

July 15, 2024

Alberta Transportation and Economic Corridors  
Main Floor, Provincial Building  
9621 – 96<sup>th</sup> Avenue  
Peace River, Alberta  
T8S 1T4

**Robert Senior**  
**Construction Technologist**

Dear Mr. Senior:

**CON0022166 Peace Region (Grande Prairie District – South) GRMP Instrumentation Monitoring Site GP008; H40:36, km 16.365 Road Surface Slumping (2.5 km North of McIntyre Mine) Section C – 2024 Spring Readings**

## **1 GENERAL**

Three slope inclinometers (SIs) (SI-1, SI-2, and SI-3) and two pneumatic piezometers (PNs) (PN-2A/B) were read at the GP008 site in the Peace Region (Grande Prairie District – South) (GP South Region) on May 22, 2024, by Tim Hillman, E.I.T. of Klohn Crippen Berger Ltd. (KCB). These instruments were read as part of the GP South Region Geohazard Risk Management Program (GRMP). The site is located on Hwy 40:36, km 16.365, north of the former McIntyre Mine (now CST Canada Coal Ltd.). The approximate site coordinates are 5986982 N, 362802 E (UTM Zone 11, NAD 83). A site plan is presented on Figure 1.

The geohazard at the GP008 site consists of three landslides in a possible mine-waste fill/dump below Hwy 40:36:

- the west slide, which cuts diagonally across the highway;
- the middle slide, which is confined to the northbound lane and shoulder; and
- the east slide, which encompasses both lanes.

In 2022, the rockfall component of the GP008 site was made into a separate site (GP053) and the ATCO slide to the northeast was added to the GP008 site. Instruments are only installed at the west/south slide.

Previous remedial actions completed on the GP008 site include regular surface patching and paving.

In 2004, a geotechnical site investigation, which included installing instruments, was conducted by a previous consultant. The encountered stratigraphy was as follows: embankment fill, overlying peat, and overlying bedrock (shale).

## 1.1 Instrumentation

KCB has been reading the instruments at this site since the spring of 2021. Instrumentation installation details are tabulated in Table 1.1. Instrument locations are shown on Figure 1. Any instruments not included in Table 1.1 or shown on Figure 1 are assumed to be inoperable and are not presented or discussed herein.

In 2004, three SIs (SI-1, SI-2, and SI-3) and three PNs (PN-1 and PN-2A/B) were installed at the west/south slide by a previous consultant to monitor movement and groundwater conditions, respectively. SI-1, SI-2, and SI-3 are installed in the upper one-third of the slope, near the midslope, and at the toe of the slope, respectively. PN-1 is now inoperable.

The instruments are protected by above-ground casing protectors.

The operable SIs were read using the same metric RST Digital MEMS Inclinometer System that has been used to read the SIs since KCB took over the readings in June 2021. The operable PNs were read using an RST C109 pneumatic piezometer readout.

**Table 1.1 Instrumentation Installation Details<sup>1</sup>**

Instrument ID	Instrument Type	Date Installed	UTM Coordinates (m)		Ground Surface Elevation (m)	Stick Up (m)	Depth (mbgs <sup>2</sup> )	Condition
			Northing	Easting				
SI-1	SI	Sep. 2004	5986974	362849	939.4	0.7	12.1	Operable
SI-2	SI	Sep. 2004	5986946	362850	928.7	0.2	11.6	Operable
SI-3	SI	Sep. 2004	5986915	362864	918.5	0.7	12.1	Operable
PN-1	PN	Sep. 2004	5986974	362849	939.4	N/A	7.6	Inoperable
PN-2A	PN	Sep. 2004	5986946	362850	928.0	N/A	5.2	Operable
PN-2B	PN	Sep. 2004	5986946	362850	928.0	N/A	9.1	Operable

**Notes:**

<sup>1</sup> Instrument installation details were taken from reports and data files prepared or provided by the previous consultant(s) or TEC. Instrument coordinates and stick ups (where applicable) were confirmed by KCB using a handheld GPS (accuracy of ± 5 m) and tape measure, respectively.

<sup>2</sup> Meters below ground surface (mbgs). Bottom reading depth for SIs, and tip depth for piezometers.  
 Interpretation

## 2 INTERPRETATION

### 2.1 General

For the operable SIs, the cumulative displacement, incremental displacement, and displacement-time data was plotted in the A-direction (i.e., the direction of the A0-grooves) and the X-direction (i.e., the direction of maximum movement obtained at a skew angle from the A0-grooves). SI-1, SI-2, and SI-3 have skew angles of 14°, 350°, and 85°, respectively, measured clockwise from the direction of the A0-grooves.

For the operable PNs, the recorded porewater pressures were converted to an equivalent water/piezometric elevation and plotted relative to ground surface elevation and the tip elevation for each instrument.

The SI and piezometer plots are included in Appendix I, and a summary of the SI and piezometer data is provided in Table 2.1 and Table 2.2, respectively.

In 2021, KCB reviewed the instrumentation data provided by the previous consultant and removed corrections applied to the historical SI data based on our experience. The instrumentation data obtained by KCB is consistent with the data obtained by the previous consultant, except for the PNs due to an increase recorded in 2021, as discussed in Section 2.3. No re-initialization of the SIs is recommended. The SI data plots presented herein include data for readings taken with both the previous consultants' and KCB's SI reading equipment.

## 2.2 Zones of Movement

Distributed movement is being recorded in

- SI-1 from ground surface to an approximate depth of 1.1 m below ground surface, and from approximately 3.6 m to 7.1 m below ground surface;
- SI-2 from ground surface to an approximate depth of 2.1 m below ground surface, and from approximately 2.0 m to 4.1 m below ground surface; and
- SI-3 from an approximate depth of 1.2 m to 2.1 m below ground surface, with most of the movement being recorded since May 2015.

The movement being recorded in all three SIs is occurring within the fill.

## 2.3 Interpretation of Monitoring Results

Since the instruments were installed in 2007, the rate of movement being recorded in SI-1, SI-2, and SI-3 in the fill has been slow (less than 2 mm/year), except for increased movement (up to approximately 6 mm/year) recorded in the X-direction of SI-2 in early 2006 and 2021. In 2021, the increased rate of movement recorded in SI-2 was likely a result of the SI reading equipment being changed when KCB took over the readings in June 2021. Since 2021, the movement rates recorded in SI-2 are once again slow (less than 1 mm/year).

TEC has noted that cracking usually reflects through pavement patches at the site very quickly. It is noted that the existing SIs are installed at the west slide area only and movements recorded in them may not be reflective of movements occurring at the middle or east/north slide areas where no instruments are installed.

**Table 2.1 Slope Inclinometer Reading Summary**

Instrument ID	Date				Ground Surface Elevation (m)	Depth of Movement (mbgs <sup>1</sup> )	Direction of Movement, Skew Angle <sup>2</sup>	Movement (mm)		Rate of Movement (mm/year)		
	Initialized	Previous Maximum Cumulative Movement Recorded	Previous Reading	Most Recent Reading				Maximum Cumulative	Incremental Since Previous Maximum Cumulative	Previous Maximum	Most Recent Reading	Change from Previous Reading
SI-1	Sep. 27, 2004	Jun. 23, 2022	Jun. 08, 2023	May 22, 2024	939.4	0.0 – 1.1	X-Direction, 14°	13.6	0.1	4.4	0.0	-0.2
		Jun. 08, 2023				3.6 – 7.1		20.7	0.6	2.2	0.6	0.2
SI-2	Sep. 27, 2004	Jun. 28, 2021	Jun. 08, 2023	May 22, 2024	928.7	0.1 – 2.1	X-Direction, 350°	28.5	-0.4	10.0	0.0	-0.2
		Jun. 28, 2021				2.0 – 4.1		4.6	0.0	1.8	0.2	0.1
SI-3	Sep. 27, 2004	Jun. 08, 2023	Jun. 08, 2023	May 22, 2024	918.5	1.1 – 2.1	X-Direction, 85°	6.7	0.4	2.5	0.4	0.3

**Notes:**

<sup>1</sup> Meters below ground surface (mbgs).

<sup>2</sup> Skew angle of the X-direction measured clockwise from the A-direction. The azimuths of the A0-grooves in the SIs were measured by KCB with a magnetic compass in spring 2022.

**Table 2.2 Pneumatic Piezometer Reading Summary**

Instrument ID	Serial No.	Date			Ground Surface Elevation (m)	Tip Depth (mbgs <sup>1</sup> )	Water Level		
		Installed	Previous Reading	Most Recent Reading			Previous Reading (mbgs <sup>1</sup> )	Most Recent Reading (mbgs <sup>1</sup> )	Change from Previous Reading (m)
PN-2A	29181	Sep. 2004	Jun. 08, 2023	May 22, 2024	928.0	5.2	5.2	5.1	0.1
PN-2B	29182	Sep. 2004	Jun. 08, 2023	May 22, 2024	928.0	9.1	9.0	9.0	0.0

**Notes:**

<sup>1</sup> Meters below ground surface (mbgs).

Although a peat layer was identified in the SI data plots, the distributed shearing movements recorded in SI-1 appear to be on a basal plane above the peat layer. The peat layer is most likely the cause of the movement and the SI data points may be shifted upwards due to soil logging or SI stick up issues. Alternatively, there could be a loose zone of fine-grained segregated material near the base of the fill that is straining under embankment load. Observations of the highway embankment slope surface during the 2021 and 2024 Section B inspections indicated that the fill material is likely mine waste that could have been end-dumped in thick lifts (with minimal compaction) before or as part of highway construction. Movements recorded in SI-2 and SI-3 are well above the peat layer, indicating that straining of the embankment along a segregated fine-grained layer in the mine waste fill is more likely.

SI-1 and SI-2 (located near the top of the slope and mid-slope, respectively) are recording movement to the southeast. However, SI-2 (located near the toe of the slope) is recording movement more toward the southwest. This could indicate that the movement pattern for the highway embankment is complex and difficult to assess, given that the highway embankment was constructed in thick lifts with minimal compaction.

Since the instruments were installed in 2004, water levels recorded in the PN-2A and PN-2B have been near tip elevation (i.e., the instruments have been dry), except during the spring and fall 2021 readings when water levels increased to 0.2 m and 0.4 m above tip elevation, respectively. Since the spring 2022 reading, the instruments have once again been dry.

### **3 RECOMMENDATIONS**

#### **3.1 Future Work**

All operable instruments should continue to be read once per year (spring) unless movements increase and begin to impact the highway. Spring readings should be completed after late-May or early-June, due to the risk of water inside the instrument casings being frozen earlier in the year.

The site should continue to be inspected by the Maintenance Contract Inspector (MCI) and as part of the GP South region GRMP Section B inspections.

#### **3.2 Instrument Repairs and Maintenance**

No instrument repairs or maintenance is required.

### **4 CLOSING**

This report is an instrument of service of Klohn Crippen Berger (KCB). The report has been prepared for the exclusive use of Alberta Transportation and Economic Corridors (Client) for the specific application to the GP South Geohazard Risk Management Program (Contract No. CON0022166), and it may not be relied upon by any other party without KCB's written consent.

KCB has prepared this report in a manner consistent with the level of care, skill and diligence ordinarily provided by members of the same profession for projects of a similar nature at the time and place the services were rendered. KCB makes no warranty, express or implied.

Use of or reliance upon this instrument of service by the Client is subject to the following conditions:

1. The report is to be read in full, with sections or parts of the report relied upon in the context of the whole report.
2. The observations, findings and conclusions in this report are based on observed factual data and conditions that existed at the time of the work and should not be relied upon to precisely represent conditions at any other time.
3. The report is based on information provided to KCB by the Client or by other parties on behalf of the client (Client-supplied information). KCB has not verified the correctness or accuracy of such information and makes no representations regarding its correctness or accuracy. KCB shall not be responsible to the Client for the consequences of any error or omission contained in Client-supplied information.
4. KCB should be consulted regarding the interpretation or application of the findings and recommendations in the report.
5. This report is electronically signed and sealed and its electronic form is considered the original. A printed version of the original can be relied upon as a true copy when supplied by the author or when printed from its original electronic file.

Yours truly,

**KLOHN CRIPPEN BERGER LTD.**



Courtney Mulhall, M.Sc., P.Eng.  
Geotechnical Engineer

Tim Hillman, E.I.T.  
Geotechnical Engineer-in-Training

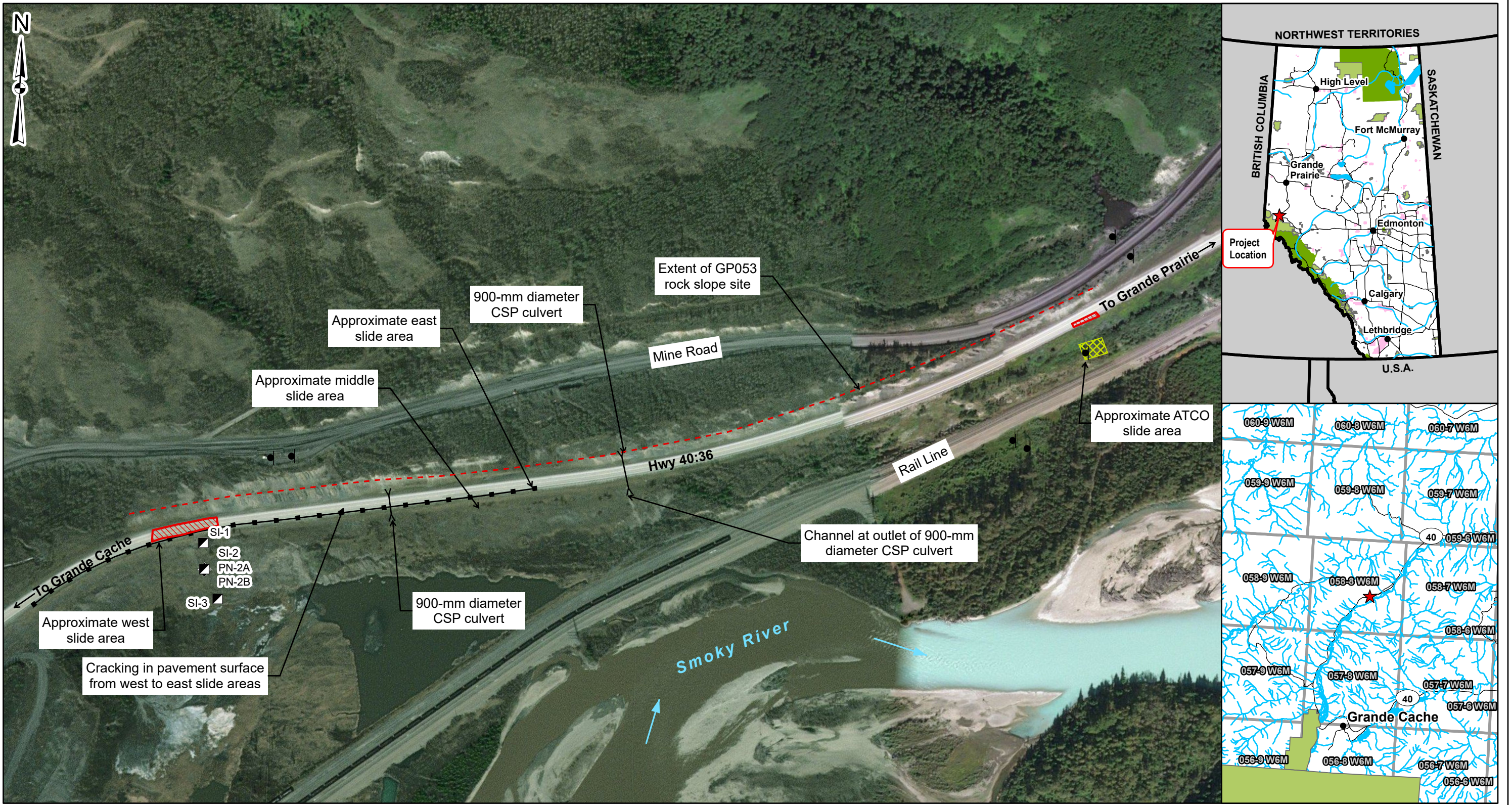
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#### ATTACHMENTS

Figure  
Appendix I      Instrumentation Plots

## FIGURE

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File: Z:\A\EDM\A05116A01\ABT Grande Prairie South GRMP\400 Drawings\GIS\MXD\2022\2022 GRMP Figures\_2024\25.aprx Date: Time: Creator: aharrison

**Legend**

- Powerpole
- Approximate Pneumatic Piezometer Location
- Approximate Slope Inclinometer Location
- Flow Direction
- Rockfall Corridor
- Guardrail
- Culvert
- ATCO Excavation
- Pavement Patch



NOTES:  
 1. HORIZONTAL DATUM: NAD83  
 2. GRID ZONE: UTM ZONE 11N  
 3. IMAGE SOURCE: 2022 MICROSOFT CORPORATION, 2022 MAXAR CNES, DISTRIBUTION AIRBUS DS

CLIENT

PROJECT	PEACE REGION (GRANDE PRAIRIE DISTRICT-SOUTH) GEOHAZARD RISK MANAGEMENT PROGRAM	
TITLE	Site Plan GP008 - Road Surface Slumping (2.5 km North of McIntyre Mine) Hwy 40:36, km 16.365 and 17.139	
SCALE	PROJECT No.	FIG No.
1:4,000	A05116A01	1

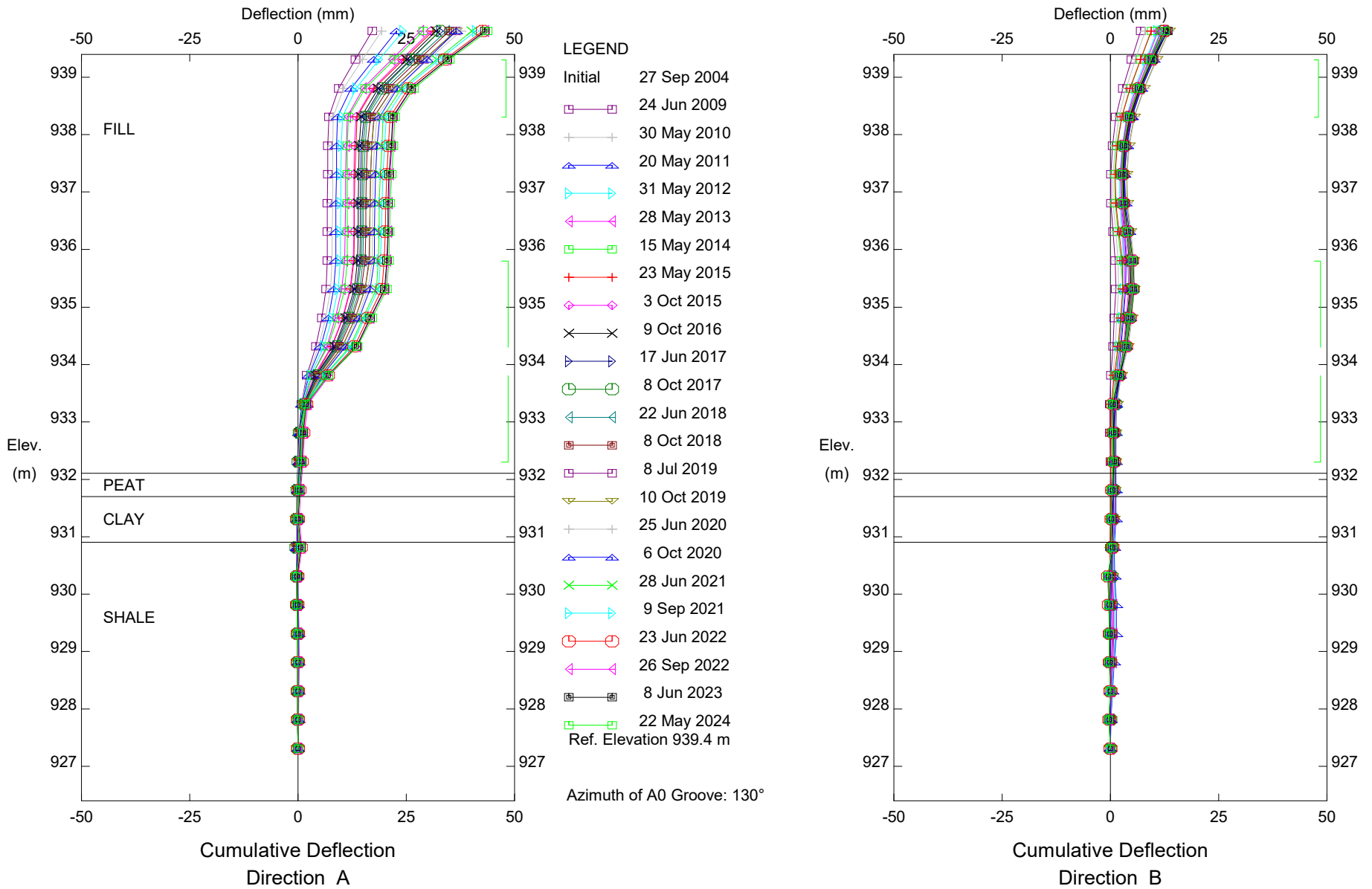


# APPENDIX I

## Instrumentation Plots

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# Klohn Crippen Berger - Edmonton

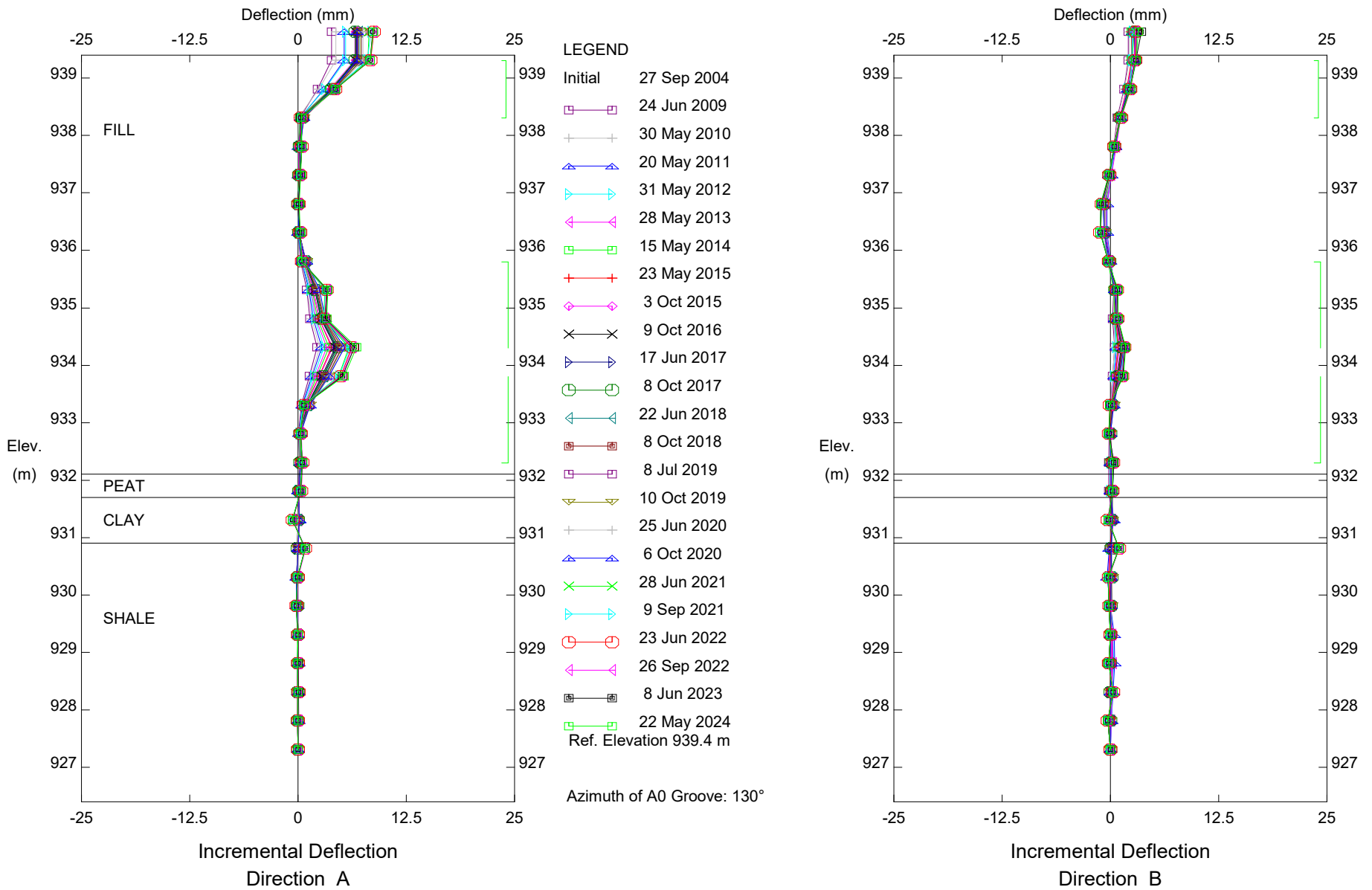


GP008; H40:36, Road Surface Slumping, Inclinometer SI-1

Alberta Transportation

GP008; H40:36, Road Surface Slumping

# Klohn Crippen Berger - Edmonton

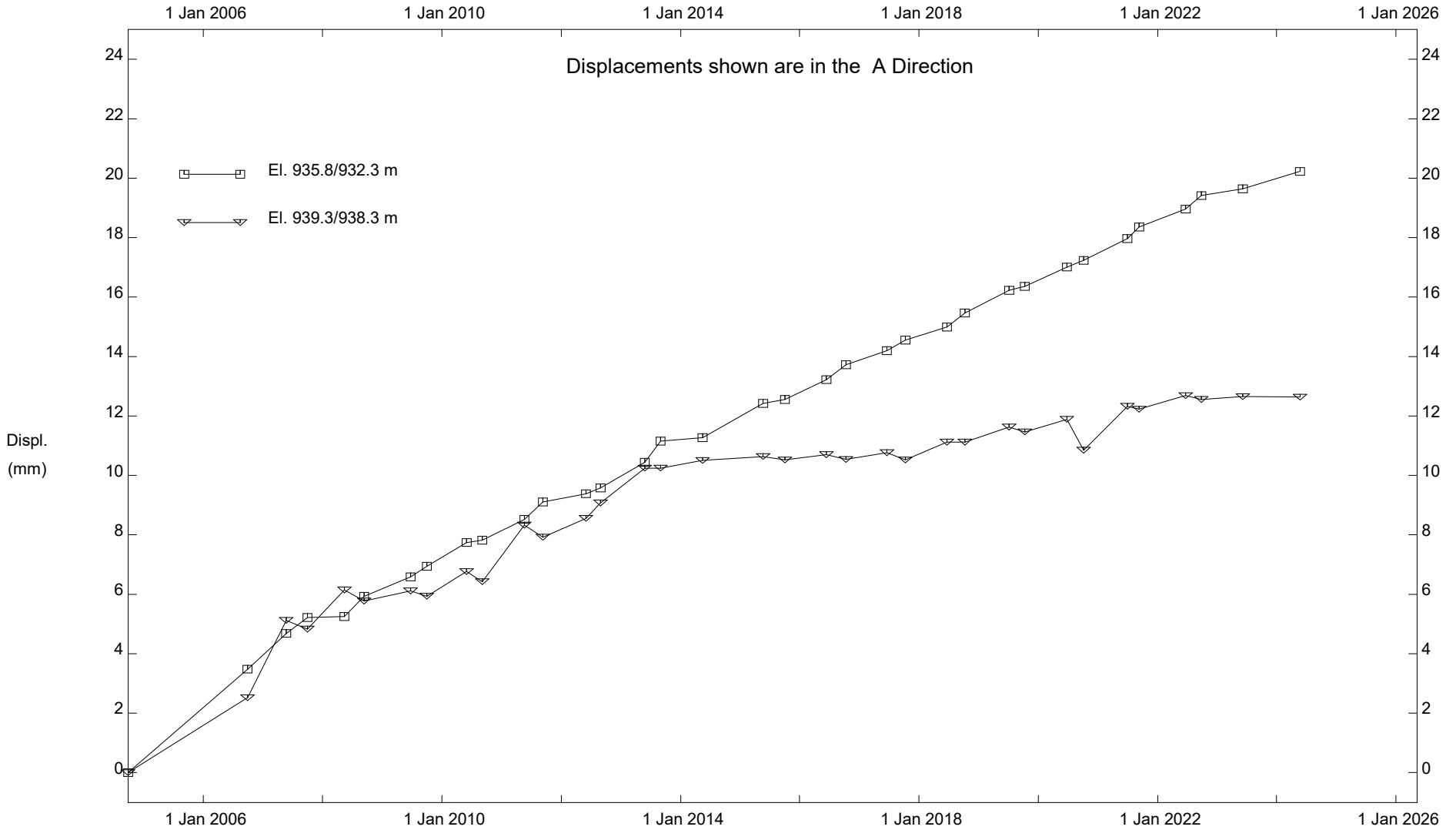


GP008; H40:36, Road Surface Slumping, Inclinometer SI-1

Alberta Transportation

GP008; H40:36, Road Surface Slumping

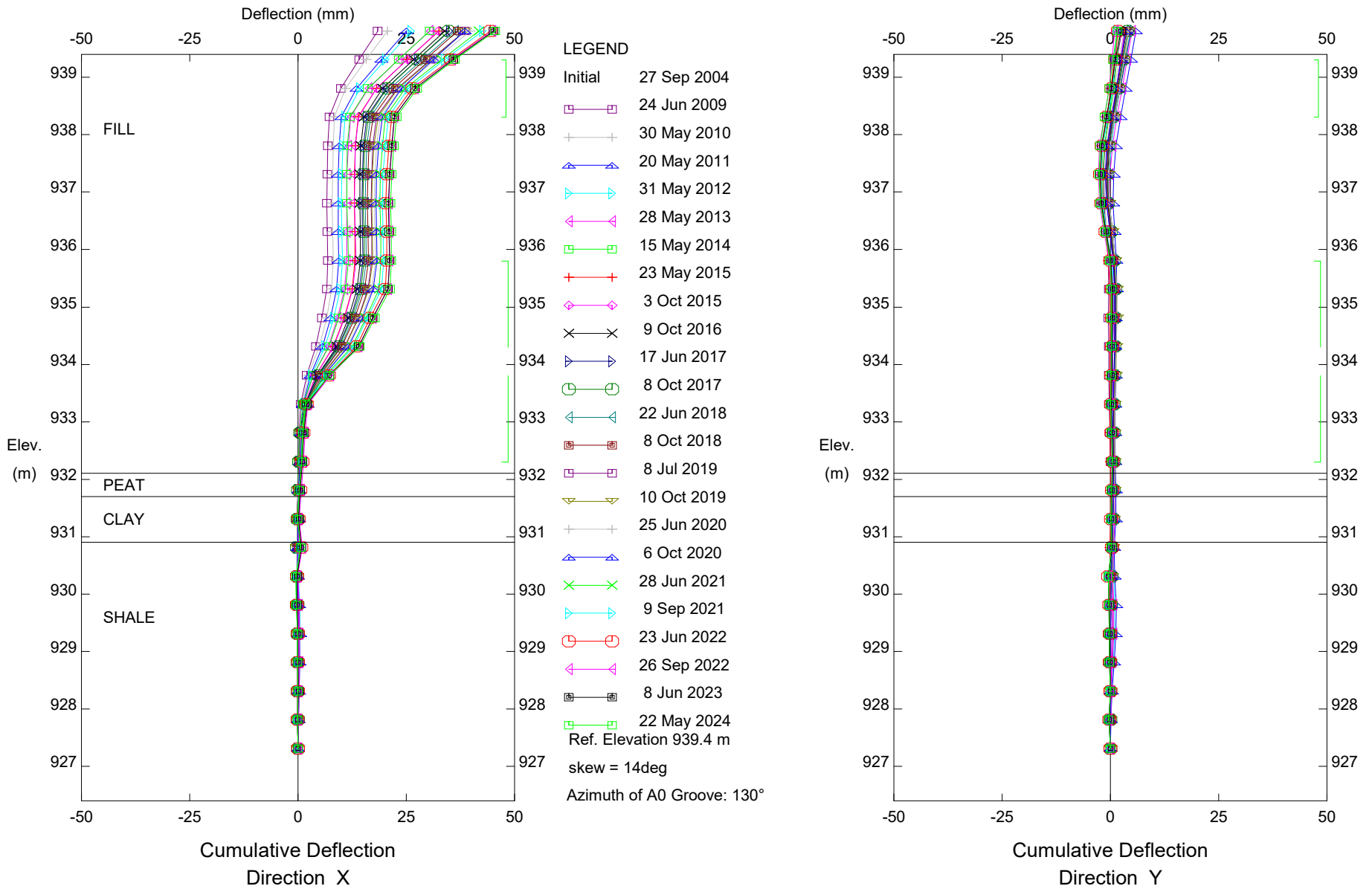
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GP008; H40:36, Road Surface Slumping, Inclinator SI-1

Alberta Transportation

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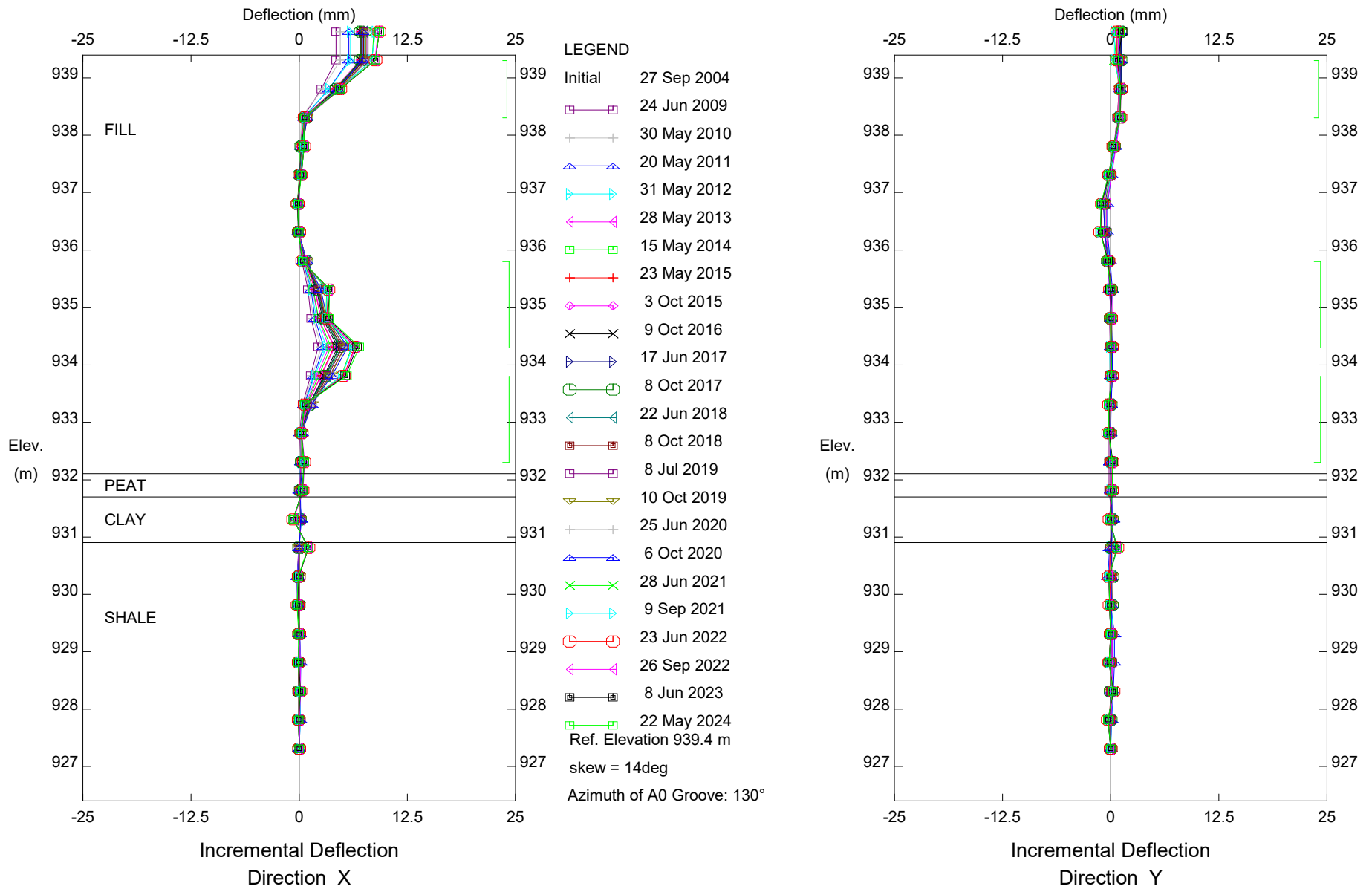


GP008; H40:36, Road Surface Slumping, Inclinometer SI-1

Alberta Transportation

GP008; H40:36, Road Surface Slumping

# Klohn Crippen Berger - Edmonton

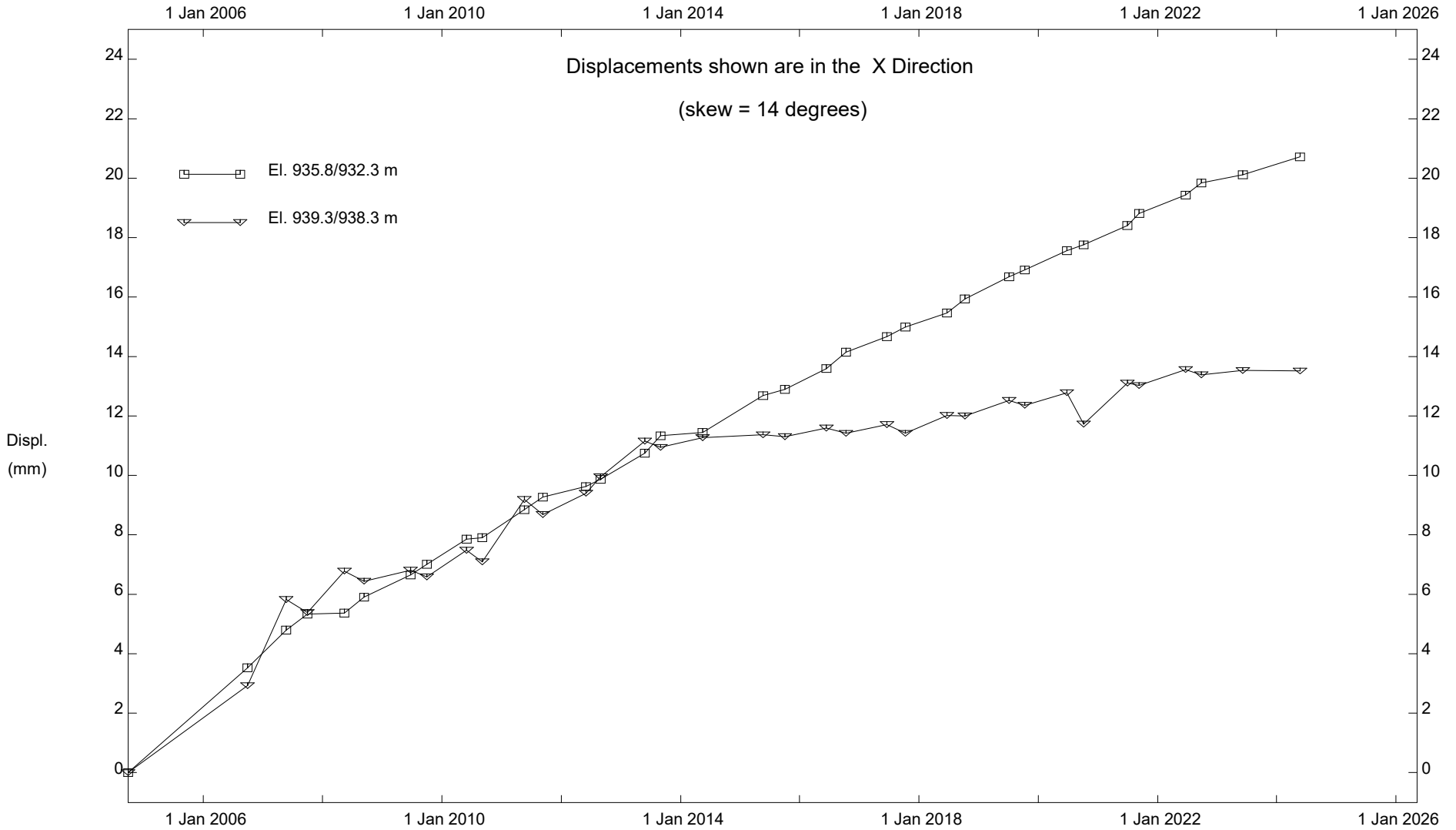


GP008; H40:36, Road Surface Slumping, Inclinometer SI-1

Alberta Transportation

GP008; H40:36, Road Surface Slumping

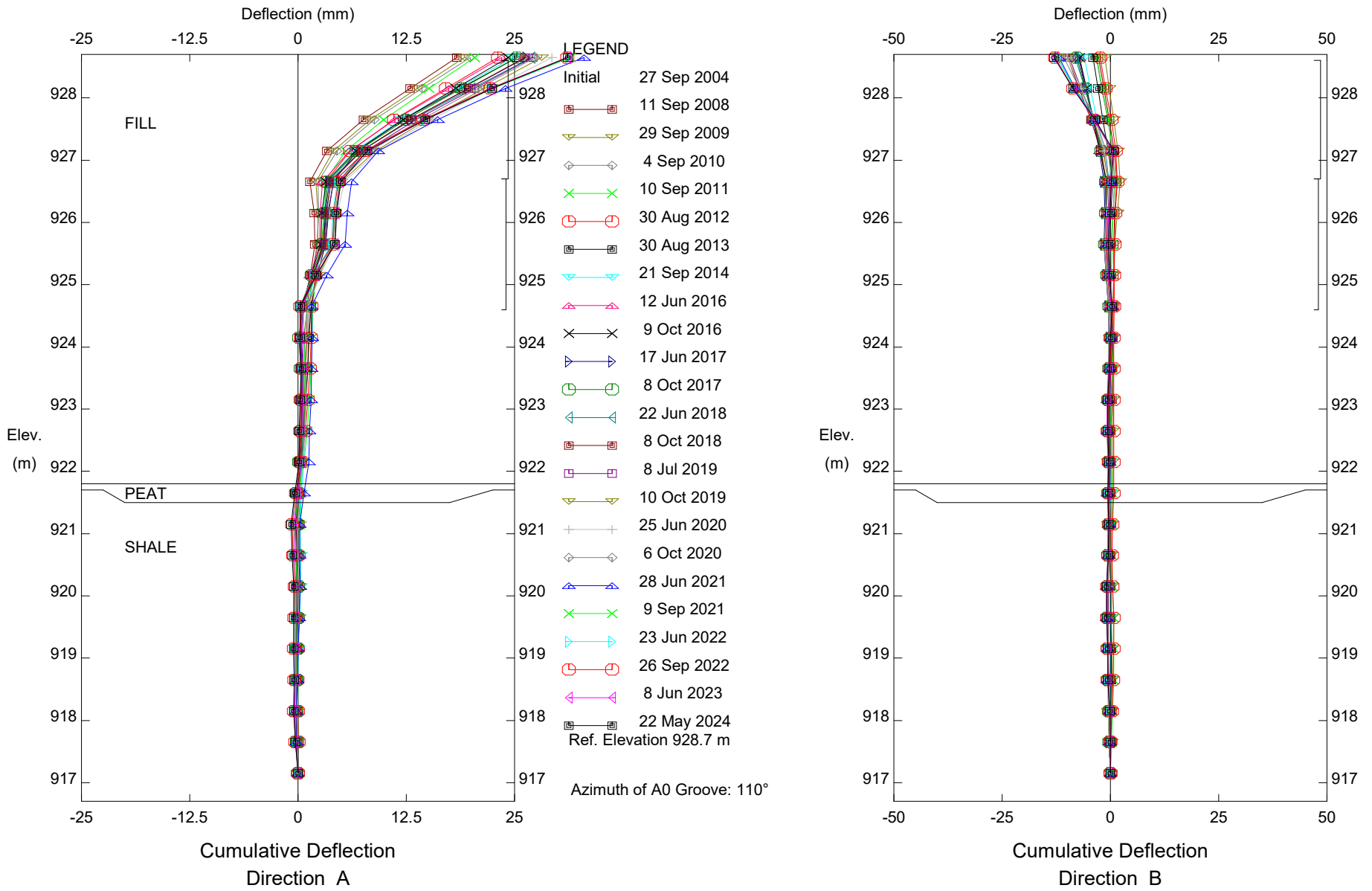
# Klohn Crippen Berger - Edmonton



GP008; H40:36, Road Surface Slumping, Inclinator SI-1

Alberta Transportation

# Klohn Crippen Berger - Edmonton



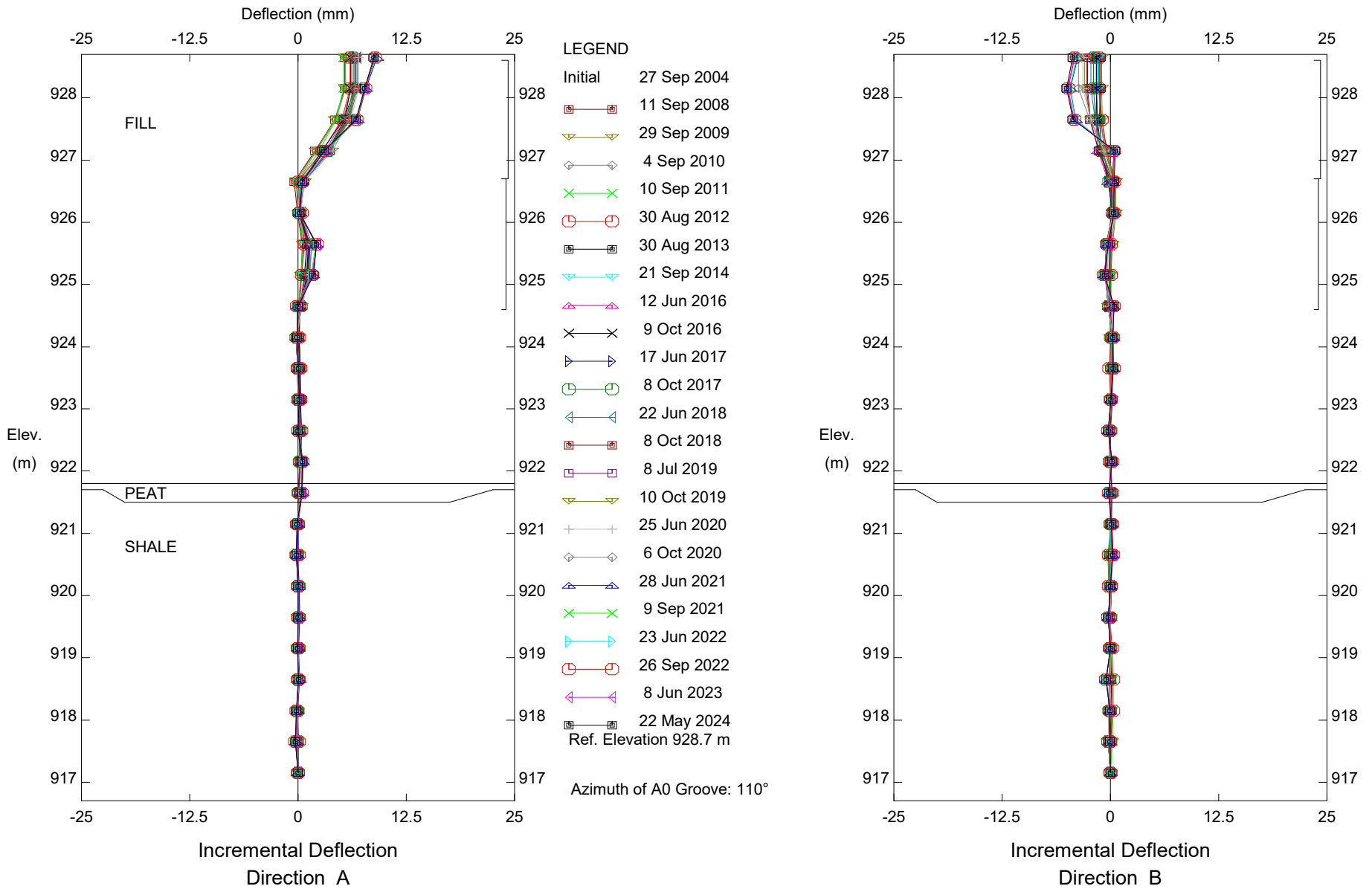
GP008; H40:36, Road Surface Slumping, Inclinometer SI-2

Alberta Transportation

GP008; H40:36, Road Surface Slumping



# Klohn Crippen Berger - Edmonton

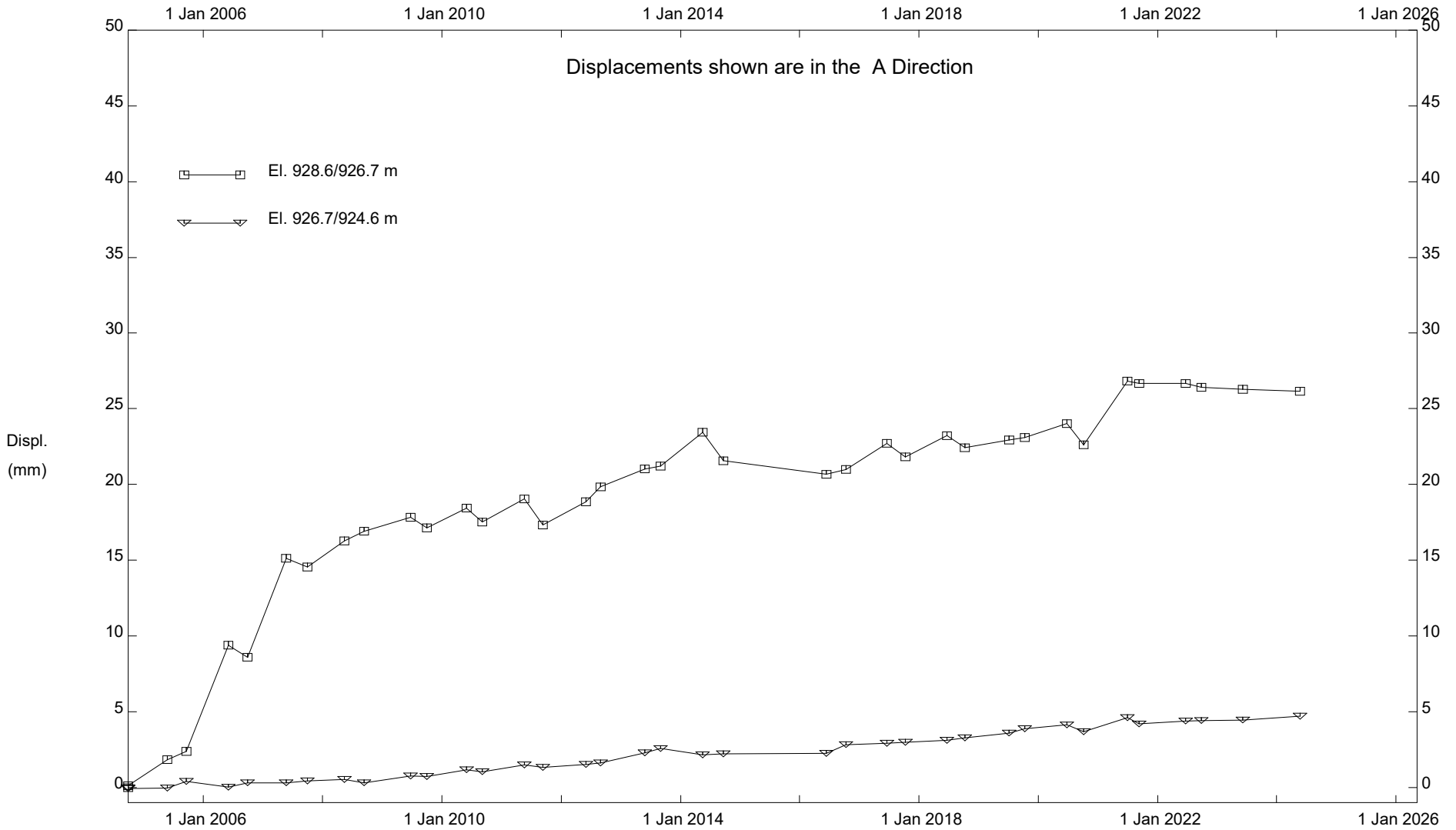


GP008; H40:36, Road Surface Slumping, Inclinometer SI-2

Alberta Transportation

GP008; H40:36, Road Surface Slumping

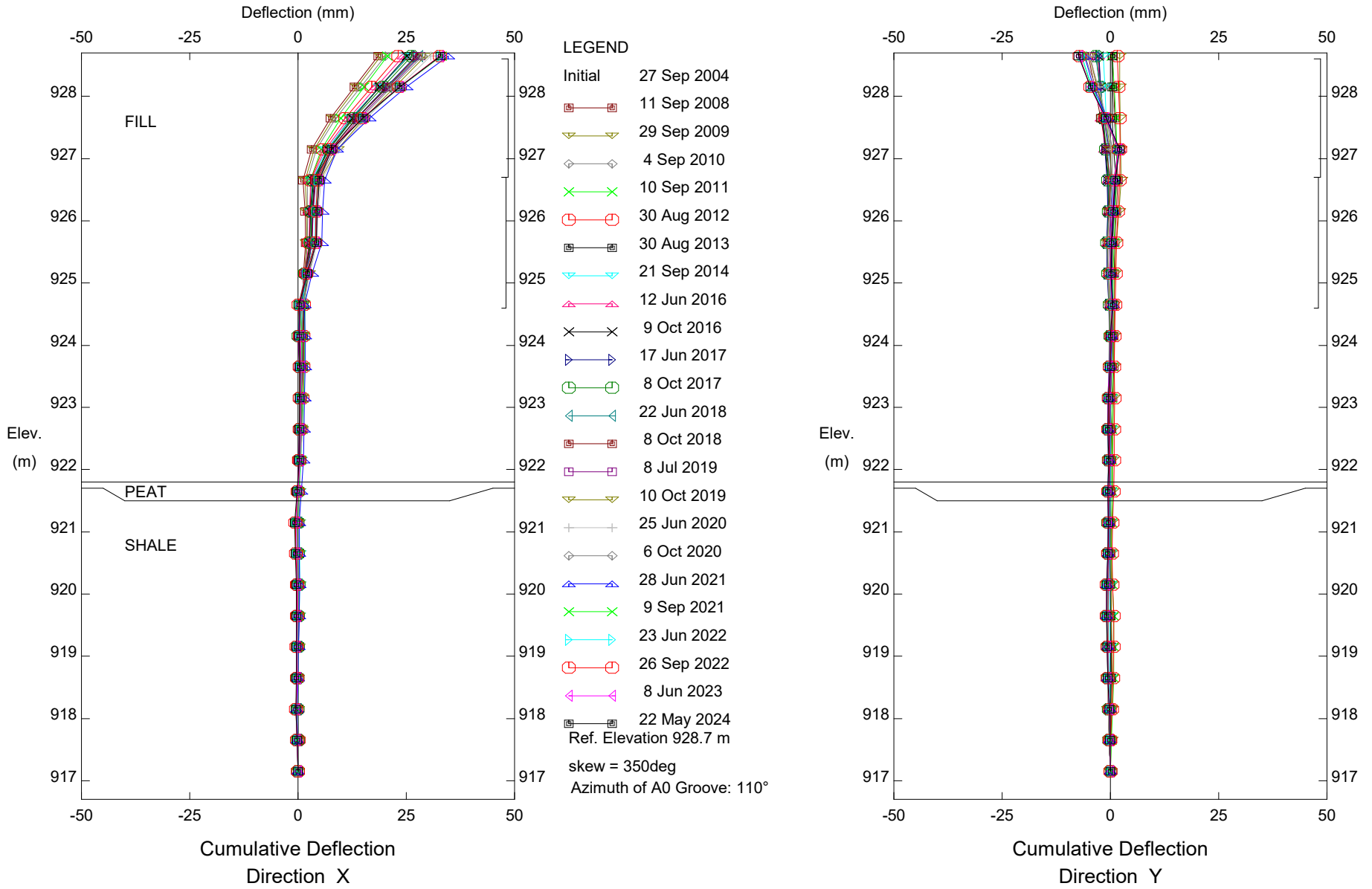
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GP008; H40:36, Road Surface Slumping, Inclinator SI-2

Alberta Transportation

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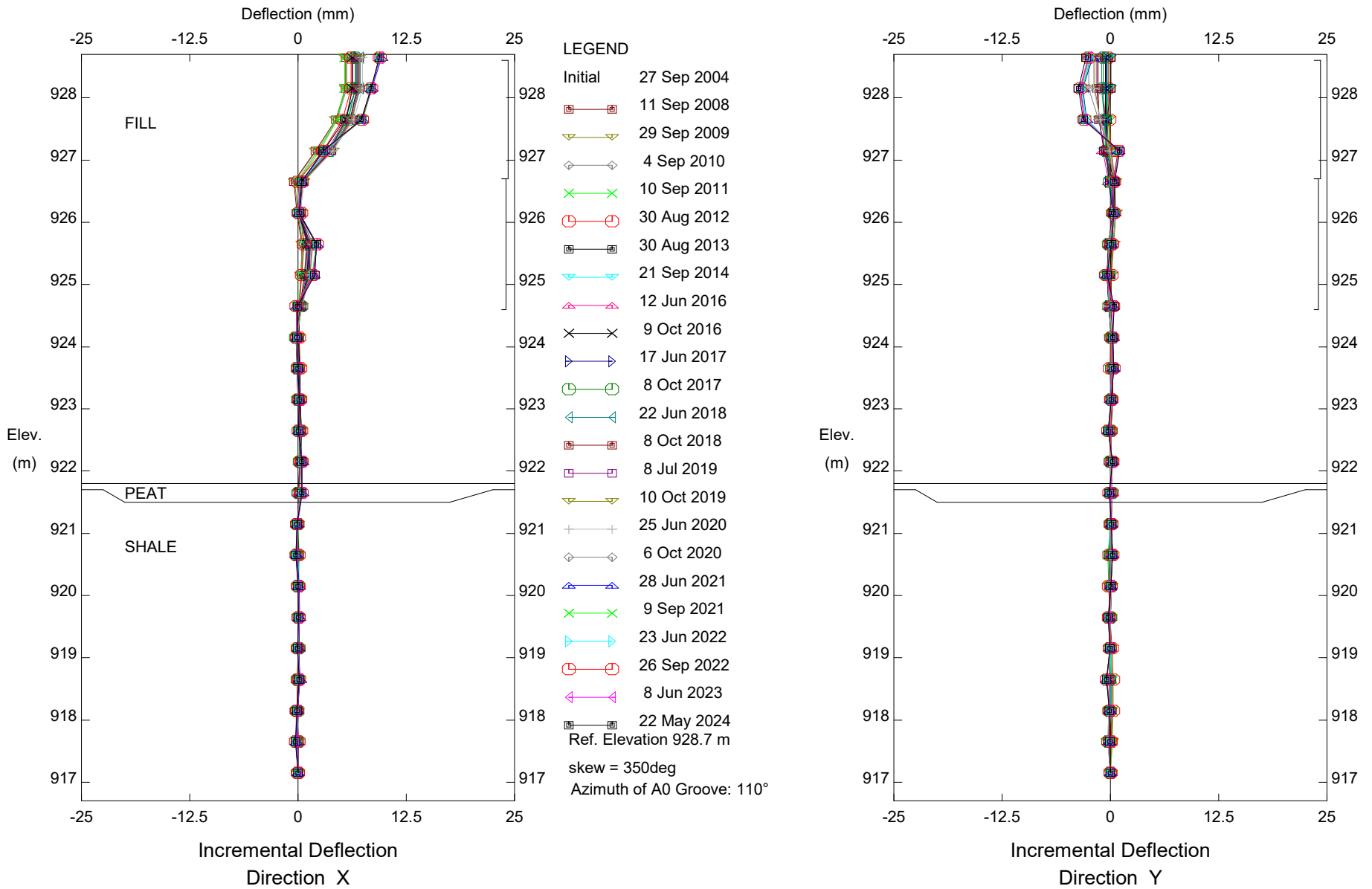


GP008; H40:36, Road Surface Slumping, Inclinometer SI-2

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GP008; H40:36, Road Surface Slumping

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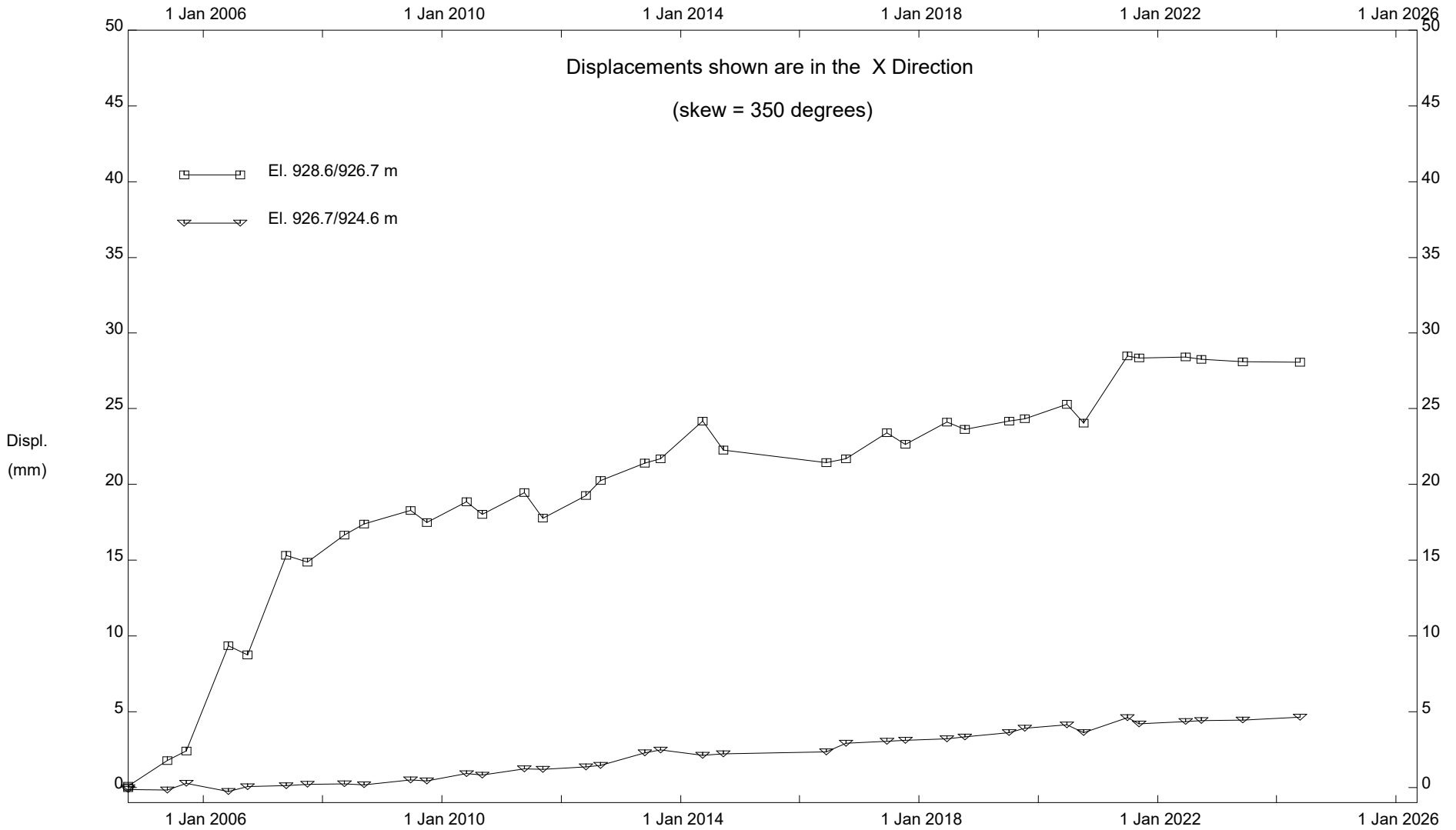


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GP008; H40:36, Road Surface Slumping

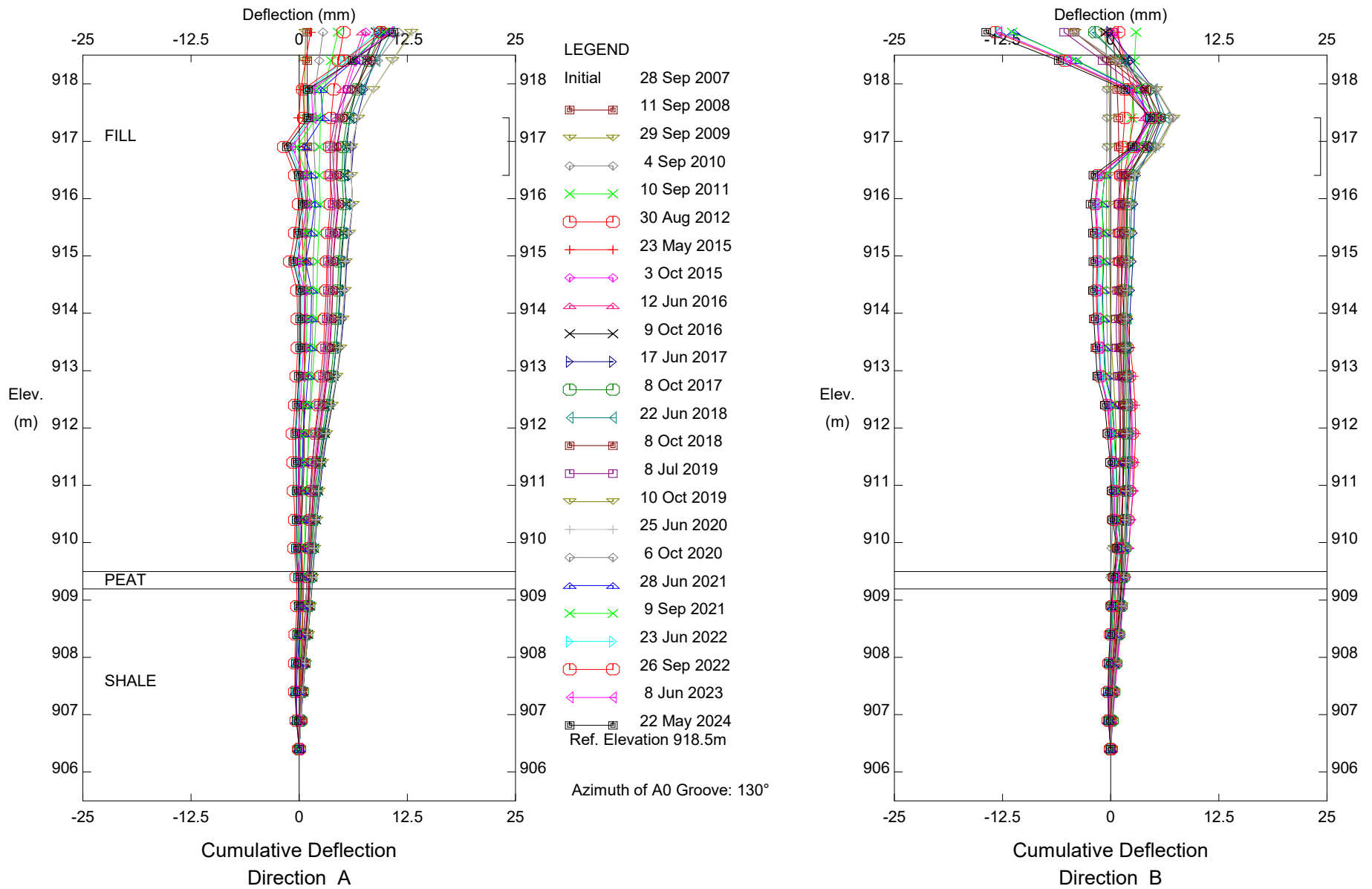
# Klohn Crippen Berger - Edmonton



GP008; H40:36, Road Surface Slumping, Inclinometer SI-2

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# Klohn Crippen Berger - Edmonton

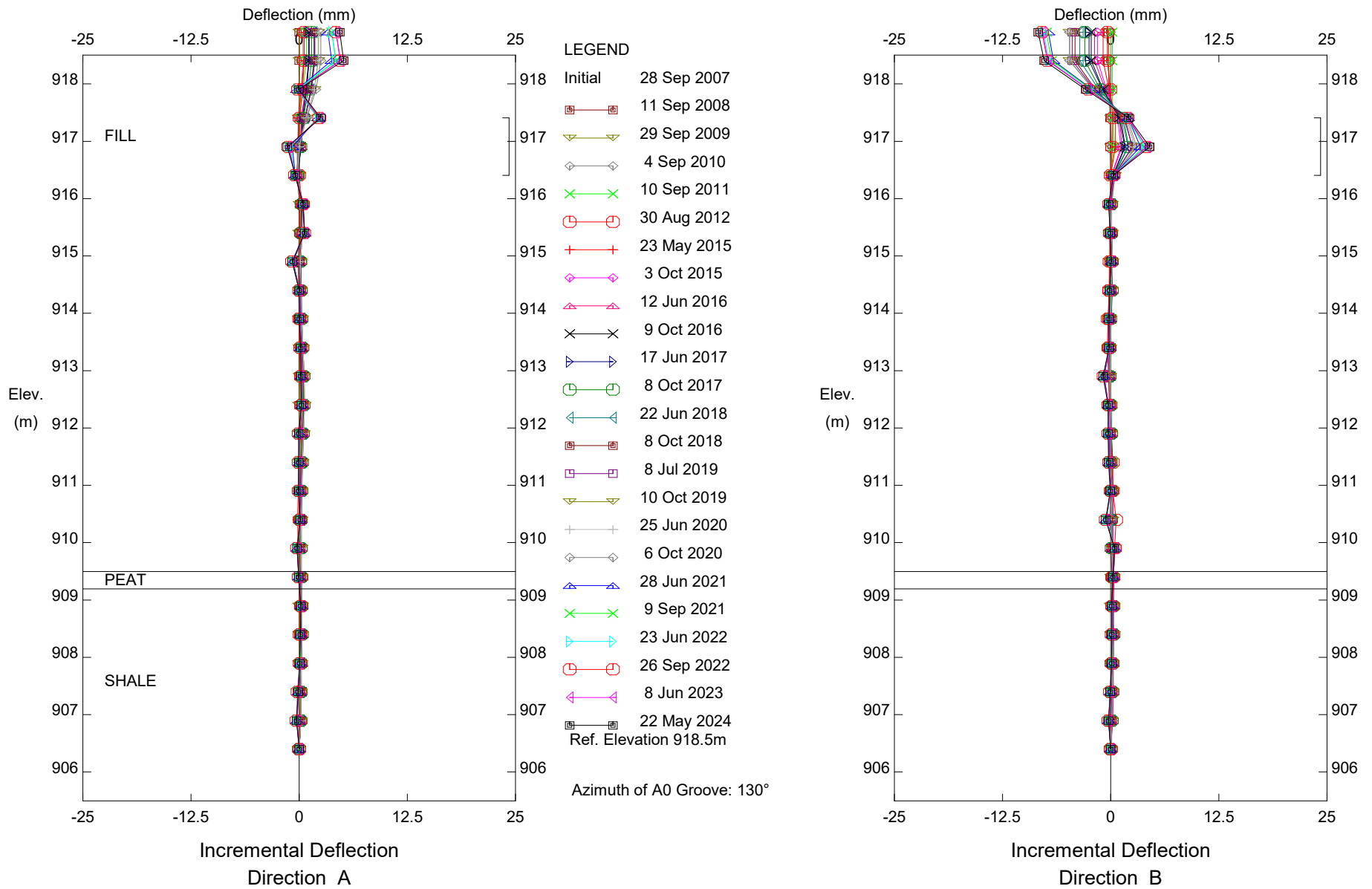


GP008; H40:36, Road Surface Slumping, Inclinator SI-3

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GP008; H40:36, Road Surface Slumping

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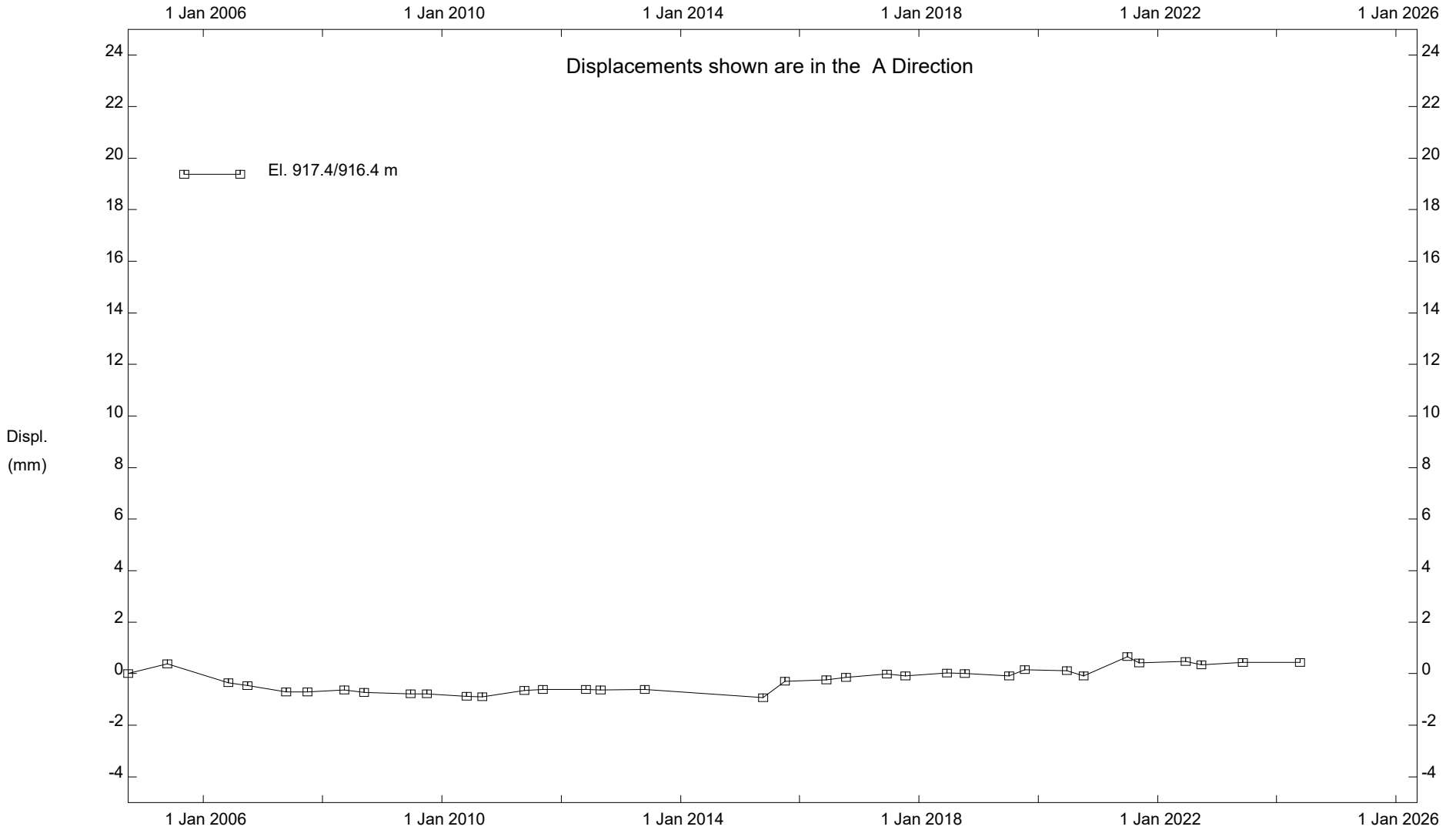


GP008; H40:36, Road Surface Slumping, Inclinometer SI-3

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GP008; H40:36, Road Surface Slumping

# Klohn Crippen Berger - Edmonton

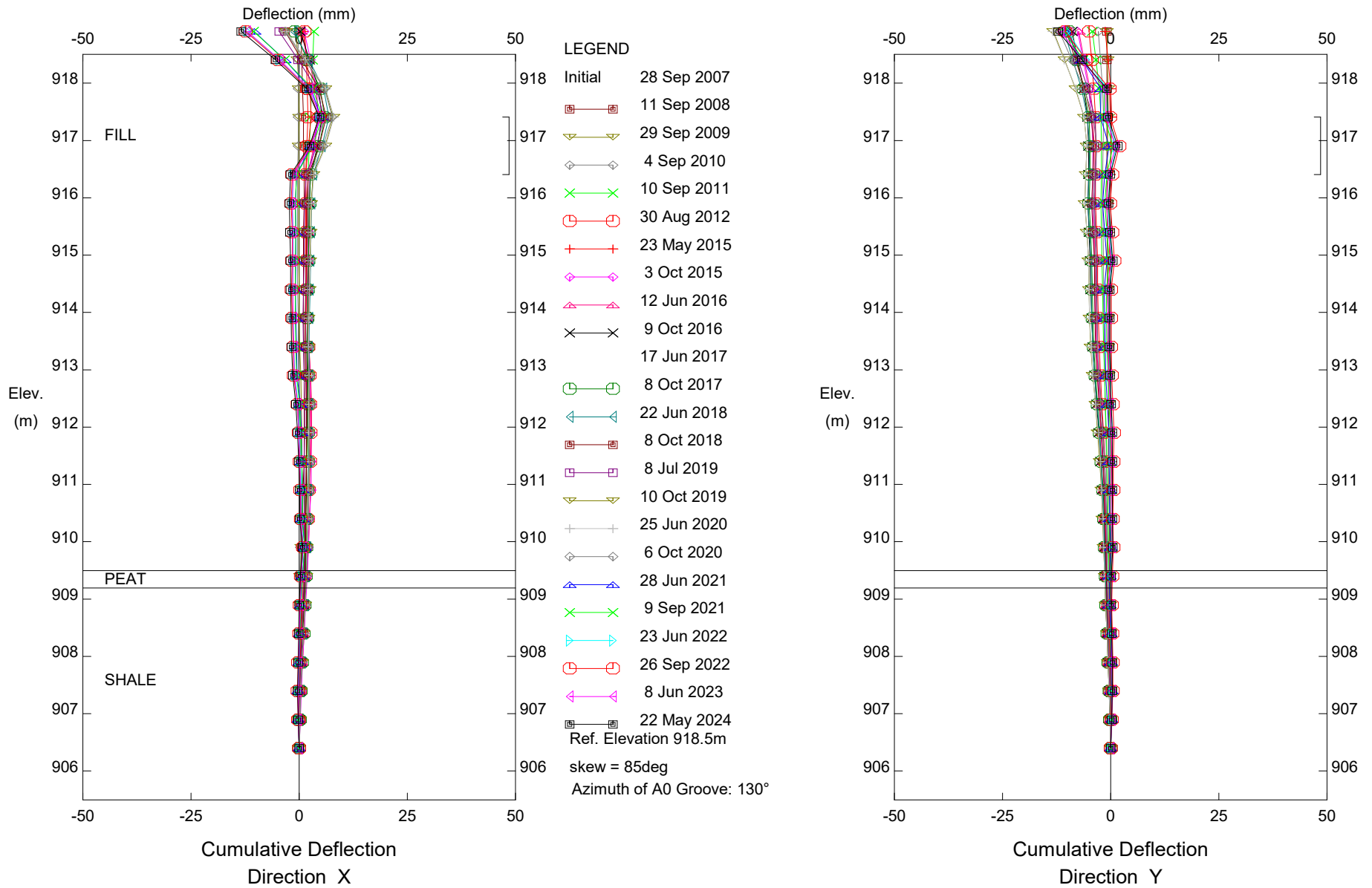


GP008; H40:36, Road Surface Slumping, Inclinometer SI-3

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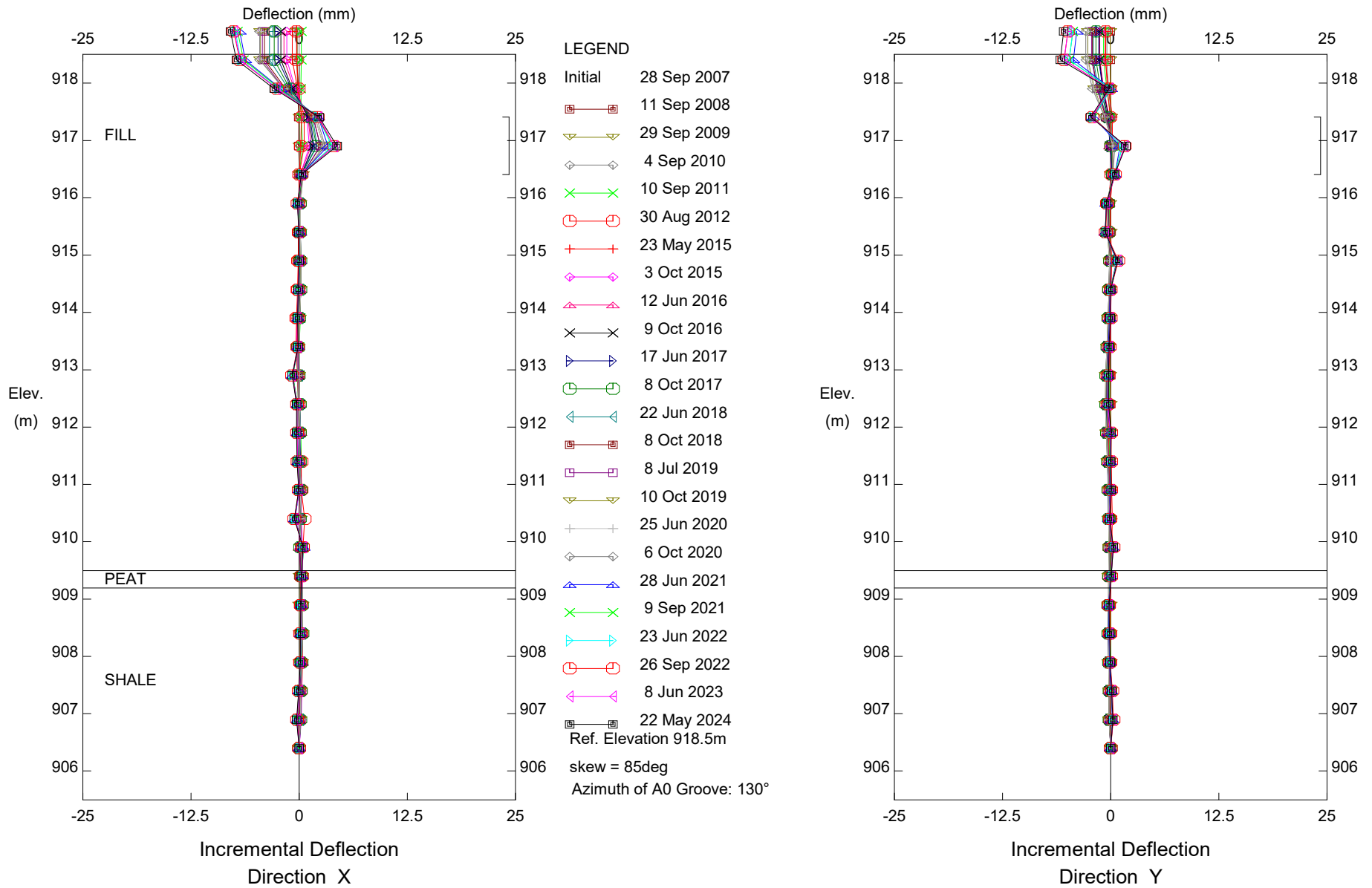


GP008; H40:36, Road Surface Slumping, Inclinometer SI-3

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GP008; H40:36, Road Surface Slumping

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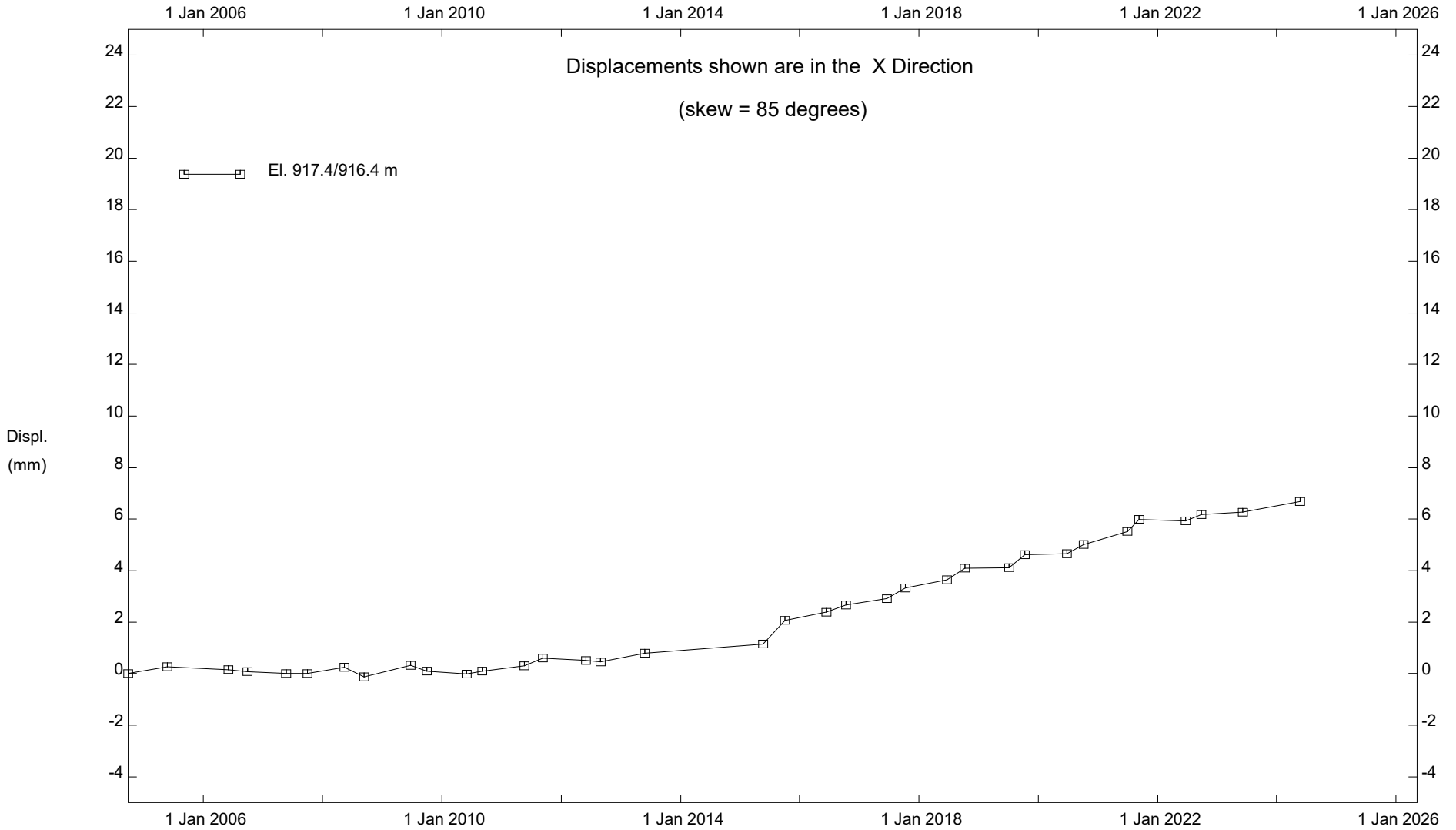


GP008; H40:36, Road Surface Slumping, Inclinometer SI-3

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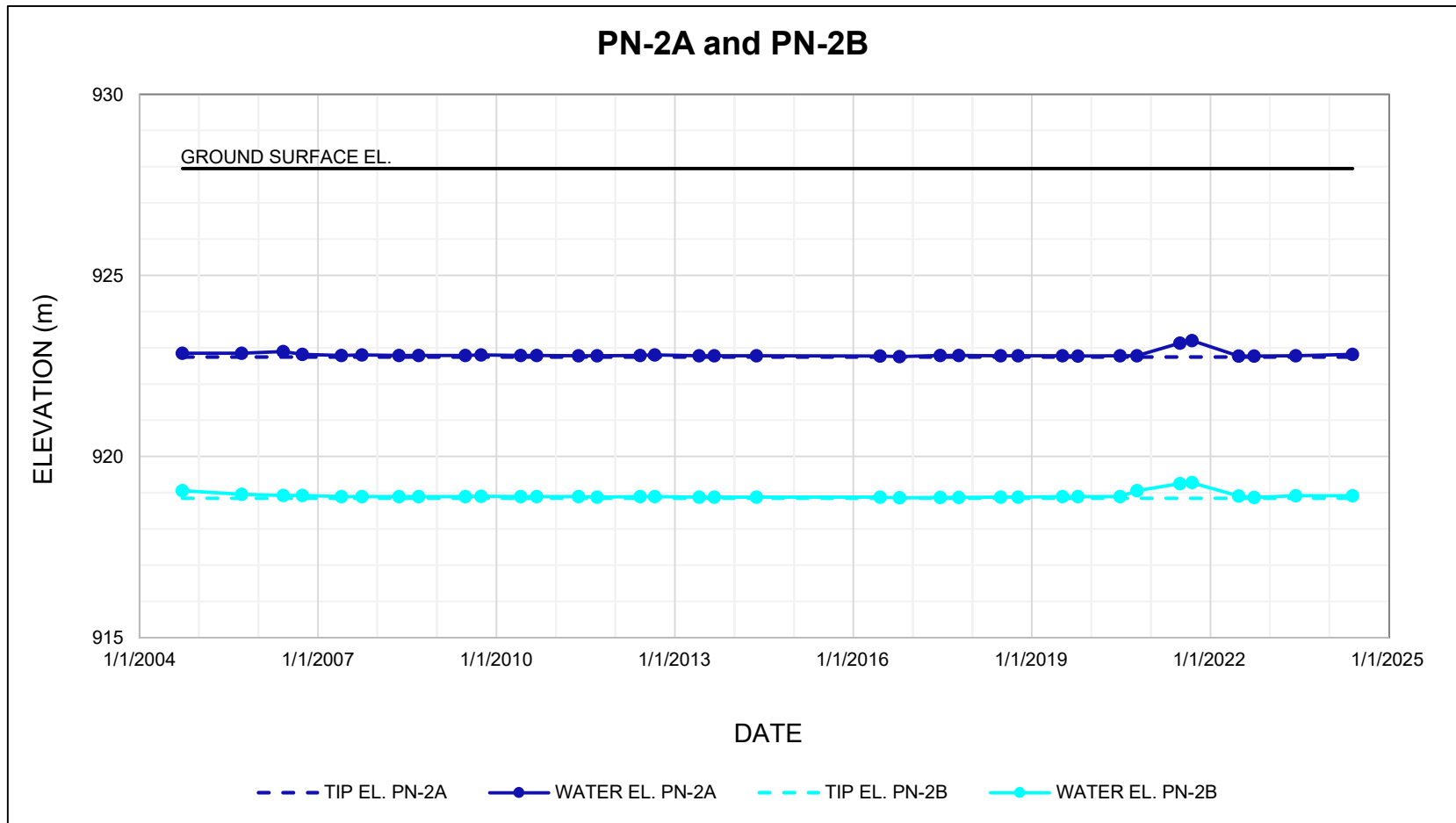
GP008; H40:36, Road Surface Slumping

# Klohn Crippen Berger - Edmonton





GP008; H40:36, Road Surface Slumping, Inclinator SI-3

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**NOTES:**

1. PIEZOMETER DATA OBTAINED BEFORE JUNE 28, 2021, PROVIDED TO KLOHN CRIPPEN BERGER LTD. BY ALBERTA TRANSPORTATION AND ECONOMIC CORRIDORS ON JUNE 25, 2021.

CLIENT 	PROJECT PEACE REGION (GRANDE PRAIRIE DISTRICT - SOUTH) GEOHAZARD RISK MANAGEMENT PROGRAM		
	TITLE Piezometer Data GP008 - Road Surface Slumping (2.5 km North of McIntyre Mine) Hwy 40:36, km 16.365		
	SCALE --	PROJECT No. A05116A01	FIG No.