



THURBER ENGINEERING LTD.

October 26, 2022

File No.: 32122

Alberta Transportation
Construction and Maintenance Division
North Central Region
Box 4596, 4513 – 62 Avenue
Barrhead, Alberta
T7N 1A5

Attention: Ms. Amy Driessen, P.Eng.

**ALBERTA TRANSPORTATION GRMP (CON0022163)
NORTH CENTRAL (ATHABASCA AND FORT McMURRAY DISTRICTS)
INSTRUMENTATION MONITORING RESULTS – FALL 2022**

SECTION C

SITE NC006: HWY 2:46 MITSUE LAKE RECREATION AREA (KM 47.6)

Dear Ms. Driessen:

This report provides the results of the bi-annual geotechnical instrumentation monitoring for the above-mentioned site as part of Alberta Transportation's Geohazard Risk Management Program for North Central – Athabasca and Fort McMurray Districts (CON0022163).

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.

1. FIELD PROGRAM AND INSTRUMENTATION STATUS

Four slope inclinometers (SI20-1, SI20-2, SI20-3, and SI20-4) and seven vibrating wire piezometers (VW20-1, VW20-2A, VW20-2B, VW20-3A, VW20-3B, VW20-4A and VW20-4B) were read at the NC006 Hwy 2:46 Mitsue Lake Recreation Area (km 47.6) site on September 25, 2022, by Mr. Niraj Regmi, G.I.T. and Mr. Kyle Crooymans, both of Thurber Engineering Ltd. A site plan showing the approximate instrument locations is included in Appendix A.

There is one SI (SI-1) and two standpipe piezometers (TH05-3 and TH05-4) that were previously monitored at the site as part of the bi-annual instrumentation readings for Alberta Transportation; however, these instruments are not included in the current GRMP instrument monitoring program and were therefore not read.

The SIs were read using a RST Digital Inclinometer probe with a 2 ft. wheelbase and a RST Pocket PC readout. Inclinometer reading depths were defined as per cable markings with respect to the top of the inclinometer casings. The vibrating wire piezometers were read using a GEOKON GK-404 digital readout.



2. DATA PRESENTATION

2.1 General

SI plots for A and B directions are included in Appendix A. Where movement has been recorded the resultant plot (X direction, if applicable) and rate of movement have also been provided. Standpipe and vibrating wire piezometer plots are also provided in Appendix A.

Slope inclinometer and piezometer reading summary tables are provided below. These tables also include instruments deleted from the GRMP program for future reference.

2.2 Zones of Movement

No zones of new movement were observed in the SIs since the previous readings in the spring of 2022.

A zone of movement had been previously observed in SI20-2 over 0.6 m to 1.8 m depth. This instrument seemed to show an apparent upslope movement in the spring of 2022 readings, when compared to the spring of 2021 readings. However, SI20-2 had been damaged between the spring of 2021 and the fall of 2021 readings, and when it was repaired in the spring of 2022, the upper portion of the SI casing was somewhat shifted, leading to erroneous reading. Therefore, the spring of 2022 reading has been chosen to be the new initial reading for this instrument. The zone of movement has also been expanded to 0.6 m to 2.4 m depth.

Zones of movements are summarized in Table NC006-1 below. Table NC006-1 also provides a historical account of the total movement, the depth of movement and the maximum rate of movement that has occurred in the SIs since initialization.



**TABLE NC006-1
FALL 2022 – HWY 2:46 MITSUE LAKE RECREATION AREA (KM 47.6)
SLOPE INCLINOMETER INSTRUMENTATION READING SUMMARY**

Date Monitored: September 25, 2022

INSTRUMENT #	DATE INITIALIZED	TOTAL CUMULATIVE RESULTANT MOVEMENT AND DEPTH OF MOVEMENT TO DATE (mm)	MAXIMUM RATE OF MOVEMENT (mm/yr)	CURRENT STATUS OF SI	DATE OF PREVIOUS READING	INCREMENTAL MOVEMENT SINCE PREVIOUS READING (mm)	CURRENT RATE OF MOVEMENT (mm/yr)	CHANGE IN RATE OF MOVEMENT SINCE PREVIOUS READING (mm/yr)
SI-1	May 23, 1997	131.4 over 0.7 m to 5.0 m depth in 4° direction	32.9 between May and Oct. 2004	Not read*	Sep. 29, 2020	N/A	N/A	N/A
SI20-1	December 21, 2020	No discernible movement	N/A	Operational	June 5, 2022	N/A	N/A	N/A
SI20-2	June 5, 2022 (reinitialized)	7.9 over 0.6 m to 2.4 m depth in 355° direction	25.8 in September 2022	Operational	June 5, 2022	7.9	25.8	N/A
SI20-3	December 20, 2020	9.7 over 1.4 m to 3.2 m depth in 346° direction	21.9 in June 2021	Operational	June 5, 2022	No discernible movement	N/A	-4.9
SI20-4	December 19, 2021	No discernible movement	N/A	Operational	June 5, 2022	N/A	N/A	N/A

Drawing 32122-NC006 in Appendix A provides a sketch of the approximate location of the monitoring instrumentation for this site.

* SI-1 is not included in current GRMP instrumentation and was therefore not read.



**TABLE NC006-2
FALL 2022– HWY 2:46 MITSUE LAKE RECREATION AREA (KM 47.6)
PNEUMATIC PIEZOMETER INSTRUMENTATION READING SUMMARY**

Date Monitored: Not monitored

INSTRUMENT #	DATE INITIALIZED	TIP DEPTH** (m)	GROUND ELEV. (m)	CURRENT STATUS	HIGHEST MEASURED GROUNDWATER LEVEL BGS (m)	MEASURED PORE PRESSURE (kPa)	CURRENT GROUNDWATER LEVEL BGS (m)	PREVIOUS GROUNDWATER LEVEL BGS (m)	CHANGE IN WATER LEVEL SINCE PREVIOUS READING (m)
<i>PN1</i>	<i>Jan. 27, 1993</i>	<i>Unknown</i>	<i>-</i>	<i>Damaged</i>	<i>6.2 kPa on May 24, 1999</i>	<i>N/A</i>	<i>N/A</i>	<i>PN1</i>	<i>Jan. 27, 1993</i>
<i>PN2</i>	<i>Jan. 27, 1993</i>	<i>Unknown</i>	<i>-</i>	<i>Damaged</i>	<i>9.0 kPa on Jul. 29, 1993</i>	<i>N/A</i>	<i>N/A</i>	<i>PN2</i>	<i>Jan. 27, 1993</i>

Drawing 32122-NC006 in Appendix A provides a sketch of the approximate location of the monitoring instrumentation for this site.
Note: pneumatic piezometers are not included in current GRMP instrumentation and were therefore not read.



**TABLE NC006-3
FALL 2022 – HWY 2:46 MITSUE LAKE RECREATION AREA (KM 47.6)
STANDPIPE PIEZOMETER INSTRUMENTATION READING SUMMARY**

Date Monitored: Not monitored

INSTRUMENT #	DATE INITIALIZED	TIP DEPTH (m)	GROUND ELEV. (m)	CURRENT STATUS	HIGHEST MEASURED GROUNDWATER LEVEL BGS (m)	CURRENT GROUNDWATER DEPTH BGS (m)	PREVIOUS GROUNDWATER DEPTH BGS (m)	CHANGE IN WATER LEVEL SINCE PREVIOUS READING (m)
TH05-1	2005	-0.06	N/A	Active, covered by chip seal*	16.26 on September 28, 2012	NOT READ	NOT READ	N/A
TH05-2	2005	0.94	N/A	Destroyed	12.11 on September 20, 2011	N/A	N/A	N/A
TH05-3	2005	1.07	N/A	Not read*	11.89 on September 20, 2011	N/A	12.34	N/A
TH05-4	2005	0.75	N/A	Not read*	3.54 on Oct. 8, 2008	N/A	6.60	N/A

Drawing 32122-NC006 in Appendix A provides a sketch of the approximate location of the monitoring instrumentation for this site.

* standpipe piezometers are not included in current GRMP instrumentation and therefore not read.



**TABLE NC006-4
FALL 2022 – HWY 2:46 MITSUE LAKE RECREATION AREA (KM 47.6)
VIBRATING WIRE PIEZOMETER INSTRUMENTATION READING SUMMARY**

Date Monitored: September 25, 2022

INSTRUMENT #	DATE INITIALIZED	TIP DEPTH (m)	GROUND ELEV. (m)	CURRENT STATUS	HIGHEST MEASURED GROUNDWATER LEVEL BGS (m)	CURRENT GROUNDWATER DEPTH BGS (m)	PREVIOUS GROUNDWATER DEPTH BGS (m)	CHANGE IN WATER LEVEL SINCE PREVIOUS READING (m)
VW20-1 (70917)	December 19, 2020	12.04	-	Operational	6.76 on June 30, 2021	7.43	7.15	-0.28
VW20-2A (70911)	December 20, 2020	3.96	-	Operational	3.24 on June 30, 2021	3.82	3.52	-0.30
VW20-2B (70914)	December 20, 2020	13.72	-	Operational	5.74 on June 30, 2021	6.65	6.06	-0.59
VW20-3A (70912)	December 20, 2020	8.69	-	Operational	2.86 on June 5, 2022	4.16	2.86	-1.30
VW20-3B (70916)	December 20, 2020	16.76	-	Operational	1.48 on June 30, 2021	2.48	1.61	-0.87
VW20-4A (70913)	December 19, 2020	2.74	-	Operational	1.11 on June 5, 2022	2.25	1.11	-1.14
VW20-4B (70915)	December 19, 2020	15.24	-	Operational	2.53 on June 5, 2022	3.36	2.53	-0.83

Drawing 32122-NC006 in Appendix A provides a sketch of the approximate location of the monitoring instrumentation for this site.



3. INTERPRETATION OF MONITORING RESULTS

SI20-1, installed in the south ditch of the highway, has shown no discernible movement since initialization. SI20-2, installed through the embankment on the north side of the highway, showed a rate of movement of 25.8 mm/yr over 0.6 m to 2.4 m depth since the spring of 2022 readings. The movement in this instrument is within the highway embankment fill above the bedrock. SI20-3, installed downslope of the highway inside the tree line, showed no discernible movement since the spring of 2022 readings. SI20-3 showed a similar movement trend in 2021, with movement observed in the spring readings, followed by no discernible movement in the fall. This appears to correspond with higher groundwater levels measured at the instrument location during the spring, with the groundwater level lowering in the fall. SI20-4, installed further downslope of SI20-3 within the tree line, has shown no discernible movement since initialization.

The vibrating wire piezometers all showed decreases in groundwater level since the spring of 2022 readings, ranging from a decrease of 0.28 m in VW20-1 to a decrease of 1.30 m in VW20-3A. The vibrating wire piezometers at this site have shown a general pattern of higher groundwater levels in the spring and lower groundwater levels in the fall. VW20-4B is currently showing the lowest groundwater level measured in the instrument since it was initialized. The vibrating wire piezometer readings are summarized in Table NC006-4 and are plotted in Figure NC006-1 in Appendix A.

4. RECOMMENDATIONS

4.1 Future Work

The instruments should be read again in the spring of 2023.

4.2 Instrumentation Repairs

No instrument repairs are recommended at this time.



5. CLOSURE

We trust this report meets your requirements at present. If you have any questions, please contact the undersigned at your convenience.

Yours very truly,
Thurber Engineering Ltd.
Tarek Abdelaziz, Ph.D., P.Eng.
Principal | Senior Geotechnical Engineer

Bruce Nestor, P.Eng.
Geotechnical Engineer
/jf

Attachments:

- Statement of Limitations and Conditions
- Appendix A
 - Field Inspector's report
 - Site Plan Showing Approximate Instrument Locations (Drawing No. 32122-NC006)
 - SI Reading Plots
 - Figure NC006-1 (Piezometric Depths)



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.



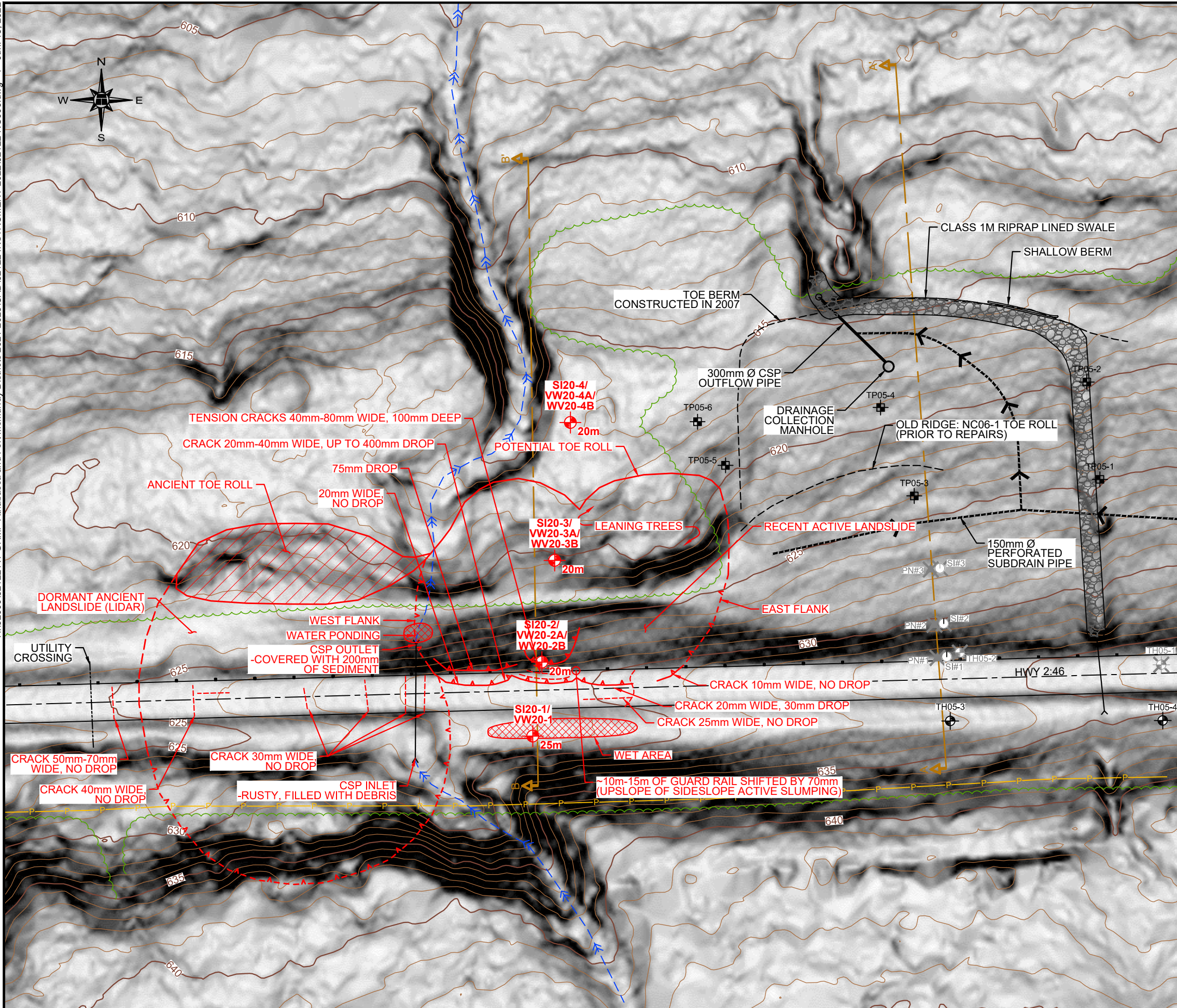
**ALBERTA TRANSPORTATION GRMP (CON0022163)
NORTH CENTRAL (ATHABASCA AND FORT McMURRAY DISTRICTS)
INSTRUMENTATION MONITORING RESULTS**

FALL 2022

**APPENDIX A
DATA PRESENTATION**

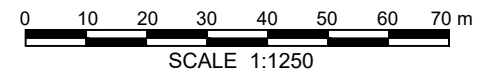
SITE NC006: HWY 2:46 MITSUE LAKE RECREATION AREA (KM 47.6)

H:\32000\32122 AT GRMP Athabasca and Fort McMurray Districts 2021-2025\CAD\32122 INSTRUMENT 2021-2025\CAD\32122-NC006.dwg - 1 - Jun. 15, 2022



- LEGEND**
- APPROXIMATE INSTRUMENT LOCATION (DEPTH (m))
 - APPROXIMATE TEST HOLE LOCATION
 - APPROXIMATE TEST PIT LOCATION
 - APPROXIMATE PNEUMATIC PIEZOMETER LOCATION (INSTRUMENTS NOT READ AS PART OF CURRENT GRMP INSTRUMENTATION PROGRAM)
 - APPROXIMATE SLOPE INCLINOMETER LOCATION (INSTRUMENTS NOT READ AS PART OF CURRENT GRMP INSTRUMENTATION PROGRAM)
 - INSTRUMENT NON-OPERATIONAL
 - MW MONITORING WELL
 - SI SLOPE INCLINOMETER
 - VW VIBRATING WIRE PIEZOMETER
 - TH TEST HOLE
 - TP TEST PIT
 - PN PNEUMATIC PIEZOMETER
 - ACTIVE HEADSCARP
 - DORMANT SCARP CRACK
 - CRACK
 - GUARD RAIL
 - OVERHEAD POWERLINE
 - TREE LINE
 - GULLY
 - 620 GROUND CONTOUR

- NOTES:**
1. SITE FEATURES ARE APPROXIMATE
 2. LIDAR PROVIDED BY ALBERTA TRANSPORTATION
 3. JUNE 10, 2019 OBSERVATIONS SHOWN IN RED



**NORTH CENTRAL
(ATHABASCA AND FORT McMURRAY DISTRICTS)**

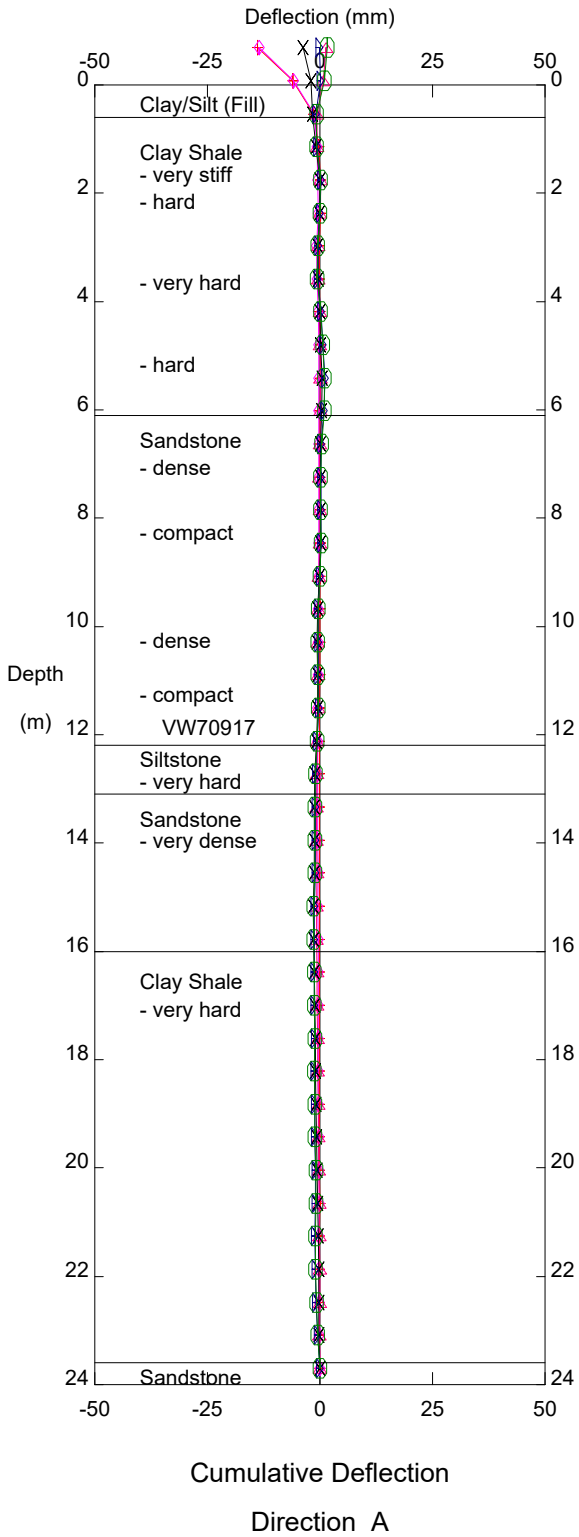
**NC006 HWY 2:46 MITSUE LAKE (KM 47.6)
SITE PLAN SHOWING APPROXIMATE
INSTRUMENT LOCATIONS**

DWG No. 32122-NC006

DRAWN BY	ML
DESIGNED BY	BWN
APPROVED BY	TSA
SCALE	1:1250
DATE	JUNE 2022
FILE No.	32122

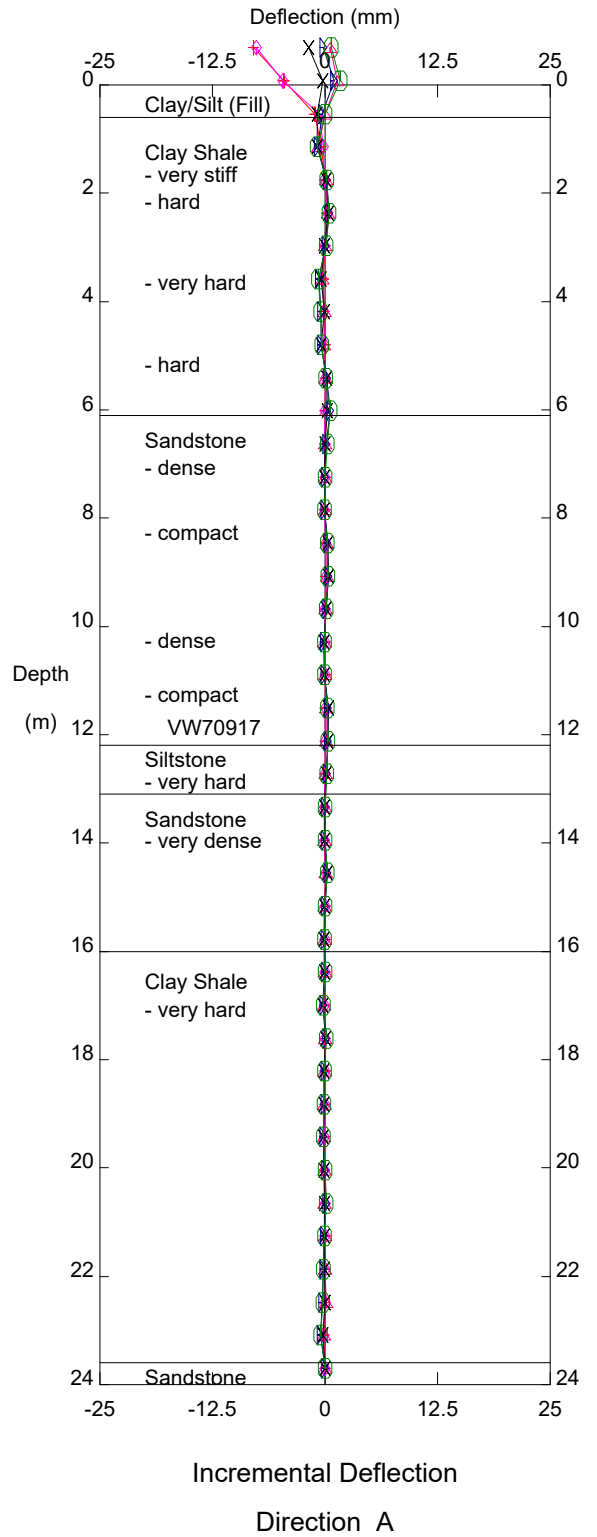
THURBER ENGINEERING LTD.

Thurber Engineering Ltd



LEGEND

Initial	19 Dec 2020
+	1 Feb 2021*
◇	9 Mar 2021*
△	30 Jun 2021*
X	11 Oct 2021*
▷	5 Jun 2022*
○	25 Sep 2022*

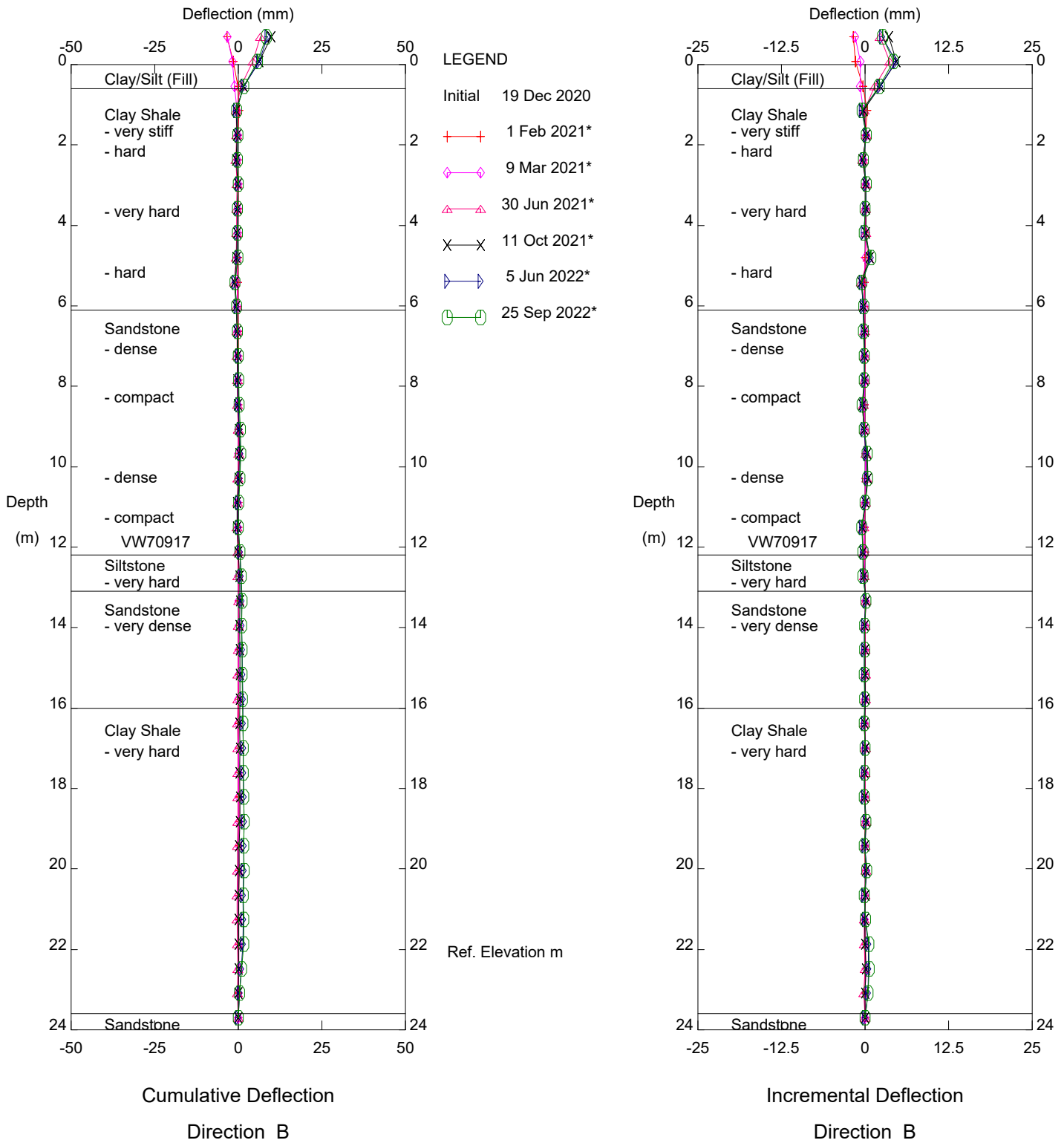


NC006 - Hwy 2:46 Mitsue Lake (km 47.6), Inclinometer SI20-1

Alberta Transportation

Sets marked * include zero shift and/or rotation corrections.

Thurber Engineering Ltd

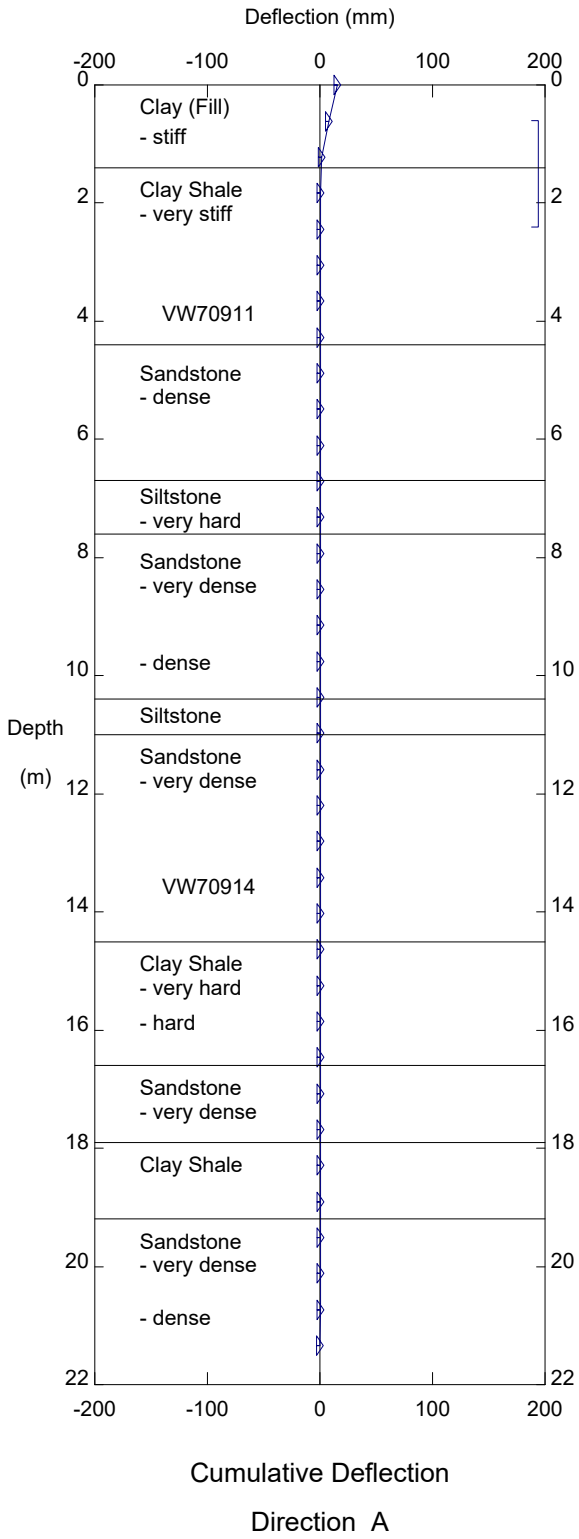


NC006 - Hwy 2:46 Mitsue Lake (km 47.6), Inclinometer SI20-1

Alberta Transportation

Sets marked * include zero shift and/or rotation corrections.

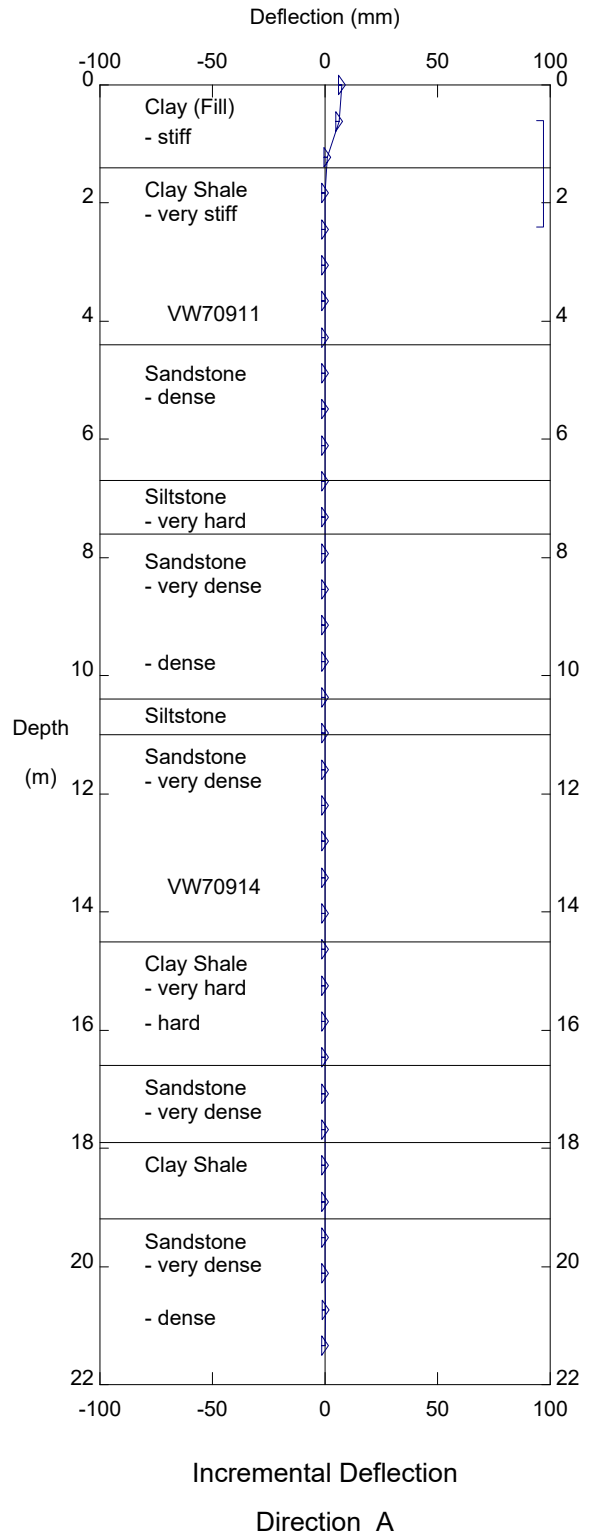
Thurber Engineering Ltd



LEGEND

Initial 5 Jun 2022

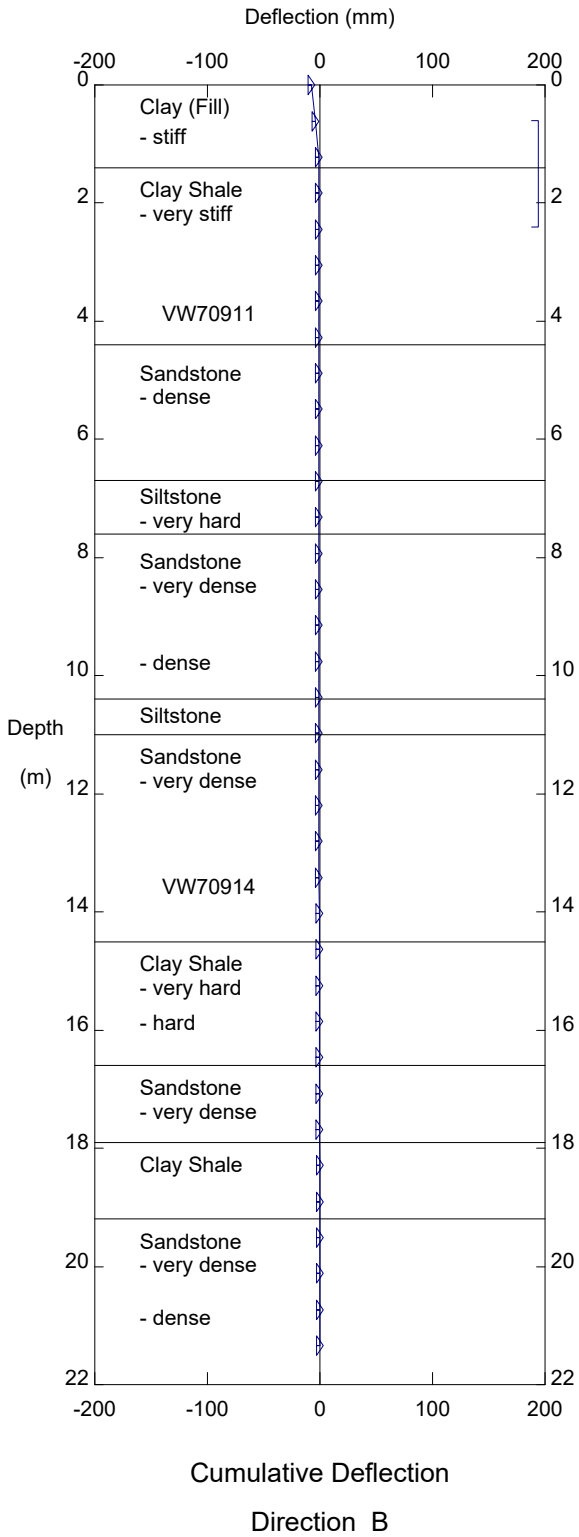
25 Sep 2022



NC006 - Hwy 2:46 Mitsue Lake (km 47.6), Inclinometer SI20-2

Alberta Transportation

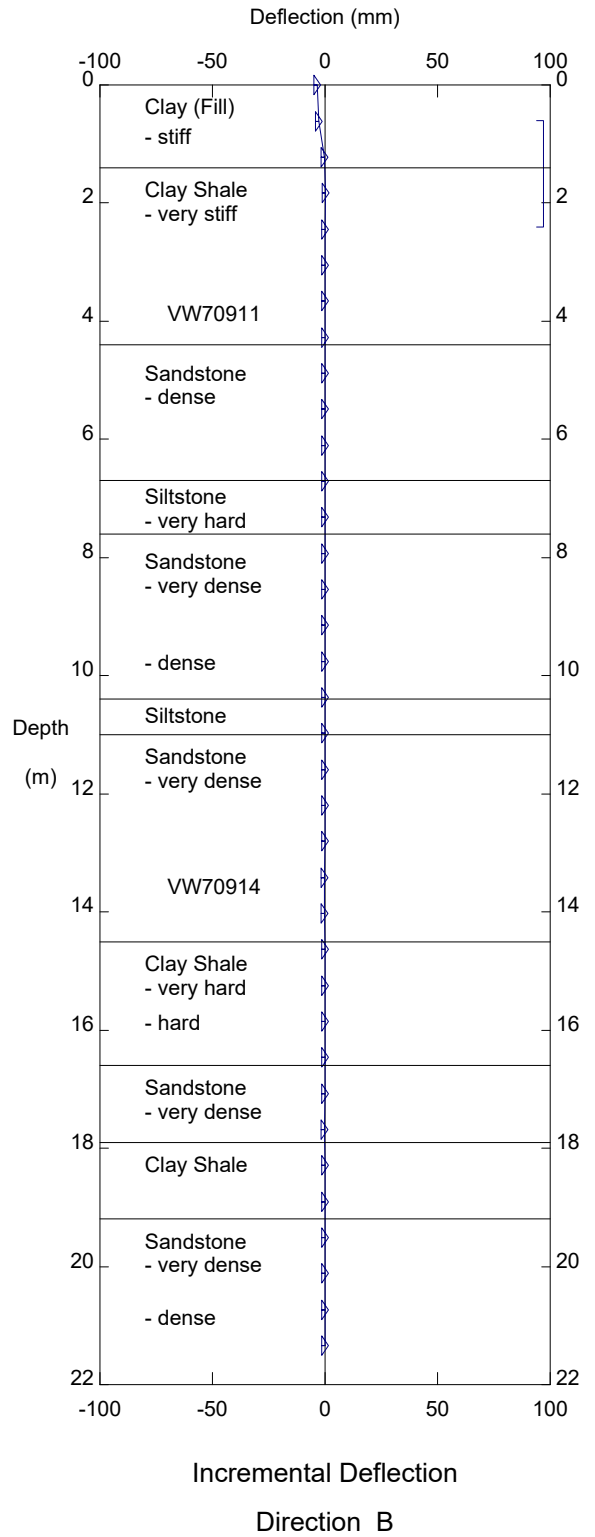
Thurber Engineering Ltd



LEGEND

Initial 5 Jun 2022

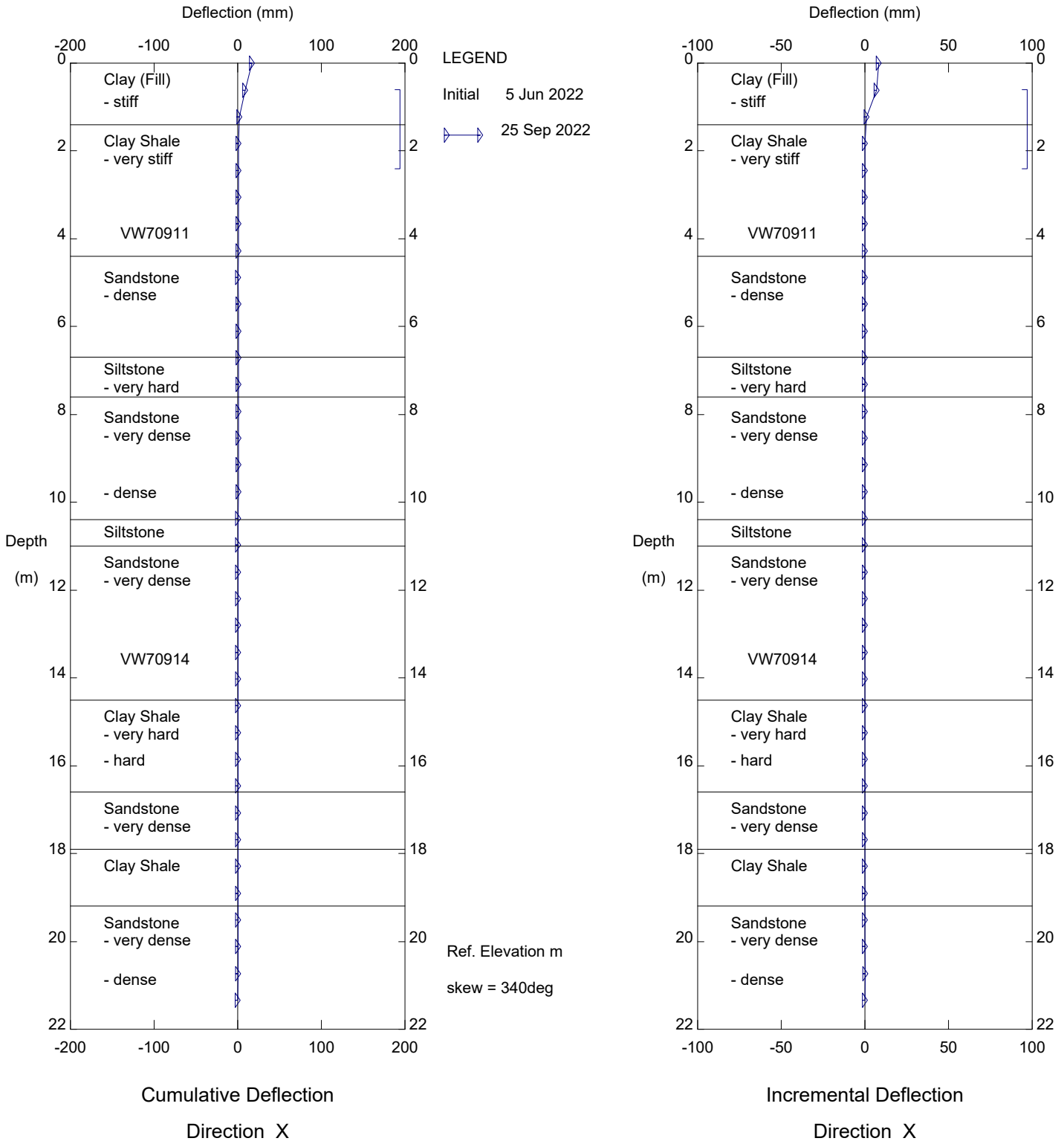
25 Sep 2022



NC006 - Hwy 2:46 Mitsue Lake (km 47.6), Inclinator SI20-2

Alberta Transportation

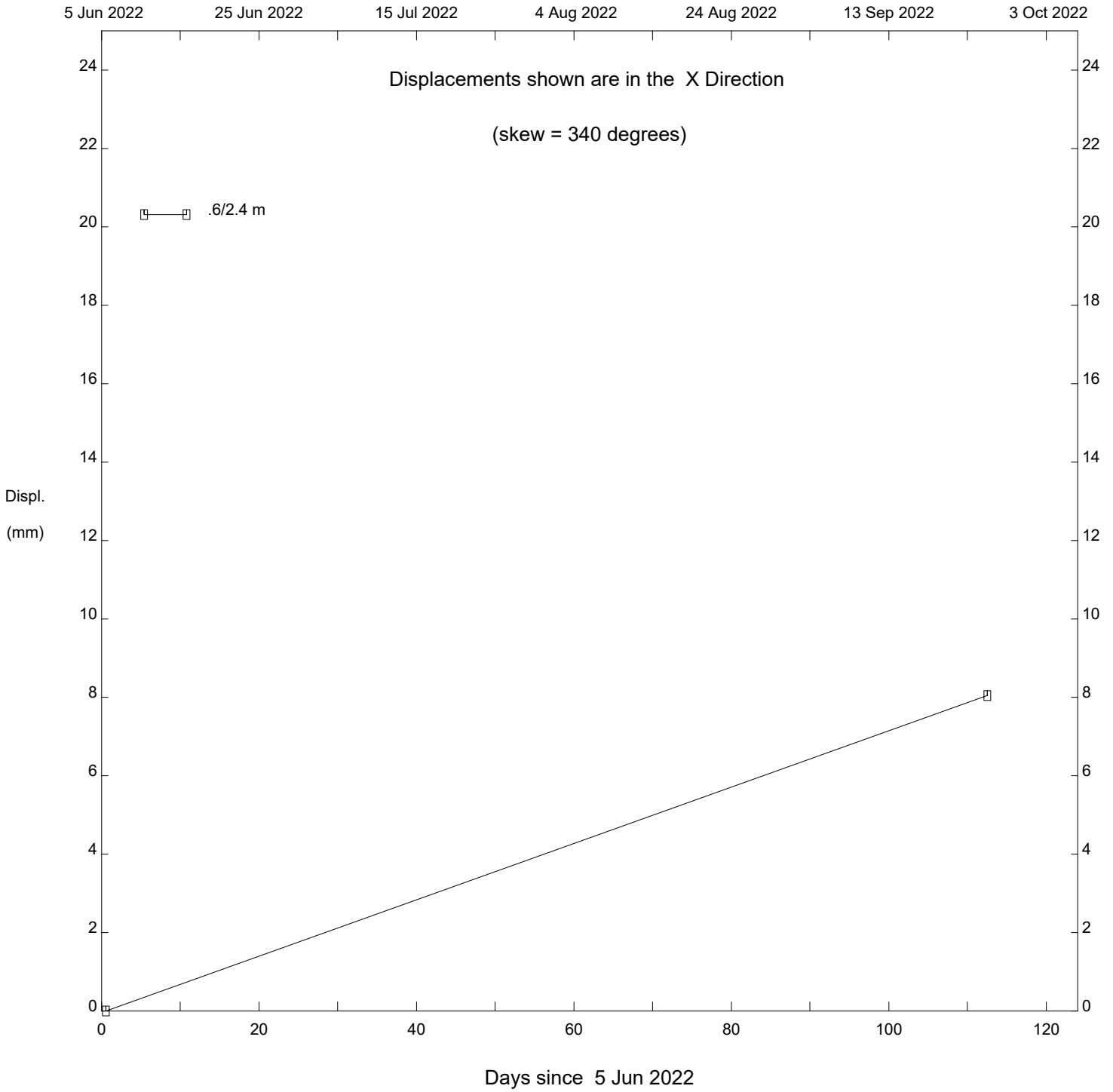
Thurber Engineering Ltd



NC006 - Hwy 2:46 Mitsue Lake (km 47.6), Inclinometer SI20-2

Alberta Transportation

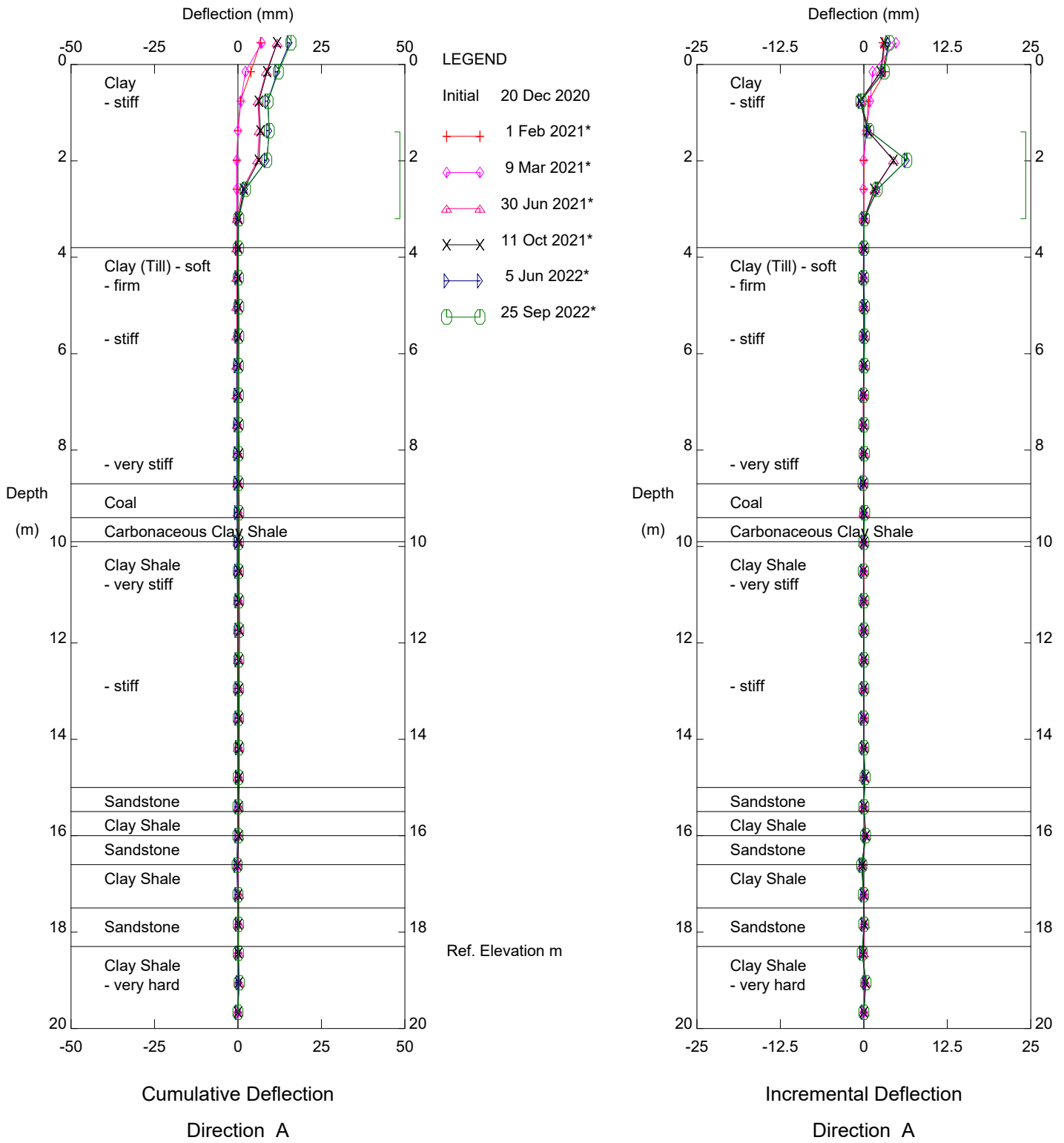
Thurber Engineering Ltd



NC006 - Hwy 2:46 Mitsue Lake (km 47.6), Inclinator SI20-2

Alberta Transportation

Thurber Engineering Ltd

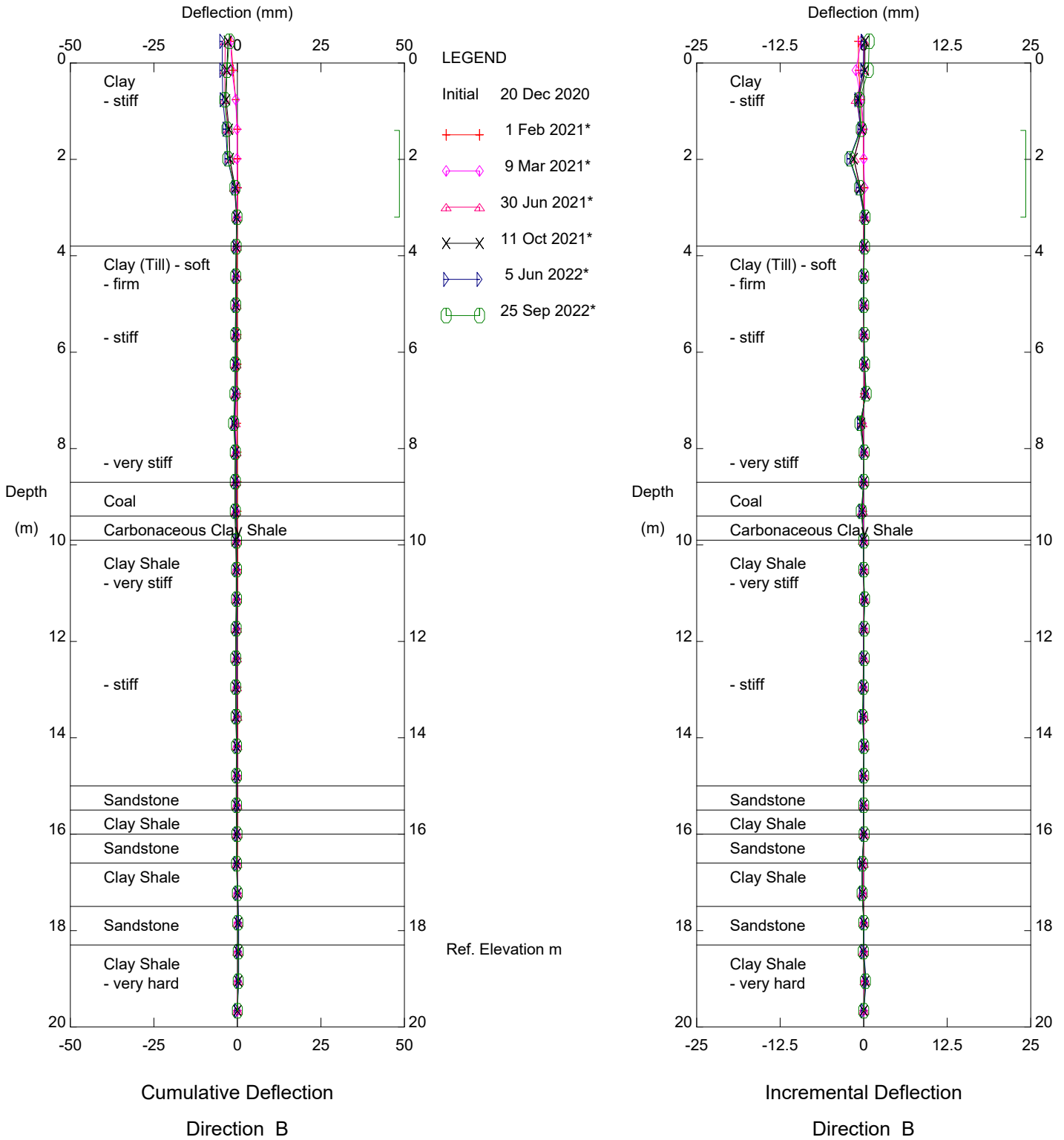


NC006 - Hwy 2:46 Mitsue Lake (km 47.6), Inclinometer SI20-3

Alberta Transportation

Sets marked * include zero shift and/or rotation corrections.

Thurber Engineering Ltd

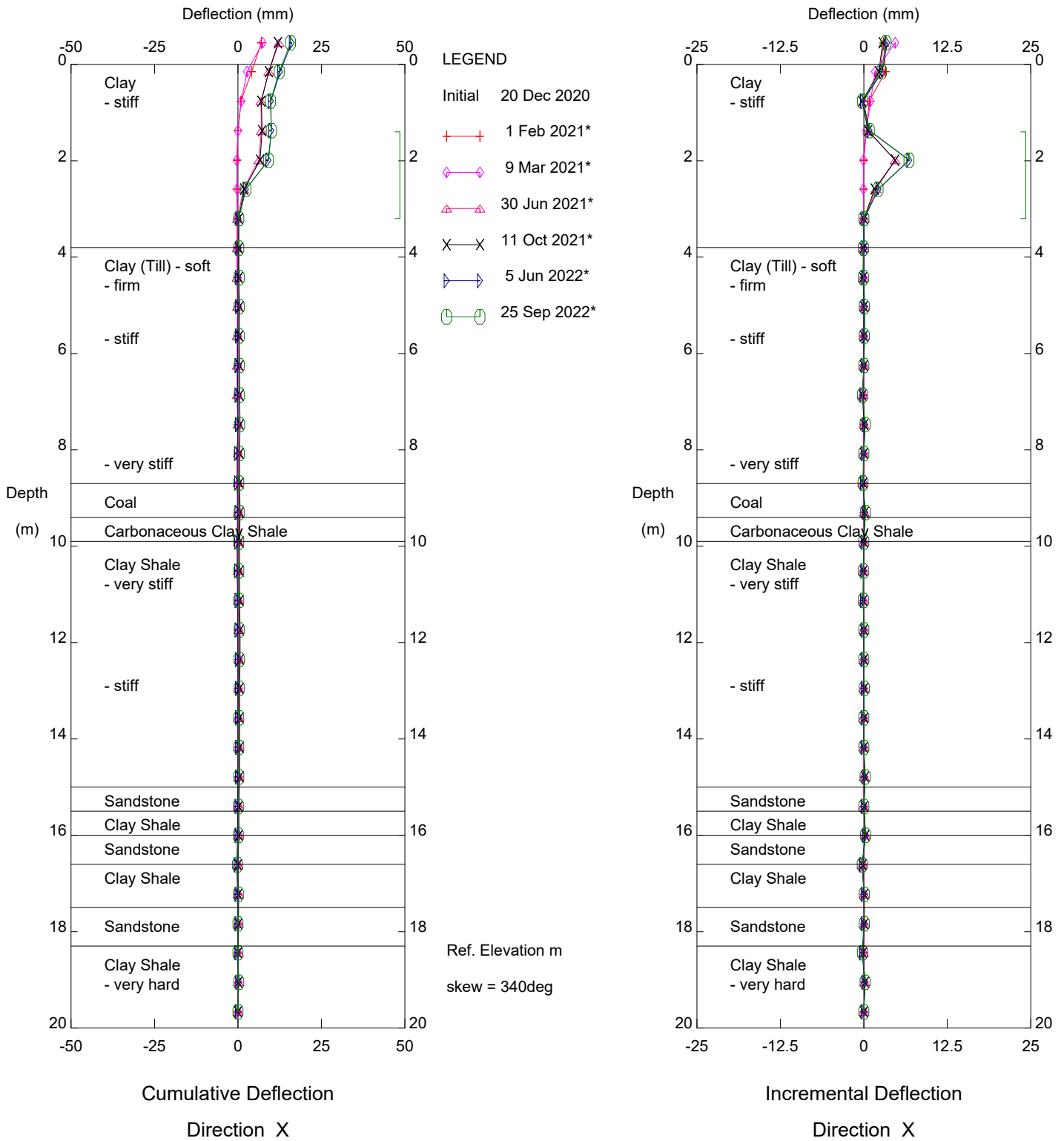


NC006 - Hwy 2:46 Mitsue Lake (km 47.6), Inclinometer SI20-3

Alberta Transportation

Sets marked * include zero shift and/or rotation corrections.

Thurber Engineering Ltd

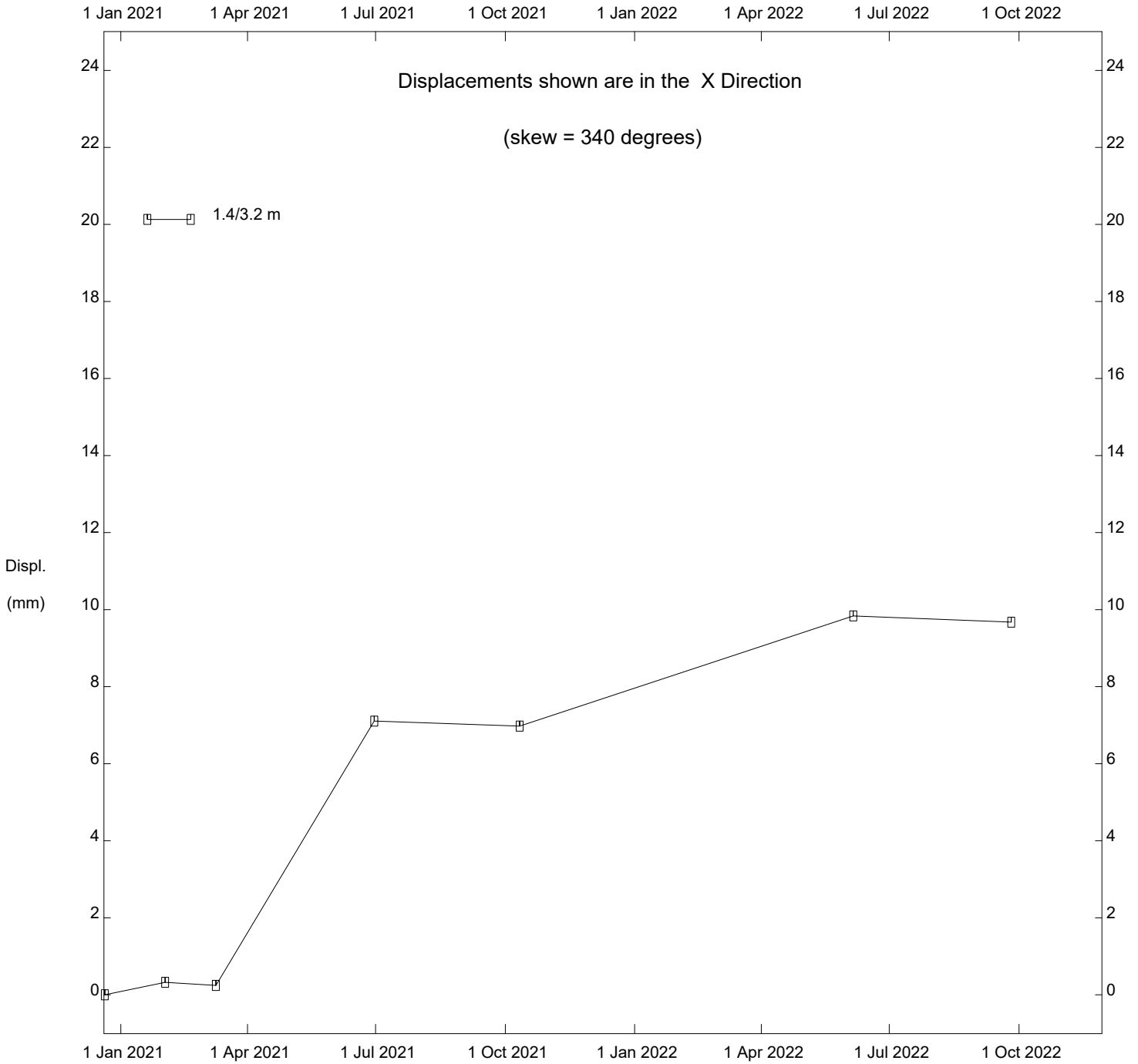


NC006 - Hwy 2:46 Mitsue Lake (km 47.6), Inclinometer SI20-3

Alberta Transportation

Sets marked * include zero shift and/or rotation corrections.

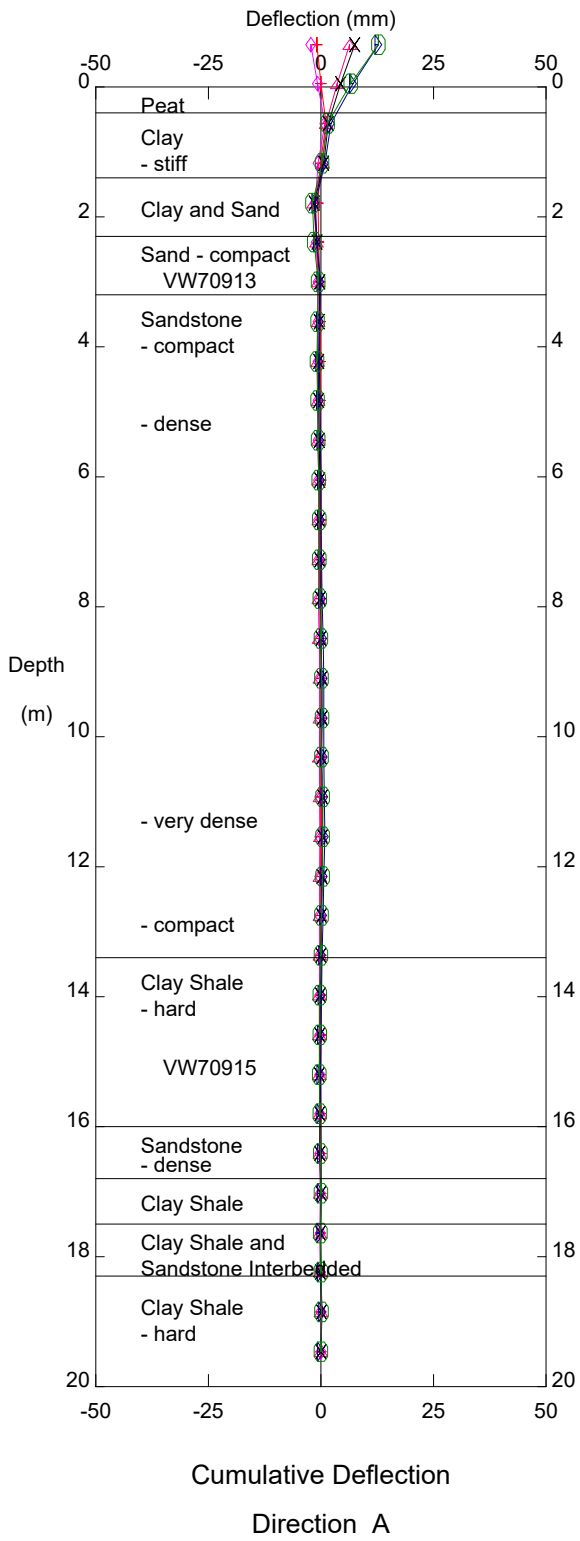
Thurber Engineering Ltd



NC006 - Hwy 2:46 Mitsue Lake (km 47.6), Inclinometer SI20-3

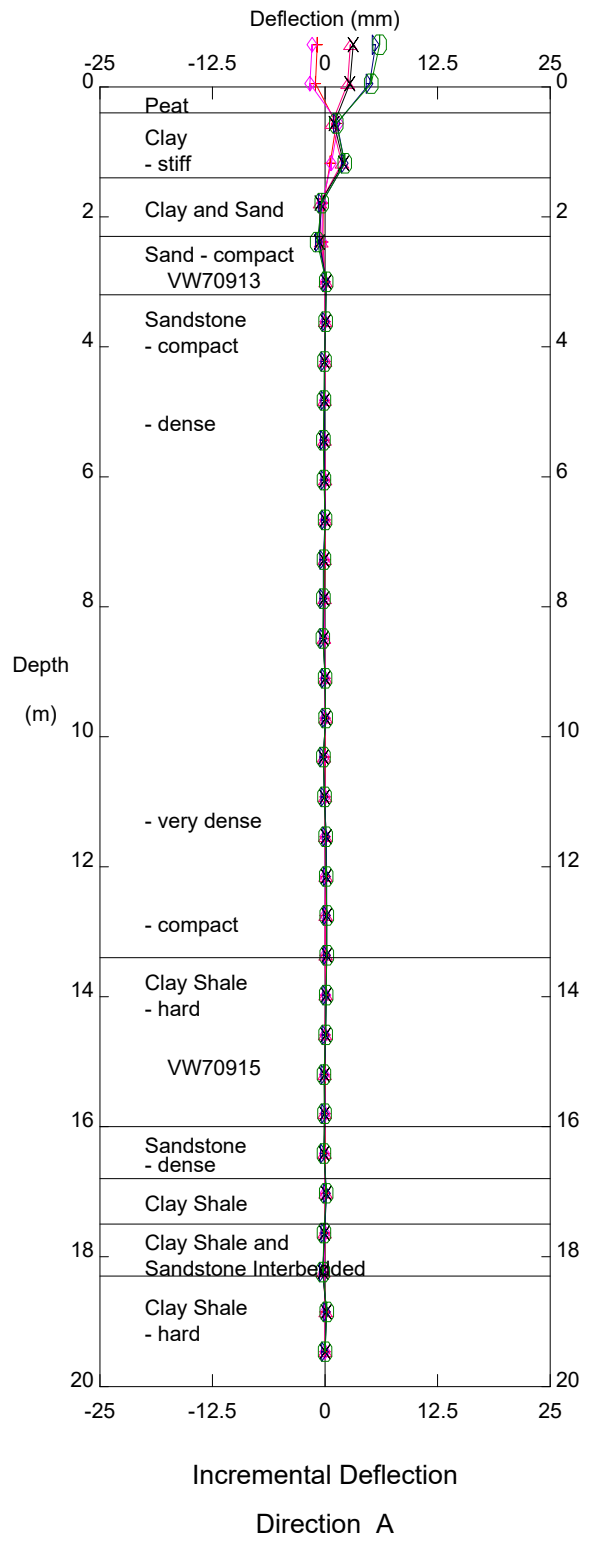
Alberta Transportation

Thurber Engineering Ltd



- LEGEND
- Initial 19 Dec 2020
 - 1 Feb 2021
 - 9 Mar 2021*
 - 30 Jun 2021*
 - 11 Oct 2021*
 - 5 Jun 2022*
 - 25 Sep 2022*

Ref. Elevation m

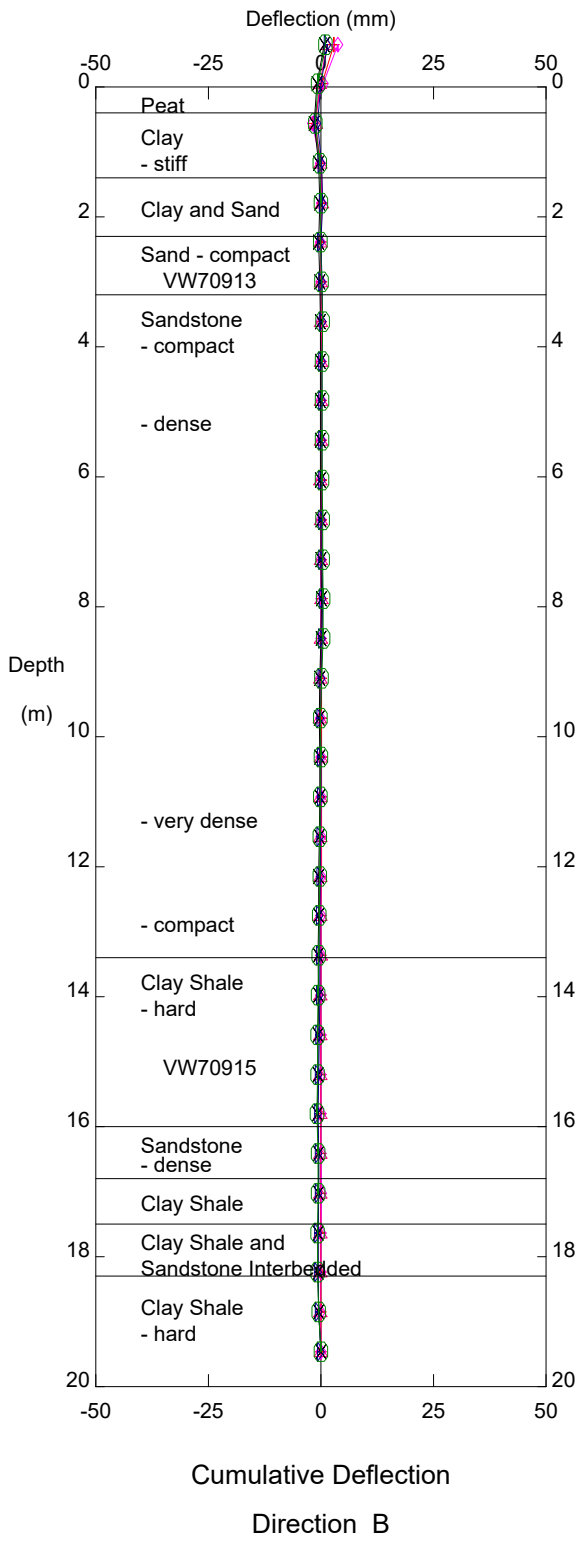


NC006 - Hwy 2:46 Mitsue Lake (km 47.6), Inclinator SI20-4

Alberta Transportation

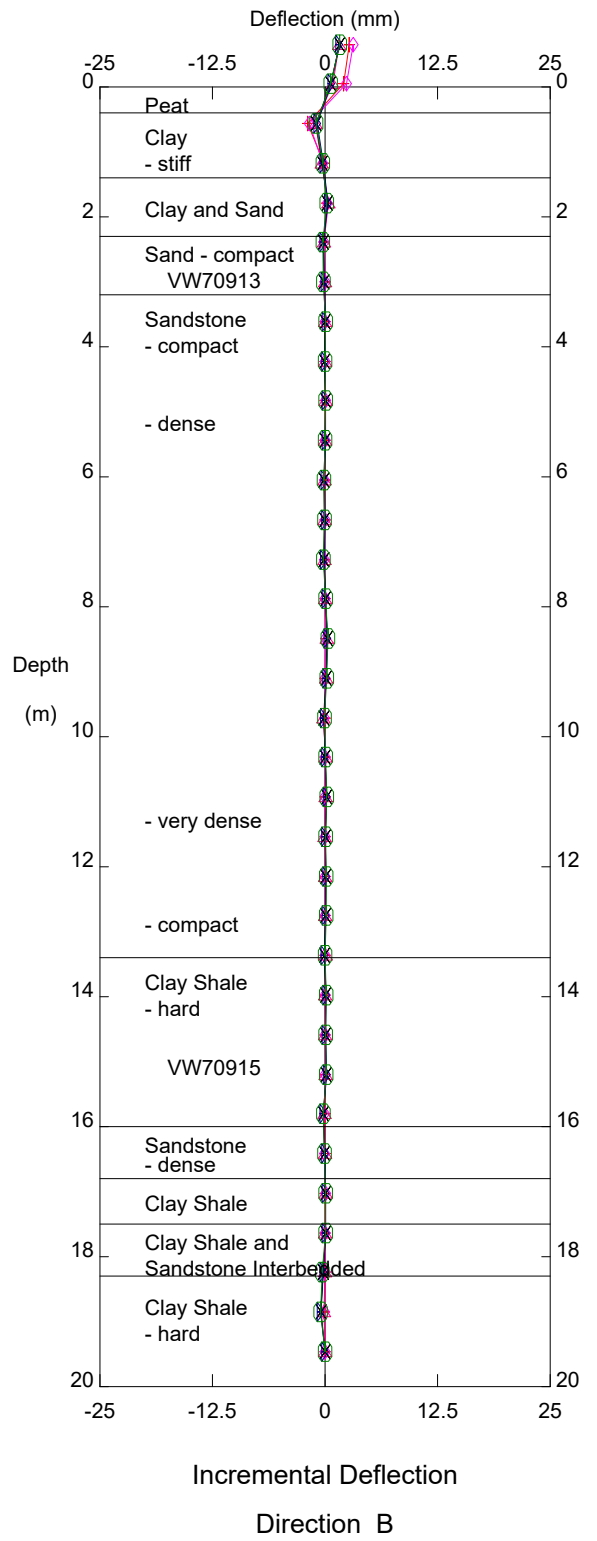
Sets marked * include zero shift and/or rotation corrections.

Thurber Engineering Ltd



- LEGEND
- Initial 19 Dec 2020
 - 1 Feb 2021
 - 9 Mar 2021*
 - 30 Jun 2021*
 - 11 Oct 2021*
 - 5 Jun 2022*
 - 25 Sep 2022*

Ref. Elevation m



NC006 - Hwy 2:46 Mitsue Lake (km 47.6), Inclinometer SI20-4

Alberta Transportation

Sets marked * include zero shift and/or rotation corrections.

**FIGURE NC006-1
HWY 2:46 MITSUE LAKE SLIDE (KM 47.6)
VIBRATING WIRE PIEZOMETER DATA**

