**ALBERTA TRANSPORTATION**
**GEOHAZARD ASSESSMENT PROGRAM**
**PEACE REGION (GRANDE PRAIRIE DISTRICT-NORTH)**
**2021 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** |
|---|---|---|---|---|
| **Previous Call Out:** | July 9, 2020 | 17 | 8 | 136 |
| **Current Inspection:** | July 14, 2021 | 10 | 8 | 80 Slide Risk Rating |
| | | 20 | 4 | 80 Erosion Risk Rating |
| **Road AADT:** | 260 | | **Year:** | 2020 |
| **Inspected By:** | Don Proudfoot, Barry Meays (Thurber).<br>Ed Szmata, Ken Szmata, Roger Skirrow, Rocky Wang (AT). | | | |
| **Report Attachments:** | ☑ Photographs ☑ Plans ☑ Maintenance Items | | | |

| | | | |
|---|---|---|---|
| **Primary Site Issue:** | Active erosion and slumping along the creek has re-activated a large ancient landslide. There are also active slides in the highway sideslopes. | | |
| **Dimensions:** | Large ancient landslide blocks have linked together and have 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. | | |
| **Date of any remediation:** | 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. | | |
| **Maintenance:** | Asphalt overlay in August 2008. Chip seal in 2017. Frequent milling/patching the last several years; extensive in 2020 after hwy closure. | **Worsened?** | |
| **Observations:** | **Description** | **Yes** | **No** |
| ☑ Pavement Distress | Numerous dips, distortion, and cracks. Very little reflective cracking through the 2020 patches. | ☐ | ☑ |
| ☑ 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 all 3 south highway embankment slumps. | ☑ | ☐ |
| ☑ Erosion | Very severe along the creek and former toe berm. | ☑ | ☐ |
| ☑ Seepage | Significant/steady seepage from base of enlarged piping slump (north side of creek channel). | ☑ | ☐ |
| ☑ Bridge/Culvert Distress | The twin culverts installed in the creek below the toe berm are ineffective due to silt build-up and channel erosion. | ☐ | ☐ |
| ☐ Other | | ☐ | ☐ |

**Instrumentation:** Last read July 15, 2021
INCLINOMETERS - One old operational inclinometer (SI-09 near west end below hwy): No discernible movement in any of the former movement zones of 4 to 8m, 10 to 12m, or 13m depth, but the tip depth of 30m may not be deep enough to intercept the slip surface of the ancient landslide.

20-1: 45mm/yr @ 4 to 5.5m; & 4mm/yr @ 50 to 54m. 20-2: 60mm/yr @ 32 to 34m; & 5mm/yr @ 42 to 43m. 20-3: 75mm/yr @ 19.5 to 21m. 20-4: 34mm/yr @ 6 to 8m; & 5mm/yr @ 60 to 62m. 20-5: 82mm/yr @ 9 to 12m; & 55mm/yr @ 31 to 36m. 20-6: 73mm/yr @ 18 to 20m; & 63mm/yr @ 28 to 31m. 20-7: 2mm/yr @ 18 to 20m; & 6mm/yr @ 32 to 34m. 20-8: 24mm/yr @ 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. The tip depths and latest measurements are shown on the cross-section drawings attached (Drawings PH023-4 to -6). All of the piezometers had small fluctuations of <1m in height since the last reading date of Feb. 18, 2021, except for the lower tips in 20-7 (dropped 2.4m) and 20-8 (dropped 1.1m). The lower tip in TH20-4 has malfunctioned and will not be read any more.

**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 AT. 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, exposed the twin pipe outlets rendering them ineffective, displaced the large riprap, and has caused some of 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 consisted of 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 (except for SI20-7), are registering movements below the present tributary level, and all except for SI20-3 and SI20-8 are registering two movement zones. The rates of movement have significantly increased in all of the 2020 inclinometers since the last reading date of Feb. 18, 2021, varying between 2 to 73 mm/yr. So far, these accelerated movements recorded in the inclinometers over the last reading interval 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:**
Discussions between Thurber and AT personnel on July 10, 2020 indicated that it would be more desirable to maintain the highway at its current location, rather than constructing a temporary re-alignment above (to the north of) the highway, which would cross other ancient slide scarps. The following on-going measures are recommended:

- Continue periodic grading, gravel infill, and milling and patching of the road surface, as necessary to maintain a smooth enough surface for traffic safety.
- Reduce the posted speed to an acceptable level through the landslide zone when required (varying between 30 to 50 km/hr depending on highway surface conditions). Post landslide warning signs and advisory speed reduction signs as needed to warn motorists of the existing hazard in this area.
- Visually monitor the landslide area to determine when additional maintenance grading and placement of surfacing gravel is required. If movements are too fast to effectively maintain a safe low speed surface the road might need to be closed again. The risk of faster movements will be higher during high precipitation and creek flow events.

**Short Term:**
1. Grade the north ditch at the east end of the site to eliminate the water ponding in the sag pond. If water does accumulate, it could be drained by installing a small diameter pipe through the road that outlets beyond the toe of the highway embankment (joined by a hose that directs water away from the crest of the erosion slide further downslope).
2. Locate the seepage sources in the large slump below the east end of the site, cover with 0.5 m of clean gravel, and drain to the creek via a 400 mm subdrain, connected with additional lateral perforated subdrains as required, then reconstruct the toe fill overtop.
3. Lower the highway over the large humps and cracks at both the east and west ends of the site and maintain these sections with a regularly graded gravel surface if required.

**Ballpark cost $600,000**

**Medium to Longer Term:**
Carry out a large-scale grading scheme to raise the creek bed over the entire slide length to create a buttress to the toe of the landslide mass. Line the completed buttress fill with a raised channel that can pass the creek flows. This channel (estimated at 1 km length) will need to be armoured with heavy riprap and/or grouted rip rap and provided with one or more drop structures. Establish a sub-drainage system to lower the groundwater table in the lower portion of the valley slope or where required elsewhere. In particular, it will be important to re-establish drains under the berm on the hwy side of the channel towards the east end of the site.

As a minimum, AEP and DFO will need to be contacted prior to these measures being undertaken.
These measures will be analysed and recommended in more detail once the on-going preliminary geotechnical investigation is completed.

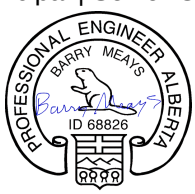
**Ballpark cost ~$20 to $30 million** (price would depend on the hydraulic and geotechnical studies).

**Long Term:**
Also, a large highway re-alignment is being considered by AT as part of a soon to be undertaken feasibility study, that bypasses all of the slide sites through the Clear River valley, potentially 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.

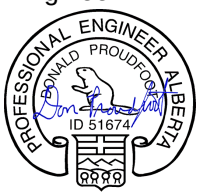
## CLOSURE

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.

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




October 6, 2021




October 7, 2021

**PERMIT TO PRACTICE**
**THURBER ENGINEERING LTD.**
RM SIGNATURE: _____
RM APEGA ID #: 51674
DATE: October 7, 2021
**PERMIT NUMBER: P005186**
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Barry Meays, P.Eng.
Senior Geotechnical Engineer

THURBER

# STATEMENT OF LIMITATIONS AND CONDITIONS

## 1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

## 2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

## 3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

## 4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

## 5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

## 6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

## 7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

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SW33 84-11-6

SE33 84-11-6

SW34 84-11-6

SE34 84-11-6

NE28 84-11-6

NW27 84-11-6

NW28 84-11-6

NE27 84-11-6

SE28 84-11-6

SW28 84-11-6

SW27 84-11-6

SE27 84-11-6

POTENTIAL BORROW AREA

SEE DWG No. 32123-3

SEE DWG No. 32123-2

96-61 (BLUE SI)

TH20-1

TH20-2

TH20-3

TH20-4

TH20-5

TH20-6

TH20-7

TH20-8

88-9

88-15

PH022 SCARP CRACKS

4143 PIPELINE

CLEAR RIVER

N

W E

S

LEGEND

APPROXIMATE TEST HOLE LOCATION

APPROXIMATE TRIBUTARY CENTERLINE

NOTE:

1. JULY 14, 2021 OBSERVATIONS SHOWN IN RED

0 100 200 300 400 500 600m

SCALE 1:10000

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

Alberta

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

**SITE PLAN**

**DWG No. 32123-PH023-1**

| | |
|---|---|
| DRAWN BY | ML |
| DESIGNED BY | BDM |
| APPROVED BY | DWP |
| SCALE | 1:10000 |
| DATE | JULY 14, 2021 |
| FILE No. | 32123 |

THURBER ENGINEERING LTD.

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W28 84-11-6

SE28 84-11-6

SE28 84-11-6

SE28 84-11-6

538
530
520
510
500
490
480
470
460
450

DI
G

900 DIA CSP
CULVERT

WESTBOUND
LANE PATCH

TH20-7

SCARP AT BUSH EDGE

BENT GUARDRAIL &
4 BROKEN POSTS

SEEPAGE AREA

TH20-8

800 DIA CSP
CULVERT

5m LONG HAIRLINE
CRACK REFLECTING
THROUGH PATCH

900 DIA CSP
CULVERT

PH022 SCARP CRACKS

RIPRAP

FIELD
ENTRANCE

N
W
E
S

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. JULY 14, 2021 OBSERVATIONS SHOWN IN RED

0 25 50 75 100 150 200 m
SCALE 1:3000

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

Alberta

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

**DETAILED SITE PLAN - WEST**

**DWG No. 32123-PH023-2**

| | |
|---|---|
| DRAWN BY | ML |
| DESIGNED BY | BDM |
| APPROVED BY | DWP |
| SCALE | 1:3000 |
| DATE | JULY 14, 2021 |
| FILE No. | 32123 |

THURBER ENGINEERING LTD.

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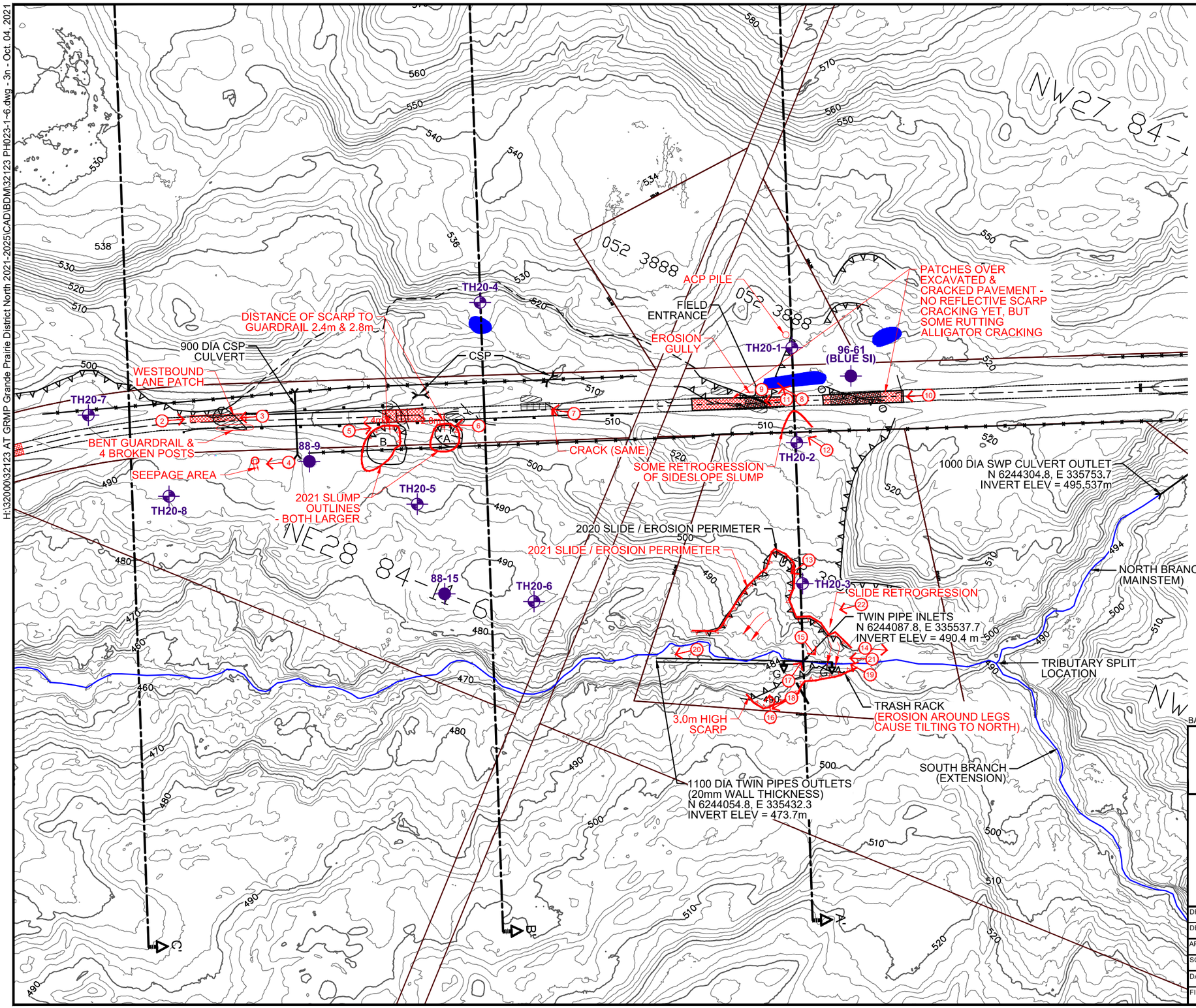


LEGEND

- 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. JULY 14, 2021 OBSERVATIONS SHOWN IN RED
2. DRY CONDITIONS & LOW FLOW IN TRIBUTARY IN 2021 CAUSED SLOWER SLIDE MOVEMENTS

0 25 50 75 100 150 200 m

SCALE 1:3000

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

Alberta

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

**DETAILED SITE PLAN - EAST**

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

| | |
|---|---|
| DRAWN BY | ML |
| DESIGNED BY | BDM |
| APPROVED BY | DWP |
| SCALE | 1:3000 |
| DATE | JULY 14, 2021 |
| FILE No. | 32123 |

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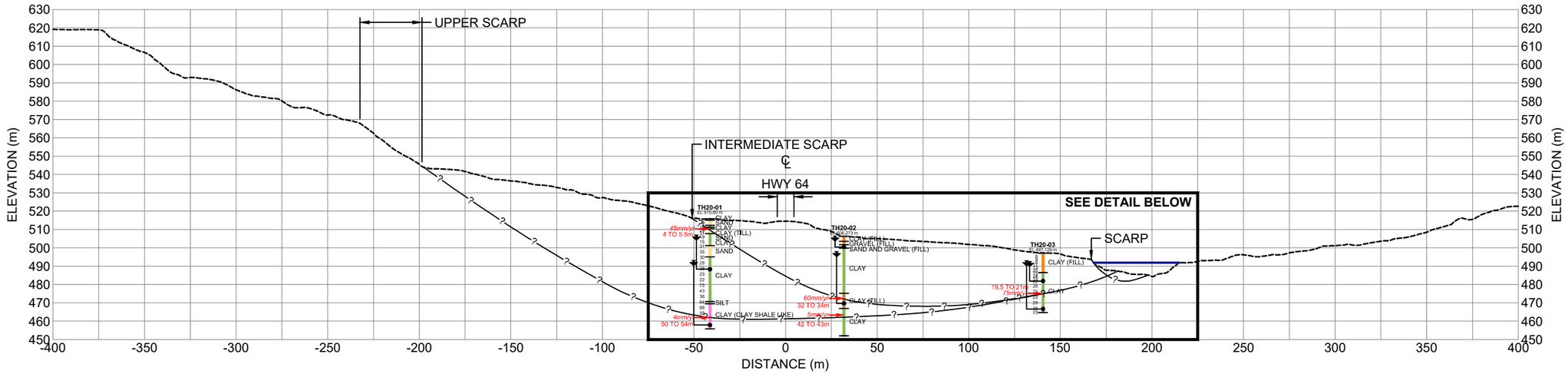
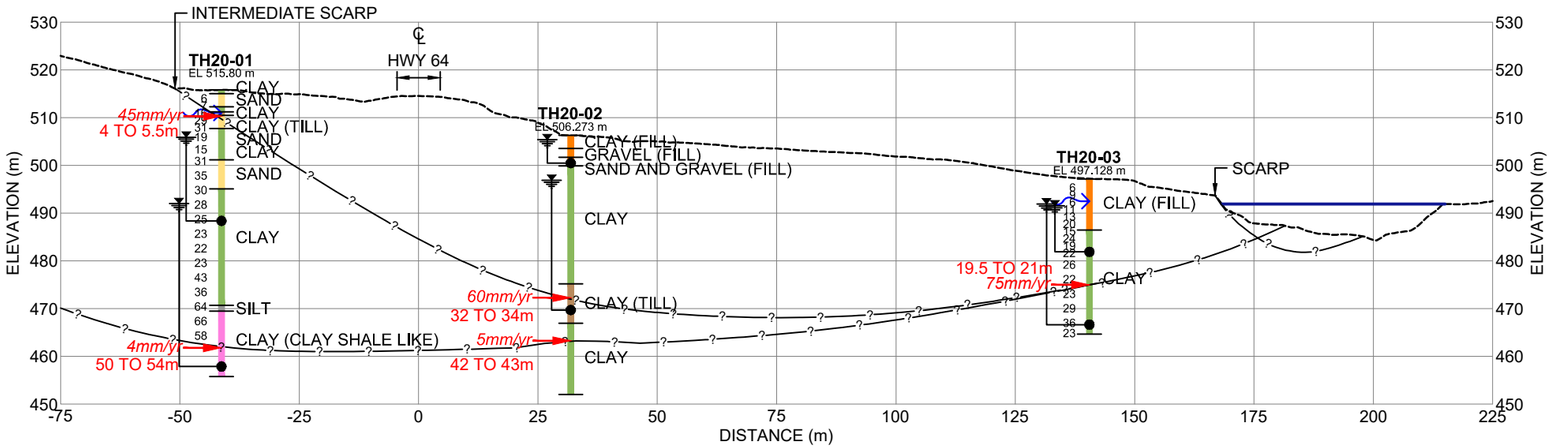
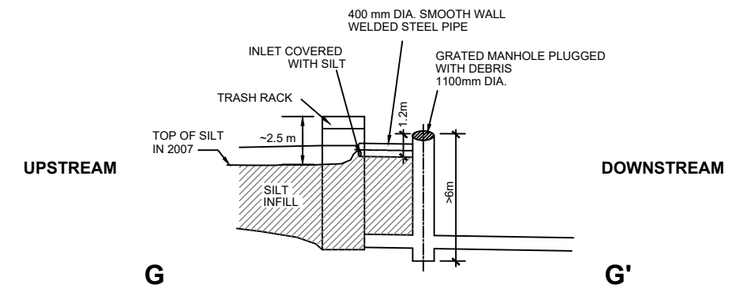



**CROSS-SECTION A-A'**
SCALE 1:2500




**DETAIL**
SCALE 1:1250




**TYPICAL DETAIL OF ONE OF TWO TRASH PIPES AND MANHOLES**
N.T.S.

LEGEND

- 15 — SPT N VALUE
- WATER LEVEL IN PIEZOMETER
- PNEUMATIC PIEZOMETER TIP LOCATION
- 4mm/yr, 42 TO 43m — BASE OF MOVEMENT ZONES AND MOVEMENT RATE FROM Xm TO Xm
- 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.

Alberta

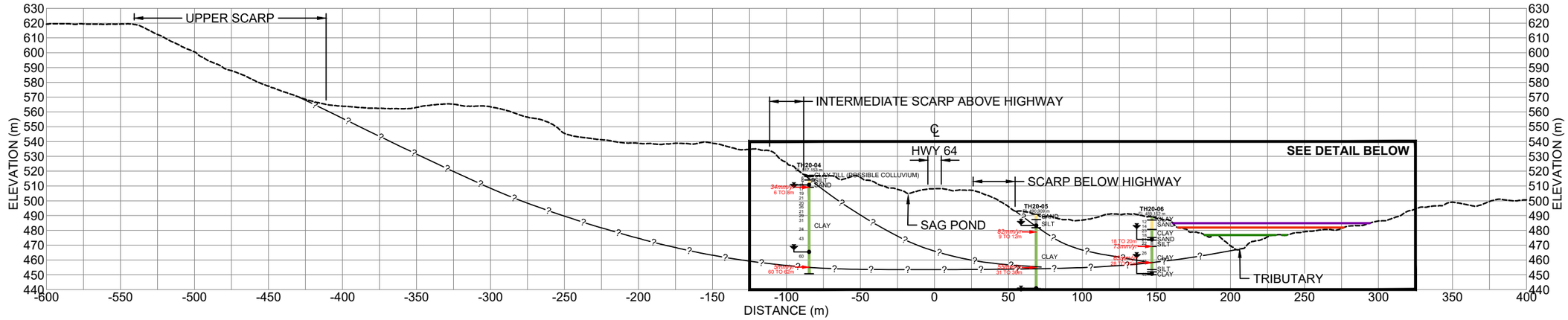
**PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)**
**PH023: HWY 64:02 CLEAR RIVER EAST HILL**

**CROSS-SECTION A-A'**

**DWG No. 32123-PH023-4**

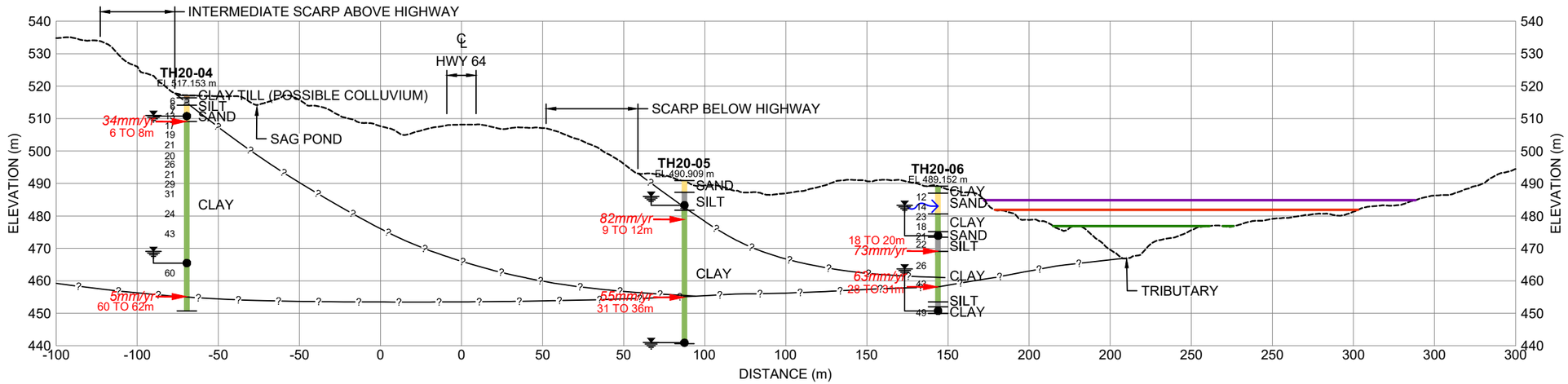
| | |
|---|---|
| DRAWN BY | ML |
| DESIGNED BY | BDM |
| APPROVED BY | DWP |
| SCALE | AS SHOWN |
| DATE | JULY 14, 2021 |
| FILE No. | 32123 |

THURBER ENGINEERING LTD.




## CROSS-SECTION B-B'

SCALE 1:3000




## DETAIL

SCALE 1:1500

LEGEND

- 15 — SPT N VALUE
- WATER LEVEL IN PIEZOMETER
- PNEUMATIC PIEZOMETER TIP LOCATION
- 4mm/yr, 42 TO 43m — BASE OF MOVEMENT ZONES AND MOVEMENT RATE FROM Xm TO Xm
- SEEPAGE
- ASSUMED SLIP SURFACE
- 10 m FILL HEIGHT (FOR POTENTIAL TOE BERM)
- 15 m FILL HEIGHT (FOR POTENTIAL TOE BERM)
- 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.

Alberta

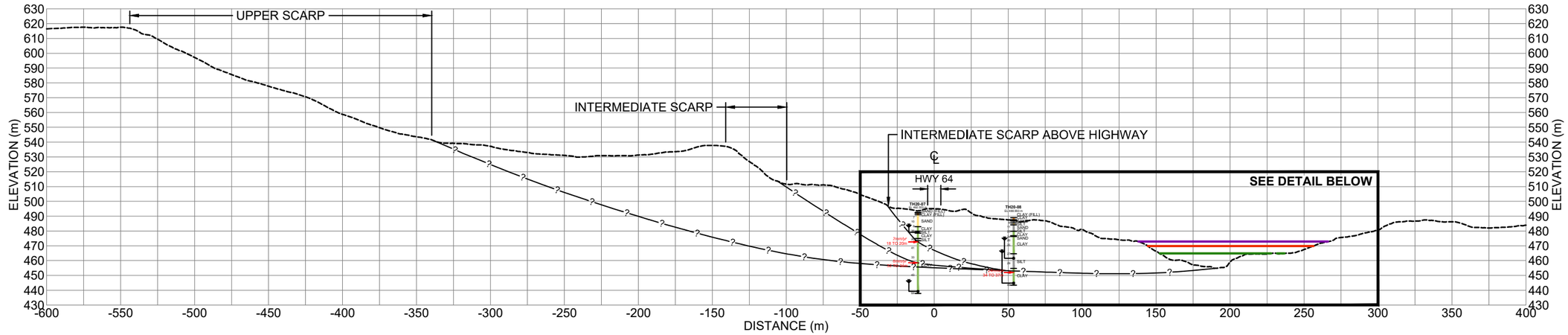
**PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)**
**PH023: HWY 64:02 CLEAR RIVER EAST HILL**

**CROSS-SECTION B-B'**

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

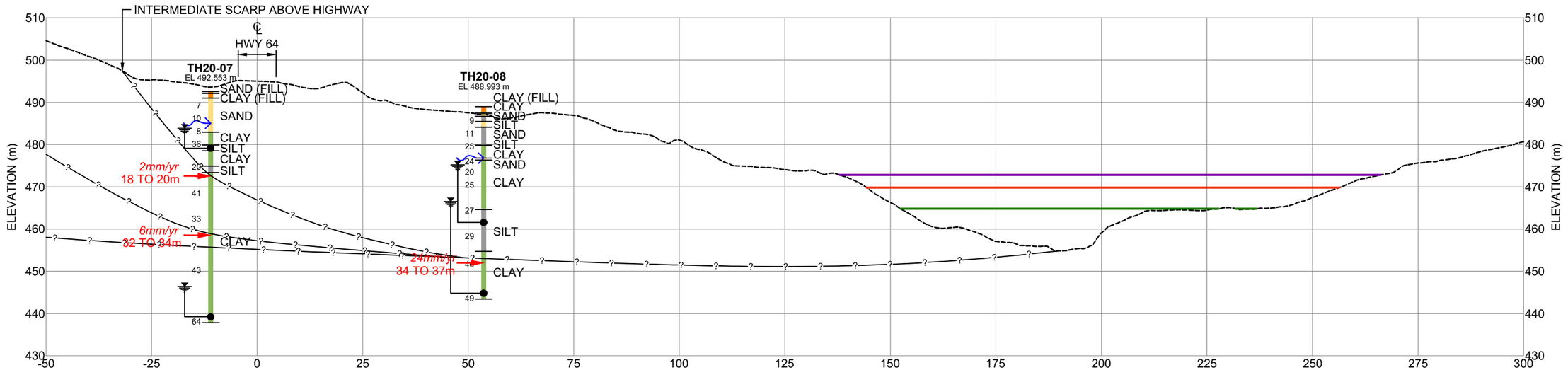
| | |
|---|---|
| DRAWN BY | ML |
| DESIGNED BY | BDM |
| APPROVED BY | DWP |
| SCALE | AS SHOWN |
| DATE | JULY 14, 2021 |
| FILE No. | 32123 |

THURBER ENGINEERING LTD.




## CROSS-SECTION C-C'

SCALE 1:3000




## DETAIL

SCALE 1:1000

LEGEND

- 15 — SPT N VALUE
- WATER LEVEL IN PIEZOMETER
- PNEUMATIC PIEZOMETER TIP LOCATION
- 4mm/yr 42 TO 43m — BASE OF MOVEMENT ZONES AND MOVEMENT RATE FROM Xm TO Xm
- SEEPAGE
- ASSUMED SLIP SURFACE
- 10 m FILL HEIGHT (FOR POTENTIAL TOE BERM)
- 15 m FILL HEIGHT (FOR POTENTIAL TOE BERM)
- 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.

Alberta

**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 | ML |
| DESIGNED BY | BDM |
| APPROVED BY | DWP |
| SCALE | AS SHOWN |
| DATE | JULY 14, 2021 |
| FILE No. | 32123 |

THURBER ENGINEERING LTD.

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.

Photo 2 – Looking east along the recent WB lane patch over the highway cracks and large dip that extends across the highway near the west end of the site.

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

Photo 4 – Looking west along the Test Holes 20-5/20-6 access trail south of the highway at an active seepage area. This caused the tracked water truck to get stuck in Sept, 2020.

Photo 5 – Looking east along the south highway Embankment Slump B.

Photo 6 – Looking west at Embankment Slump A on the south side of the hwy.

Photo 7 – Looking northwest across the highway at last years unrepaired slide cracks east of the northeast guardrail end.


Photo 8 – Looking west at the west milled/patched area over the east slide crack.

Photo 9 – Looking east along the north highway ditch at the dipped hwy and sagged cattail area (no ponded water this year).

Photo 10 – Looking west along the highway at the east milled/patch over the east scarp cracked area at the east end of the site.

Photo 11 - Looking northwest along the main scarp from near the east edge of the highway. Note the erosion gully in the foreground.


Photo 12 – Looking north towards the highway at the enlarged south hwy embankment slump below the east hwy scarp cracked area.

Photo 13 – Looking southwest at the eroded tributary channel from the north side of the eroded piping area. Significant seepage was emanating from the drains in the base.

Photo 14 - Looking east at the upstream end of the eroded and silted in channel.


Photo 15 – Looking southeast at the tilted trash rack and twin pipe inlet risers in the eroded (and now partially silted in) channel.


Photo 16 – Looking north at the piping erosion area shown in Photo 13, on the north edge of the channel.

Photo 17 – Looking northeast at the trash rack and pipe inlets in the eroded channel. Note the enlarged south bank perimeter slumping.

Photo 18 – Looking west at the fresh 3 m high slump scarp along the south edge of the channel.

Photo 19 – Looking northwest at the extensive and continued slumping/erosion along the north channel banks adjacent to the trash rack.


Photo 20 – Looking west along the creek channel at the twin pipes outlets.

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Photo 21 – UAV view looking west overtop the trash rack and twin pipe riser inlets in the eroded channel.

Photo 22 – UAV view looking west at the piping erosion area on the north edge of the eroded channel.