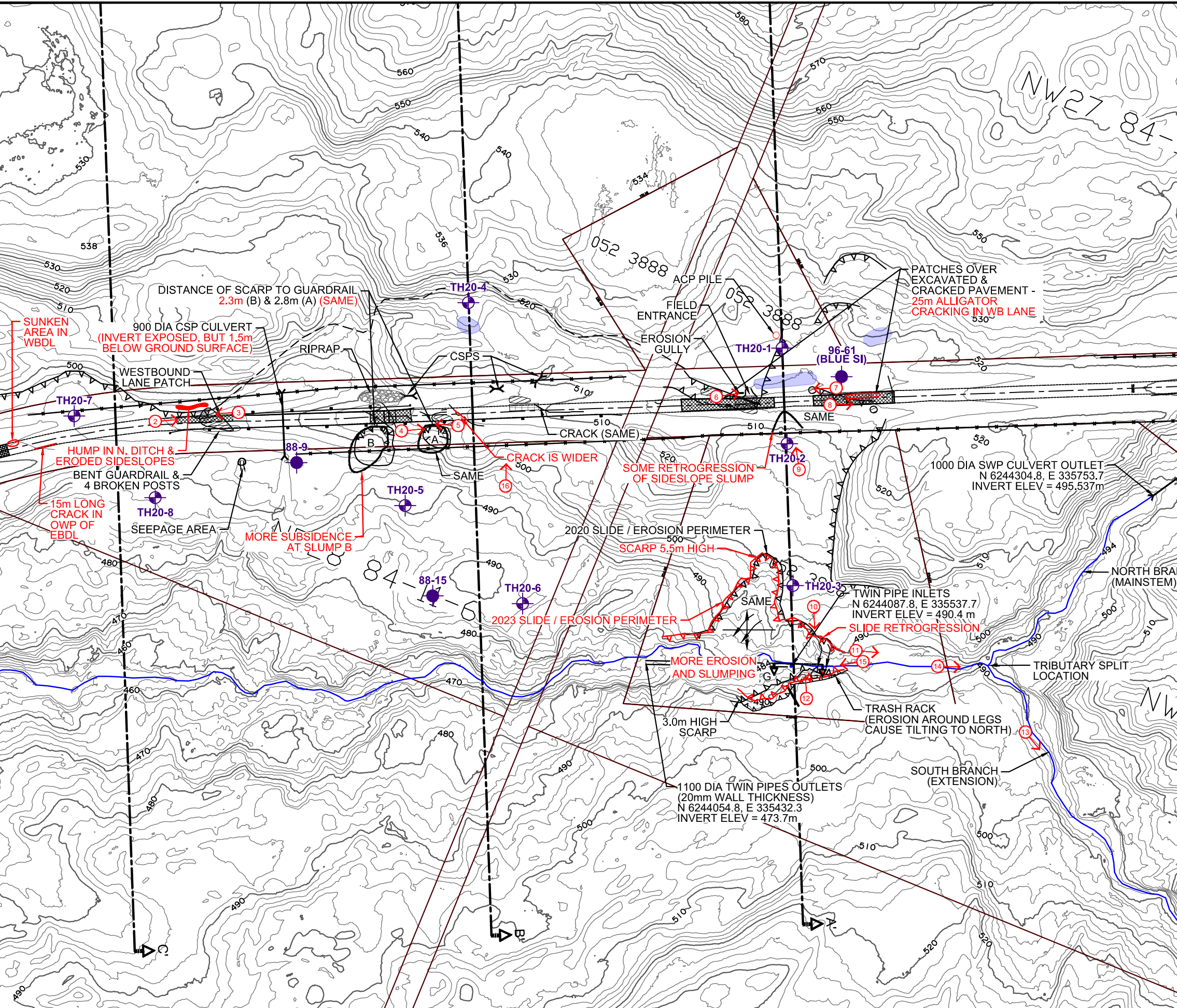
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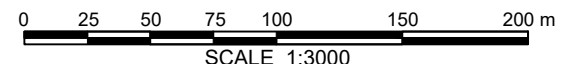
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**LEGEND**

- APPROXIMATE 2020 TEST HOLE LOCATION
- APPROXIMATE OLDER TEST HOLE LOCATION
- FENCE LINE
- GUARD RAIL
- SETTLEMENTS (JULY 9, 2020)
- CRACKS (JULY 9, 2020)
- SLIDE SCARP
- POND
- APPROXIMATE TRIBUTARY CENTERLINE
- DIRECTION AND NUMBER OF PHOTO
- ACP PATCH
- SEEPAGE

**NOTES:**  
1. MAY 31, 2023 OBSERVATIONS SHOWN IN RED



BASE PLAN PROVIDED BY WSP (LIDAR UAV FLOWN SEPT 29/30, 2020)



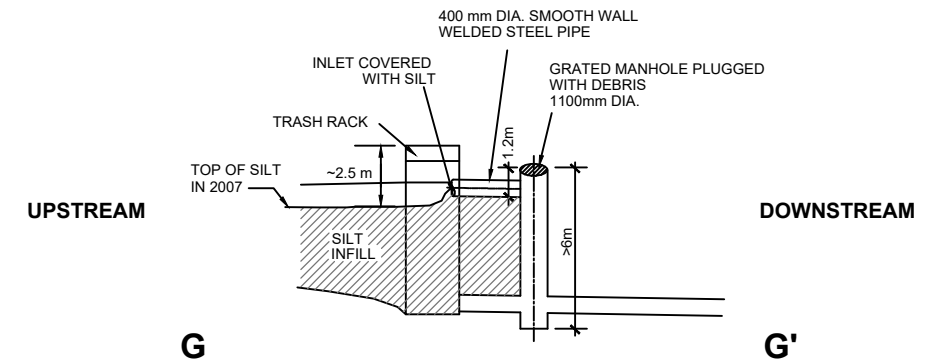
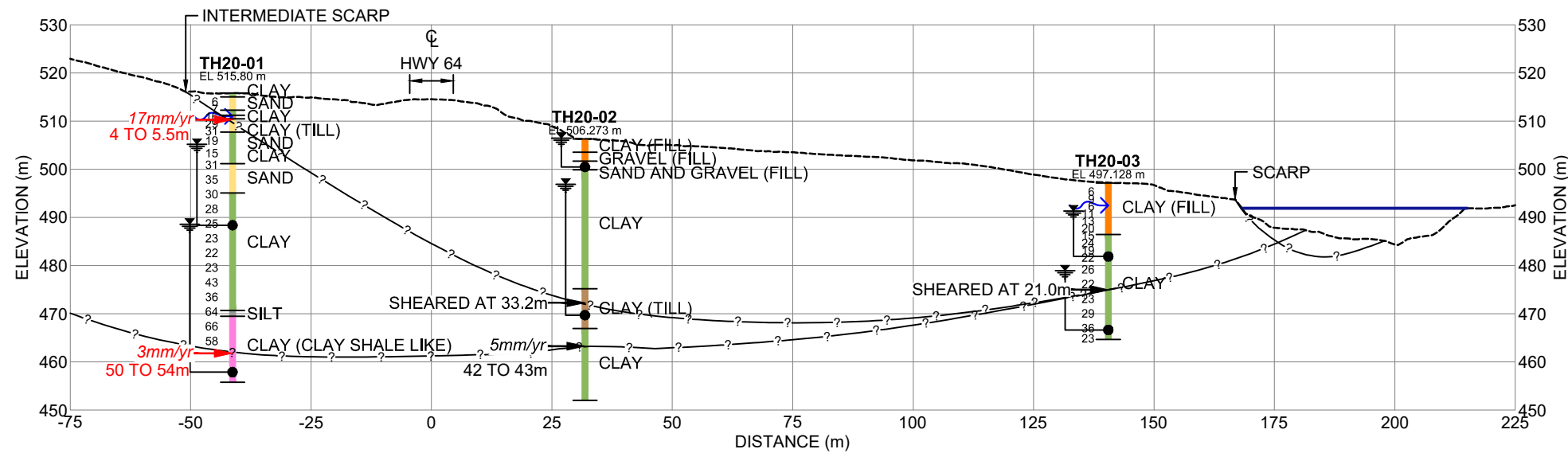
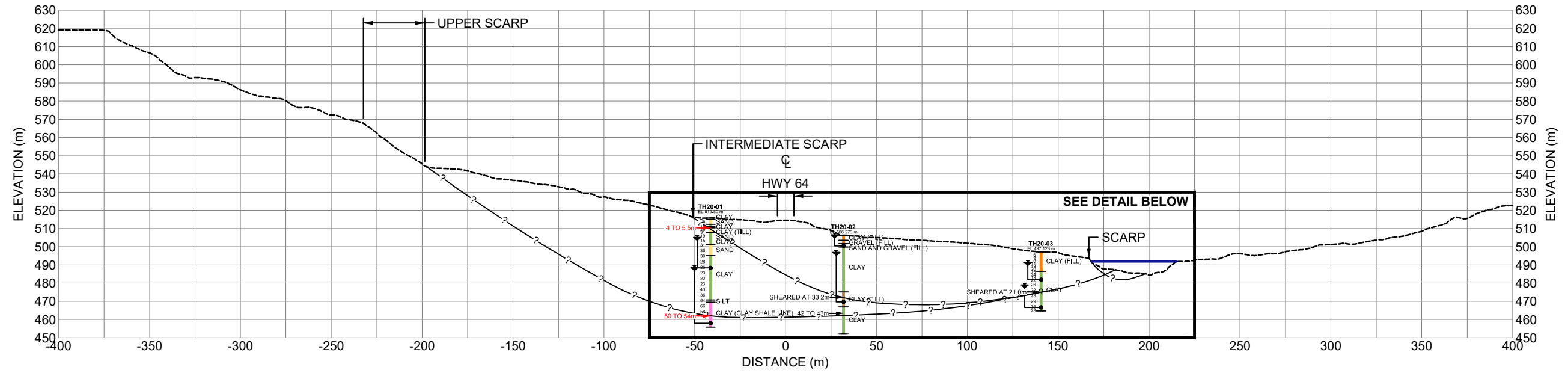
**PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)  
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**DETAILED SITE PLAN - EAST**

**DWG No. 32123-PH023-3**

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DESIGNED BY	BDM
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DATE	MAY 31, 2023
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**DETAIL**  
SCALE 1:1250

**LEGEND**

- 15 I SPT N VALUE
- Water level symbol WATER LEVEL IN PIEZOMETER (JUNE 20, 2022)
- PNEUMATIC PIEZOMETER TIP LOCATION
- 4mm/yr 42 TO 43m → BASE OF MOVEMENT ZONES AND MOVEMENT RATE FROM Xm TO Xm (JUNE 23, 2023)
- ~> SEEPAGE
- ?- ASSUMED SLIP SURFACE
- 8 m FILL HEIGHT (FOR POTENTIAL TOE BERM)

**NOTE**

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.

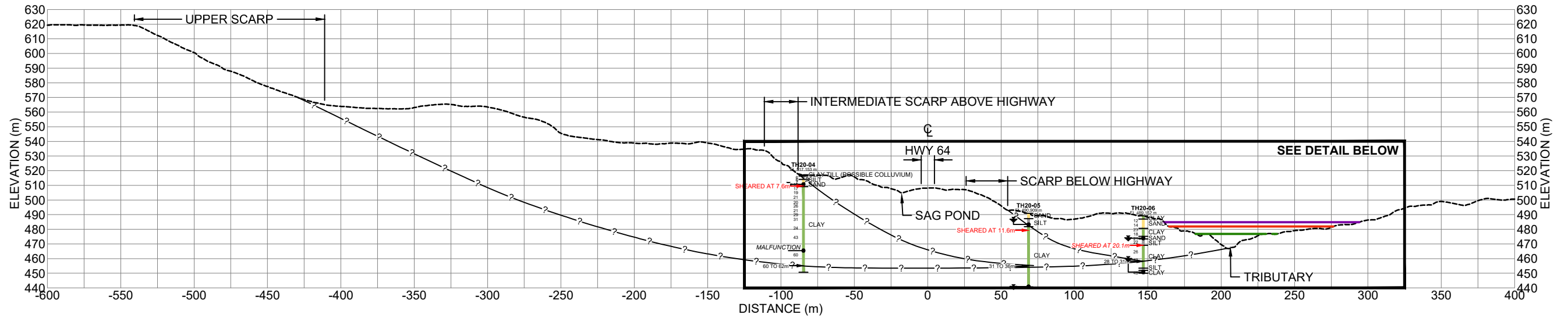
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**PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)  
PH023: HWY 64:02 CLEAR RIVER EAST HILL**

**CROSS-SECTION A-A'**

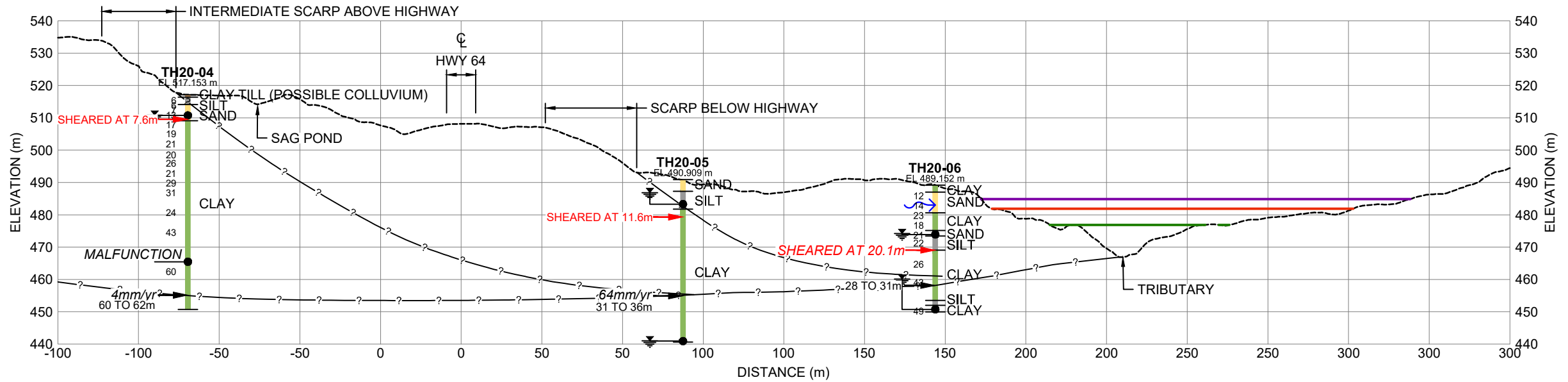
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DESIGNED BY	BDM
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SCALE	AS SHOWN
DATE	MAY 31, 2023
FILE No.	32123





**CROSS-SECTION B-B'**  
SCALE 1:3000



**DETAIL**  
SCALE 1:1500

- |  |   |
|--|---|
| <b>LEGEND</b>  | SEEPAGE                                   |
| SPT N VALUE  | ASSUMED SLIP SURFACE                      |
| WATER LEVEL IN PIEZOMETER (JUNE 20, 2022)  | 10 m FILL HEIGHT (FOR POTENTIAL TOE BERM) |
| PNEUMATIC PIEZOMETER TIP LOCATION  | 15 m FILL HEIGHT (FOR POTENTIAL TOE BERM) |
| <b>4mm/yr</b><br>42 TO 43m<br>BASE OF MOVEMENT ZONES AND MOVEMENT RATE FROM Xm TO Xm (JUNE 23, 2023) | 18 m FILL HEIGHT (FOR POTENTIAL TOE BERM) |

**NOTE**  
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.

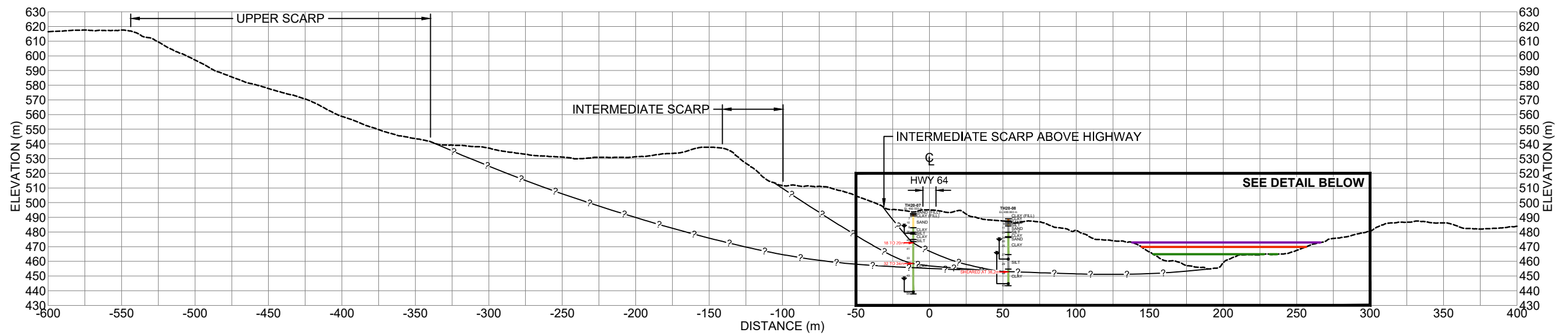
**PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)  
PH023: HWY 64:02 CLEAR RIVER EAST HILL**

**CROSS-SECTION B-B'**

**DWG No. 32123-PH023-5**

DRAWN BY	KLP
DESIGNED BY	BDM
APPROVED BY	DWP
SCALE	AS SHOWN
DATE	MAY 31, 2023
FILE No.	32123

**THURBER ENGINEERING LTD.**



**CROSS-SECTION C-C'**  
SCALE 1:3000



**DETAIL**  
SCALE 1:1000

- |   |   |
|---|---|
| <b>LEGEND</b>                             |   |
| 15 I SPT N VALUE                          | SEEPAGE                                   |
| WATER LEVEL IN PIEZOMETER (JUNE 20, 2022) | ASSUMED SLIP SURFACE                      |
| PNEUMATIC PIEZOMETER TIP LOCATION         | 10 m FILL HEIGHT (FOR POTENTIAL TOE BERM) |
| 4mm/yr<br>42 TO 43m                       | 15 m FILL HEIGHT (FOR POTENTIAL TOE BERM) |
| 8mm/yr<br>18 TO 20m                       | 18 m FILL HEIGHT (FOR POTENTIAL TOE BERM) |
| 3mm/yr<br>32 TO 34m                       |   |
| SHEARED AT 36.2m                          |   |

**NOTE**  
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.



**PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)  
PH023: HWY 64:02 CLEAR RIVER EAST HILL**

**CROSS-SECTION C-C'**

**DWG No. 32123-PH023-6**

DRAWN BY	KLP
DESIGNED BY	BDM
APPROVED BY	DWP
SCALE	AS SHOWN
DATE	MAY 31, 2023
FILE No.	32123





Photo 1 - Looking east along the highway at the milled/patched area over the two cracks first observed in 2013 that mark the west boundary of the slide on the highway. Note the two settled areas along the north edge of the hwy embankment.



Photo 2 – Looking east along the highway and scarp in the north ditch, and large dip that extends across the highway at this location, near the west end of the site.



Photo 3 – Looking west from near the west end of the guardrails along the slide scarp that extends along the north highway ditch.



Photo 4 – Looking east at Embankment Slump A on the south side of the hwy.



Photo 5 – Looking west along the distorted highway at previous slide cracks east of the northeast guardrail end.



Photo 6 – Looking east at the west milled/patched area over the east slide crack.



Photo 7 – Looking west along the north highway ditch at the sagged area with ponded water and north approach in the background.



Photo 8 - Looking east along the highway at the alligator cracked hwy area at the east end of the site.





Photo 9 – Looking north at the slump in the south hwy embankment, from the top of the piping area.



Photo 10 – Looking south across the eroded channel at the twin pipe riser inlets and eroded trash rack.



Photo 11 – Looking east at the upstream end of the eroded and silted in tributary channel.



Photo 12 - Looking north across the eroded tributary channel towards the highway, at the eroded piping area (LHS), twin pipe inlets and trash rack (Center), and eroded gabion weir (Foreground).



Drone Photo 13 – Looking southeast along the south tributary branch. Note the erosion bowl near the top part of the photo.



Drone Photo 14 – Looking east at the point where the two tributary branches merge into one.



Drone Photo 15 – Looking west along the eroded creek channel at the twin pipe inlet risers, and the eroded trash rack.



Drone Photo 16 – Looking north across the highway and north slope from the site center.