

To: Amy Driessen
Alberta Transportation

From: Leslie Cho and Carrie Murray
Stantec Consulting Ltd.

File: 123315222

Date: June 12, 2022

Reference: North Central Region, Edson, Site NC037 - Highway 32:10 South of Whitecourt, Spring 2022 Instrumentation Monitoring Report

1.0 OBSERVATIONS

1.1 FIELD PROGRAM AND INSTRUMENTATION STATUS

The Spring 2022 reading cycle consisted of instrument readings of eight slope inclinometers (SI10-5, SI10-6, SI10-7, SI10-8, SI10-9, SI18-03, SI18-04, and SI18-05), three pneumatic piezometers (PN10-5, PN10-7 and PN10-8), seven standpipes (SP05-1, SP05-2, SP05-4, SP10-8, SP20-1, SP20-2, and SP20-3), and four vibrating wire piezometers (VW18-02, VW18-03, VW18-04, and VW18-05). **Figure 1** attached provides a schematic of the site. The instruments were read by Mahendran Senthoooran, M.Eng., EIT and Akintola Fakinlede, M.Sc., Engineering Technologist on May 5, 2022.

The slope inclinometers (SI) were measured using an RST MEMS digital inclinometer probe with 0.5 m increments and handheld PC. Readings were taken based on cable markings in relation to the top of SI casing. The pneumatic piezometers (PN) were read with an RST Instruments C-109 Pneumatic Readout. Standpipe piezometers (SP) were read with a Heron Instruments water tape. The vibrating wire piezometers (VW) were read with an RST VW2106 readout box.

GPS coordinates of all instruments were obtained using a Garmin eTrex 10 handheld GPS unit.

PN10-6 was observed to be damaged during the Spring 2022 instrumentation cycle.

Slide remediation was completed in December 2020 and consisted of installing six finger drains along the highway backslope. The finger drains were connected to an interceptor drain along the south ditch. Three standpipes (SP20-1, SP20-2, and SP20-3) were installed as part of construction to monitor groundwater levels along the roadway. The interceptor drain was inspected during Spring 2022 monitoring cycle. Water level observed to be at the invert level of the drainpipe and slight water flow observed at the interceptor pipe daylight location.

2.0 INTERPRETATION

2.1 GENERAL

SI plots are provided in the attachments and summarized in the following sections. Resultant plots in the x-direction (i.e., slope dip direction) along with movement rates, total cumulative movement, maximum movement rates, and incremental movements are provided in **Table NC037-1**.

The groundwater levels from piezometer readings are plotted in the attachments and summarized in **Tables NC037-2, NC037-3, and NC037-4**.

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2.2 ZONES OF MOVEMENT

No new zones of movement were observed in any of the operational slope inclinometers.

2.3 MONITORING RESULTS

2.3.1 Slope Inclinometers

SI10-5 shows a zone of movement from about 8.8 m to 12.3 m depth. The movement zone appears to be creeping at an overall rate of less than 1 mm/yr since berm construction in 2011. The current movement rate is 10 mm/yr; however, the cumulative movement decreased by 8 mm to 33 mm.

SI10-6 has a movement zone between 6.9 m and 7.9 m depth and appears to be creeping at a rate of less than 1 mm/yr since berm construction in 2011. An increase to 3 mm/yr rate of movement was observed during Fall 2017. Since then, the rate has returned to less than 1 mm/yr.

SI10-7 shows movement between 1.2 m to 4.7 m and is moving at an average rate of 2 mm/yr since berm construction in 2011. Spring 2022 reading cycle resulting in a current rate of movement of 1 mm/yr and a cumulative movement of 120 mm.

The absolute position plot for SI10-7 suggests there is disturbance of about 40 mm in the soil surrounding the inclinometer casing between 6 m to 15 m depth. This disturbance may be causing the erratic movement observed in the incremental and cumulative movement plots.

SI10-8 has two zones of movement at approximately 2.5 m and 8.0 m depth. The deeper movement zone has recorded less than 1 mm of movement since 2016 while the upper zone has cumulative movement up to 3 mm. The current movement rate in the upper zone is less than 1 mm/yr and appears to be creeping.

Note that during the work transfer to Stantec in 2016, a slight depth discrepancy was observed in SI10-8 due to different units of measurement used during data collection. To present more accurate information, data prior to 2016 was excluded from the SI plots and the cumulative movement since initialization included on Table NC37-1.

SI10-9 has two zones of movement at approximately 4.6 m to 6.1 m and 7.6 m to 9.6 m depth. The upper movement zone shows creep movement since 2011 with movement rates of less than 1 mm/yr. Negligible movement was observed in the lower movement zone since initialization.

SI18-04 has a potential movement zone between 2 m and 4 m. The current rate of movement is less than 1 mm/yr with total cumulative movement of about 2 mm since 2018.

No discernable movement was observed in **SI18-03** and **SI18-05**.

2.3.2 Piezometers

Most of the PNs have remain consistent since Spring 2011 showing very little to no change (<0.1 m) in groundwater level.

SP05-01 shows an increase in water level by approximately 0.6 m since the Spring 2021 reading cycle.

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SP05-2 shows a decrease in water level by approximately 0.2 m since the Spring 2021 reading cycle. This SP has historically experienced variability on the order of ± 5 m in water level since 2011.

SP05-4 shows an increase in water level by 0.5 m.

SP10-8 is dry and has not changed from the previous reading cycle.

The water level was at 1.5 m bgs in **SP20-1** and at 2.0 m in **SP20-2** while **SP20-3** remained dry.

The VWP's showed little (0.1 m) to no change in piezometric level since the previous reading cycle.

3.0 RECOMMENDATIONS

3.1 FUTURE WORK

It is recommended that all instruments be read during the Spring 2023 reading cycle.

3.2 INSTRUMENTATION REPAIRS

PN10-6 was observed to be damaged during the Spring 2022 reading cycle.

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Table NC037-1: Spring 2022 Slope Inclinometer Reading Summary

Instrument Name	Date Initialized	Coordinates ⁽¹⁾ (UTM 11U, NAD1983) (m)		Total Cumulative Resultant Movement and Depth of Movement to Date (mm)	Maximum Rate of Movement (mm/yr)	Current Status	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)
		Northing	Easting							
SI10-4	Jan. 16, 2010	-	-	5 over 7.4m to 9.9m depth in the 0° direction	11 in June 2017	Non - Operational	June 12, 2017	Knocked over in Fall 2017		
SI10-5	Jan. 16, 2010	5999425	583333	33 over 8.8 m to 12.3 m depth in 355° direction	42 in Sept. 2011	Operational	July 5, 2021	-8	-10	-12
SI10-6	Jan. 16, 2010	5999420	583294	11 over 6.9m to 7.9 m depth in 343° direction	6 in Sept. 2011	Operational	July 5, 2021	<1	<1	<1
SI10-7	Jan. 16, 2010	5999468	583291	120 over 1.2m to 4.7m depth in 345° direction	728 in Oct. 2011 during construction	Operational	July 5, 2021	9	1	<1
SI10-8	Jan. 16, 2010	5999469	583662	4 over 1.9 m to 3.3 m depth in 42° direction since 2016 and 0 mm prior to 2016	2 in April 2018	Operational	July 5, 2021	<1	<1	<1
				< 1 over 7.3 m to 8.4 m depth in 42° direction since 2016 and 2 mm prior to 2016	1 in Sept. 2016			<1	<1	<1

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Instrument Name	Date Initialized	Coordinates ⁽¹⁾ (UTM 11U, NAD1983) (m)		Total Cumulative Resultant Movement and Depth of Movement to Date (mm)	Maximum Rate of Movement (mm/yr)	Current Status	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)
		Northing	Easting							
SI10-9	Jan. 16, 2010	5999477	583665	8 over 4.6 m to 6.1m depth in 26° direction	2 in Sept. 2011	Operational	September 24, 2020	Negligible Movement (less than 1 mm/yr)		
SI10-9	Jan. 16, 2010	5999477	583665	1 over 7.6m to 9.6m depth in 26° direction	4 in May 2018	Operational	July 5, 2021	<1	<1	<1
SI18-01	Mar 28, 2018	-	-	66 over 1.2m to 2.2m depth in 340° direction	98 in June 2018	Non - Operational	September 25, 2019	Sheared off @ 2.5 m in Fall 2019		
SI18-03	Mar 28, 2018	5999460	583601	No Discernable Movement		Operational	July 5, 2021	No Discernable Movement		
SI18-04	Mar 28, 2018	5999453	583541	2 over 2.2 m to 4.2 m depth in 0° direction		Operational	July 5, 2021	<1	<1	<1
SI18-05	Mar 28, 2018	5999487	583594	No Discernable Movement Zone		Operational	July 5, 2021	No Discernable Movement		
Note: (1) Updated May 5, 2022, with approximate accuracy of ± 3 m.										

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Table NC037-2: Spring 2022 Pneumatic Piezometer Reading Summary

Instrument Name	Date Initialized	Coordinates ⁽¹⁾ (UTM 11U, NAD1983) (m)		Tip Elevation (mbgs)	Ground Elevation (m) (aMSL) ⁽²⁾	Current Status	Maximum Piezometric Elevation (m bgs)	Measured Piezometric Elevation (m) (Groundwater Level)	Previous Piezometric Elevation (m) (Groundwater Level)	Change in Piezometric Level Since Previous Reading (m)
		Northing	Easting							
PN10-4 (33010)	Jan. 16, 2010	-	-	708.8	719.3	Non-operational	719.2 Sept. 2010	Damaged in Fall 2017		
PN10-5 (32890)	Jan. 16, 2010	5999425	583333	708.6	719.8	Operational	719.4 Jan 2010	708.6 (11.3 m bgs)	708.6 (11.3 m bgs)	No Change
PN10-6 (32889)	Jan. 16, 2010	5999420	583294	711.8	719.9	Non-operational	712.1 Oct 2012 & May 2016	-	711.8 (8.1 m bgs)	-
PN10-7 (32891)	Jan. 16, 2010	5999468	583291	701.8	707.1	Operational	702.2 May 2016	702.0 (5.1 m bgs)	702.0 (5.1 m bgs)	No Change
PN10-8 (32892)	Jan. 16, 2010	5999469	583662	710.4	713.6	Operational	713.6 June 2017	710.1 (3.6 m bgs)	710.2 (3.5 m bgs)	-<0.1
Note: (1) Updated May 5, 2022, with approximate accuracy of ± 3 m. (2) aMSL = Above Mean Sea Level										

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Table NC037-3: Spring 2022 Standpipe Piezometer Summary

Instrument Name	Date Initialized	Coordinates ⁽¹⁾ (UTM 11U, NAD1983) (m)		Ground Elevation (m)	Current Status	Maximum Groundwater Elevation (m)	Measured Water Level Elevation (m) (Groundwater Level)	Previous Water Level Elevation (m) (Groundwater Level)	Change in Groundwater Level Since Previous Reading (m)
		Northing	Easting						
SP05-1	May 9, 2005	5999398	583378	720.6	Operational	719.11 Oct 2014	718.3 (0.4 m bgs)	717.8 (0.9 m bgs)	0.5
SP05-2	May 19, 2005	5999430	583370	719.1	Operational	715.78 May 2015	709.8 (9.3 m bgs)	710.0 (9.1 m bgs)	-0.2
SP05-4	May 9, 2005	5999482	583369	706.8	Operational	704.87 May 2011	703.6 (3.2 m bgs)	703.1 (3.7 m bgs)	0.5
SP10-8	Jan. 16, 2012	5999469	583662	713.6	Operational	704.44 Oct 2014	Dry	Dry	No change
SP20-1	December 4, 2020	5999419	583492	-	Operational	-	- (1.5 m bgs)	- (1.6 m bgs)	0.1
SP20-2	December 4, 2020	5999429	583590	-	Operational	-	- (2.0 m bgs)	Dry	Increased from dry
SP20-3	December 4, 2020	5999439	583676	-	Operational	-	Dry	Dry	No change
Note: (1) Updated May 5, 2022, with approximate accuracy of ± 3 m.									

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Table NC037-4: Spring 2022 Vibrating Wire Piezometer Summary

Instrument Name	Date Initialized	Coordinates ⁽¹⁾ (UTM 11U, NAD1983) (m)		Ground Elevation (m)	Tip Elevation (m)	Current Status	Maximum Piezometric Level (mbgs)	Measured Piezometric Elevation (m) (Piezometric Level)	Previous Piezometric Elevation (m) (Piezometric Level)	Change in Piezometric Level Since Previous Reading (m)
		Northing	Easting							
VW18-01	Mar. 28, 2018	-	-	-	714.7	Non – Operational	1.1 Sept. 2018	Found sheared off in Fall 2019.		
VW18-02	Mar. 28, 2018	5999415	583539	718.4	715.4	Operational	1.0 March 2018	716.8 (1.6 m bgs)	716.9 (1.5 m bgs)	- 0.1
VW18-03	Mar. 28, 2018	5999460	583601	715.9	711.9	Operational	3.7 May 2018	Dry	Dry	No change
VW18-04	Mar. 28, 2018	5999453	583541	716.6	712.0	Operational	4.1 May 2020	Dry	Dry	No change
VW18-05	Mar. 28, 2018	5999487	583594	709.8	702.2	Operational	7.5 Sept. 2018	Dry	702.3 (7.5 m bgs)	Decreased to dry
Note: (1) Updated May 5, 2022, with approximate accuracy of ± 3 m.										

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4.0 CLOSING

We trust this instrumentation report meets your requirements. If you have any questions, please do not hesitate to contact the undersigned.

Stantec Consulting Ltd.

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Attachment: Figure 1 – Proposed Remediation Plan
SI10-5 Slope Inclinator Plots
SI10-6 Slope Inclinator Plots
SI10-7 Slope Inclinator Plots
SI10-8 Slope Inclinator Plots
SI10-9 Slope Inclinator Plots
SI18-03 Slope Inclinator Plots
SI18-04 Slope Inclinator Plots
SI18-05 Slope Inclinator Plots
Pneumatic Piezometer Elevation vs. Time Plot
Pneumatic Piezometer Depth vs Time Plot
Standpipe Piezometer Elevation vs. Time Plot
Standpipe Piezometer Depth vs Time Plot
Vibrating Wire Piezometer Depth vs Time Plot
NC037 Spring 2022 Damaged Instruments Photo

DEPARTMENT BAR CODE
 DRAWING
 HIGHWAY
 CONTRACT
 DESCRIPTION
 PHOTO
 DATE
 BY
 SURVEYED

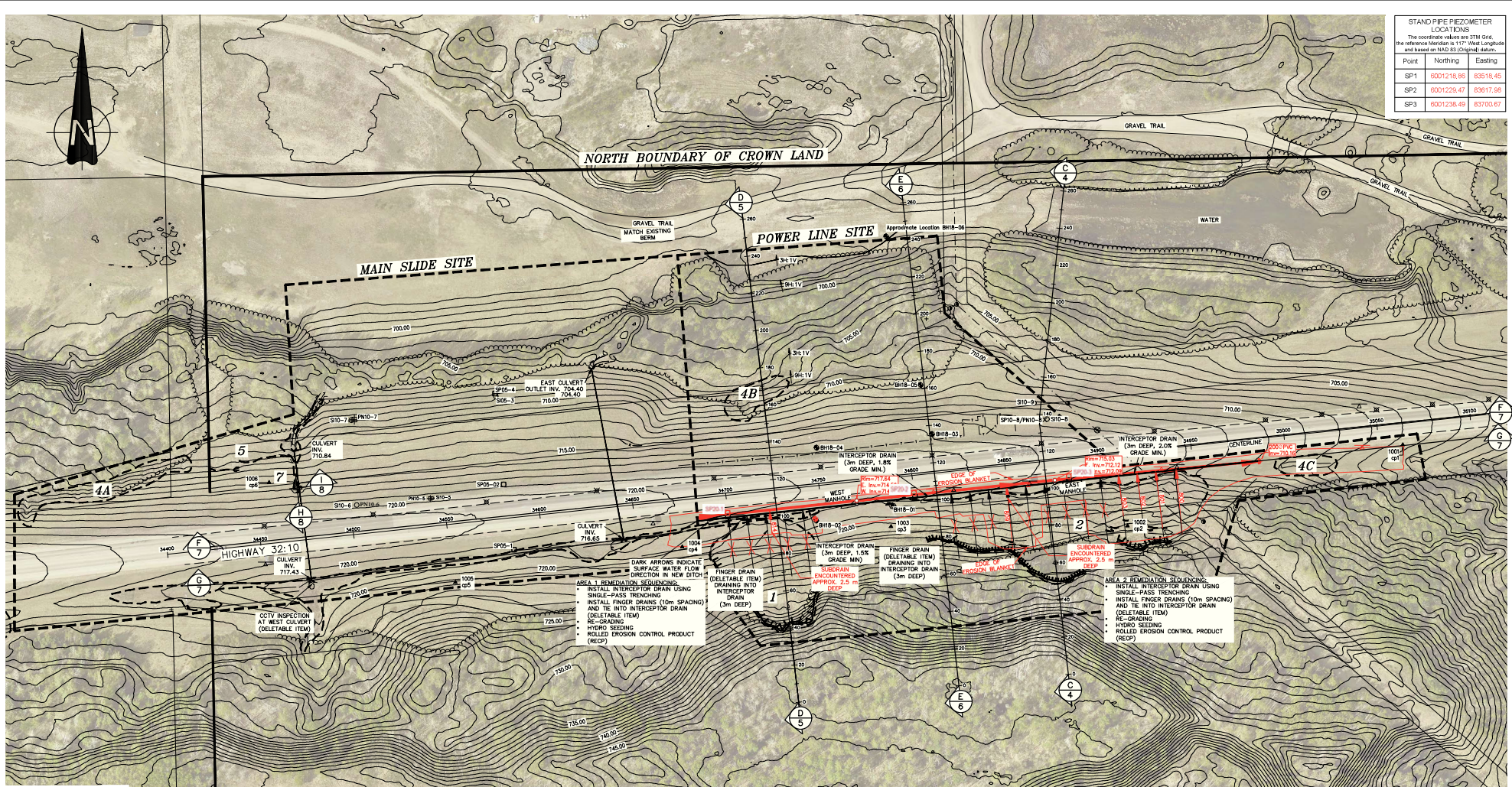
21302-202005-RD-0003
 32.10
 21302

SLOPE FAILURE - NC37 WHITECOURT, AB REMEDIATION PLAN

2018-05-28

DM

UNREVIEWED



STAND PIPE PIEZOMETER LOCATIONS
 The coordinate values are 27M Grid. The reference Meridian is 117 West Longitude and based on NAD 83 (Original datum).

Point	Northing	Easting
SP1	6001216.96	635116.45
SP2	6001226.47	636117.98
SP3	6001236.49	637003.67

- LEGEND**
- BH BOREHOLE
 - SP STANDPIPE PIEZOMETER
 - PNP PNEUMATIC PIEZOMETER
 - OSI SLOPE INCLINOMETER
 - POWERPOLE
 - × DELINEATOR
 - ▲ SIGN
 - ▣ PEDESTAL
 - GUYWIRE
 - OVERHEAD POWERLINES
 - - - BURIED TELEPHONE LINES
 - - - FENCE LINES
 - TREE LINES
 - SCARP
 - ▲ CONTROL POINT

- PHASE 1 REMEDIATION**
- 1 WEST LANDSLIDE
 - 2 EAST LANDSLIDE
 - 4 GULLY / EROSION AREA
 - 5 TENSION CRACKS
 - 7 CULVERT / SINKHOLE & EROSION
- PROJECT LIMIT
- CROSS SECTION LOCATION
- × DRAIN NOT CONSTRUCTED

NOTES

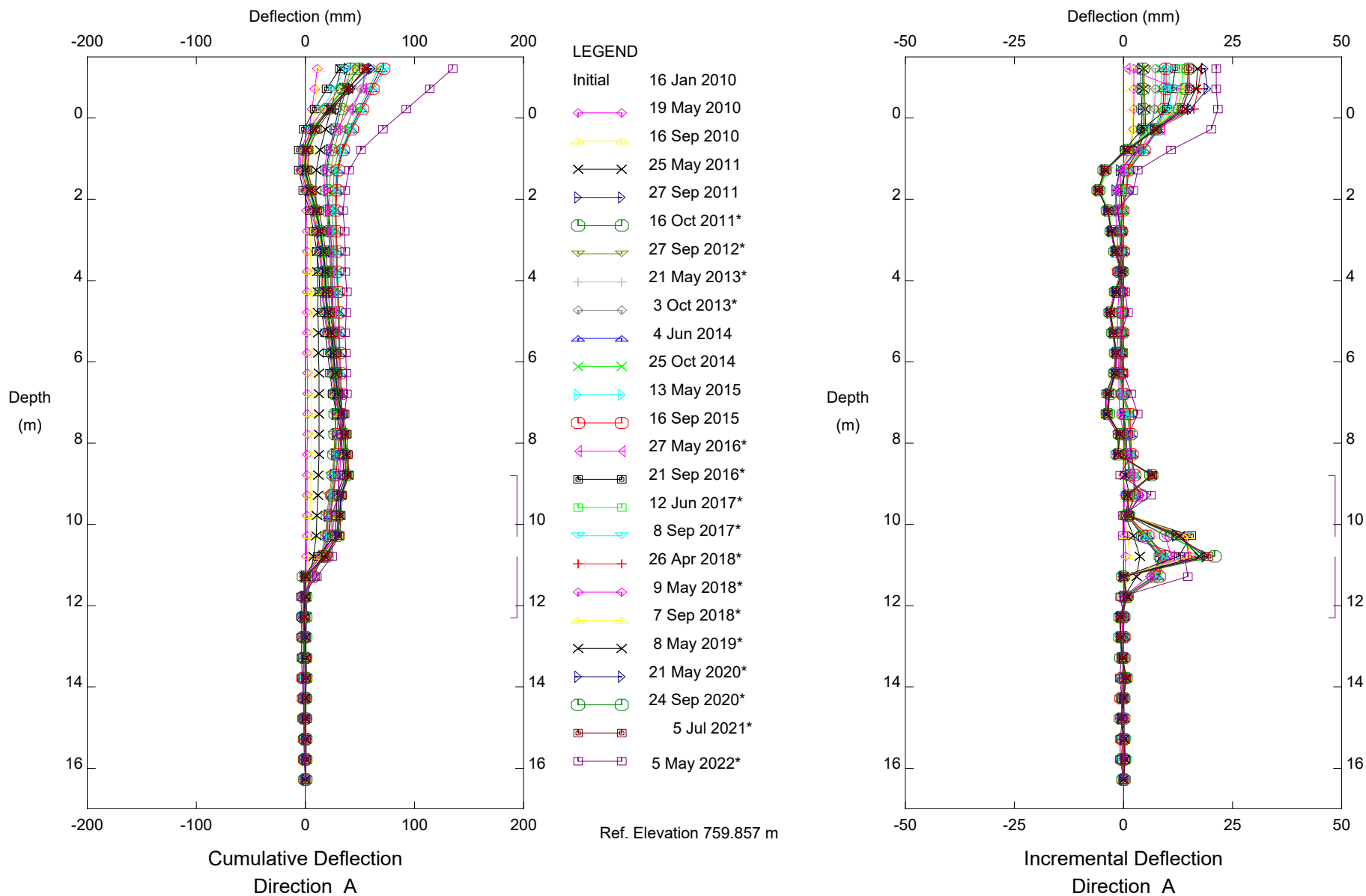
ALL DIMENSIONS AND ELEVATIONS ARE EXPRESSED IN METRES AND DECIMALS THEREOF

STATIONING DISTANCES ARE GRID DISTANCES.

PLAN
 1:1000

CONSULTANT Stantec	DESIGNER PERMIT TO PRACTICE STANTEC CONSULTING LTD. Signature: [Signature] Date: 16 March 2021 PERMIT NUMBER: P 0258 The Association of Professional Engineers and Geoscientists of Alberta	CHECKER [Signature] 16 March 2021	REVISIONS <table border="1"> <tr> <th>REV</th> <th>DATE</th> <th>REVISION</th> <th>BY</th> </tr> <tr> <td>1</td> <td>2021-02-26</td> <td>RECORD DRAWINGS</td> <td>LC</td> </tr> <tr> <td>2</td> <td>2020-10-27</td> <td>ISSUED FOR CONSTRUCTION</td> <td>LC</td> </tr> <tr> <td>3</td> <td>2020-06-08</td> <td>ISSUED FOR TENDER</td> <td>LC</td> </tr> <tr> <td>4</td> <td>2020-05-12</td> <td>ISSUED FOR REVIEW</td> <td>LC</td> </tr> </table>	REV	DATE	REVISION	BY	1	2021-02-26	RECORD DRAWINGS	LC	2	2020-10-27	ISSUED FOR CONSTRUCTION	LC	3	2020-06-08	ISSUED FOR TENDER	LC	4	2020-05-12	ISSUED FOR REVIEW	LC	<p>Alberta Transportation</p> <p>HIGHWAY 32 NC37 PROPOSED REMEDIATION PLAN</p>
REV	DATE	REVISION	BY																					
1	2021-02-26	RECORD DRAWINGS	LC																					
2	2020-10-27	ISSUED FOR CONSTRUCTION	LC																					
3	2020-06-08	ISSUED FOR TENDER	LC																					
4	2020-05-12	ISSUED FOR REVIEW	LC																					
JOB No. 123312435	DATE 2021-03-16	DATE 2020-05-12	DATE 2020-10-27	LOCATION WHITECOURT, AB SITE NC37 CONTRACT 21302 HIGHWAY 32:10 SHEET 3 of 8 DRAWING 21302-202005-RD-0003																				

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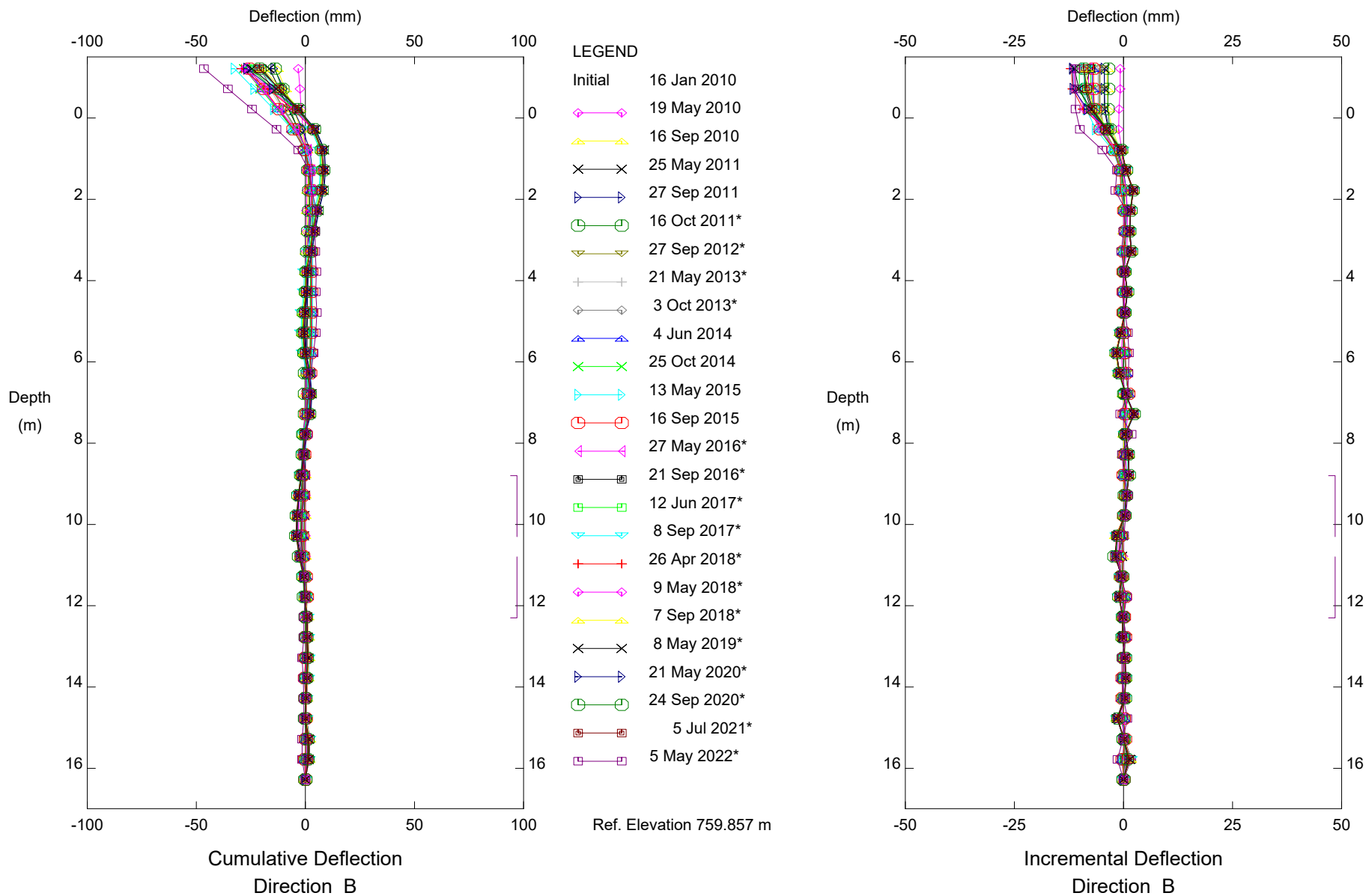


HWY32:10 South of Whitecourt (NC037), Inclinometer SI10-5

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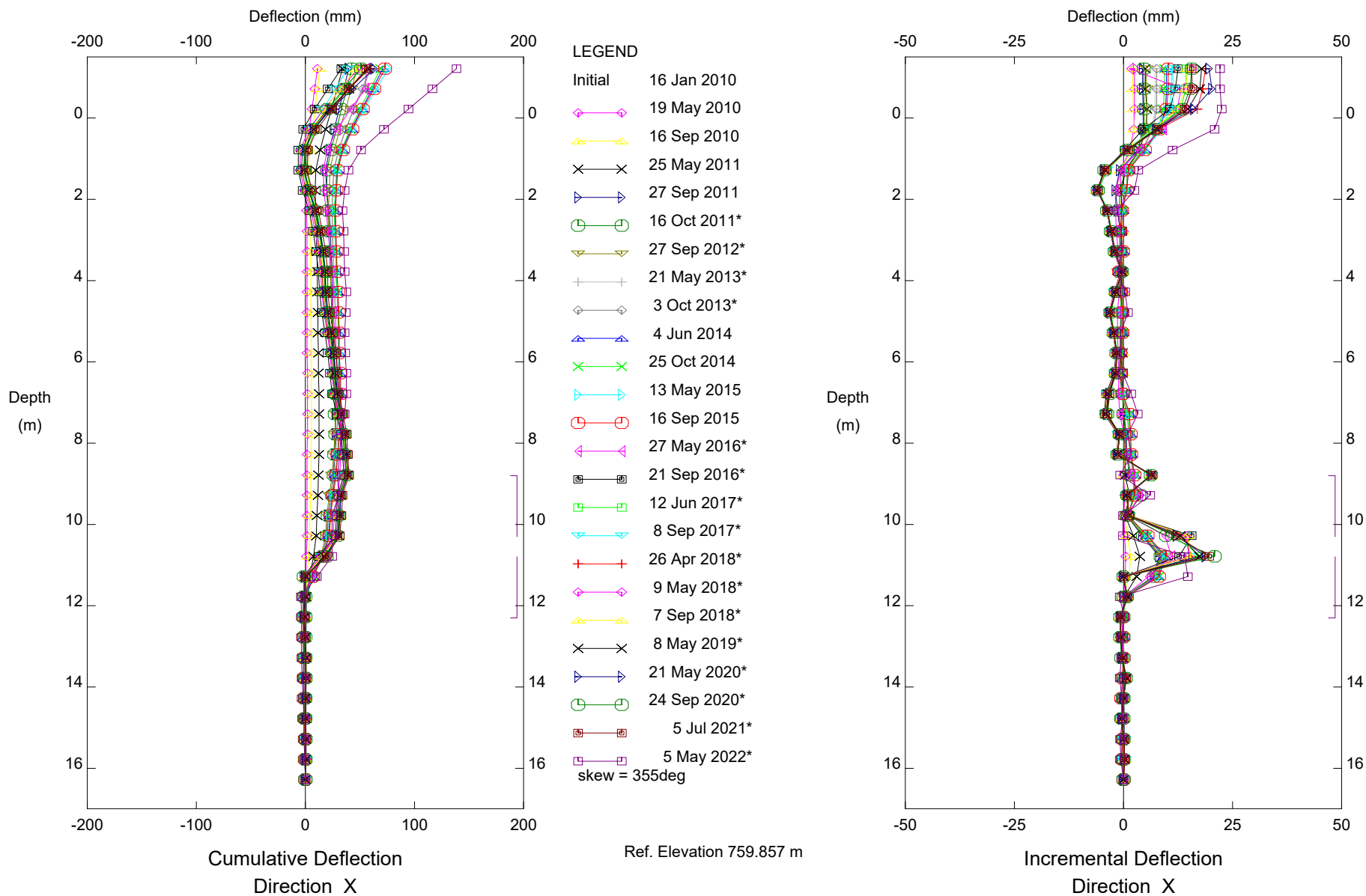


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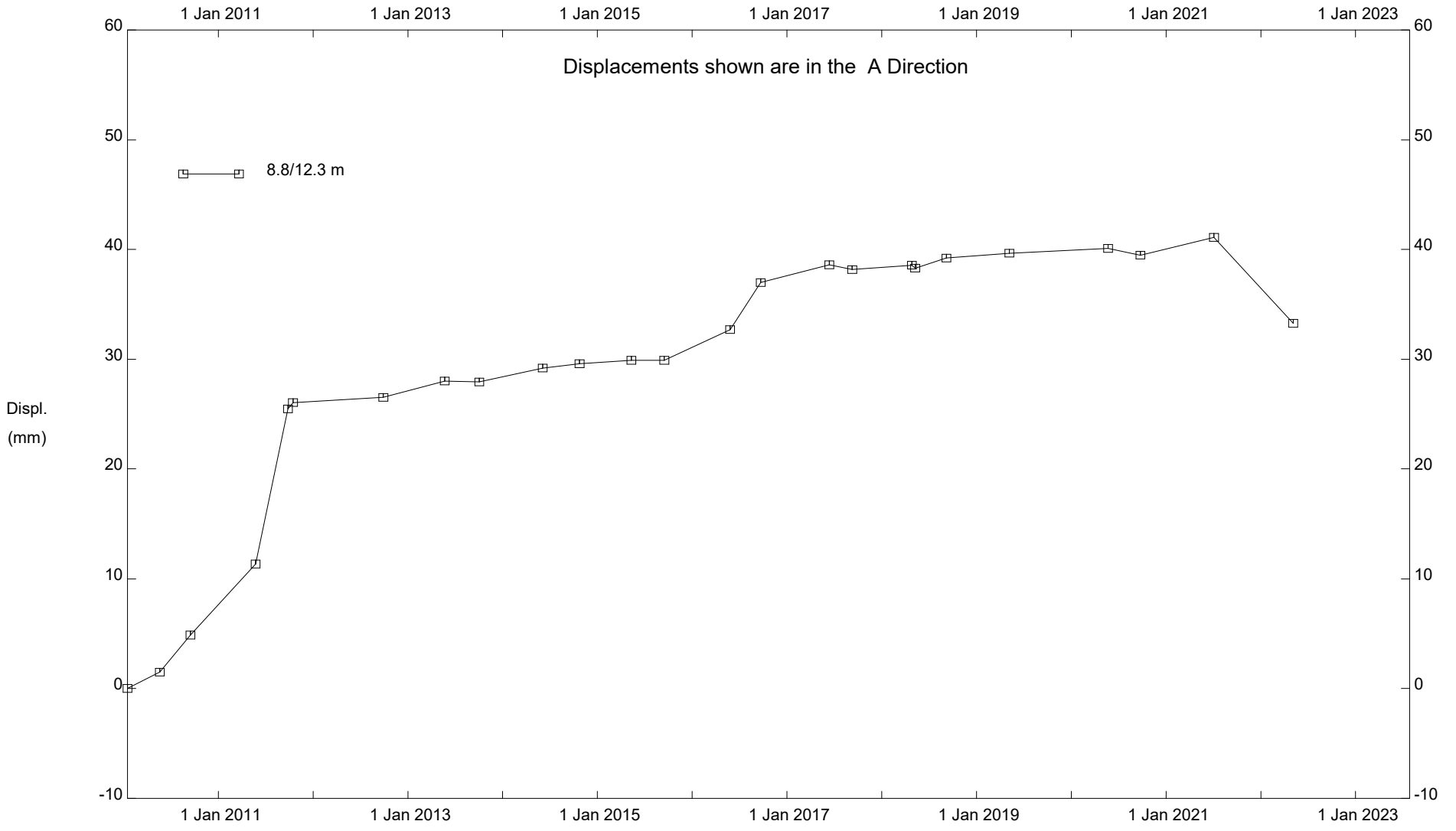
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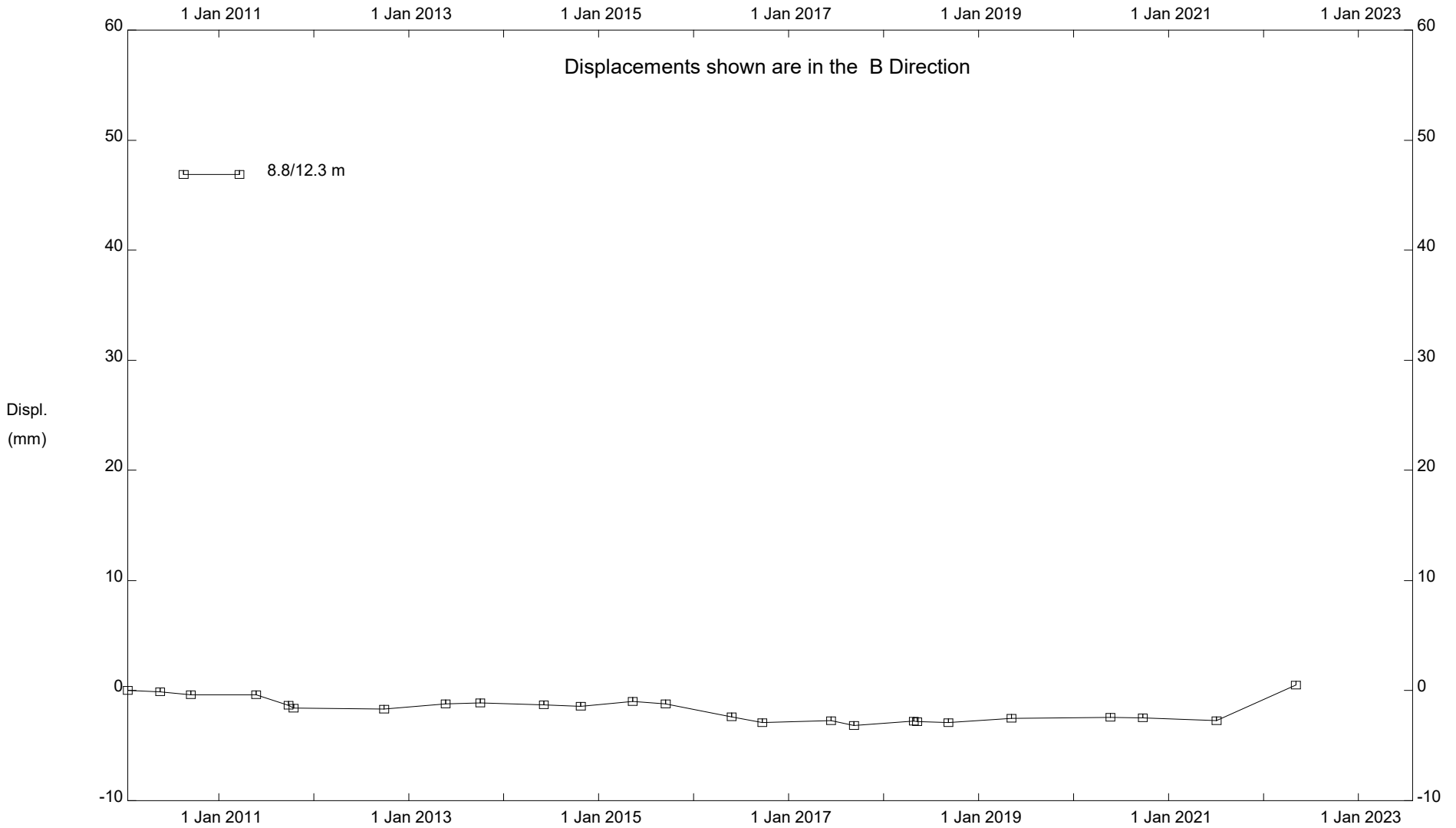
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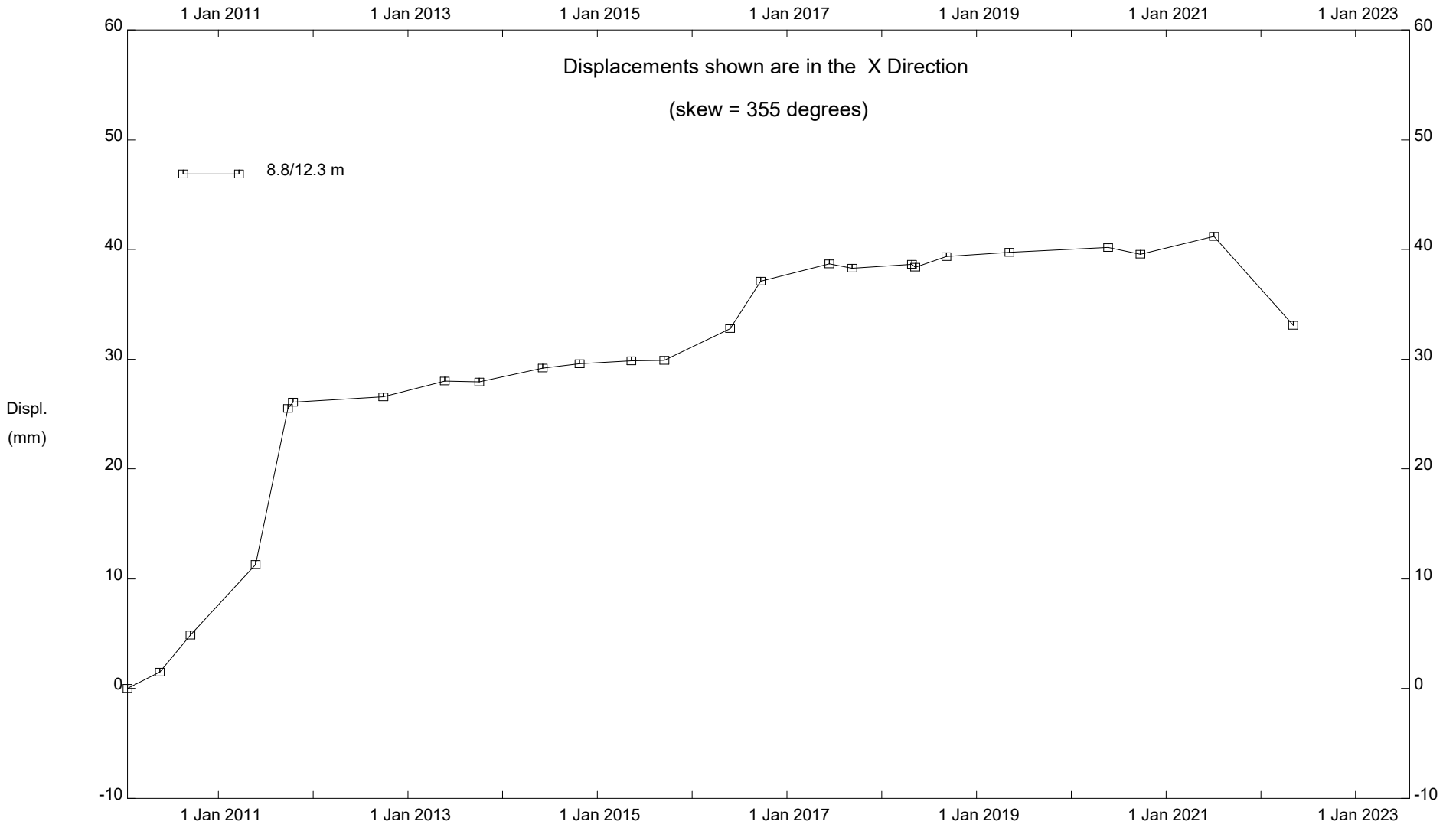
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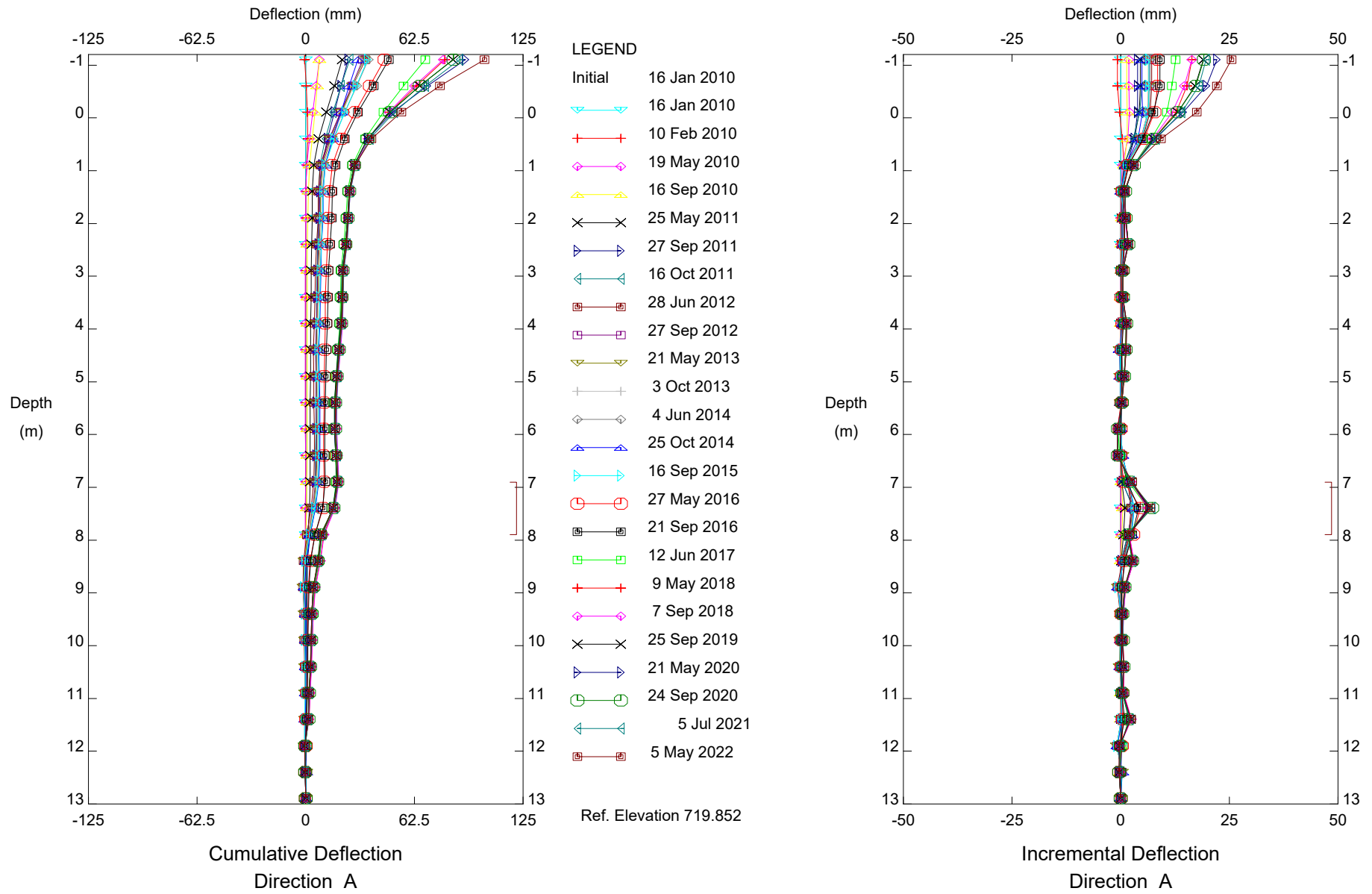
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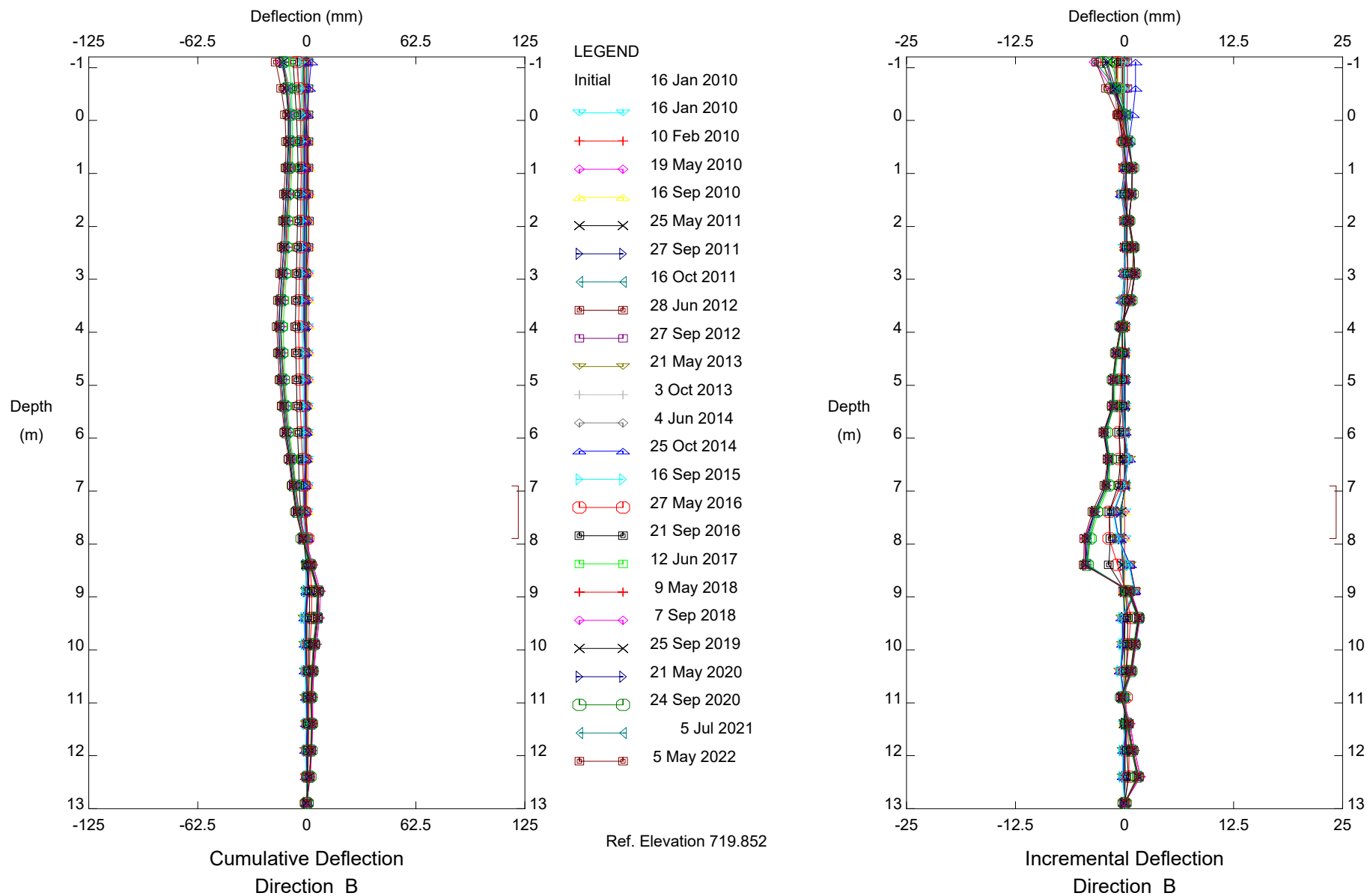
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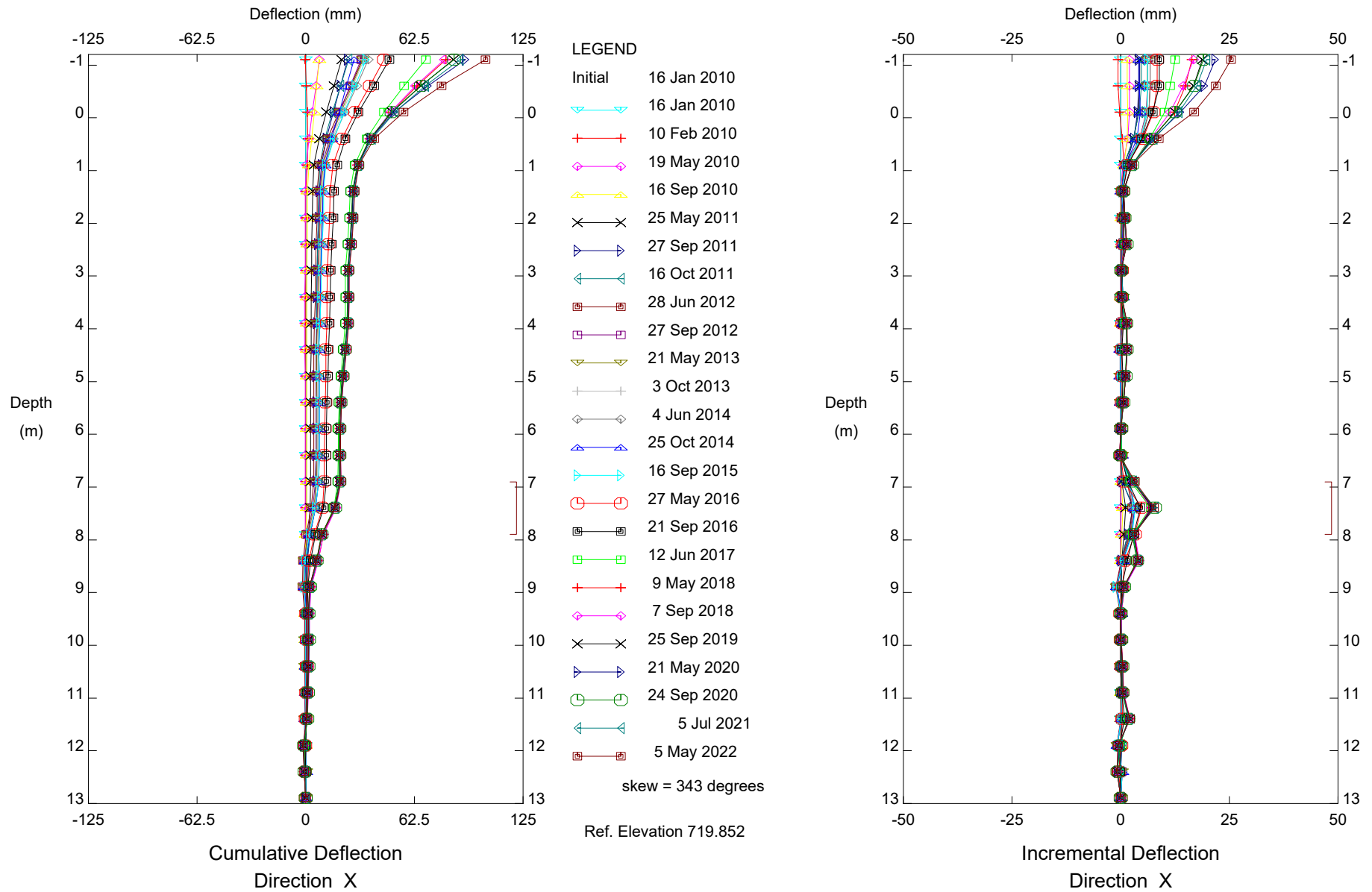


HWY32:10 South of Whitecourt (NC037), Inclinometer SI10-6
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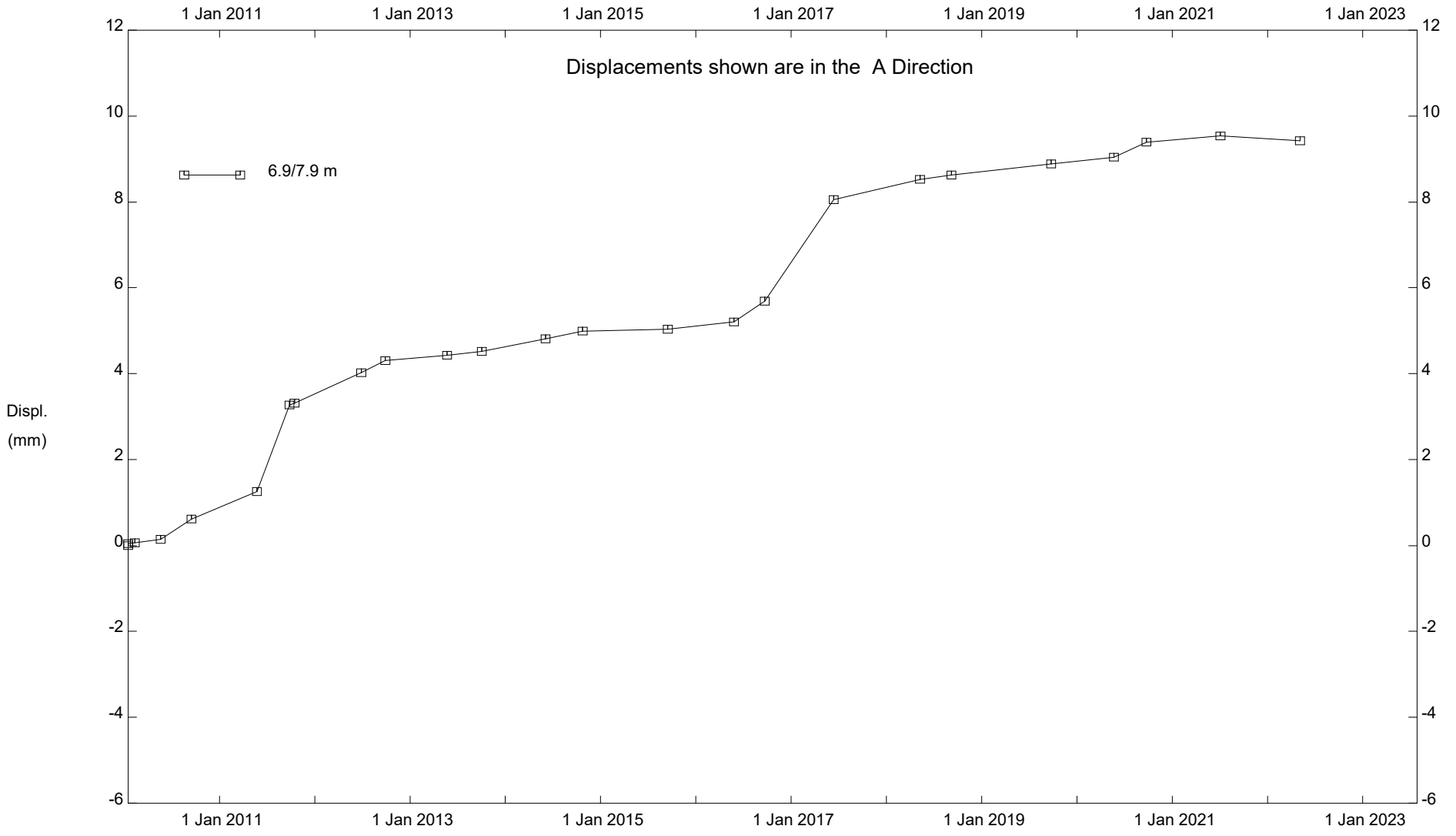
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HWY32:10 South of Whitecourt (NC037), Inclinometer SI10-6
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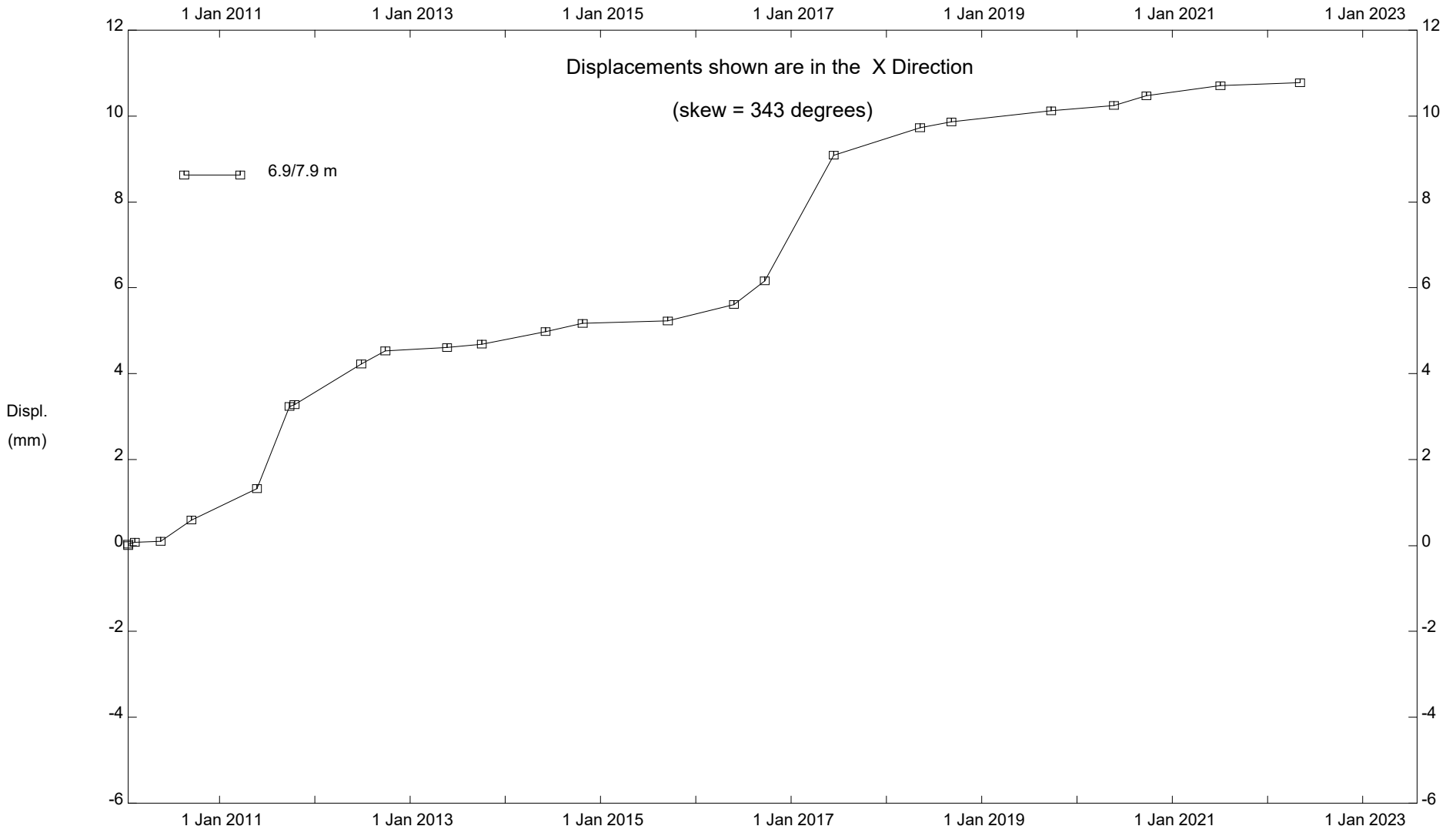
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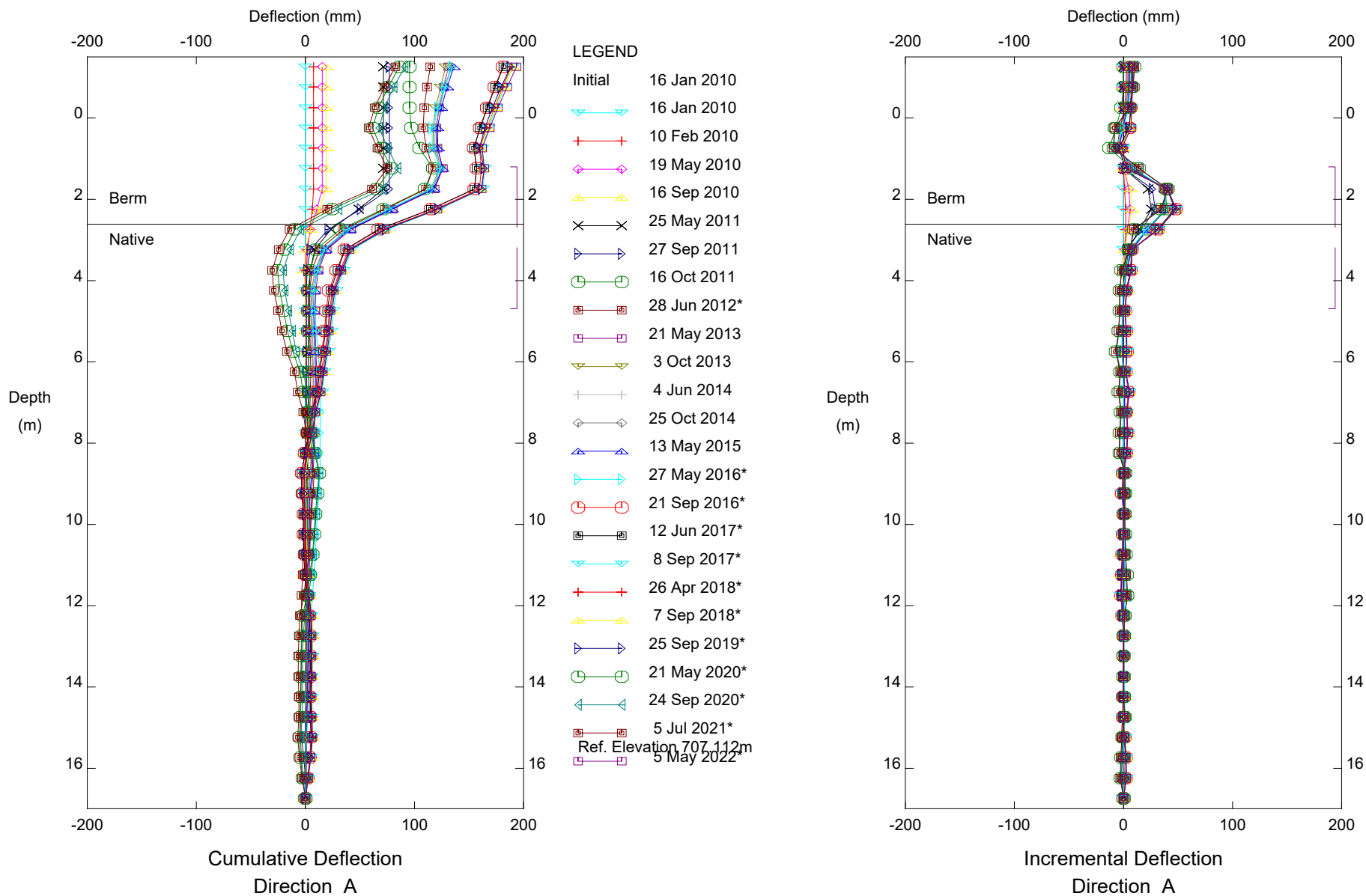
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HWY32:10 South of Whitecourt (NC037), Inclinometer SI10-6

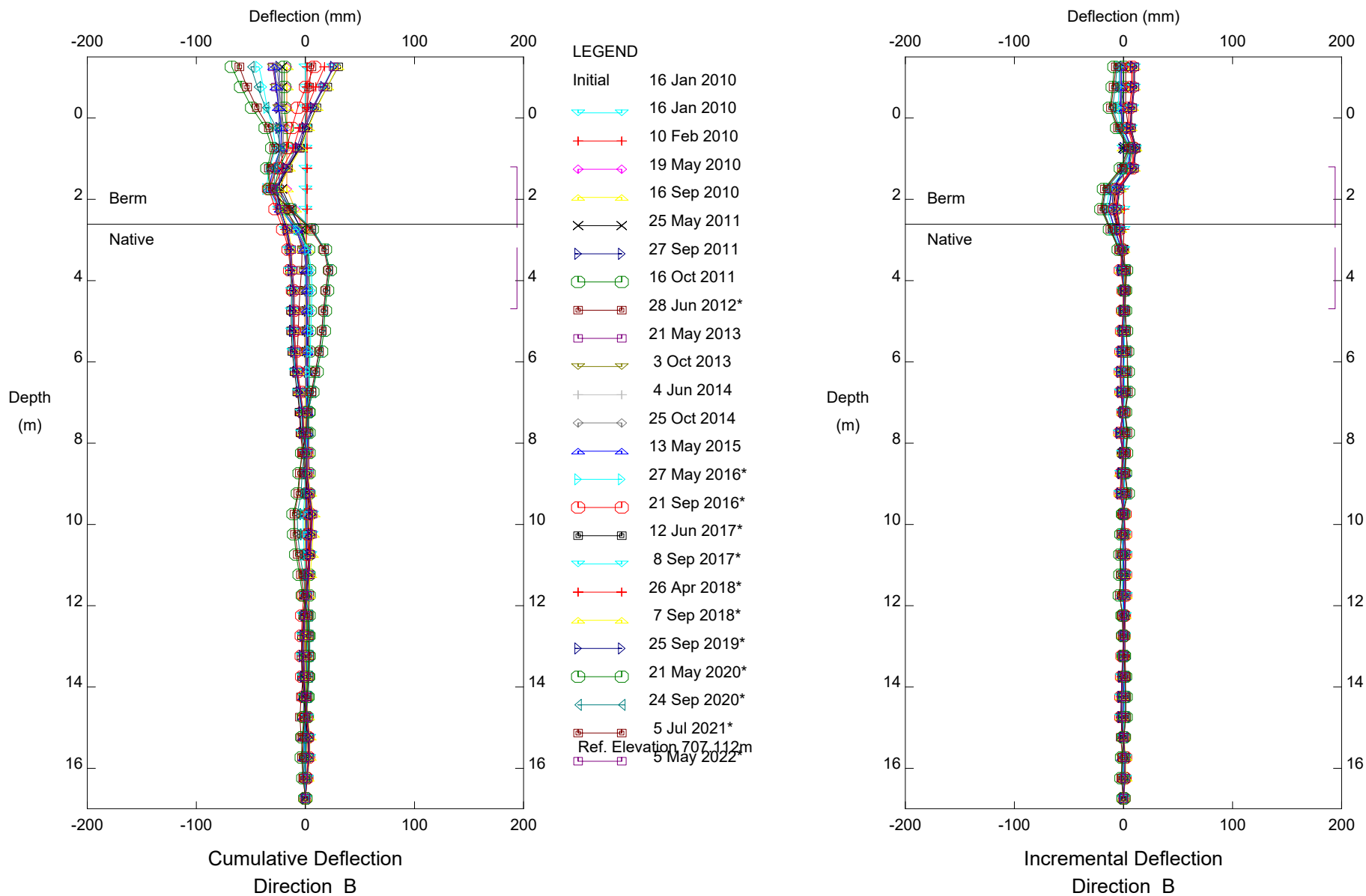
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HWY32:10 South of Whitecourt (NC037), Inclinometer SI10-7

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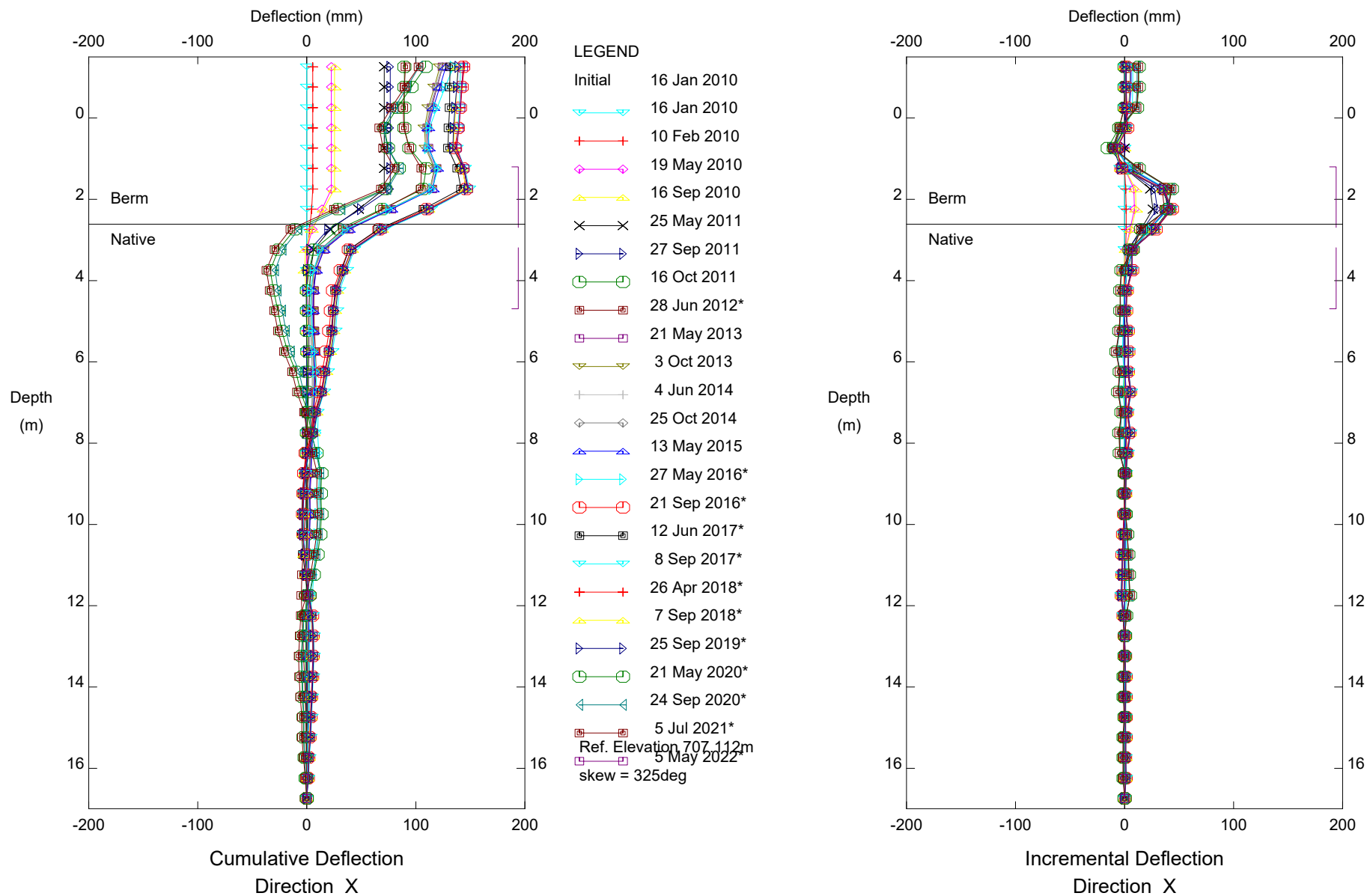
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HWY32:10 South of Whitecourt (NC037), Inclinometer SI10-7

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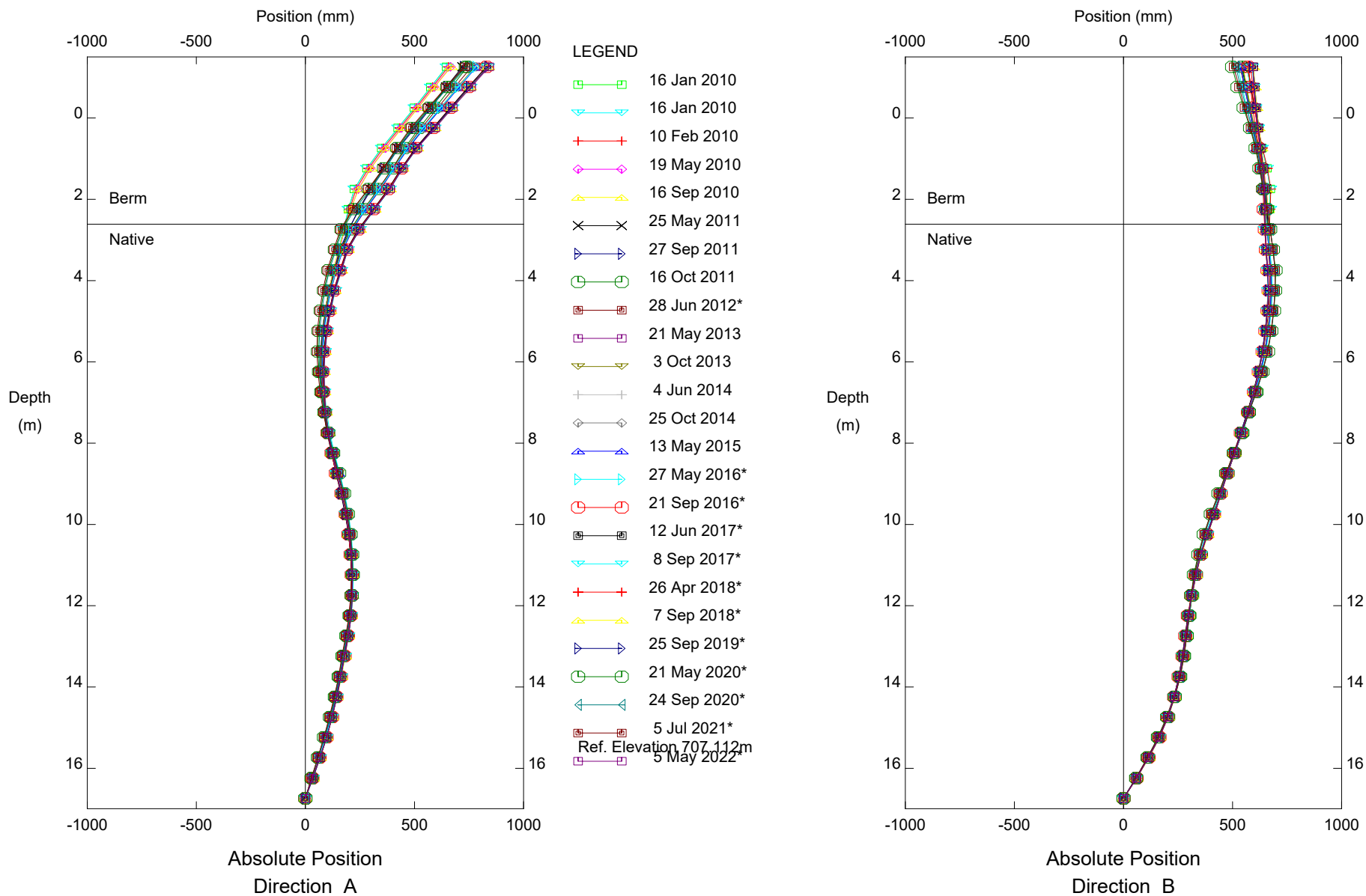


HWY32:10 South of Whitecourt (NC037), Inclinometer SI10-7

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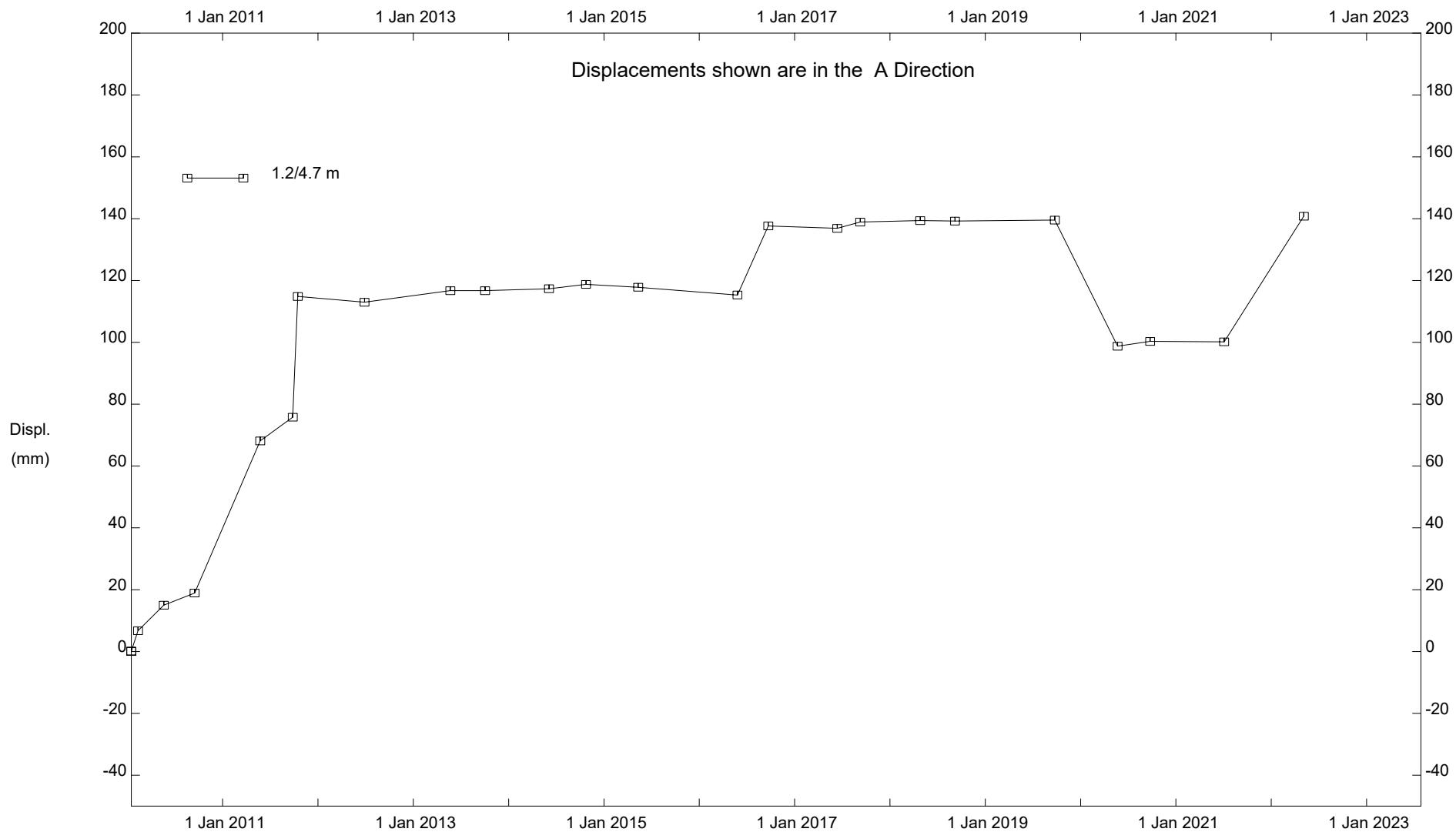


HWY32:10 South of Whitecourt (NC037), Inclinometer SI10-7

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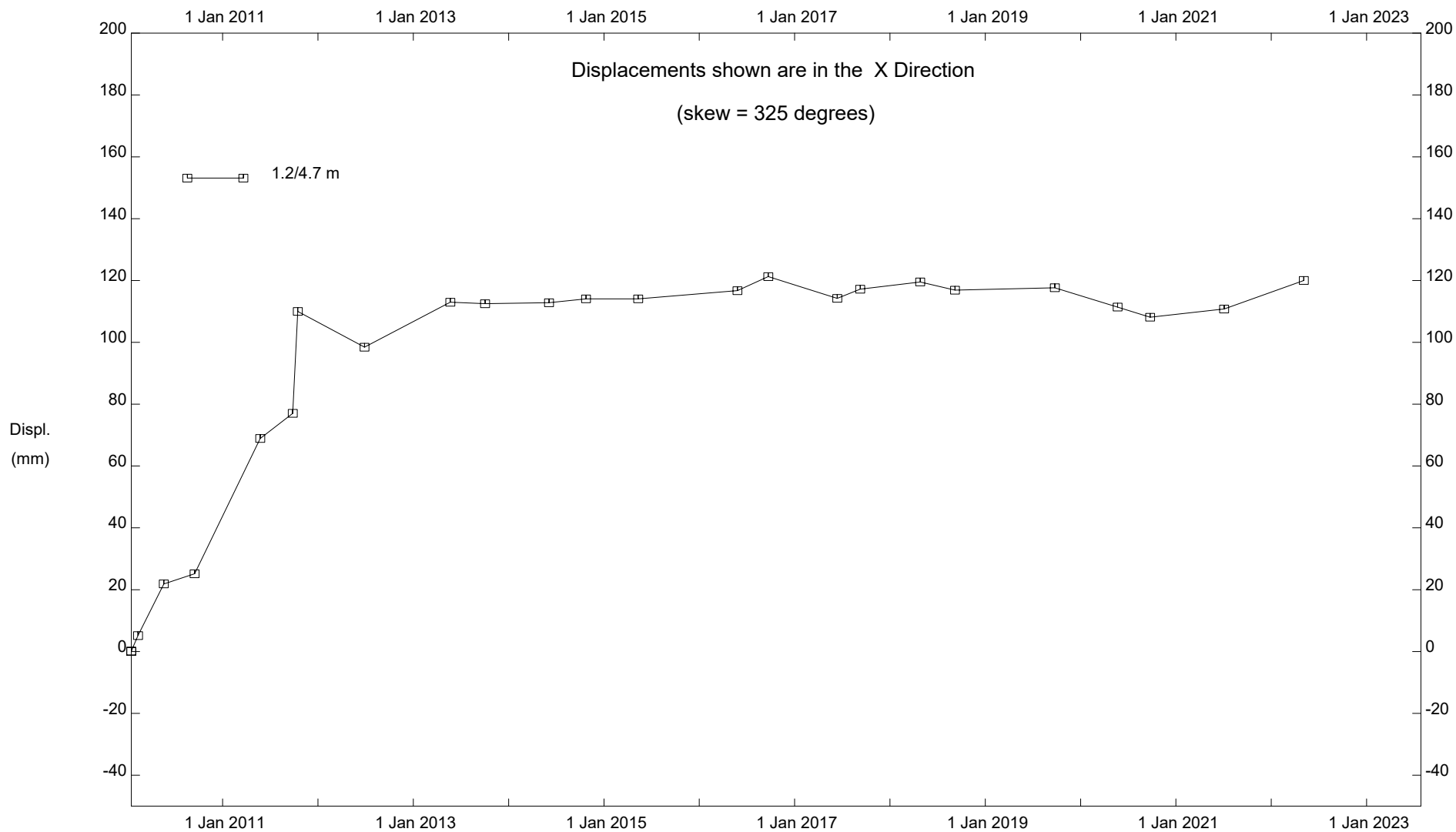
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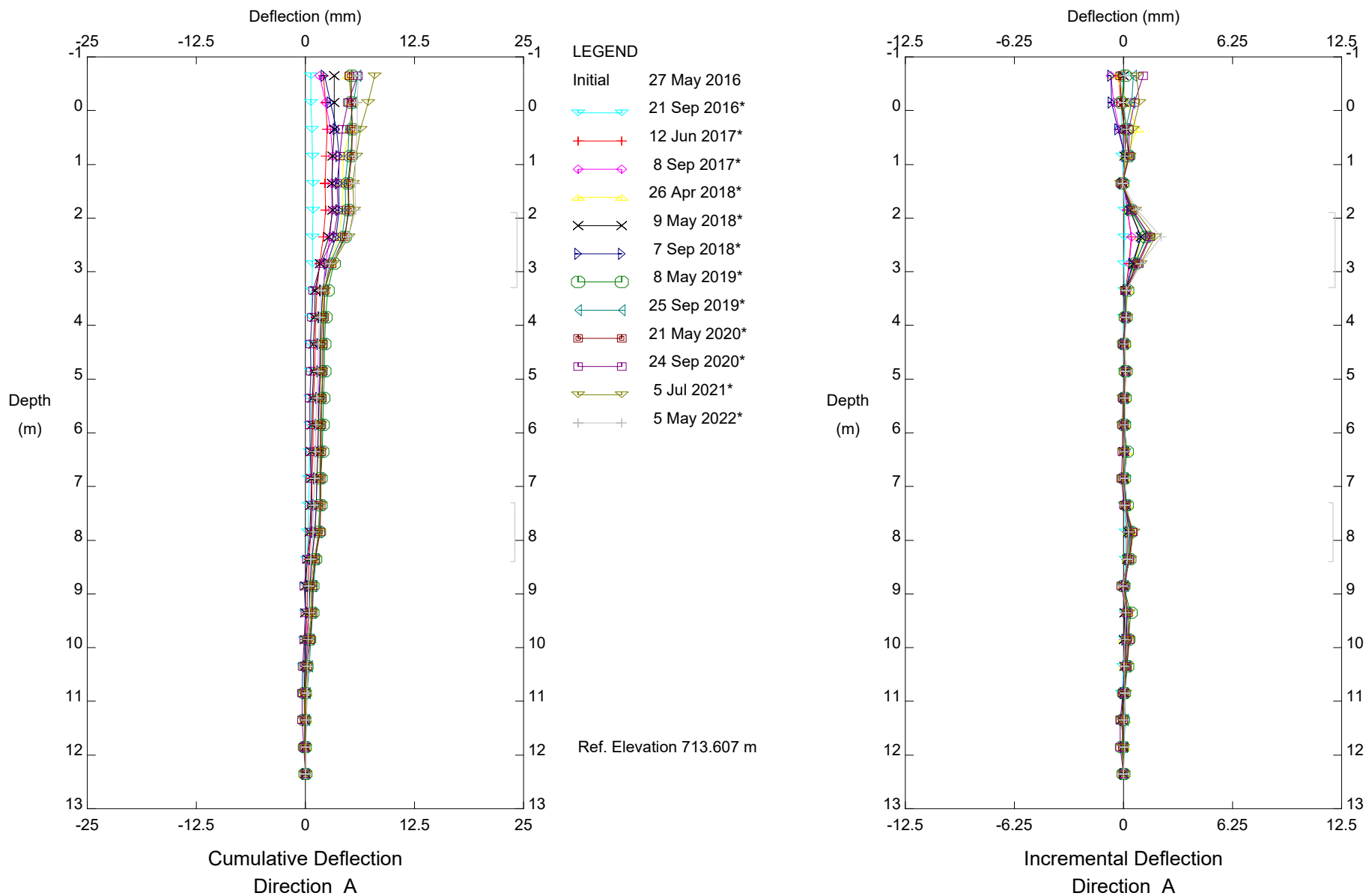
HWY32:10 South of Whitecourt (NC037), Inclinometer SI10-7

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HWY32:10 South of Whitecourt (NC037), Inclinometer SI10-7

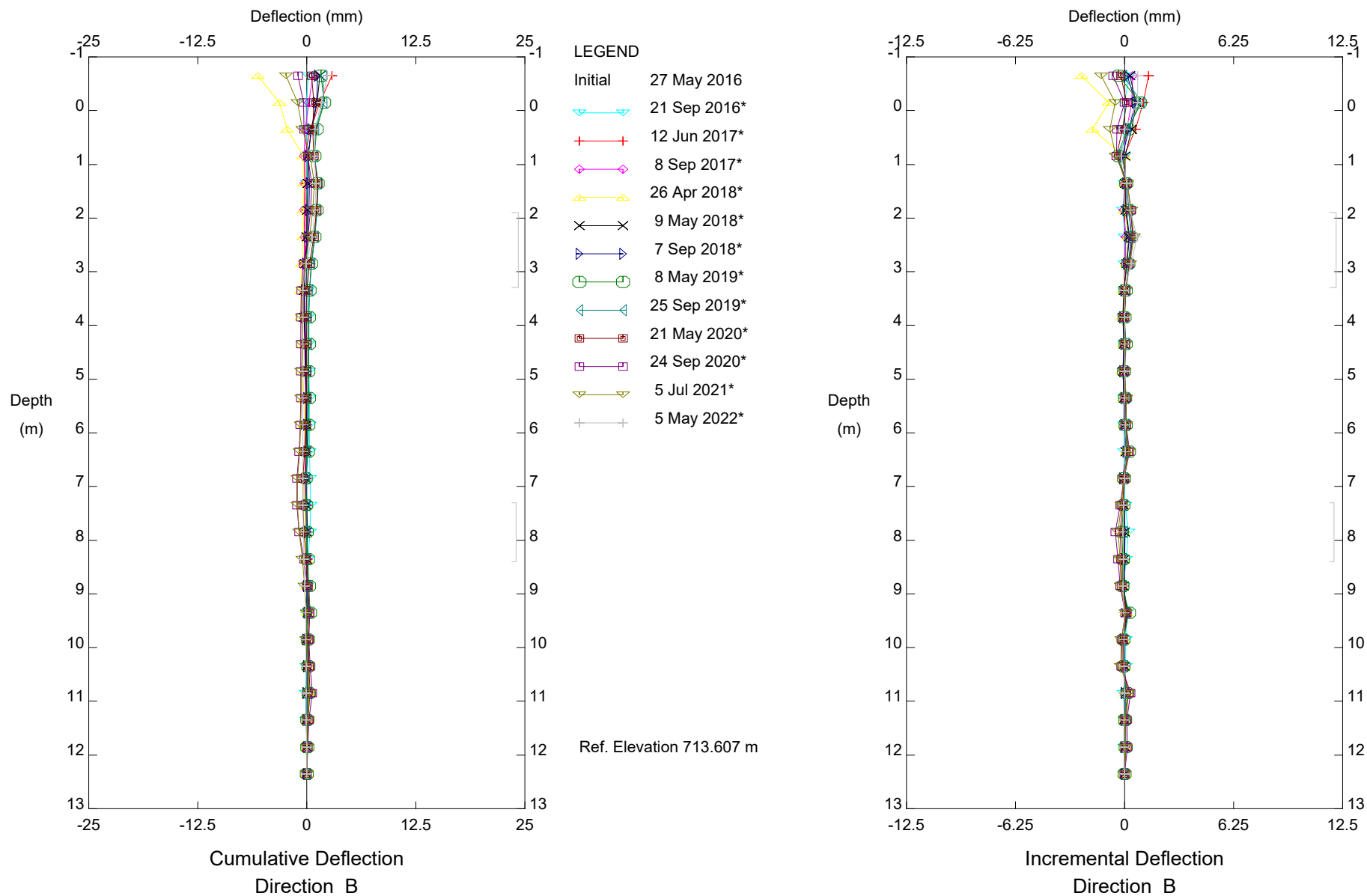
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HWY32:10 South of Whitecourt (NC037), Inclinometer SI10-8

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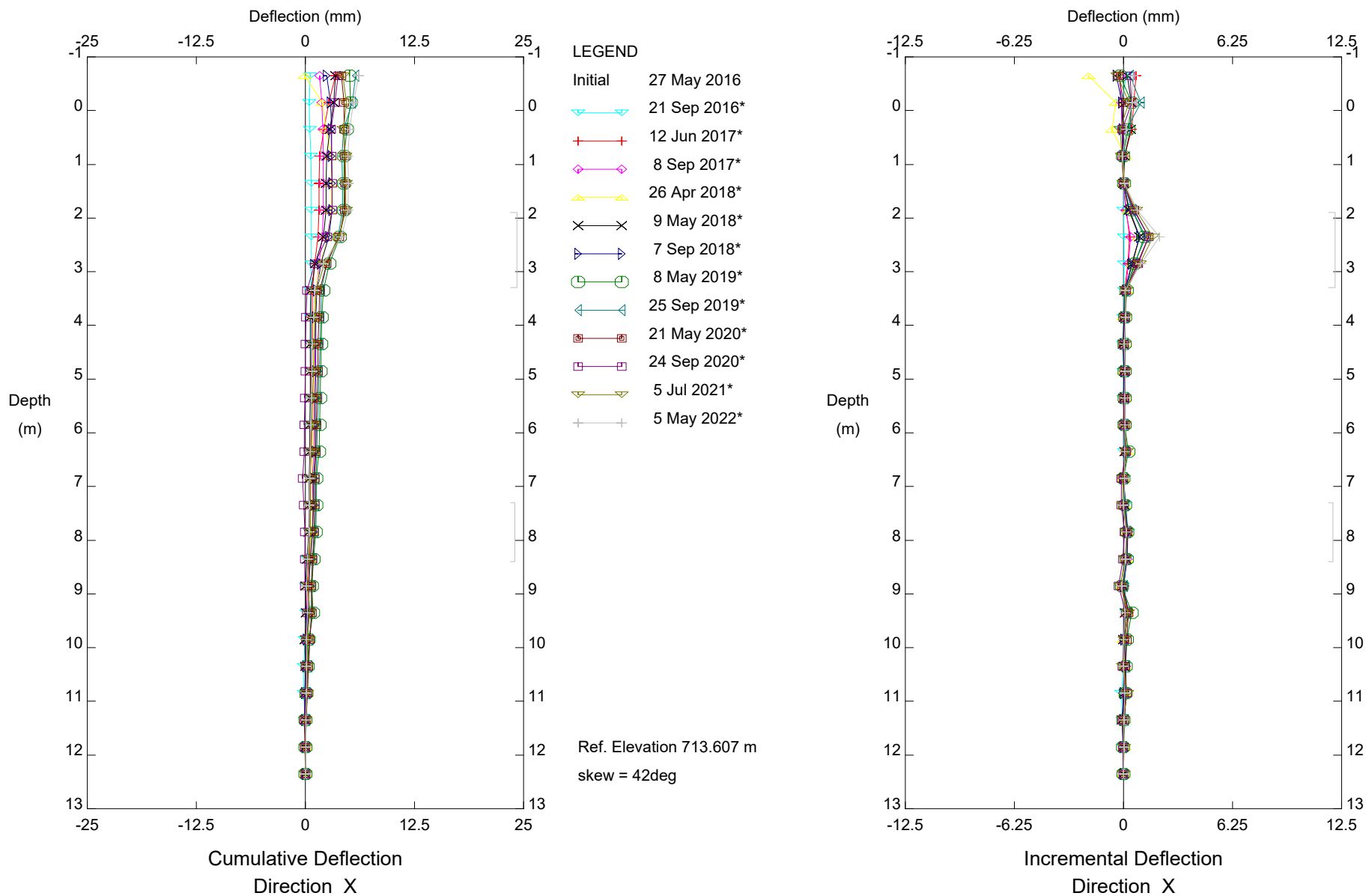
Sets marked * include zero shift and/or rotation corrections.



HWY32:10 South of Whitecourt (NC037), Inclinometer SI10-8

Alberta Transportation

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

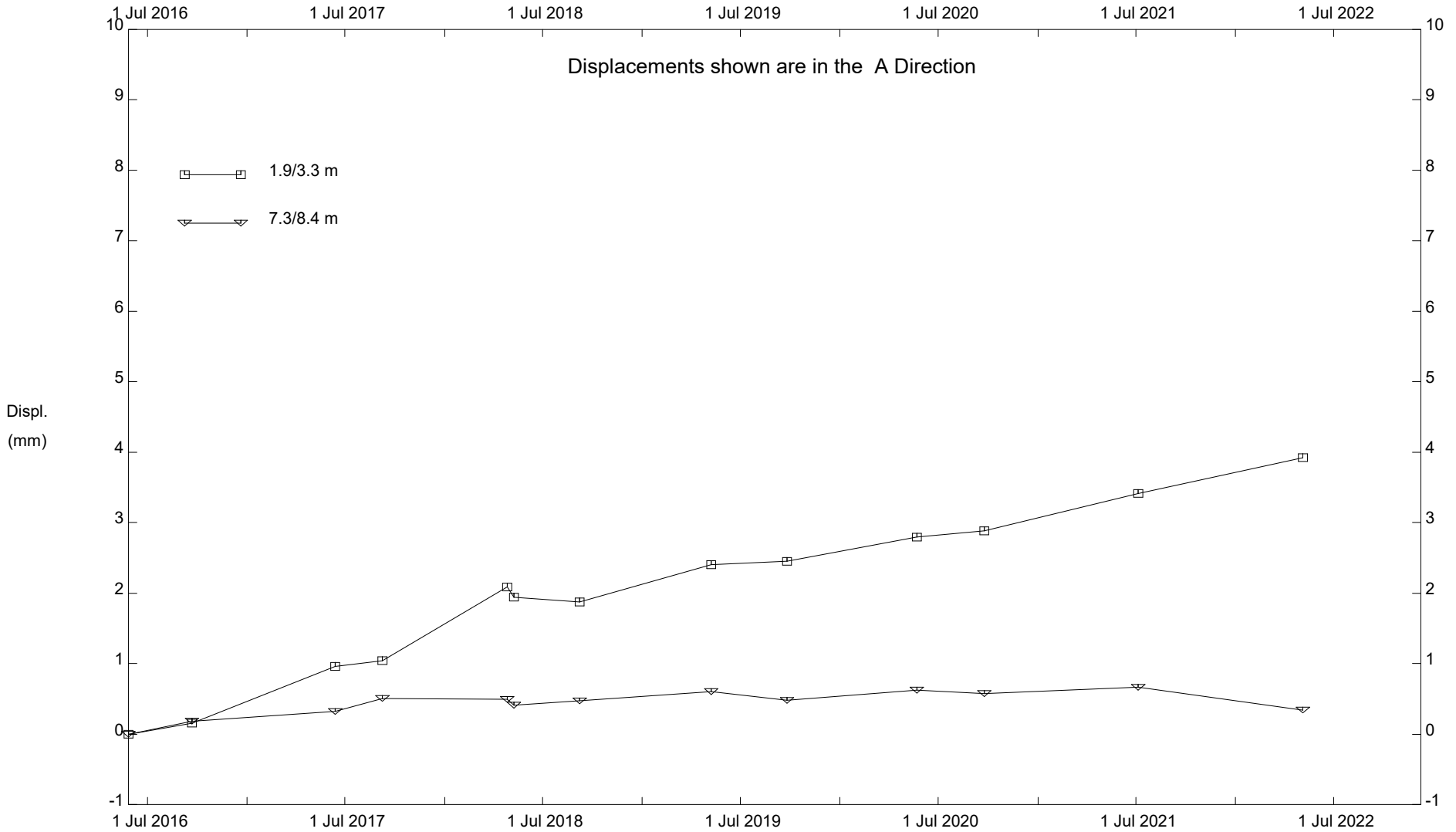


HWY32:10 South of Whitecourt (NC037), Inclinometer SI10-8

Alberta Transportation

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

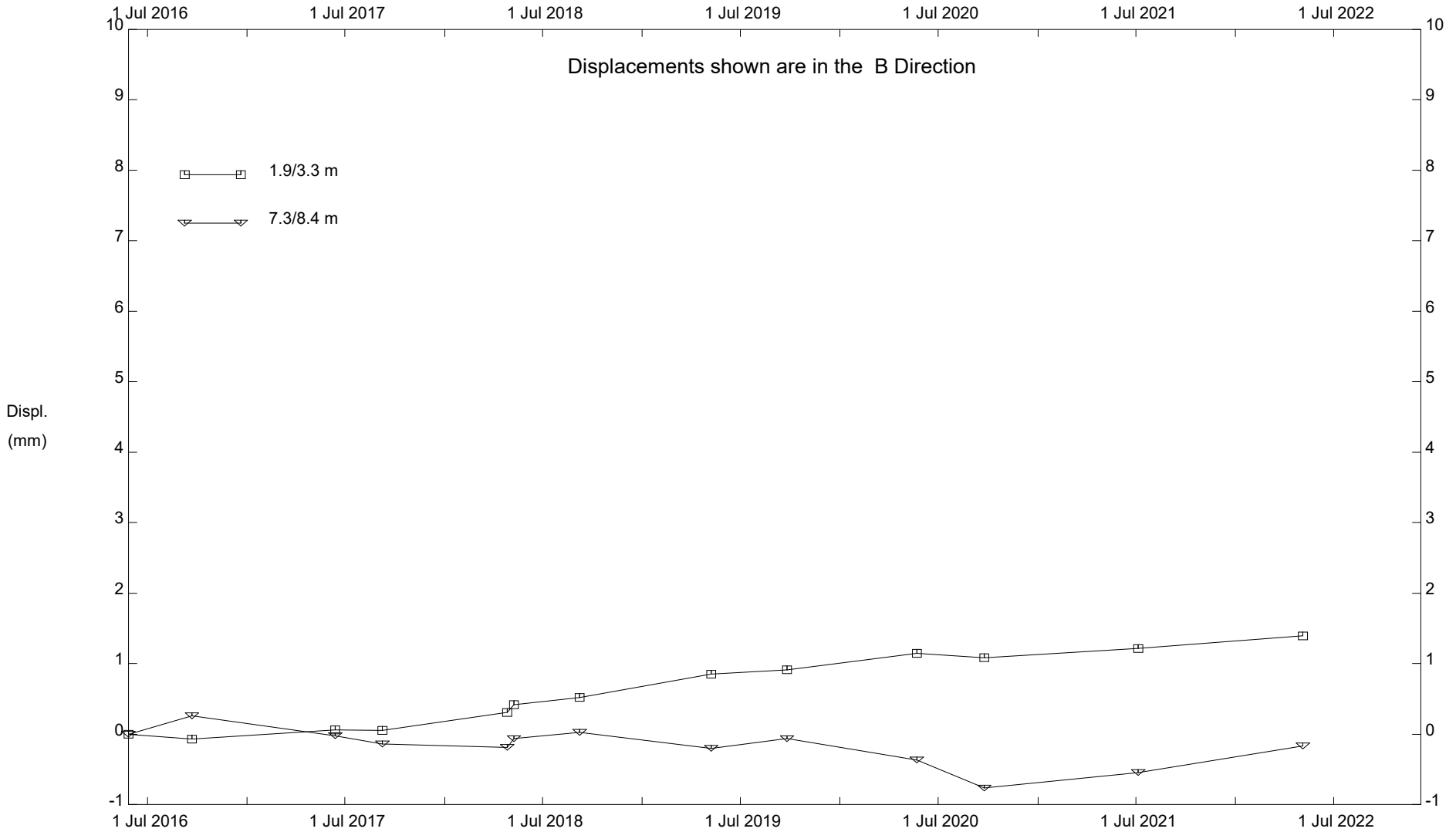
Stantec Consulting Ltd - Edmonton



HWY32:10 South of Whitecourt (NC037), Inclinometer SI10-8

Alberta Transportation

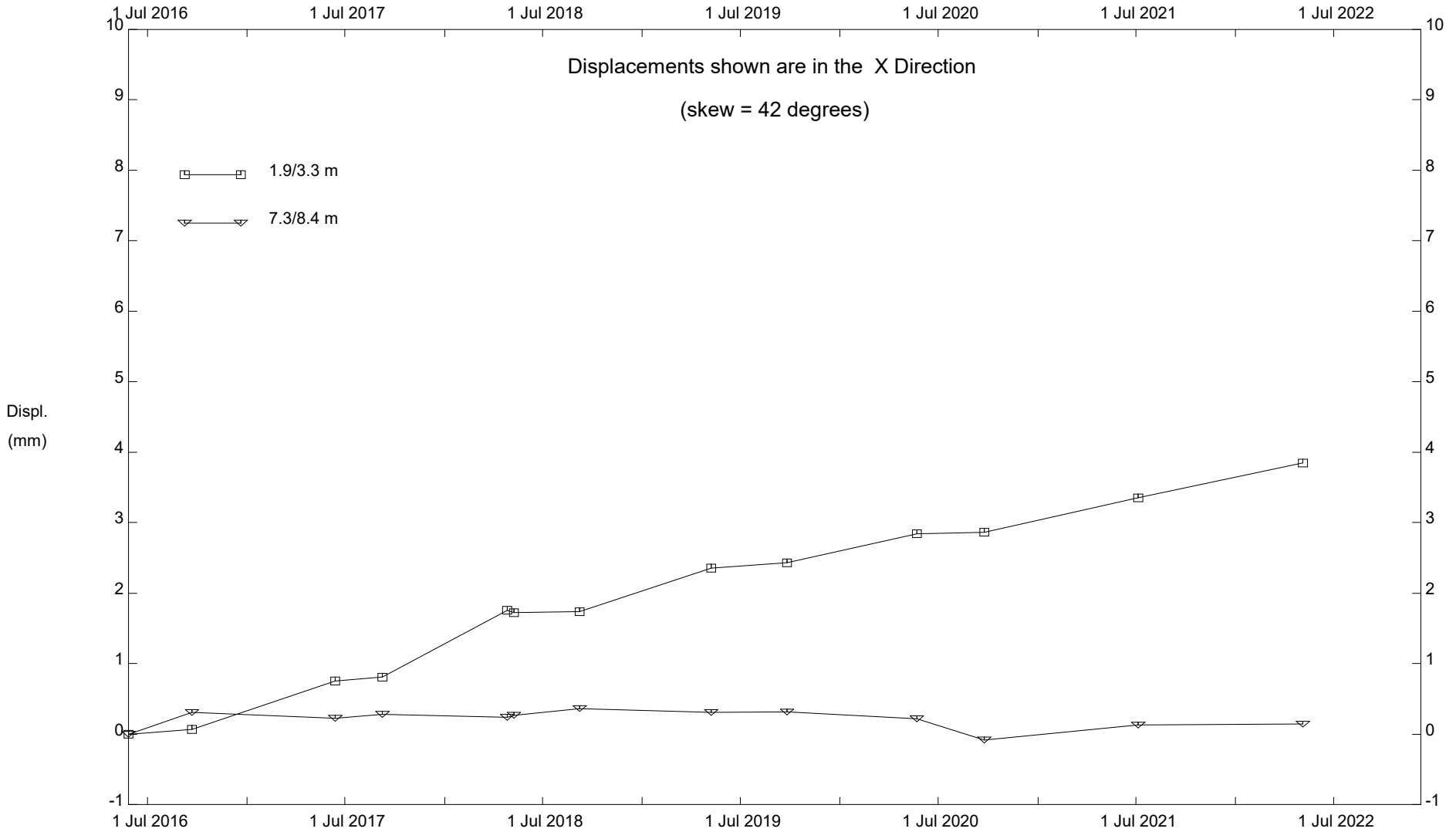
Stantec Consulting Ltd - Edmonton



HWY32:10 South of Whitecourt (NC037), Inclinometer S110-8

Alberta Transportation

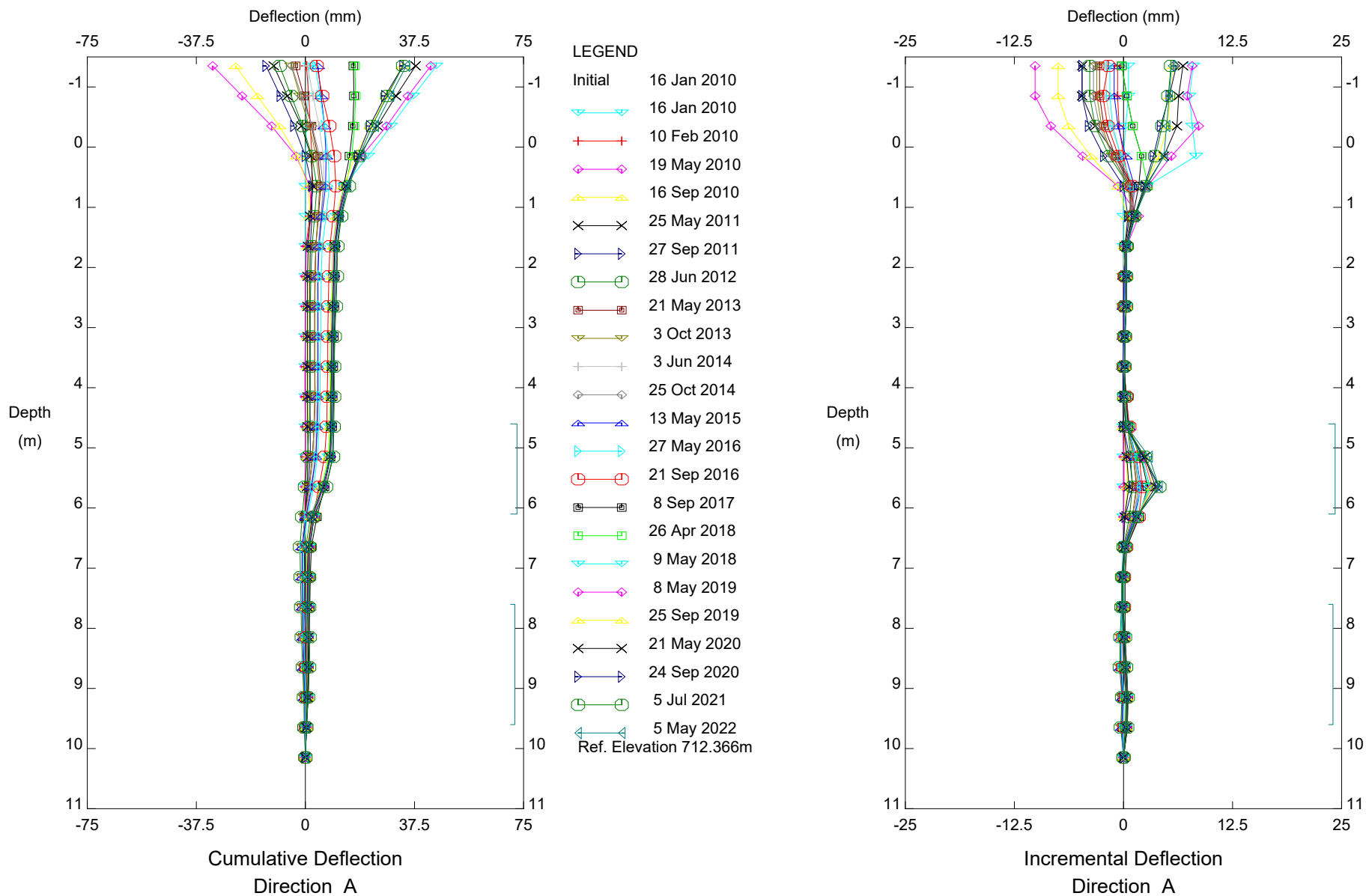
Stantec Consulting Ltd - Edmonton



HWY32:10 South of Whitecourt (NC037), Inclinometer SI10-8

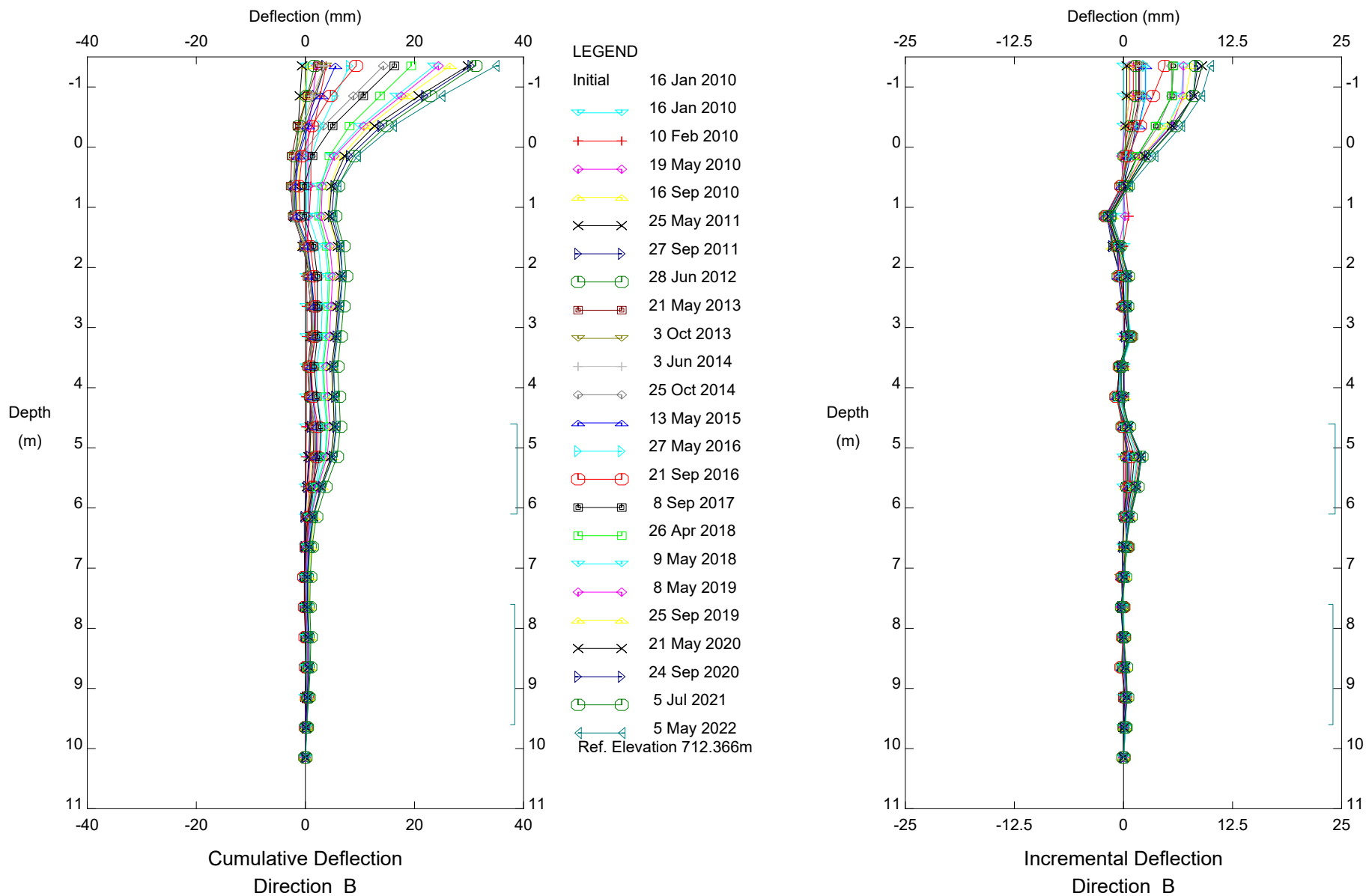
Alberta Transportation

Stantec Consulting Ltd - Edmonton



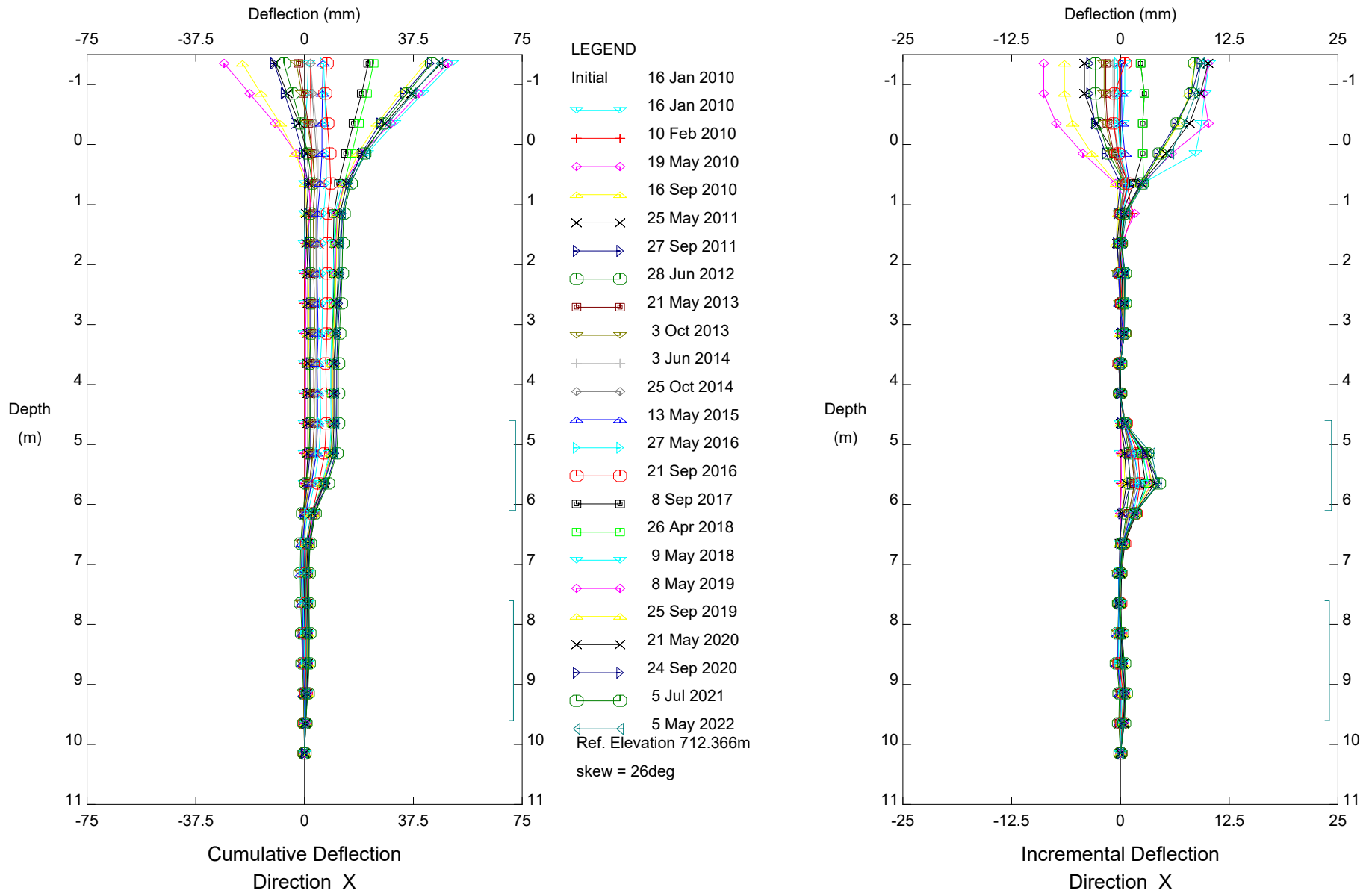
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 Alberta Transportation

Stantec Consulting Ltd - Edmonton



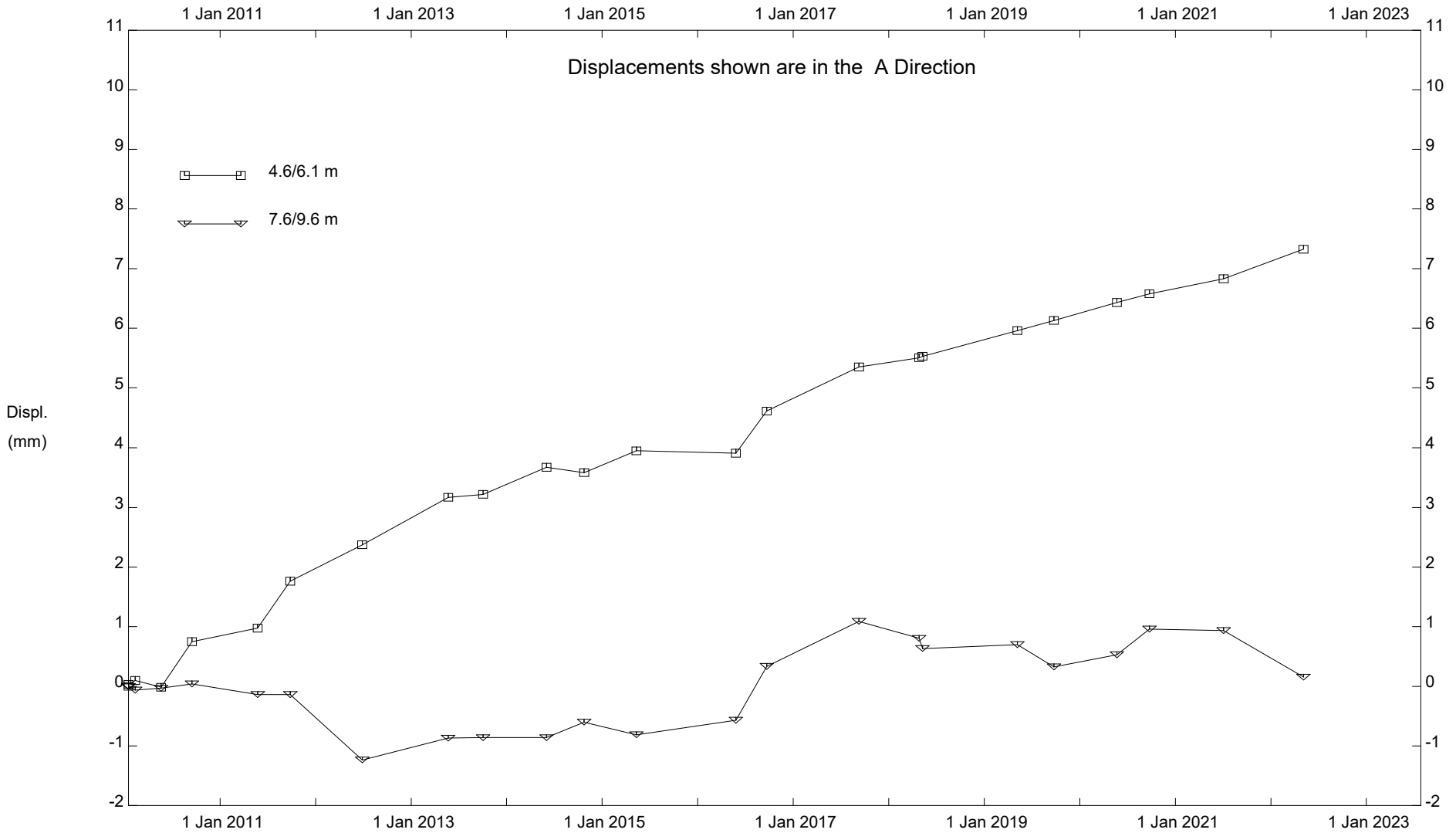
HWY32:10 South of Whitecourt (NC037), Inclinometer SI10-9
 Alberta Transportation

Stantec Consulting Ltd - Edmonton



HWY32:10 South of Whitecourt (NC037), Inclinometer SI10-9
Alberta Transportation

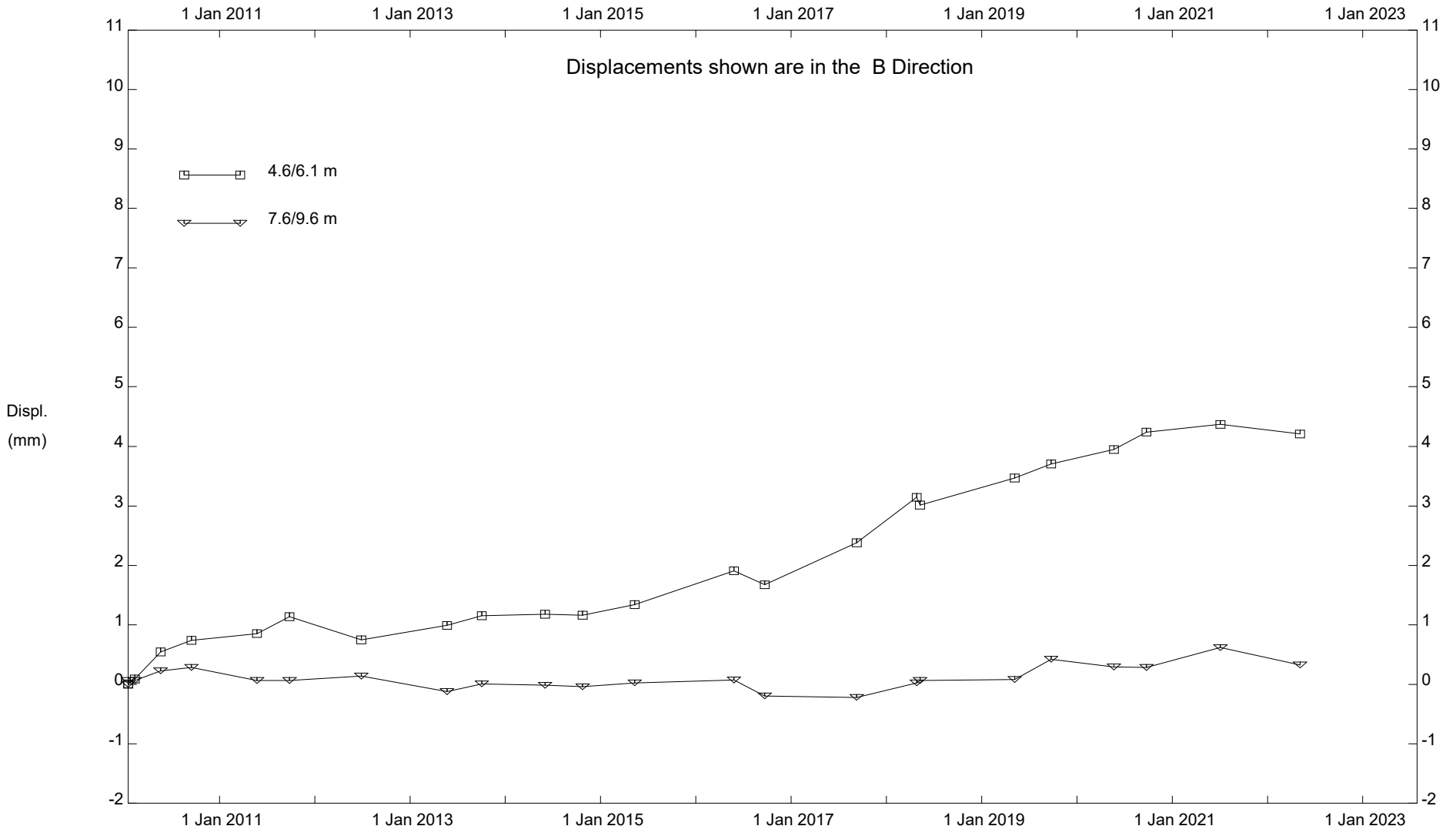
Stantec Consulting Ltd - Edmonton



HWY32:10 South of Whitecourt (NC037), Inclinometer S110-9

Alberta Transportation

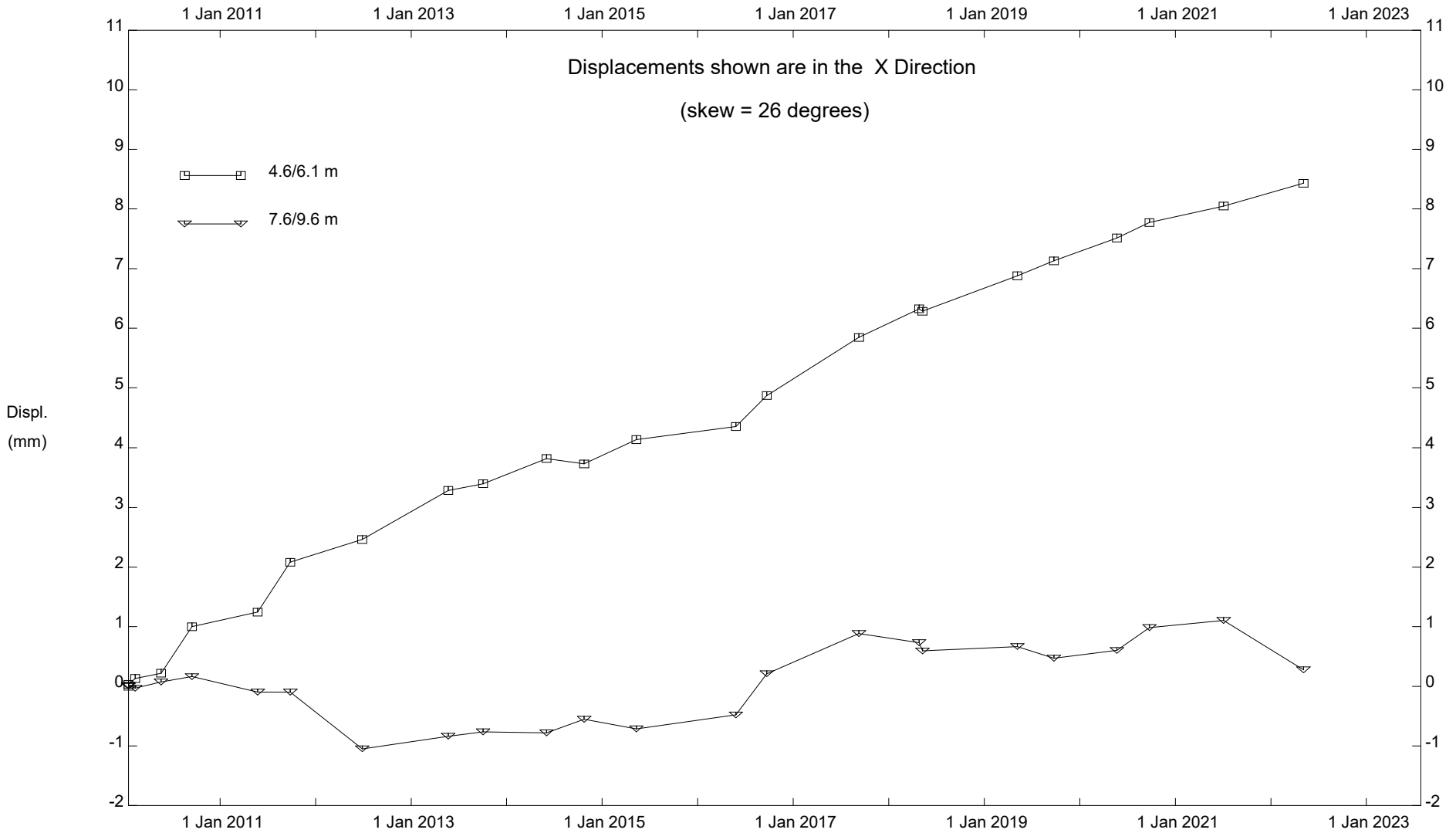
Stantec Consulting Ltd - Edmonton



HWY32:10 South of Whitecourt (NC037), Inclinometer S110-9

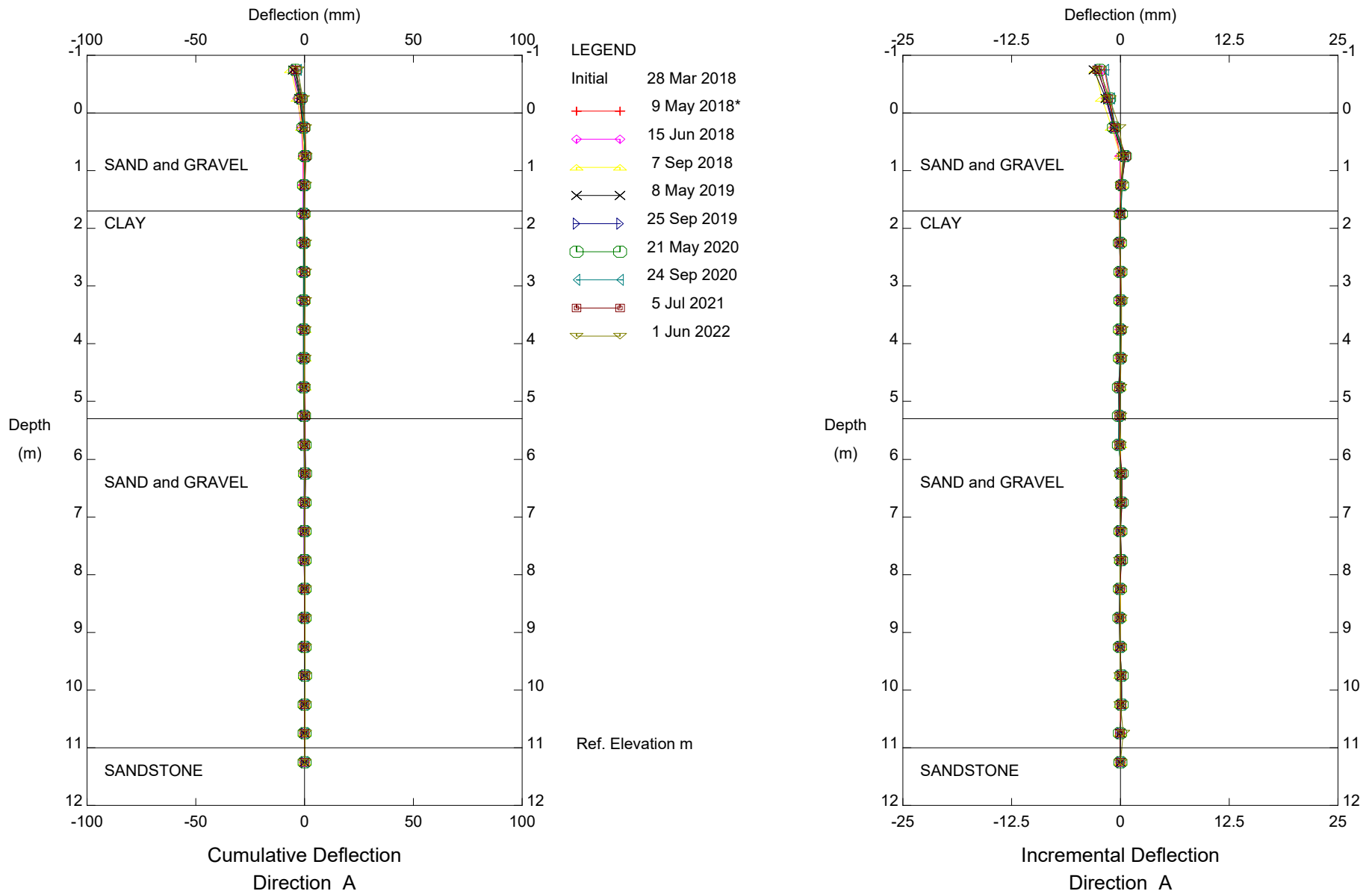
Alberta Transportation

Stantec Consulting Ltd - Edmonton



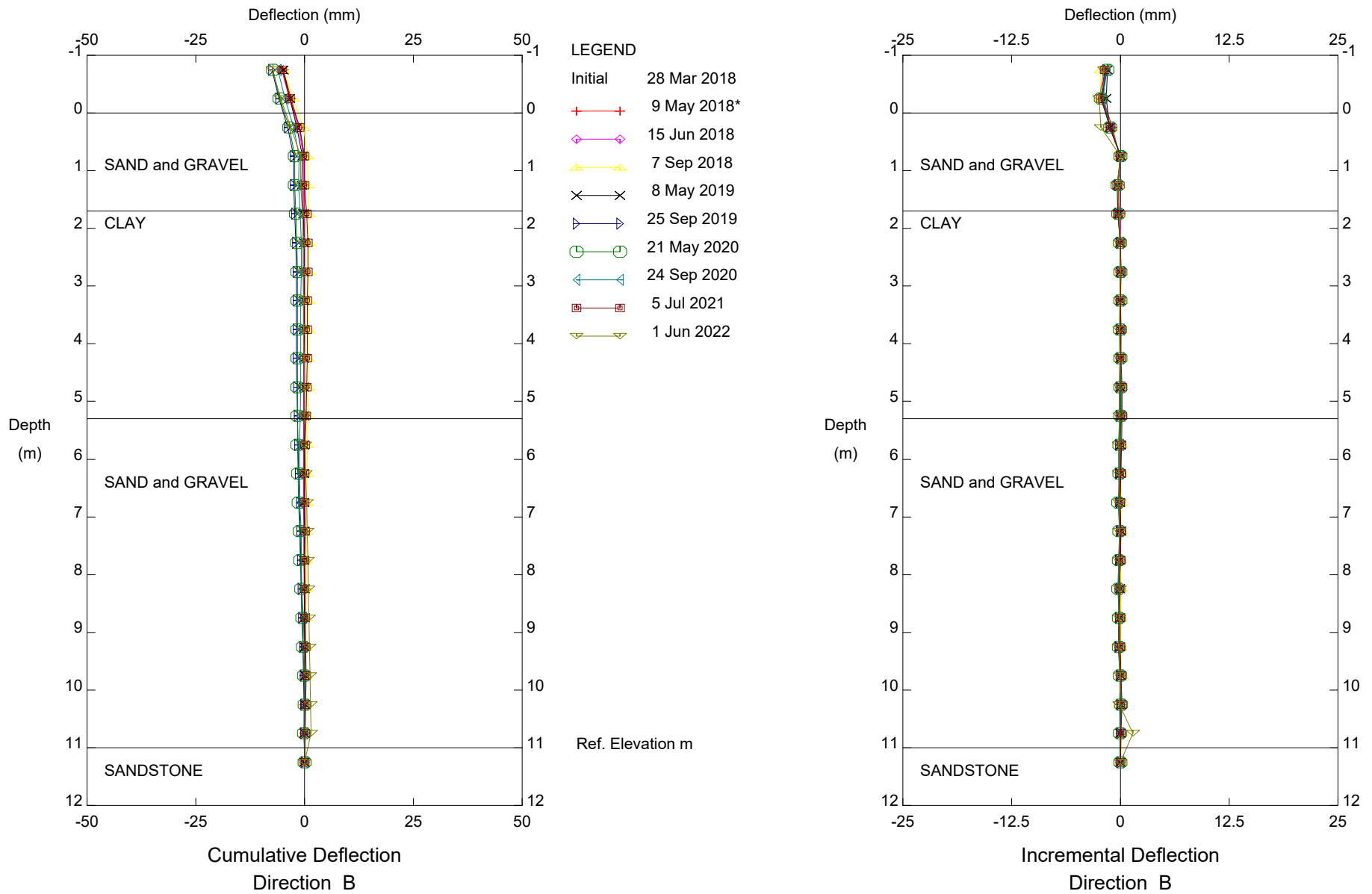
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Alberta Transportation



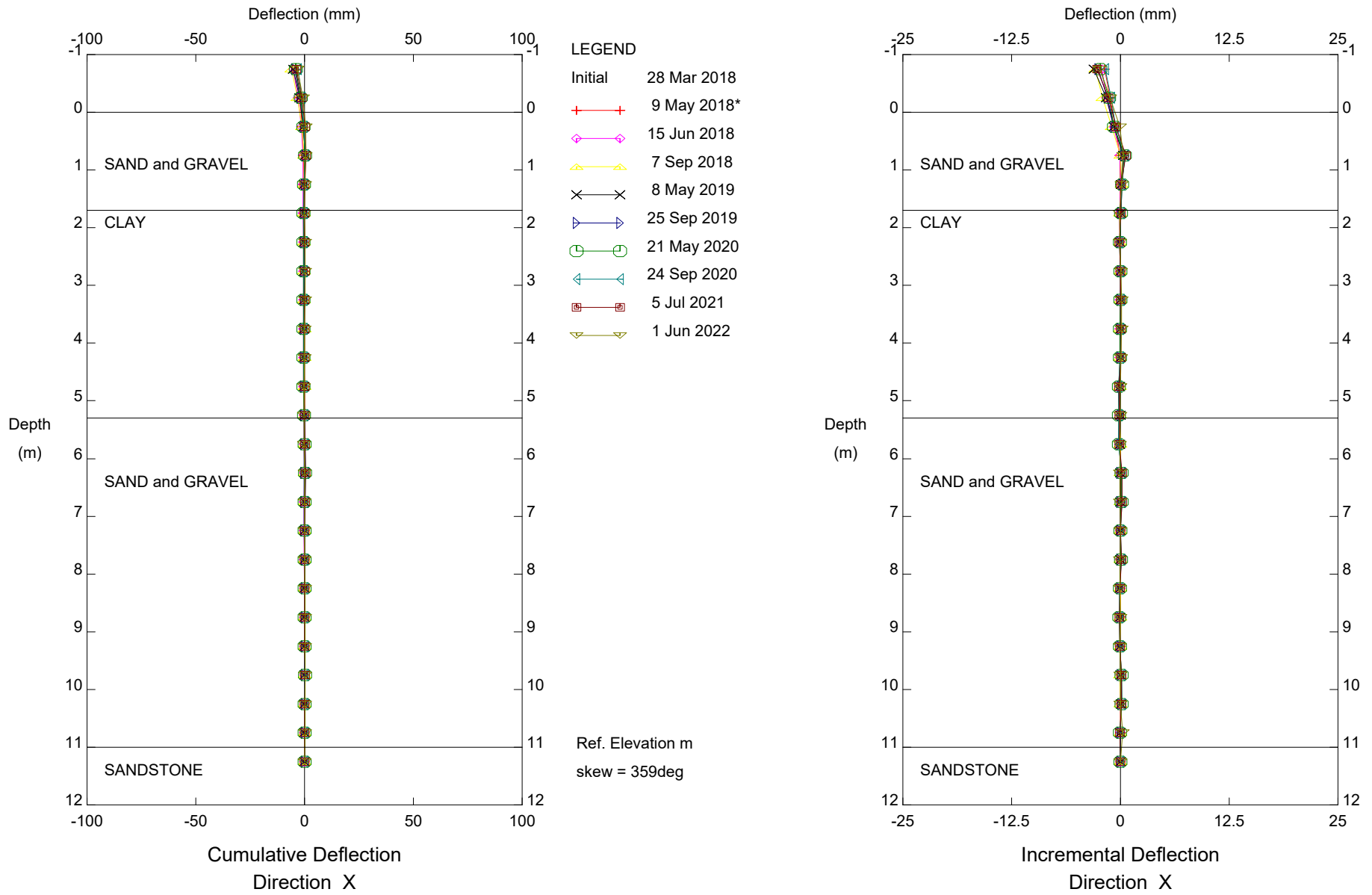
NC037, Inclinometer SI18-03

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



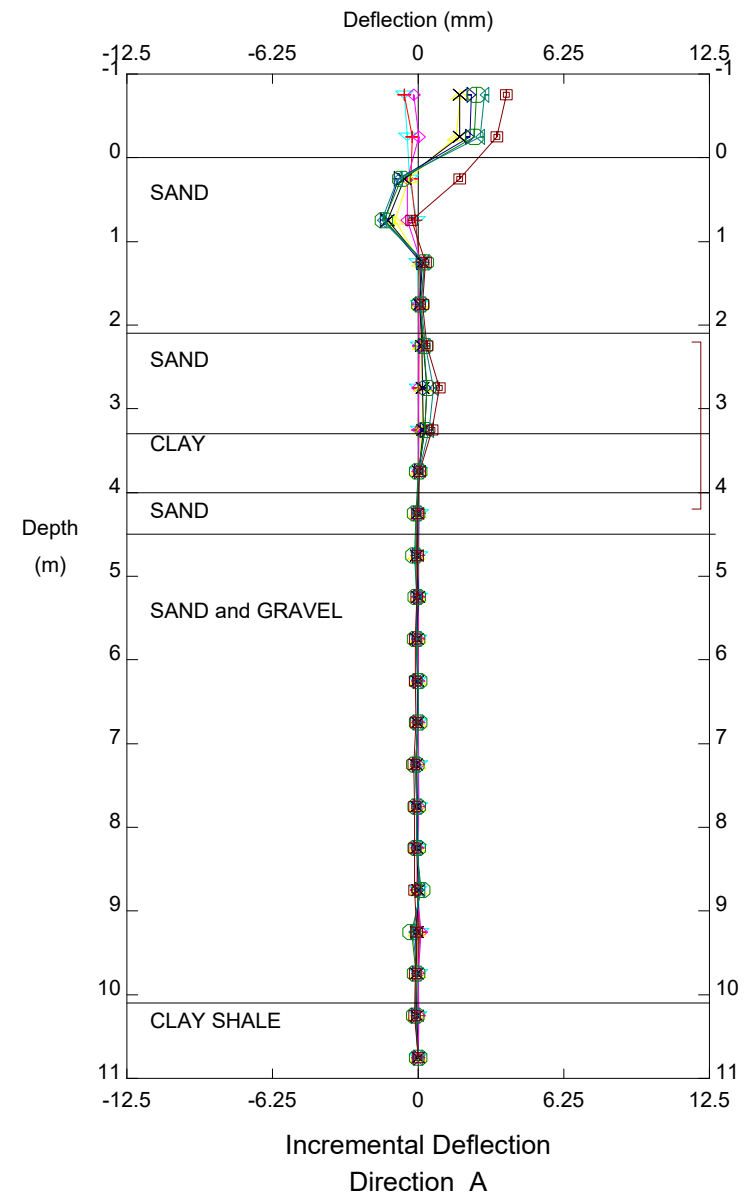
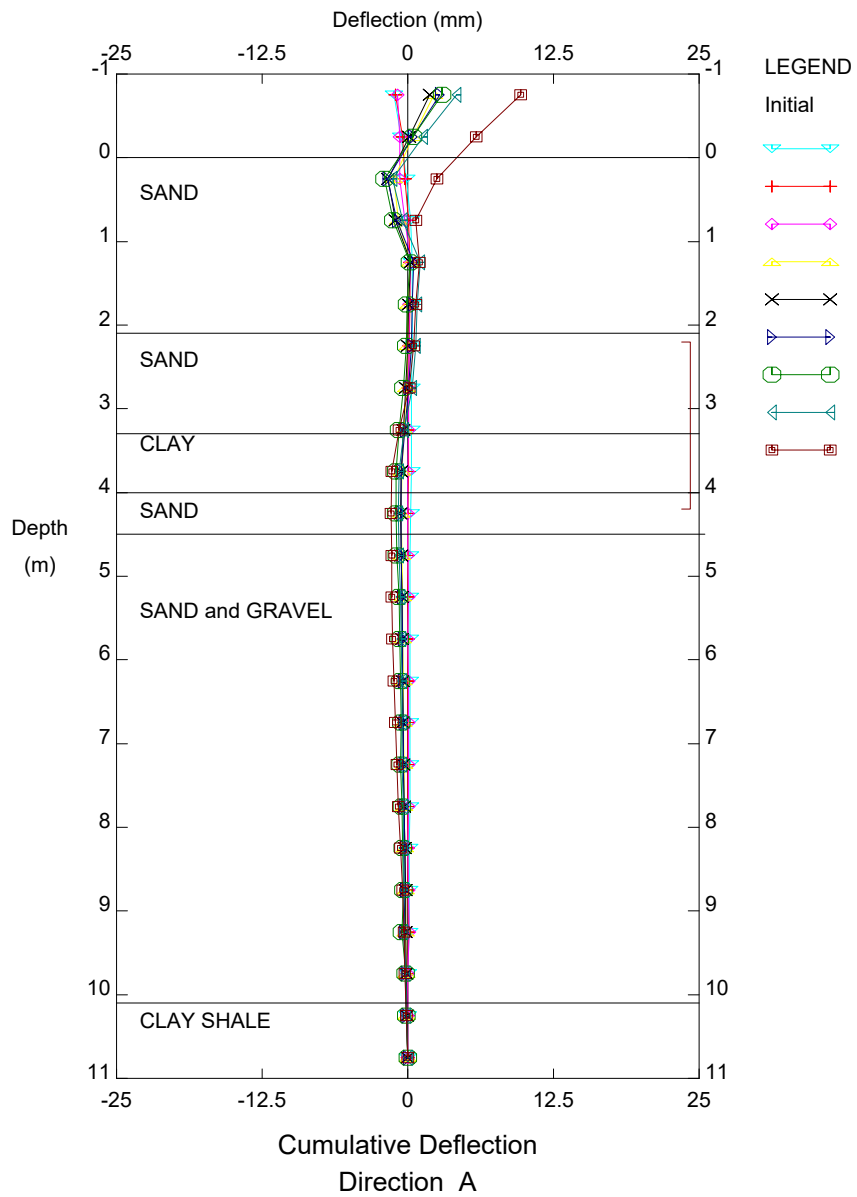
NC037, Inclinometer SI18-03

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



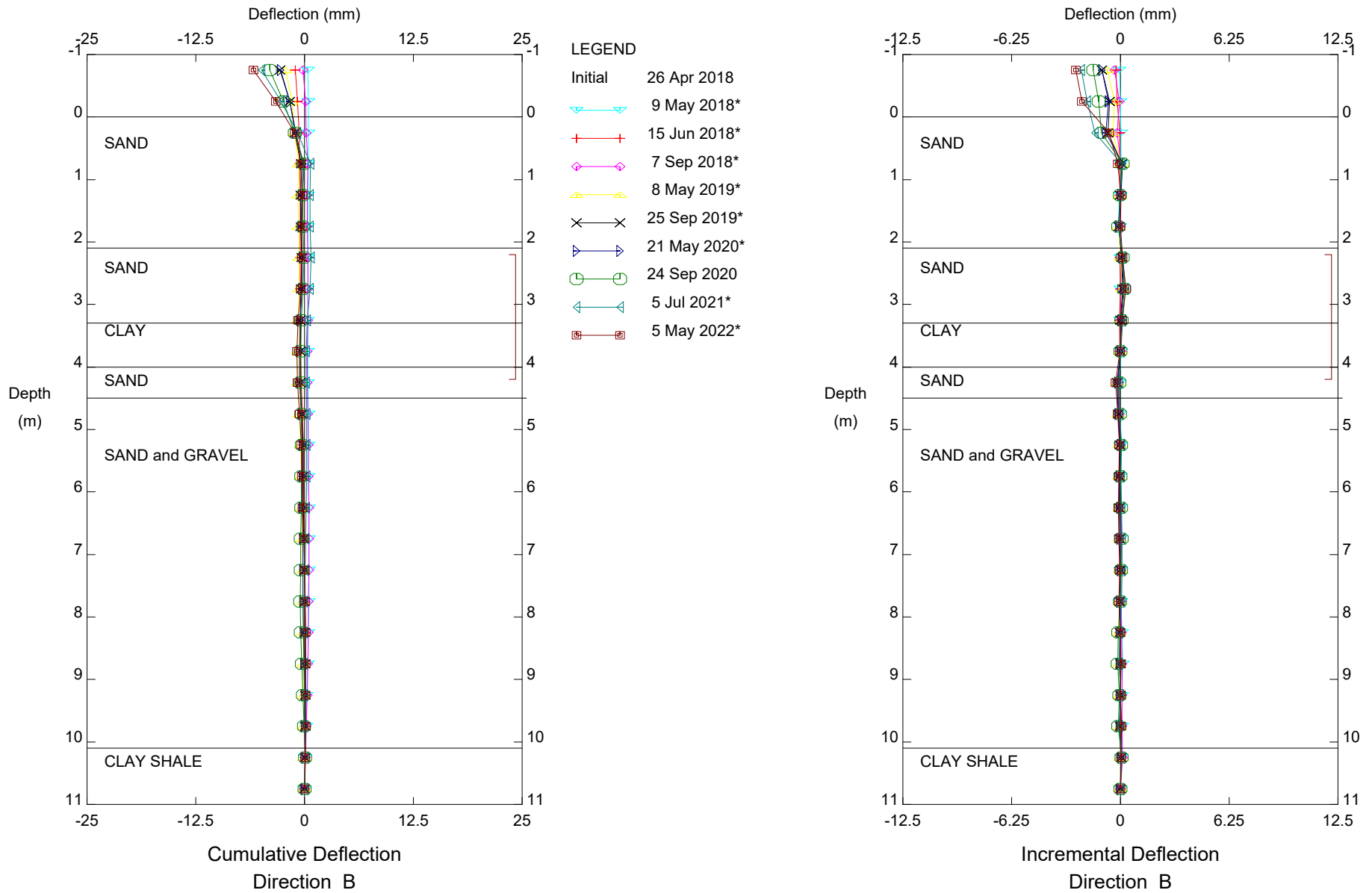
NC037, Inclinometer SI18-03

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



NC037, Inclinator SI18-04

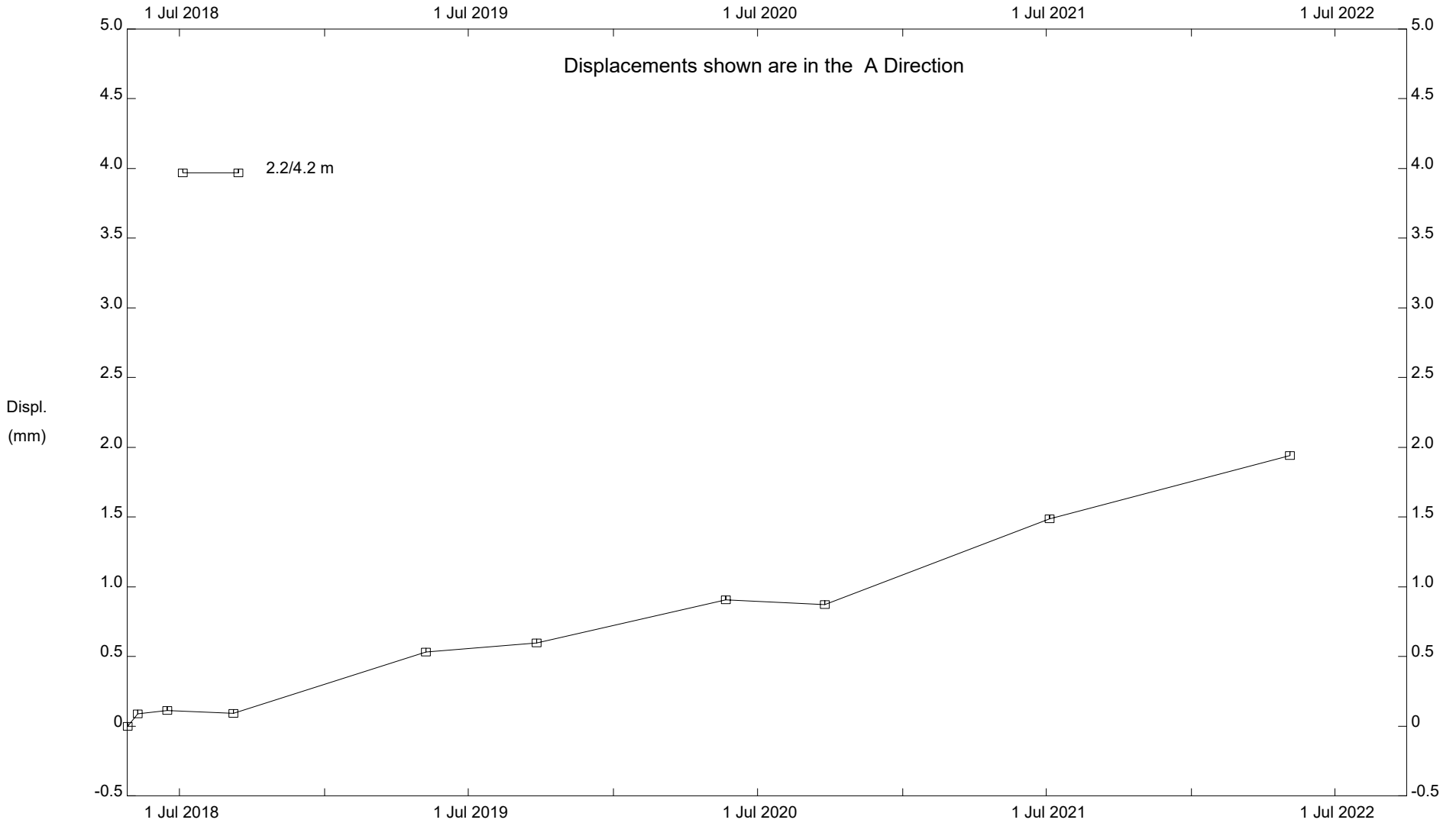
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NC037, Inclinometer SI18-04

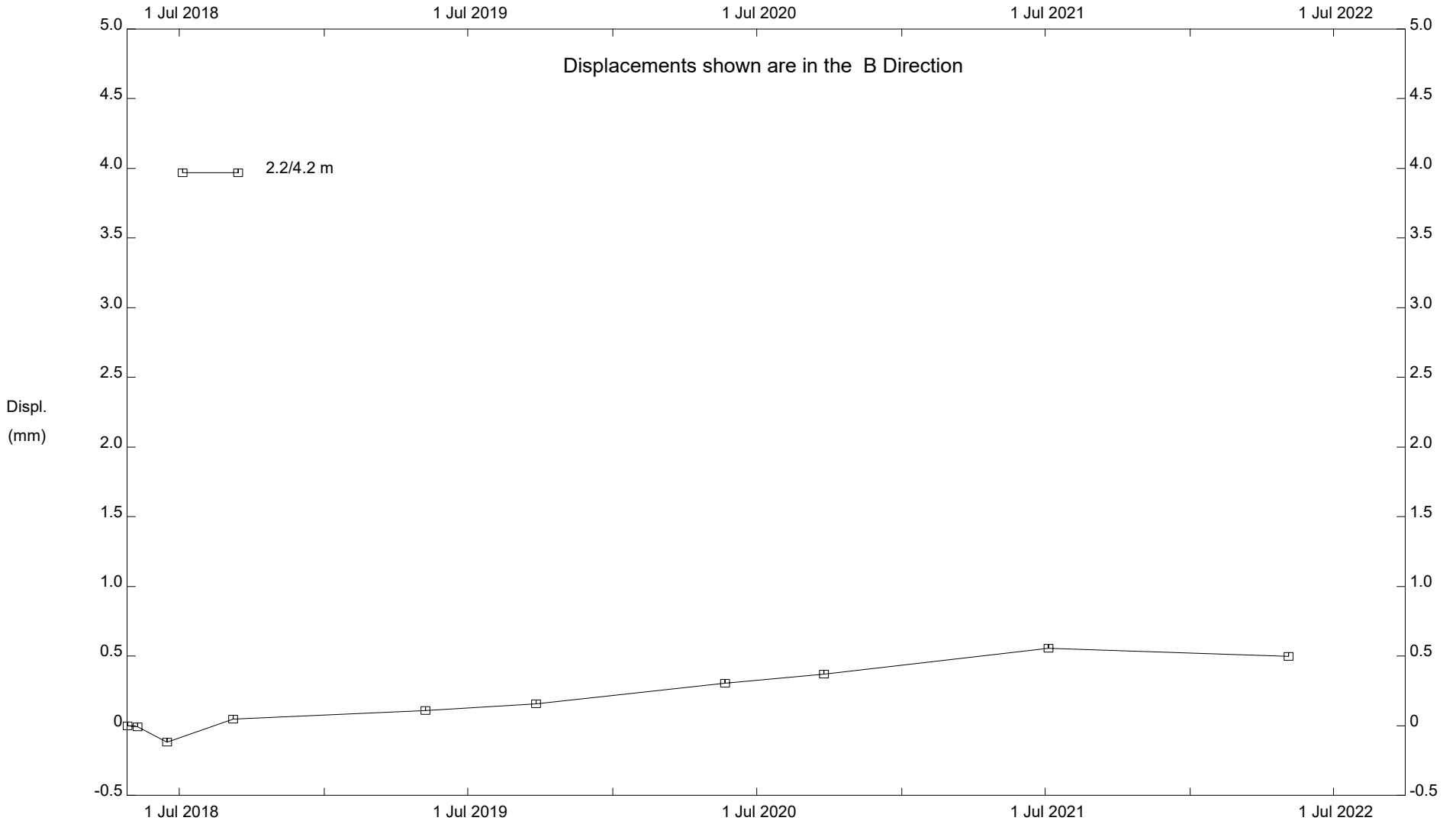
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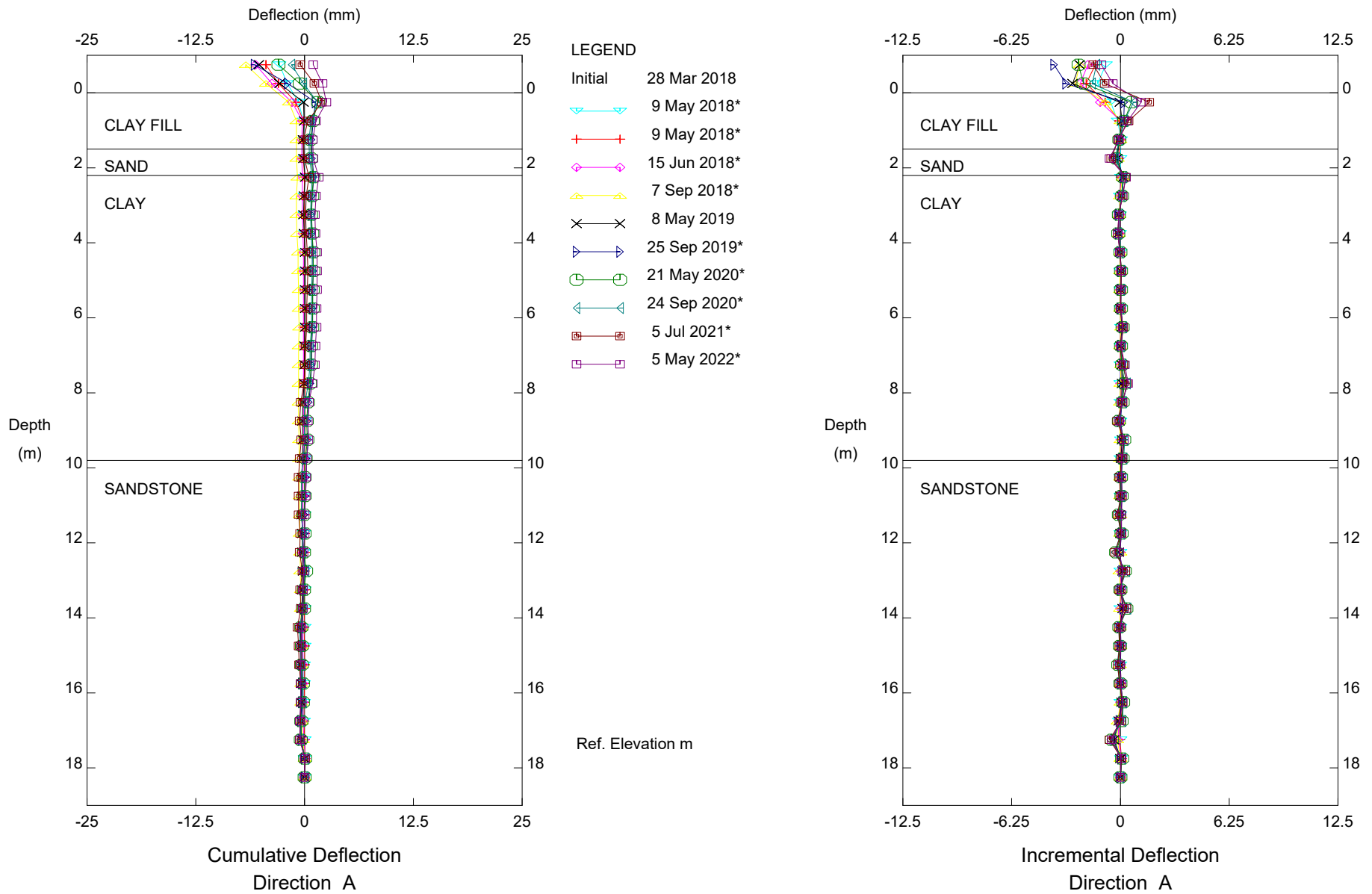


NC037, Inclinator SI18-04

Stantec Consulting Ltd - Edmonton

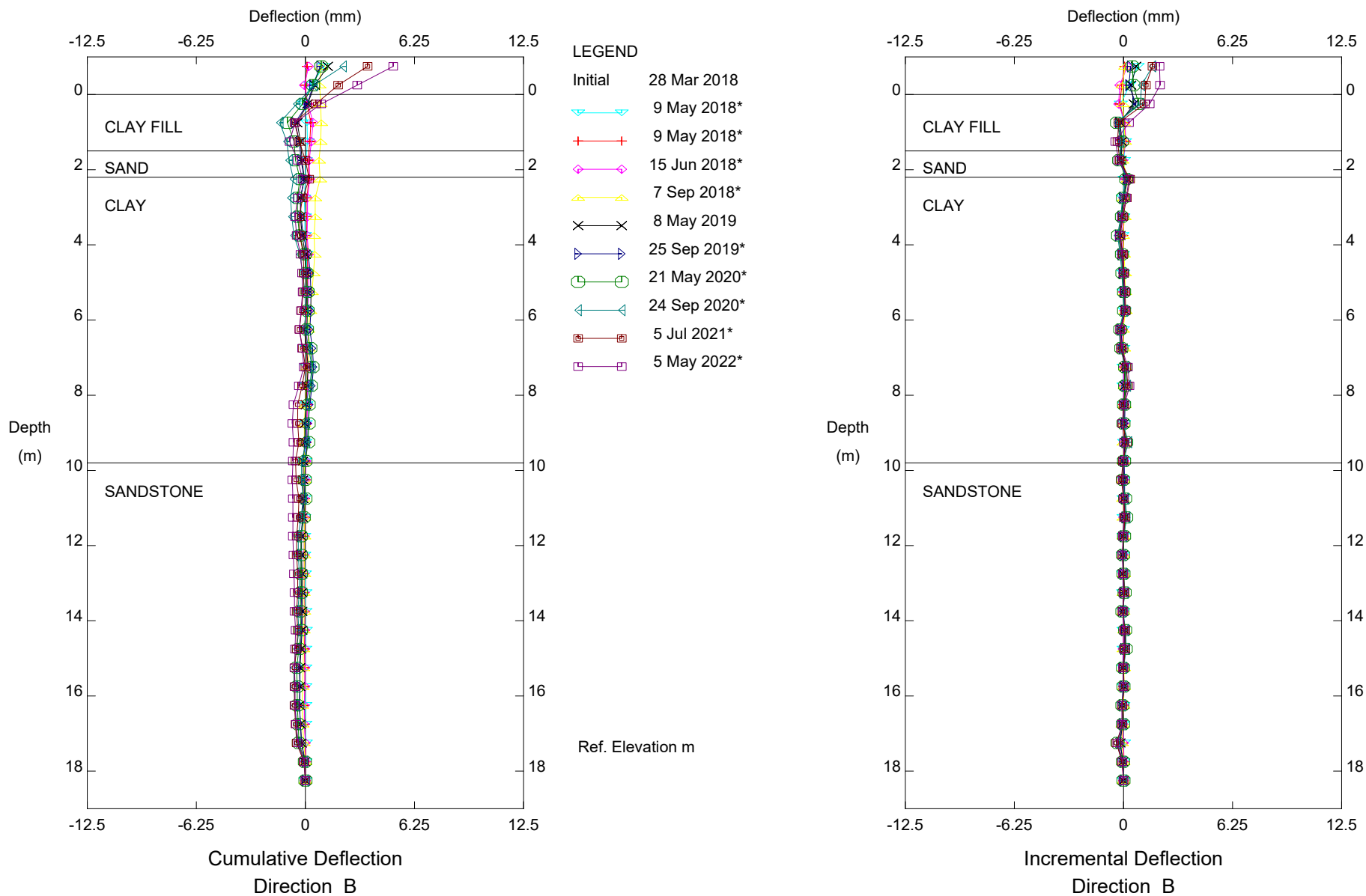


NC037, Inclinator SI18-04



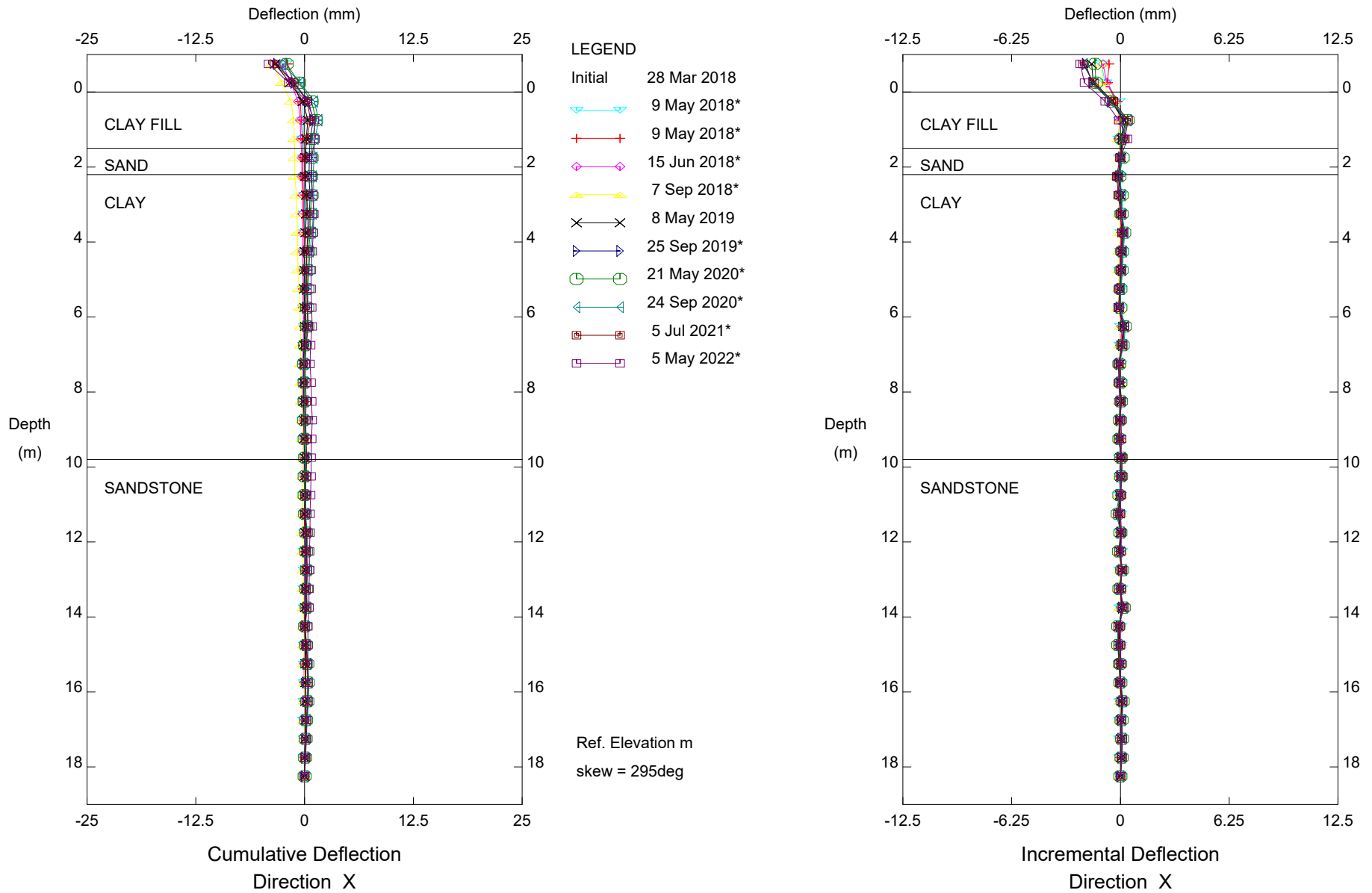
NC037, Inclinometer SI18-05

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



NC037, Inclinometer SI18-05

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



NC037, Inclinometer SI18-05

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

