

July 15, 2025

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

Robert Senior
Construction Technologist

Dear Mr. Senior:

CON0022166 Peace Region (Grande Prairie District – South) GRMP Instrumentation Monitoring Site GP016; H666:02, km 34.837 Slide 2 km West of Hwy 40 and Hwy 666 Junction Section C – 2025 Spring Readings

1 GENERAL

Three slope inclinometers (SIs) (SI-1, SI-2, and SI-41), one vibrating wire piezometer (VWP) (VW14-55A), five pneumatic piezometers (PNs) (PN-13A/B, PN-51A/B, PN-52B), and two standpipe piezometers (SPs) (SP14-51 and SP14-54) were read at the GP016 site in the Peace Region (Grande Prairie District – South) (GP South Region) on June 2, 2025, by Evan Hergott, E.I.T. and Min Hou, 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 666:02, km 34.837, 2 km west of Hwy 40 and Hwy 666 junction. The approximate site coordinates are 6103361 N, 383748 E (UTM Zone 11, NAD 83). A site plan is presented on Figure 1.

The geohazard at the GP016 site consists of three landslides (Sites 1 through 3) along the south slope of the Wapiti River Valley. Site 1 is the middle landslide, while Sites 2 and 3 are on the east and west sides of the site, respectively. It is noted that the entire south slope of the Wapiti River Valley is a sliding zone.

Previous remedial actions completed at the GP016 site include regular milling and paving, with milling and paving being completed in both 2020 and 2021, and the site being returned to gravel in 2024.

Between 1989 and 2014, several geotechnical site investigations, which included installing instruments, were conducted by the previous consultants. The encountered stratigraphy has not been provided to KCB.

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.

Between 1989 and 2014, several SIs and piezometers were installed by the previous consultants to monitor the depth of movement and groundwater conditions, respectively. Many of these instruments are now inoperable (e.g., sheared or damaged), as detailed in Table 1.1 (see table notes). Recommendations for replacement are made in Section 3.

The tubing for PN-52A broke during the spring 2024 readings and could not be repaired during the spring 2024 or spring 2025 readings. The three previous readings indicated the instrument may have been failing due to age (installed in 2003) as they were several meters above the instrument tip elevation and inconsistent with past readings indicating the instrument was dry. This instrument will not be read again. A replacement instrument is not recommended at this time since readings recorded in this instrument have been at or near the tip elevation of the instrument since installation and the deeper nested instrument (PN-52B) is still operable.

PN-51A may be damaged. Readings recorded in this instrument increased 6.4 m to above ground surface between the fall 2020 and spring 2022 readings then decreased 8.4 m to the instrument tip elevation between the spring 2022 and spring 2024 readings. The spring 2025 reading was also near the instrument tip elevation. The readings above ground surface likely indicate the instrument is beginning to malfunction or fail due to age (installed in 2003). This instrument will continue to be read for now.

The instruments are protected by above-ground casing protectors.

The operable SIs were read using the same metric RST Digital MEMS Inclinator System that has been used to read the SIs since KCB took over the readings in June 2021. The operable VWPs, PNs, and SPs were read using a GEOKON GK-404 vibrating wire readout, RST C109 pneumatic piezometer readout box, and Heron Water Level Meter, respectively.

Table 1.1 Instrumentation Installation Details ¹

Instrument Type	Instrument ID	Date Installed	UTM Coordinates (m)		Ground Surface Elevation (m)	Stick Up (m)	Depth (mbgs ²)	Condition
			Northing	Easting				
SI	SI-1	Feb. 19, 1997	6102779	383232	668.6	0.8	59.5	Operable
	SI-2	Feb. 19, 1997	6102793	383286	668.5	0.8	59.5	Operable
	SI-3	Unknown						Inoperable
	SI-13	Jun. 19, 1989	6103088	383338	594.6	0.8	22.9	Inoperable ³
	SI-41	May 09, 1995	6103295	383734	570.1	1.1	19.6	Operable
	SI-51	Unknown						Inoperable
	SI-52	Dec. 06, 2003	6103499	383723	548.8	Unknown		Inoperable ³
	SI-53	Dec. 06, 2003	Unknown					
PN	PN-13A	Jun. 06, 2001	6103088	383338	594.6	N/A	4.6	Operable
	PN-13B					N/A	18.3	Operable
	PN-51A	Dec. 06, 2003	6103441	383704	554.2	N/A	7.6	Operable ⁵
	PN-51B					N/A	10.7	Operable
	PN-51C					N/A	18.0	Inoperable
	PN-52A	Dec. 06, 2003	6103499	383723	548.8	N/A	4.9	Inoperable ⁴
	PN-52B					N/A	17.4	Operable
	PN14-51	Oct. 08, 2014	6102924	382899	630.2	N/A	15.2	Inoperable
	PN14-52	Oct. 11, 2014	6102955	382905	623.4/7 ³	N/A	13.7/14.0 ³	Inoperable
VWP	VW14-51	Oct. 08, 2014	6102924	382899	631.2	N/A	30.5	Inoperable
	VW14-53	Oct. 16, 2014	Unknown	Unknown	616.9	N/A	15.2	Inoperable
	VW14-55A	Oct. 18, 2014	6102966	382935	621.7	N/A	12.2	Operable
SP	SP14-51	Oct. 21, 2014	6102924	382899	631.2	0.9	6.5	Operable
	SP14-54	Oct. 23, 2014	6102932	382934	627.0	0.8	6.4	Operable

Notes:

¹ Instrument installation details were taken from reports and data files prepared or provided by the previous consultant(s) or TEC. Ground surface elevations and coordinates were not provided for all of the SIs, so the ground surface elevation and coordinates from the adjacent instruments/piezometer tips were used if available. Instrument coordinates and stick ups (where applicable) were confirmed by KCB using a handheld GPS (accuracy of ± 5 m) and tape measure, respectively. Note ground surface elevation for PN14-52 reported as 623.4 m and 623.7 m in files provided by previous consultant.

² Meters below ground surface (mbgs). Bottom reading depth for SIs, and tip or screen depth for piezometers.

³ SI-13, SI-52, and SI-53 have sheared at an approximate depth of 16.0 m, 18.9 m, and 4.9 m below ground surface, respectively. Instruments last read in June 2021, October 2015, and October 2019.

⁴ SI-3, SI-51, PN-51C, PN14-51, PN14-52, VW14-51, and VW14-53 were reported as inoperable by a previous consultant. Piezometers last read between July 2016 and July 2019.

⁵ PN-52A was inoperable (tube broke then no readings obtained) during the spring 2024 and spring 2025 readings and could not be repaired. Instrument last read in June 2023.

⁶ PN-51A may be malfunctioning or failing due to age.

2 INTERPRETATION

2.1 General

For the operable SIs, the cumulative displacement, incremental displacement, and displacement-time (if discernible movement recorded) data was plotted in the A-direction (i.e., the direction of the A0-groove) and, where applicable, the X-direction (i.e., the direction of maximum movement obtained at a skew angle from the A0-grooves). SI-41 has a skew angle of 351°, measured clockwise from the direction of the A0-grooves.

For the operable PNs and VWP, 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.

For the operable SPs, the water level data was plotted relative to ground surface elevation and the screen 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 through Table 2.4.

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 generally consistent with the data obtained by the previous consultant, except for the following:

- For SI-1, the data is relatively noisy and the readings after 2021 do not line up well with the previous consultants' readings. To improve our ability to interpret the data, we have re-initialized this instrument to the June 2021 readings. Only the re-initialized plots are included in Appendix I.
- For SI-2, the previous consultant was copying the bottom eight readings (4 m) for each subsequent reading instead of using the data obtained in the field. Without this correction, there is a "kick-out" at the base of the instrument when compared to the previous readings. With the replacement readings, KCB's readings are relatively consistent with the previous readings. However, to improve our ability to interpret the data, we have re-initialized this instrument to the June 2021 readings. Only the re-initialized plots are included in Appendix I.

In general, the data for SI-1 and SI-2 is noisy and difficult to interpret. Based on the absolute plots for these instruments, they have several kinks and tilts up to 1.0 m.

The SI data plots presented herein for SI-41 include data for readings taken with both the previous consultants' and KCB's SI reading equipment.

Table 2.1 Slope Inclinometer Reading Summary

Instrument ID	Date				Ground Surface Elevation (m)	Depth of Movement (mbgs ¹)	Direction of Movement, Skew Angle ²	Movement (mm)				Rate of Movement (mm/year)		
	Initialized (Re-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
								Before Re-Initialization	After Re-Initialization	Total				
SI-1	Feb. 19, 1997 (Jun. 27, 2021)	N/A	May 24, 2024	Jun. 02, 2025	668.6	N/A – No discernible movement recorded.								
SI-2	Feb. 19, 1997 (Jun. 27, 2021)	N/A	May 24, 2024	Jun. 02, 2025	668.5	N/A – No discernible movement recorded.								
SI-41	May 09, 1995	May 24, 2024	May 24, 2024	Jun. 02, 2025	570.1	0.1 - 3.1	X-direction, 351°	84.2			-4.0	5.7	-3.9	-6.8

Notes:
¹ Meters below ground surface (mbgs).
² 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.
³ As discussed in Section 2.1, SI-1 and SI-2 were re-initialized to the June 2021 readings to improve our ability to interpret the data, and data for both instruments is noisy and difficult to interpret.

Table 2.2 Pneumatic Piezometer Reading Summary

Instrument ID	Serial No.	Date			Ground Surface Elevation (m)	Tip Depth (mbgs ¹)	Water Level		
		Installed	Previous Reading	Most Recent Reading			Previous Reading (mbgs ¹)	Most Recent Reading (mbgs ¹)	Change from Previous Reading (m)
PN-13A	20475	Jun. 06, 2001	May 24, 2024	Jun. 02, 2025	594.6	4.6	N/A – instrument is dry		
PN-13B	20492		May 24, 2024	Jun. 02, 2025		18.3	6.4	6.0	0.4
PN-51A	28901	Dec. 06, 2003	May 24, 2024	Jun. 02, 2025	554.2	7.6	N/A – instrument is dry		
PN-51B	28900		May 24, 2024	Jun. 02, 2025		10.7	7.4	7.8	-0.4
PN-52B	28441	Dec. 06, 2003	May 24, 2024	Jun. 02, 2025	548.8	17.4	15.5	15.5	0.0

Notes:
¹ Meters below ground surface (mbgs).

Table 2.3 Vibrating Wire Piezometer Reading Summary

Instrument ID	Serial No.	Date			Ground Surface Elevation (m)	Tip Depth (mbgs ¹)	Water Level		
		Installed	Previous Reading	Most Recent Reading			Previous Reading (mbgs ¹)	Most Recent Reading (mbgs ¹)	Change from Previous Reading (m)
VW14-55A	1401844	Oct. 18, 2014	May 24, 2024	Jun. 02, 2025	621.7	12.2	5.9	6.0	-0.1

Notes:
¹ Meters below ground surface (mbgs).

Table 2.4 Standpipe Piezometer Reading Summary

Instrument ID	Date			Ground Surface Elevation (m)	Screen Depth (mbgs ¹)	Water Level		
	Installed	Previous Reading	Most Recent Reading			Previous Reading (mbgs ¹)	Most Recent Reading (mbgs ¹)	Change from Previous Reading (m)
SP14-51	Oct. 21, 2014	May 24, 2024	Jun. 02, 2025	631.2	6.5	2.0	2.5	-0.5
SP14-54	Oct. 23, 2014	May 24, 2024	Jun. 02, 2025	627.0	6.4	5.7	5.1	0.6

Notes:
¹ Meters below ground surface (mbgs).

2.2 Zones of Movement

No defined zones of discernible movement have been recorded in SI-1 and SI-2 since installation. These instruments are installed at the valley crest of Site 1, upslope (south) of the highway.

Before shearing between the spring 2021 and spring 2022 readings, distributed movement was recorded in SI-13 from an approximate depth of 1.5 m to 5.0 m below ground surface (elevation 588.5 m to 593.0 m). Another less pronounced zone of movement was also recorded from approximately 15.0 m to 16.0 m below ground surface (elevation 579.0 m and 578.0 m). This instrument is installed on the valley slope of Site 1, downslope (north) of the highway. Between 2017 and late-2021/early-2022, when the instrument sheared, movement rates up to approximately 25 mm/year and 28 mm/year were recorded.

In SI-41, which is installed upslope (south) of the highway at Site 2, distributed movement is being recorded from ground surface to an approximate depth of 2.1 m below ground surface (elevation 570 m to 568 m).

2.3 Interpretation of Monitoring Results

Since June 2009, the rate of movement recorded in SI-41 has been slow (less than 4 mm/year). The pavement distress previously observed at Site 2 does not appear to have been reflected in the data obtained from SI-41, which is installed upslope (south) of the highway.

The spring 2025 readings for most of the piezometers (SP14-51, SP14-54, PN-13A/B, PN-51B, PN-52B, and VW14-55A) are relatively consistent with previous readings for these instruments, except for a slight increase (approximately 0.4 m) recorded in PN-13A. Water levels/porewater pressures recorded in these instruments have historically fluctuated, likely in response to seasonal variations in precipitation and freshet infiltration.

3 RECOMMENDATIONS

3.1 Future Work

All operable instruments should continue to be read once per year (spring). 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.

Since the GP016 site is a monitoring-only site, the site should continue to be inspected by the Maintenance Contract Inspector (MCI) but not as part of the GP South Region GRMP Section B inspections.

3.2 Instrument Installs, Repairs, and Maintenance

Depending on long-term plans for the site, TEC could consider replacing SI-13, since it was the last active SI at highway surface, and either removing or replacing SI-01 and SI-02, since the data recorded in these instruments is noisy and difficult to interpret. Alternatively, TEC could adopt change-detection or remote-sensing type monitoring, including Light Detection and Ranging (LiDAR), Interferometric Synthetic Aperture Radar (InSAR), or low-cost differential Global Positioning System (GPS) if the risk of equipment loss or damage is acceptable. Such an assessment would help provide a wider perspective assessment on where movements are occurring across the whole slope and may offer some opportunities to assess the influence of toe-of-slope movements and associated time-lag effects to when the slope movements affect the highway surface.

Otherwise, no instrument installs, 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 Peace Region (Grande Prairie District – 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

Evan Hergott, E.I.T.
Civil Engineer-in-Training

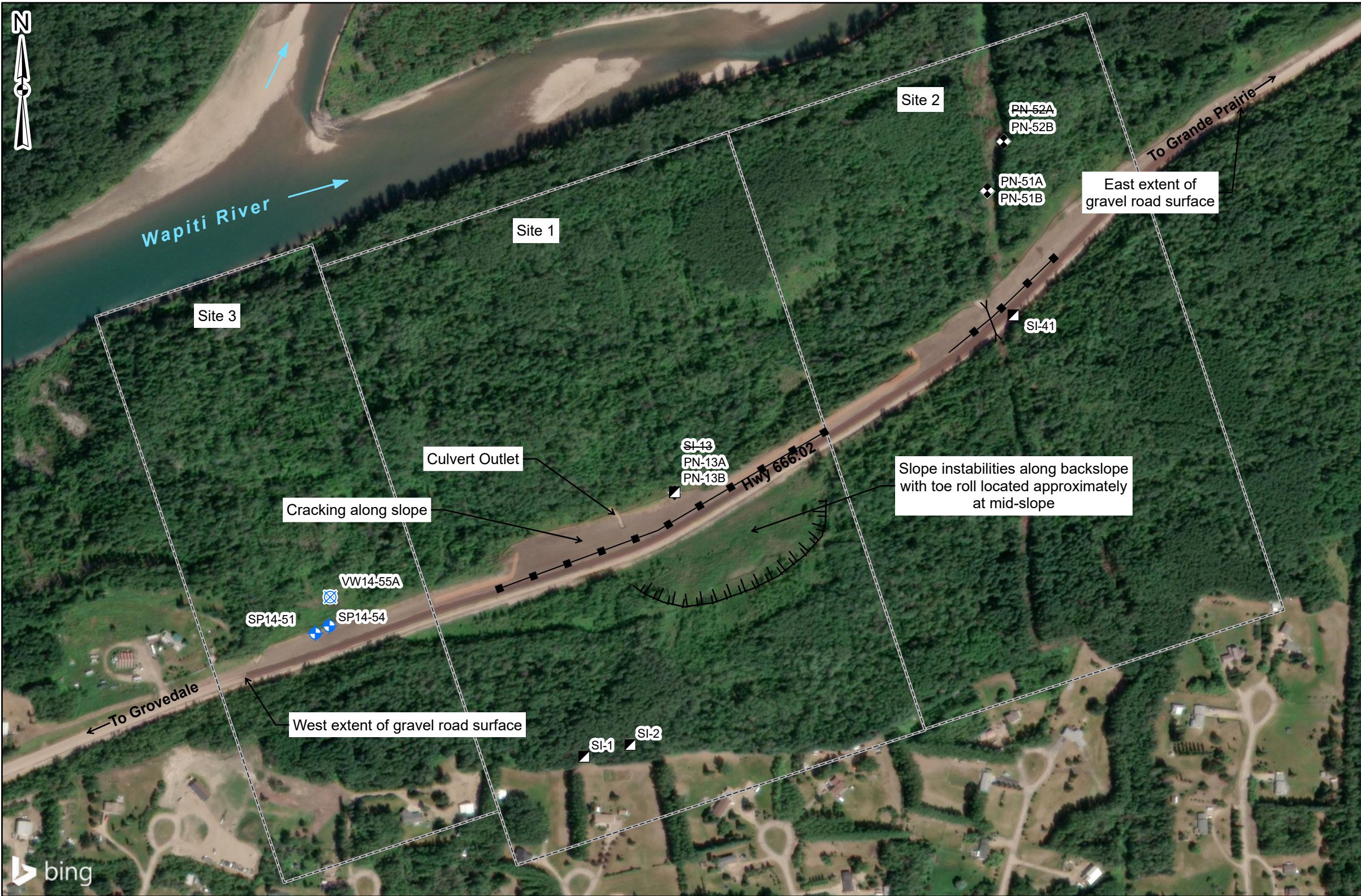
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Cc: Chris Gräpel, M.Eng., P.Eng.

ATTACHMENTS

Figure
Appendix I Instrumentation Plots

FIGURE



Legend

- ◆ Pneumatic Piezometer (PN)
- Slope Inclinator (SI)
- ⊕ Standpipe Piezometer (SP)
- ⊗ Vibrating Wire Piezometer (VW)
- Flow Direction
- Scarp
- Culvert
- Site Extent
- New_guardrail

NOTES:
1. HORIZONTAL DATUM: NAD83
2. GRID ZONE: UTM ZONE 11N
3. IMAGE SOURCE: 2025 MICROSOFT CORPORATION, 2025 MAXAR CNES, DISTRIBUTION AIRBUS DS
4. STRIKETHROUGH INDICATES INSTRUMENT IS INOPERABLE. INSTRUMENT LOCATIONS APPROXIMATE. INSTRUMENTS INOPERABLE PRIOR TO 2021 MAY NOT BE SHOWN.

CLIENT

Alberta

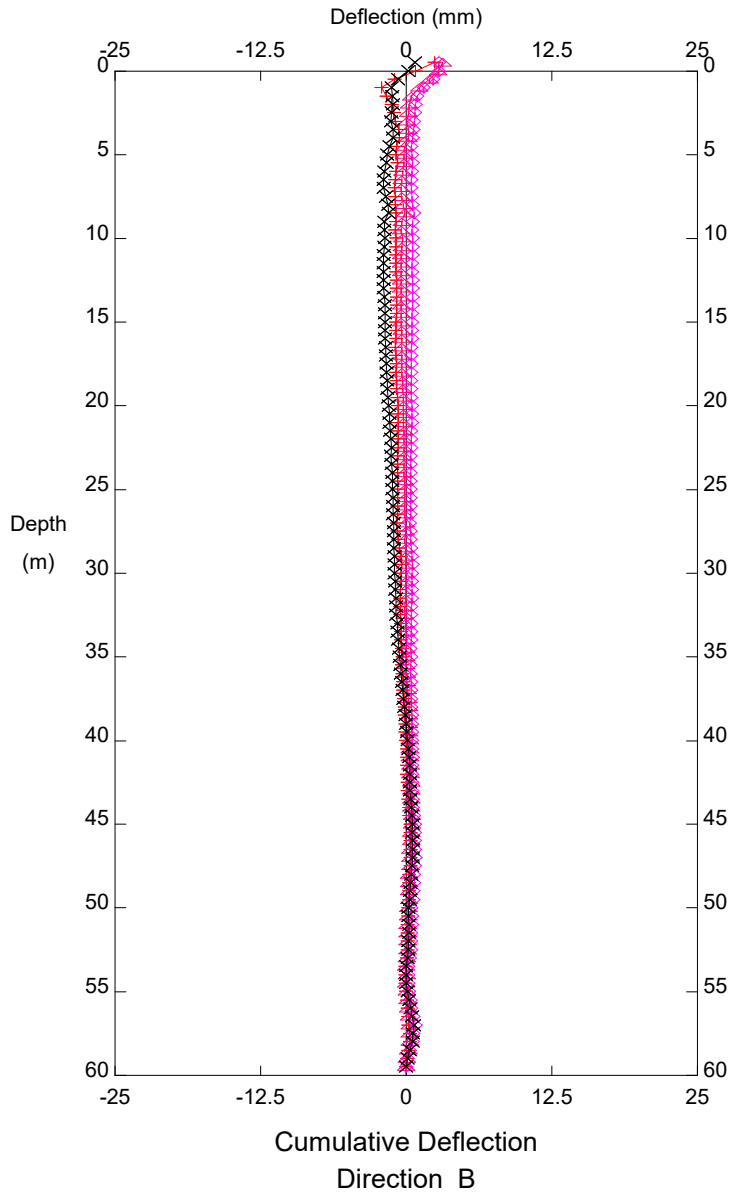
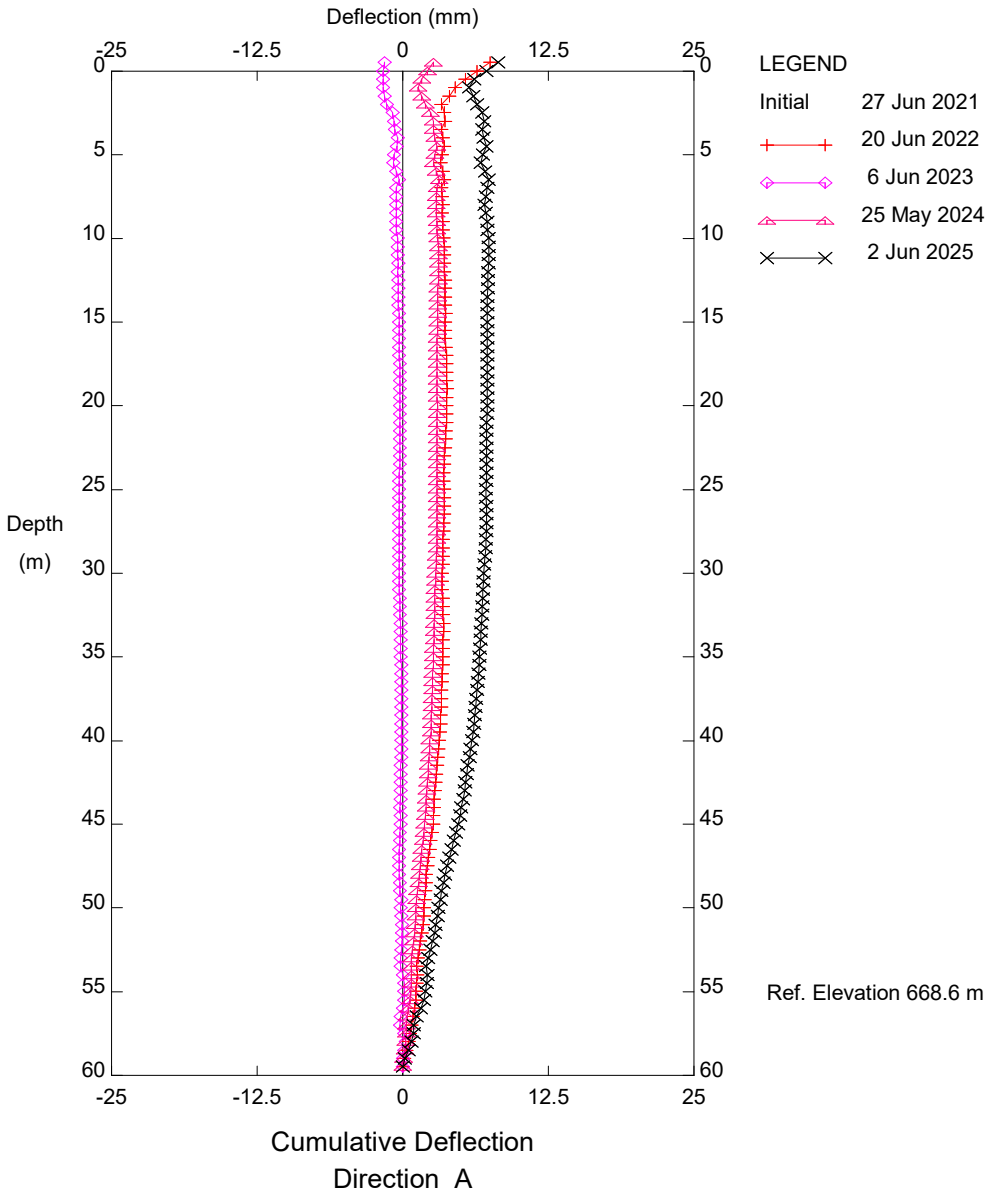
Klohn Crippen Berger

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TITLE Site Plan GP016 - Slide 2km W. of Hwy 40 and Hwy 666 Junction Hwy 666:02, km 34.837		
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APPENDIX I

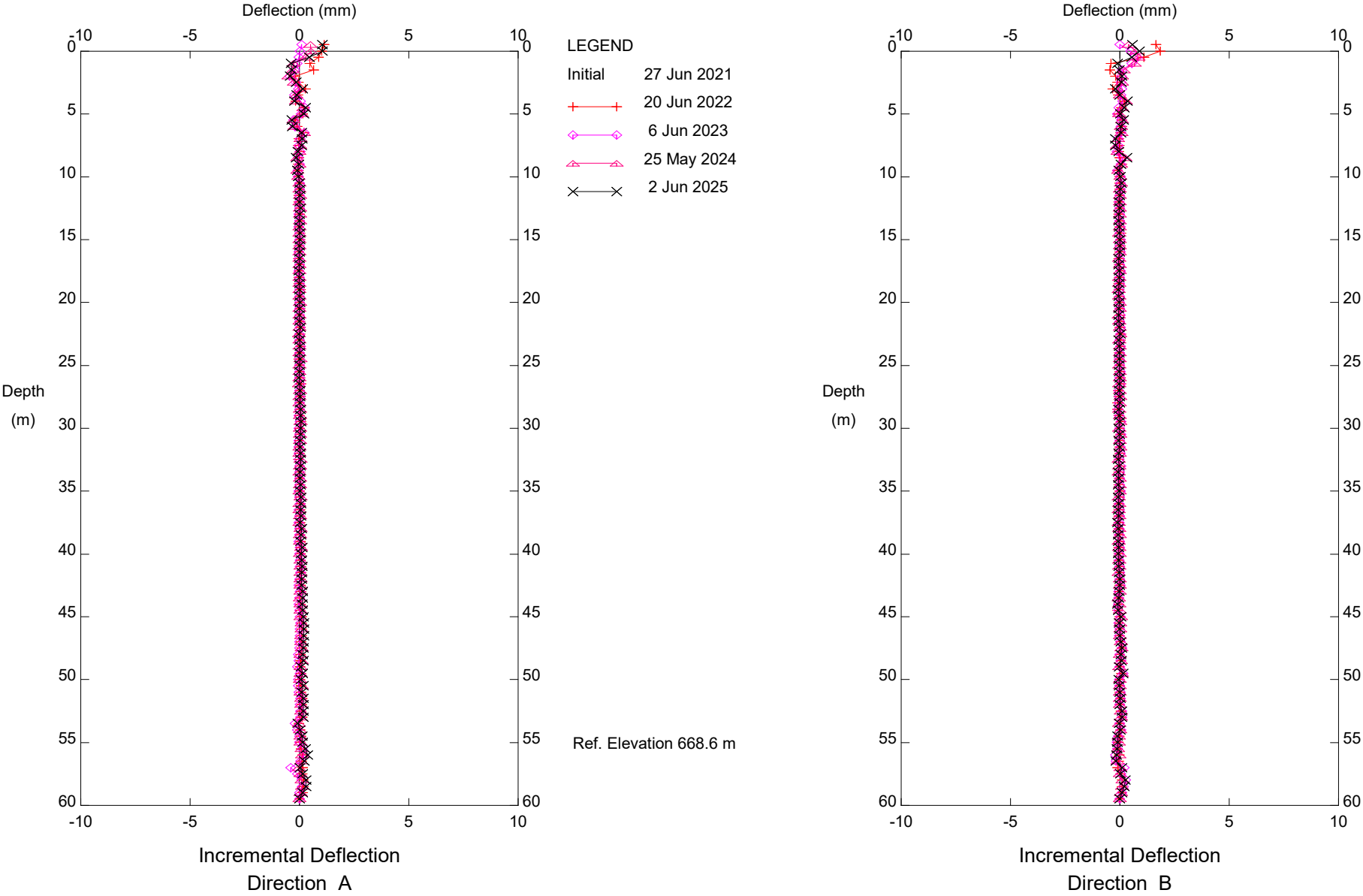
Instrumentation Plots

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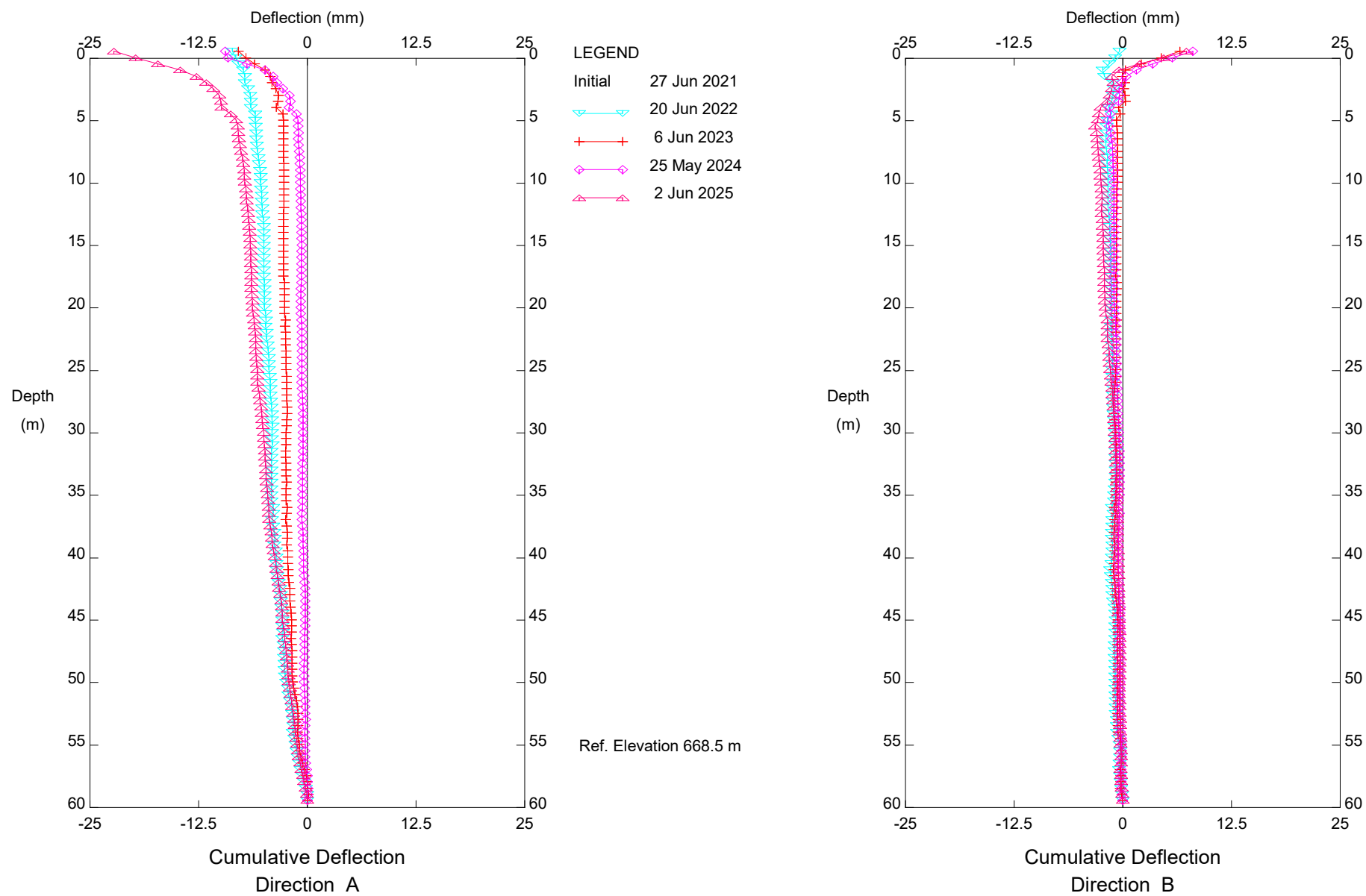


GP016; H666:02 Slide 2 km West of Hwy 40, Inclinator SI-1
Alberta Transportation

Klohn Crippen Berger - Edmonton



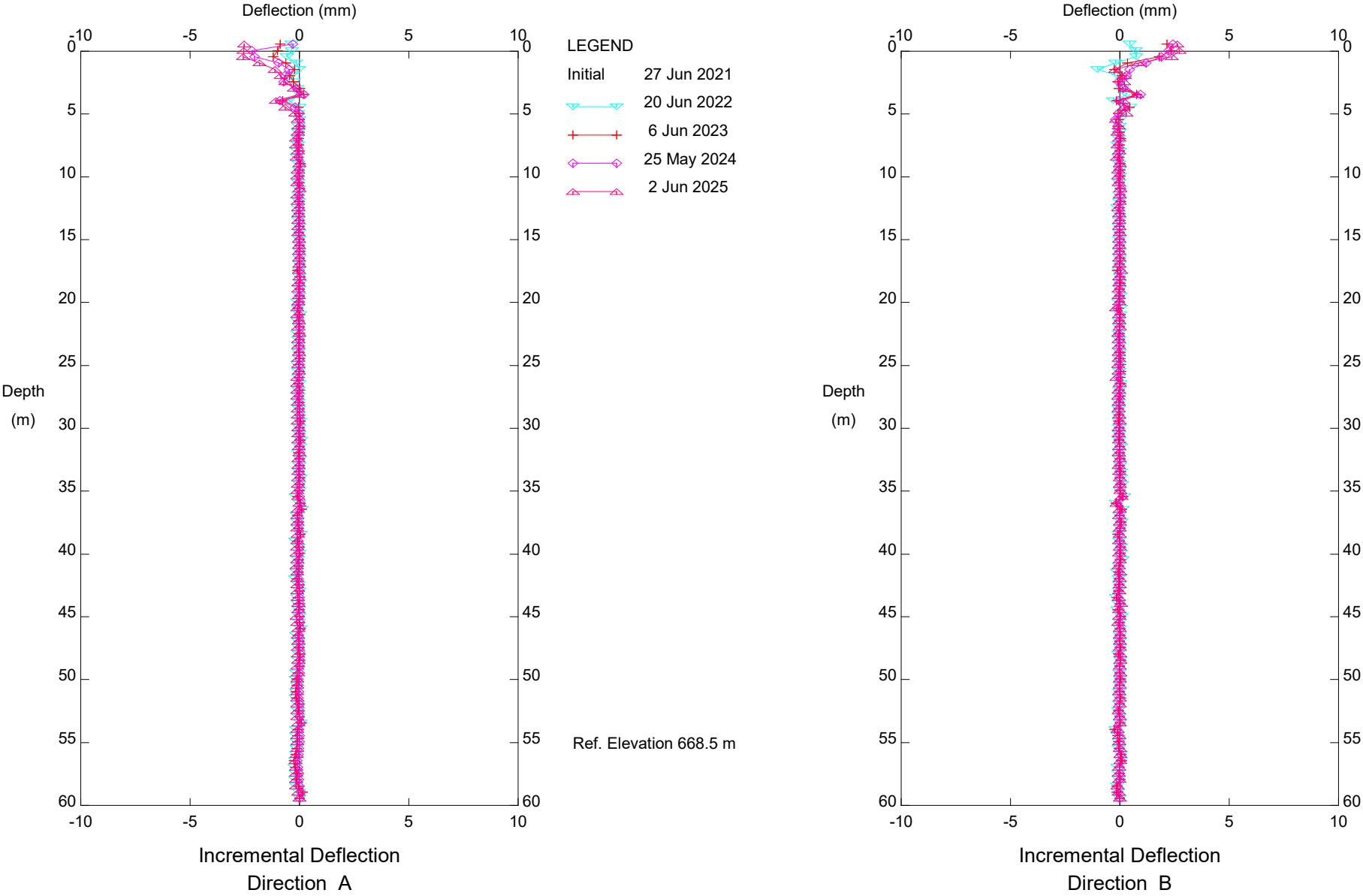
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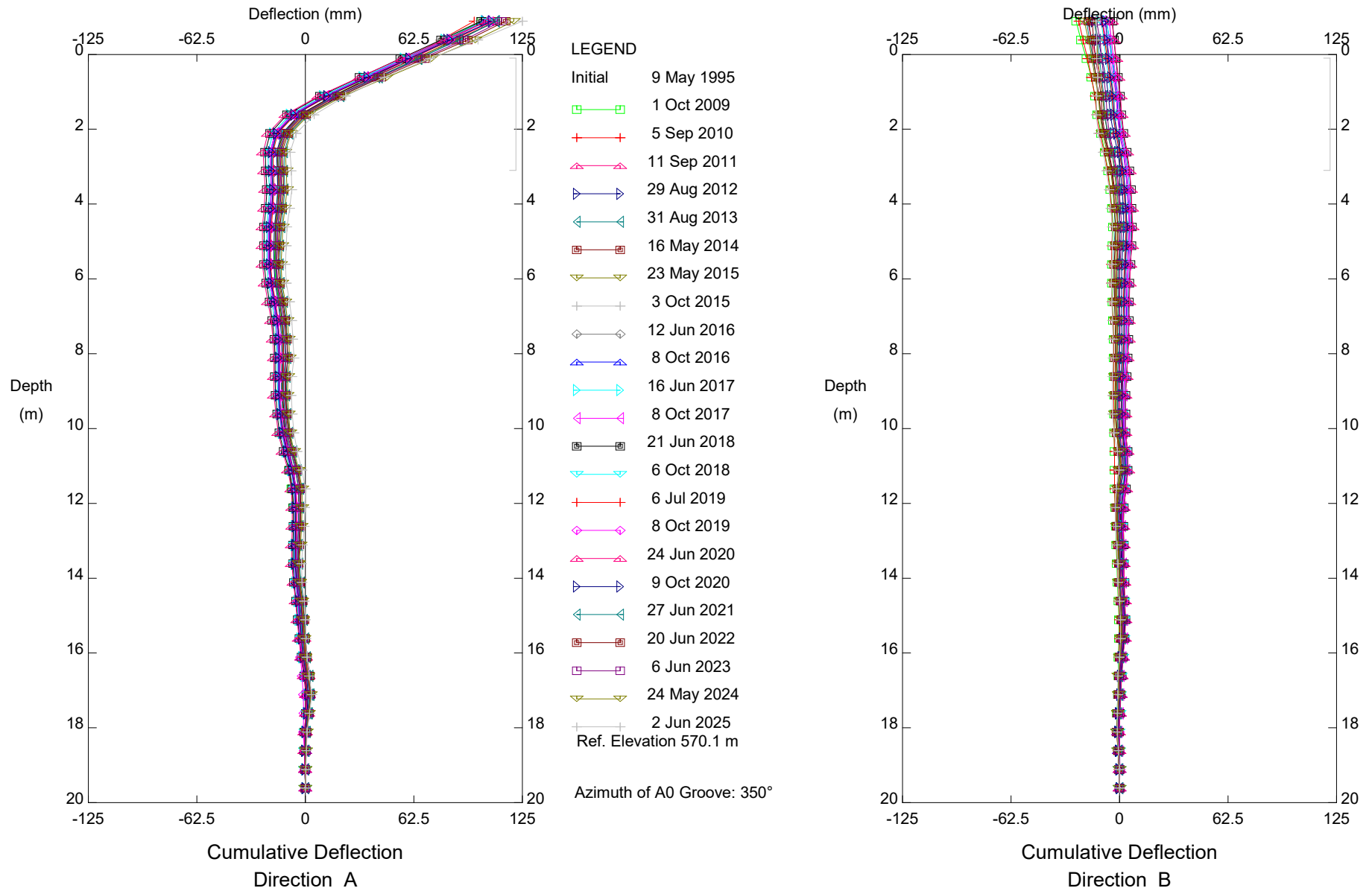
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Alberta Transportation

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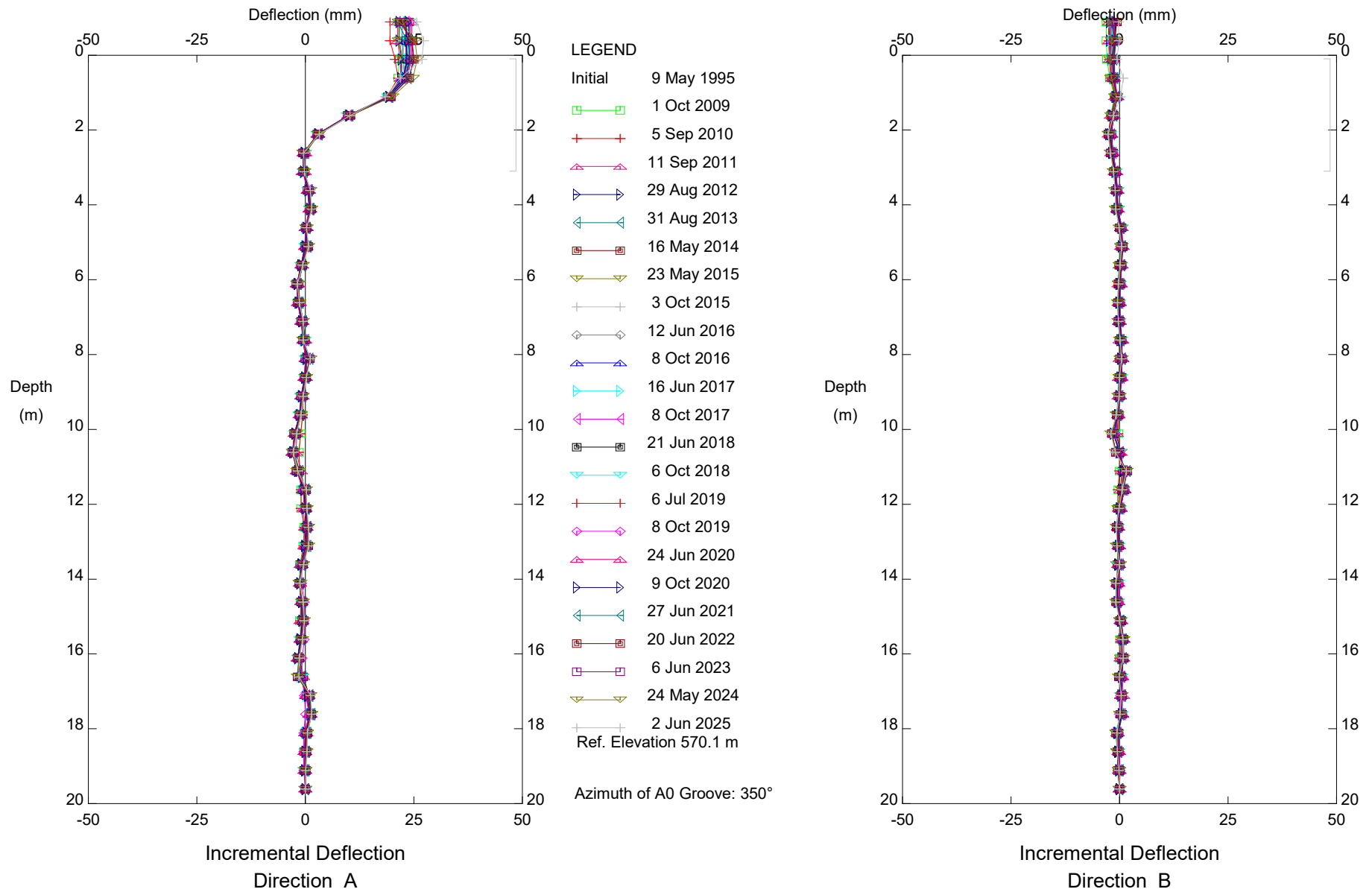
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Alberta Transportation

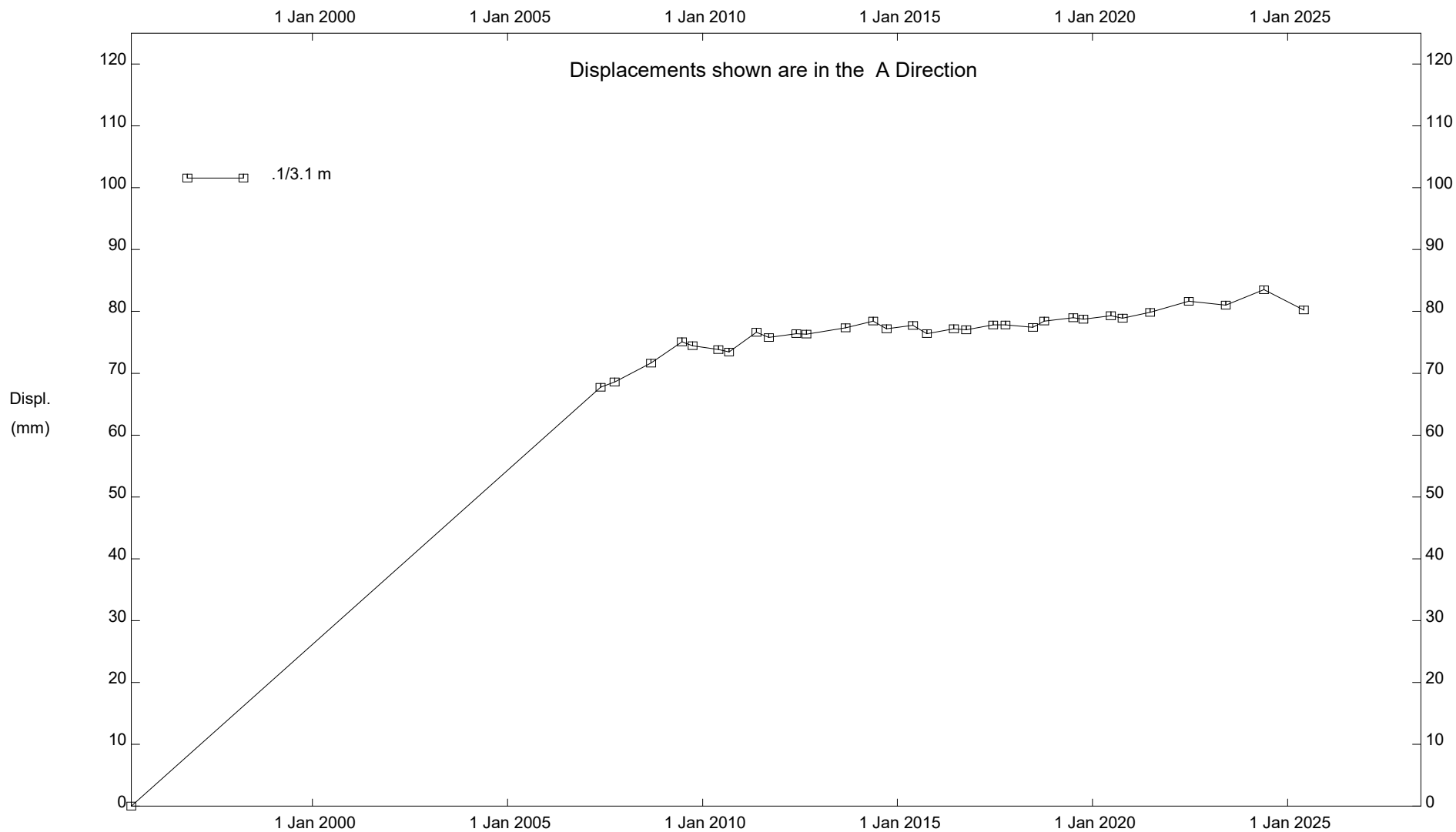
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Alberta Transportation

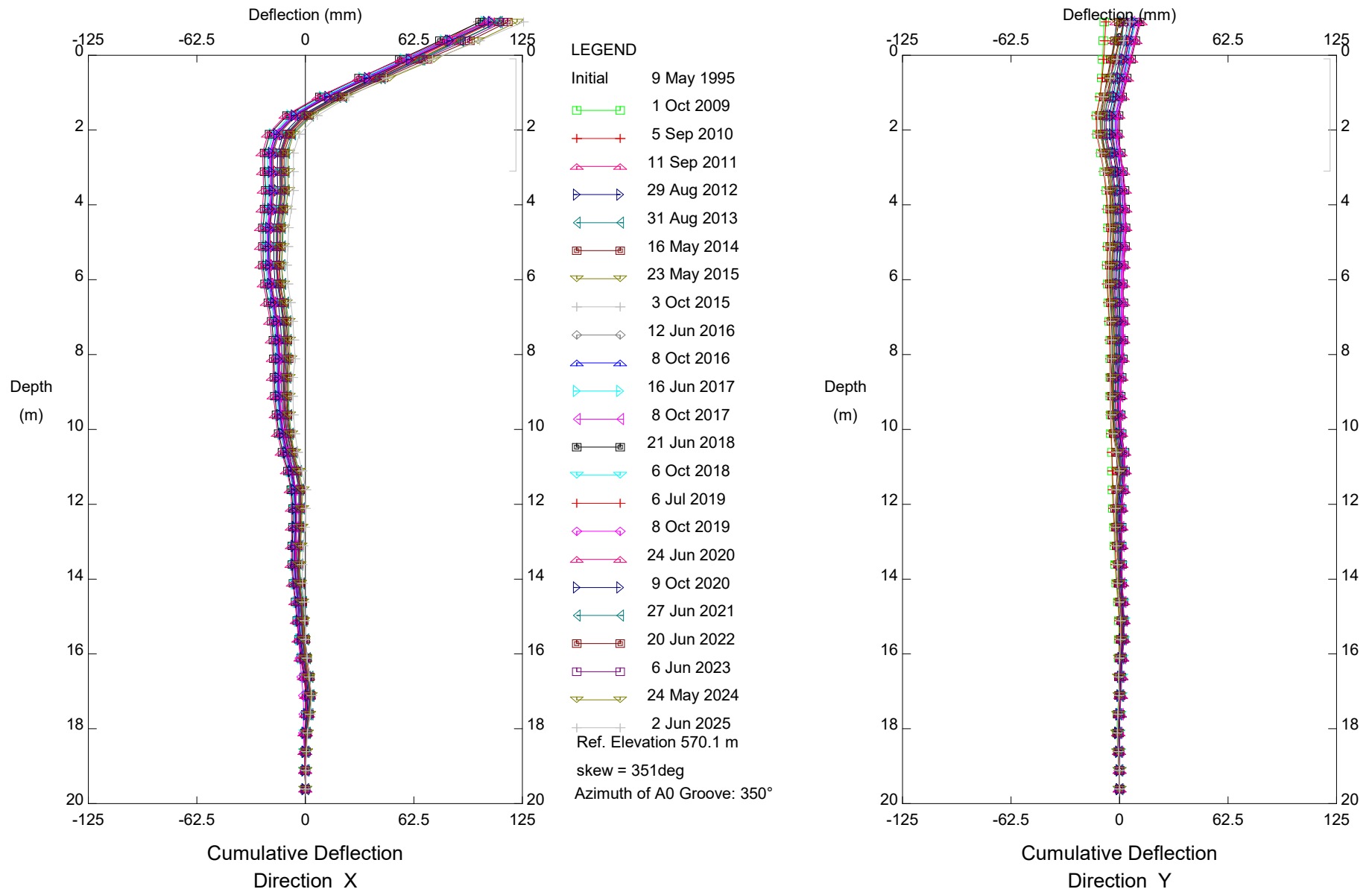
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GP016; H666:02 Slide 2 km West of Hwy 40, Inclinator SI-41

Alberta Transportation

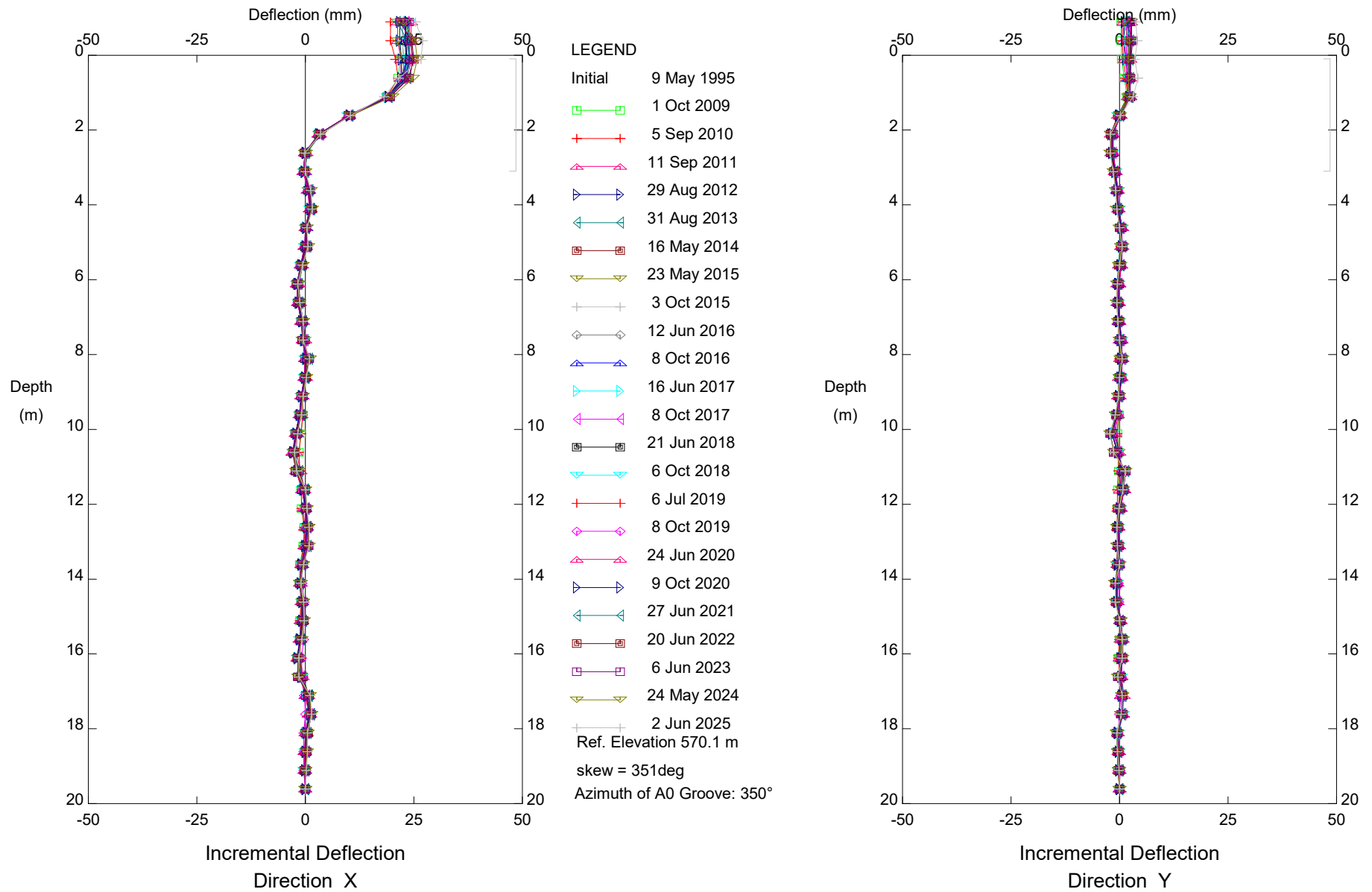
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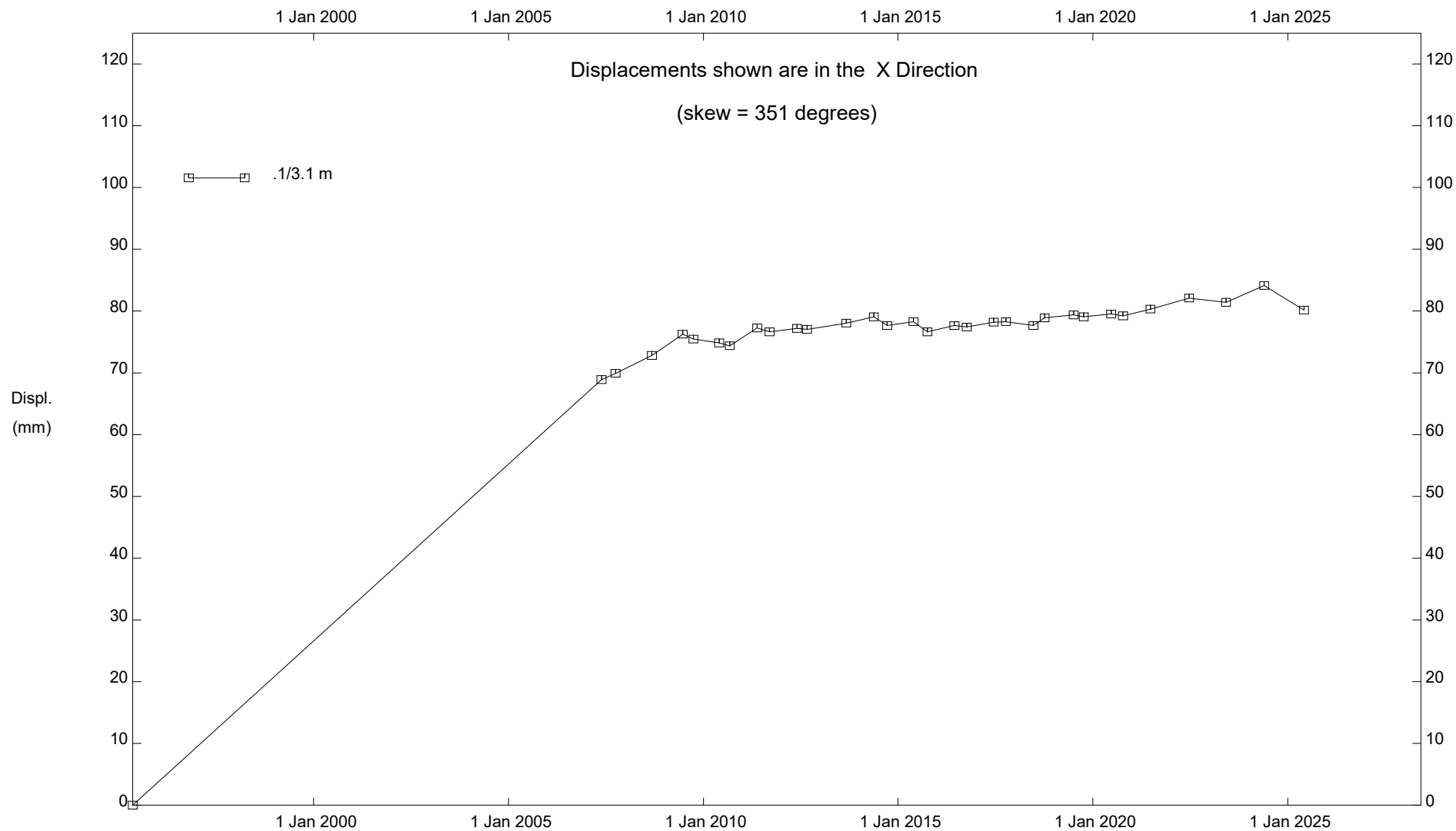
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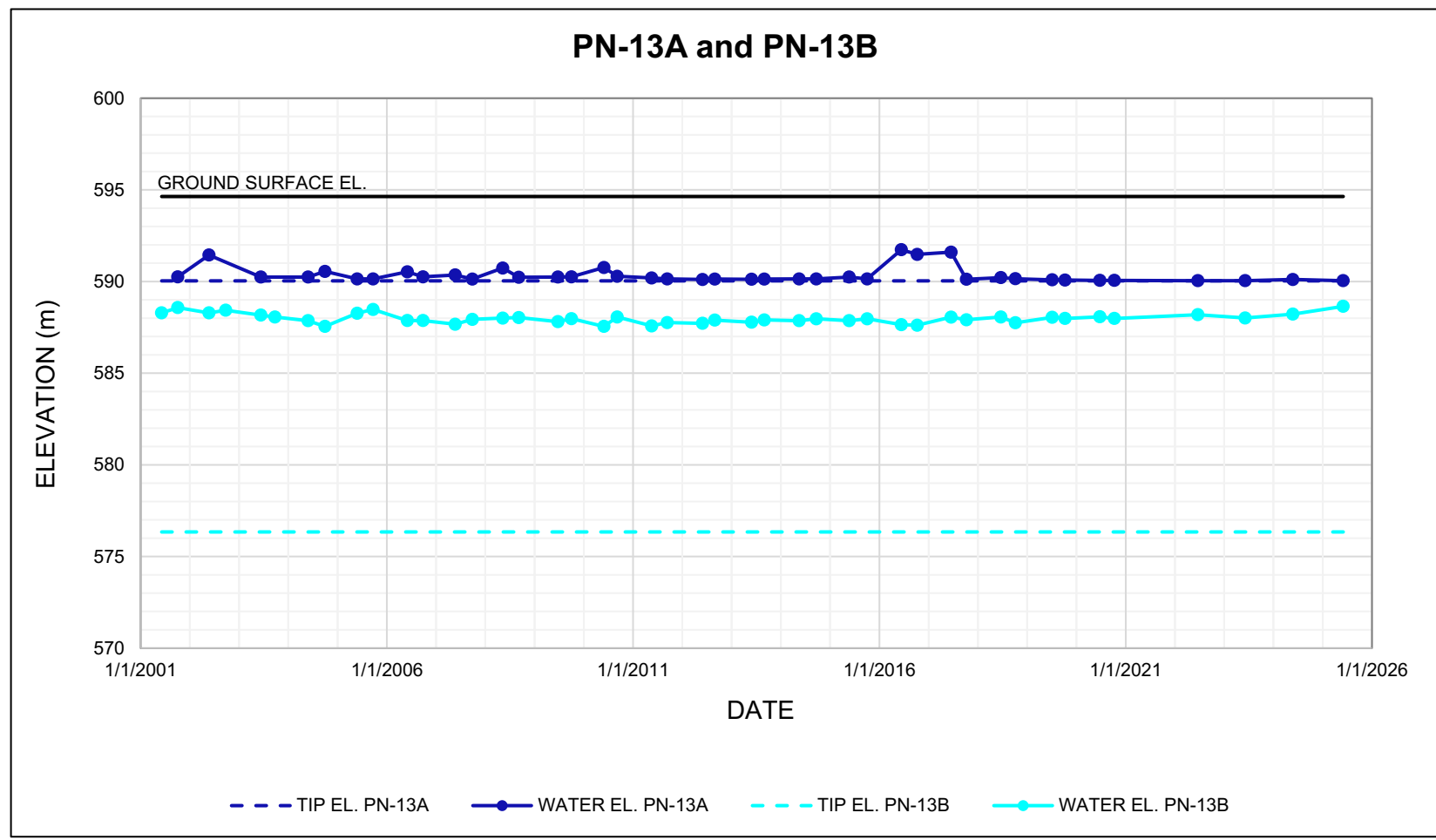
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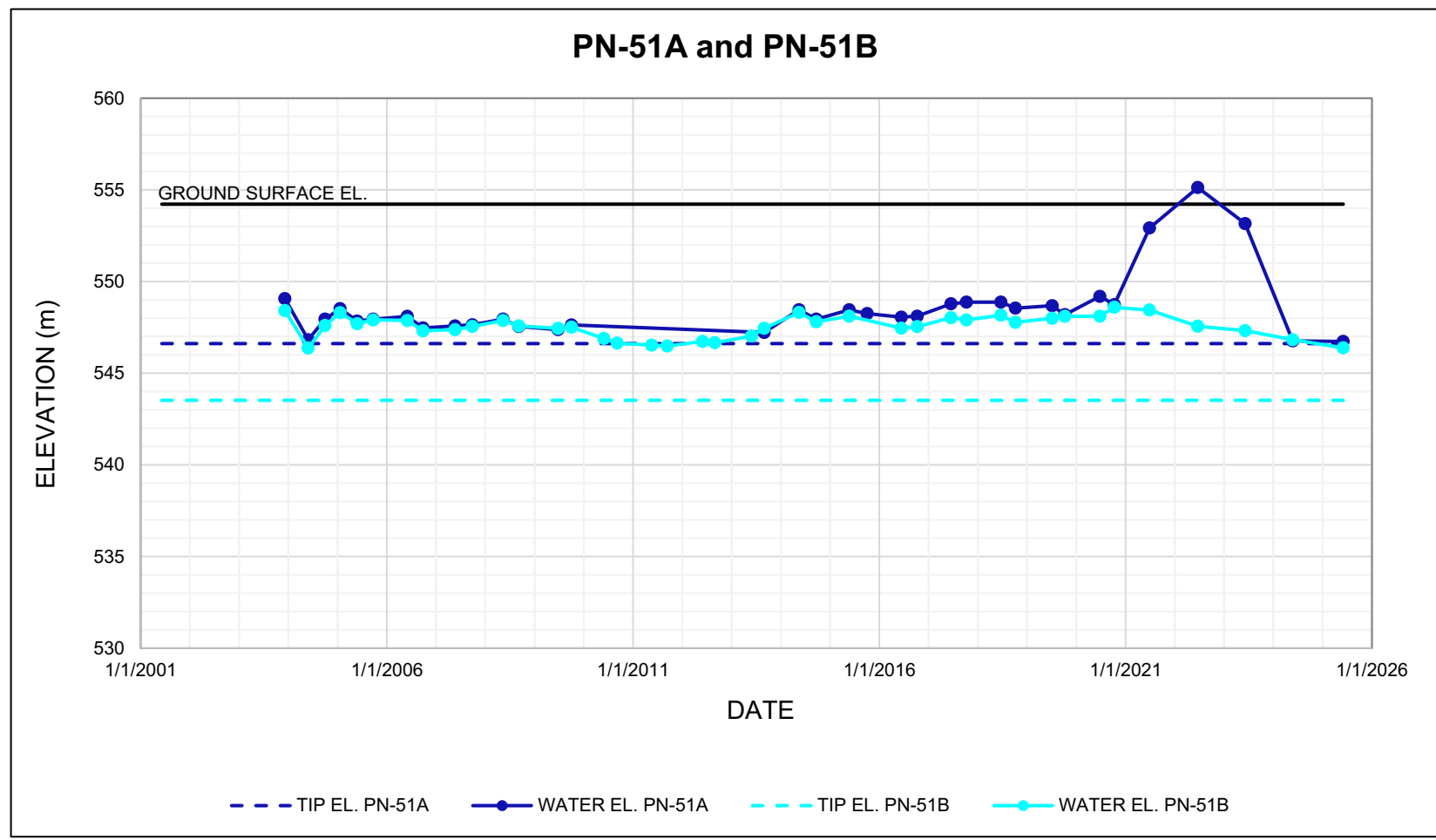
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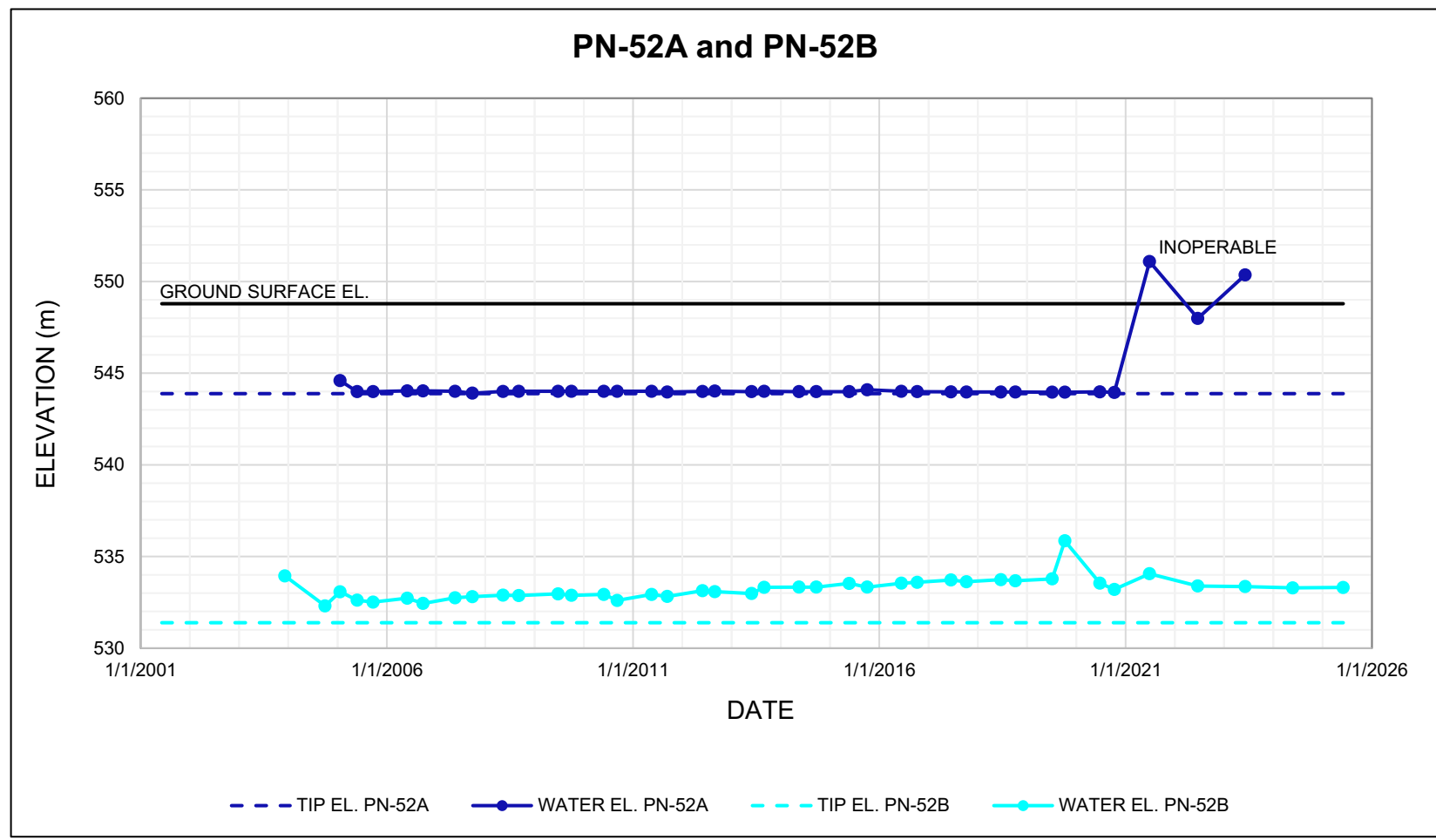
NOTES:
 1. PIEZOMETER DATA OBTAINED BEFORE JUNE 27, 2021, PROVIDED TO KLOHN CRIPPEN BERGER LTD. BY ALBERTA TRANSPORTATION AND ECONOMIC CORRIDORS ON JUNE 25, 2021.

CLIENT		PROJECT	
 		PEACE REGION (GRANDE PRAIRIE DISTRICT - SOUTH) GEOHAZARD RISK MANAGEMENT PROGRAM	
		TITLE PIEZOMETER DATA GP016 - SLIDE 2 KM WEST OF HWY 40 HWY 666:02, KM 34.837	
SCALE	PROJECT No.	A05116A01	FIG No.





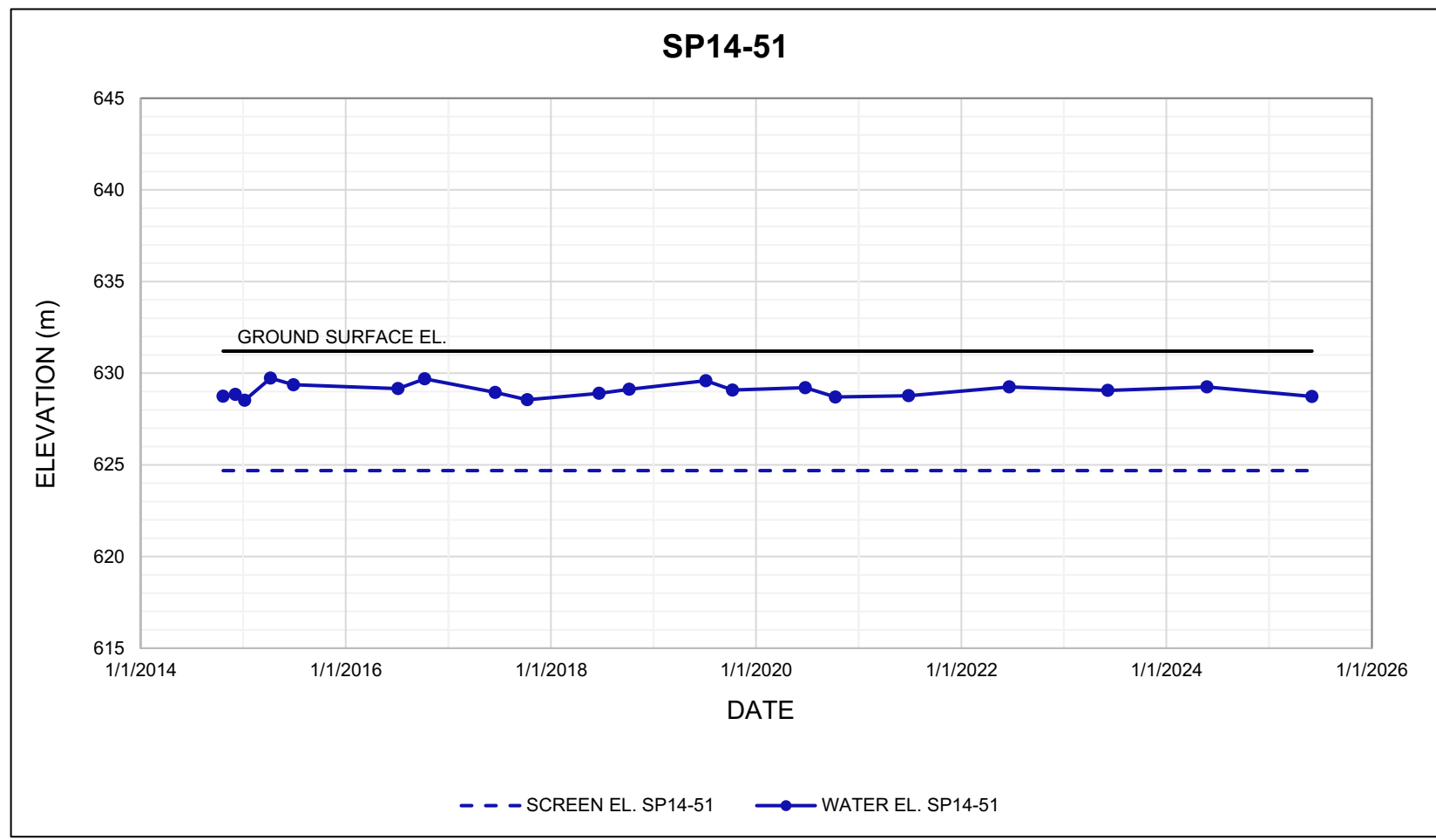
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SCALE	PROJECT No.	A05116A01	FIG No.





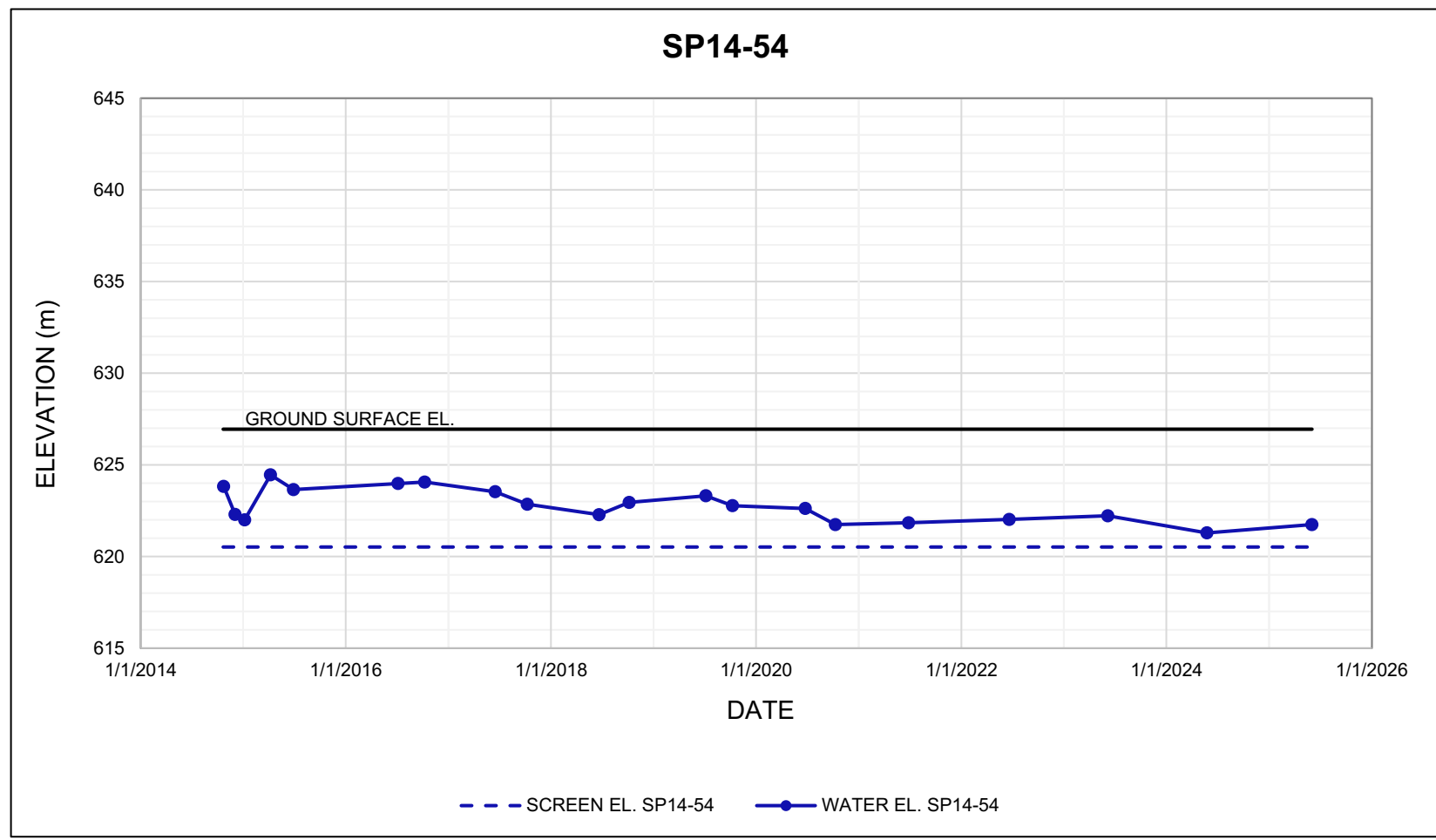
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		TITLE	
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SCALE	PROJECT No.	A05116A01	FIG No.





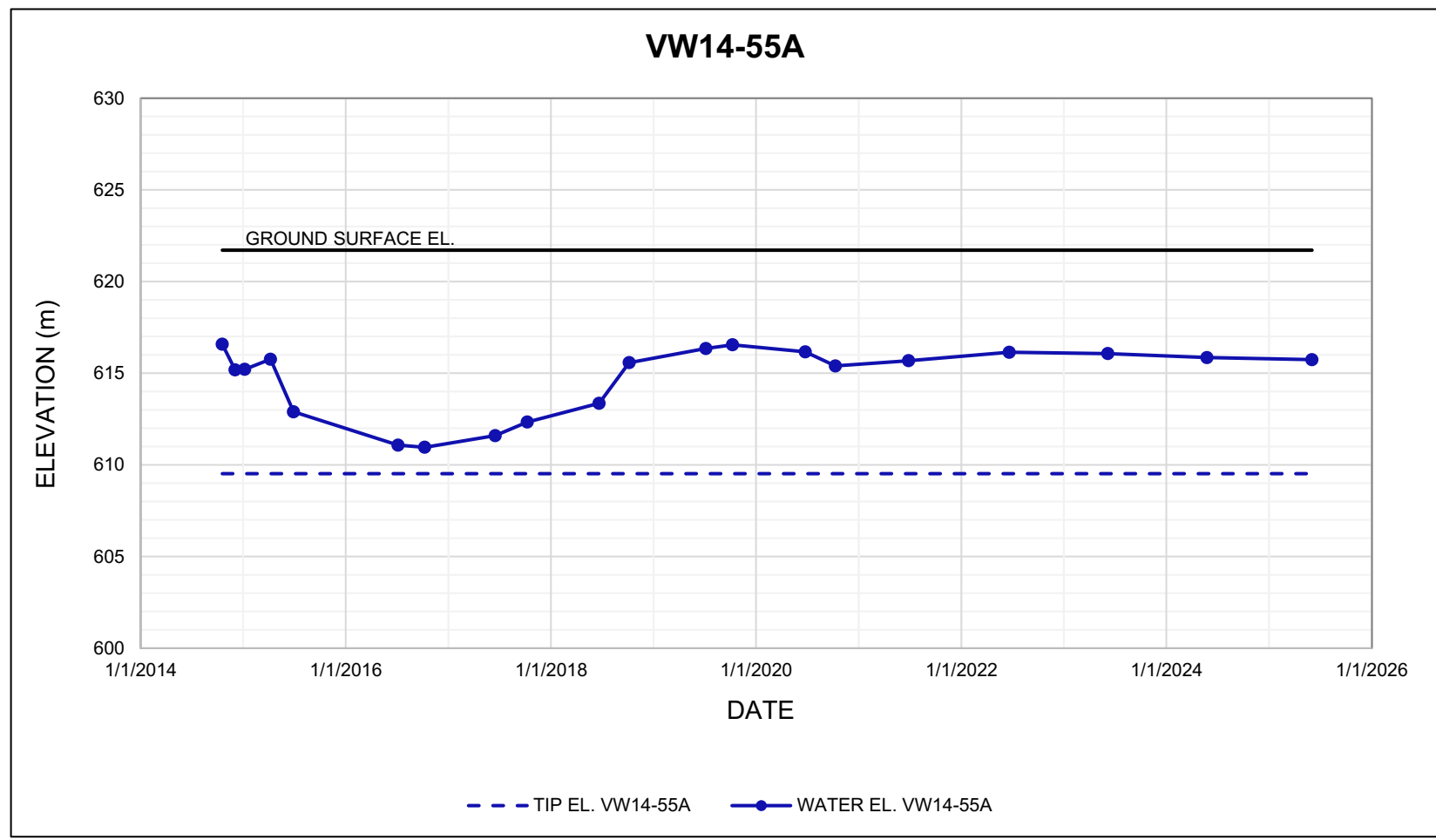
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		SCALE	PROJECT No. A05116A01
		FIG No.	





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SCALE	PROJECT No.	A05116A01	FIG No.



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		TITLE PIEZOMETER DATA GP016 - SLIDE 2 KM WEST OF HWY 40 HWY 666:02, KM 34.837	
		SCALE	PROJECT No. A05116A01 FIG No.