November 28, 2025

Alberta Transportation and Economic Corridors
Main Floor, Provincial Building
9621 – 96th Avenue
Peace River, Alberta
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Robert Senior
Construction Technologist

Dear Mr. Senior:

CON0022166 Peace Region (Grande Prairie District – South) GRMP Instrumentation Monitoring Site GP007; H40:36, km 29.339 Wanyandie Road Slide
Section C – 2025 Fall Readings

1 GENERAL

Nine slope inclinometers (SIs) (SI98-4, SI98-6, SI98-7, SI03-11, SI03-12, and SI22-1 through SI22-4), ten pneumatic piezometers (PNs) (PN-4, PN-5, PN-6, PN-7, PN-11A/B, PH-12A/B/C, and PN-13A), nineteen vibrating wire piezometers (VWPs) (VW20-2A/B, VW20-3A/B, VW20-6A/B, VW22-1A/B/C, VW22-2A/B/C/D, VW22-3A/B/C/D, VW22-4A/B), and three standpipe piezometers (SPs) (SP20-1, SP20-4, and SP20-8) were read at the GP007 site in the Peace Region (Grande Prairie District – South) (GP South Region) on September 4, 2025, by Evan Hergott, E.I.T. and Katrina Cereno, 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 29.339, near the intersection with Wanyandie Road. The approximate site coordinates are 5993890 N, 372875 E (UTM Zone 11, NAD 83). A site plan is presented on Figure 1.

The geohazard at the GP007 site consists of a deep-seated landslide (or nested slide) along the north valley slope of the Smoky River.

Previous remedial actions completed at the GP007 site include asphalt overlays in 2018 and 2019, and ongoing pavement patching, and sub-excavation and backfilling of surface voids with granular fill. In 2020 and 2021, the highway surface was returned to gravel in the summer/fall then paved for winter and in 2024, the north highway ditch at the west end of the site was regraded.

Geotechnical site investigations were conducted at the GP007 site in 1998, 2002, 2003, and 2020 by the previous consultants. During these investigations, 14 SIs and 21 piezometers were installed. KCB conducted a more recent geotechnical site investigation in 2022, during which 4 deep SIs and 13 VWPs (with data loggers) were installed to improve the understanding of movement and groundwater conditions at the site, respectively.

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The stratigraphy encountered during the 2022 investigation varied, but generally consisted of silt, colluvium, till, or some combination thereof, overlying bedrock (clay shale, siltstone, and sandstone). At the west end of the site, the depth to bedrock observed during the 2022 investigation was deeper than the depth to bedrock observed during the 1998 investigations, which could indicate some of the SIs installed in 1998 were not anchored in bedrock as previously reported by others.

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.

As discussed above, 18 SIs and 34 piezometers have been installed at the site between 1998 and 2022 by the previous consultants and KCB. Some of these instruments are now inoperable (e.g., sheared or damaged) as detailed in Table 1.1 (see table notes). For the instruments installed by previous consultants (14 SIs and 21 piezometers) it is noted that:

- Most of these piezometers have been dry or near dry (i.e., recording water levels below or near their tip elevations) since installation with a water level above tip elevation
- Several of the SIs did not record clear movement patterns before they became inoperable (SI98-1), were not anchored in bedrock (TH20-2, TH20-3, and TH20-6), or may not have been installed deep enough (SI98-4 and SI98-6, SI03-11 and SI03-12) since the movement or lack of movement recorded in the instrument is inconsistent with movement recorded in other nearby SIs and/or, as discussed in Section 1, the instruments may not have been anchored in bedrock as previously reported by others.

Most of the instruments are protected by above-ground casing protectors, excluding SI98-4 through SI98-7, and PN-4 through PN-7.

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 VWPs, PNs, and SPs were read using RST Instruments DT Logger Host software, an RST C109 pneumatic piezometer readout box, and a 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	~~SI98-1~~	~~Mar. 10, 1998~~	~~5993897~~	~~372794~~	~~965.4~~	~~0.9~~	~~29.3~~	~~Inoperable[3]~~
	~~SI98-2~~	~~Mar. 05, 1998~~	~~5993849~~	~~372785~~	~~961.0~~	~~0.2~~	~~30.9~~	~~Inoperable[4]~~
	~~SI98-3~~	~~Mar. 05, 1998~~	~~5993519~~	~~372798~~	~~903.7~~	~~0.8~~	~~29.1~~	~~Inoperable[3]~~
	SI98-4	Oct. 24, 1998	5993908	372881	964.9	0.6	20.2	Operable
	~~SI98-5~~	~~Oct. 20, 1998~~	~~5993851~~	~~372889~~	~~954.5~~	~~0.8~~	~~25.7~~	~~Inoperable[4]~~
	SI98-6	Oct. 22, 1998	5993878	373084	967.3	0.9	27.9	Operable
	SI98-7	Oct. 21, 1998	5993777	373101	943.5	0.7	29.1	Operable
	~~SI98-8~~	~~Oct. 26, 1998~~	~~5993585~~	~~373184~~	~~926.7~~	~~0.8~~	~~23.3~~	~~Inoperable[5]~~
	SI03-11	Nov. 25, 2003	5993966	372951	991.5	0.6	44.7	Operable
	SI03-12	Nov. 27, 2003	5993964	373058	991.4	0.9	44.9	Operable[6]
	~~SI03-13~~	~~Nov. 22, 2003~~	~~5994014~~	~~3373395~~	~~995.2~~	~~0.9~~	~~41.5~~	~~Inoperable[5]~~
	~~SI20-2~~	~~Jul. 28, 2020~~	~~5993885~~	~~373238~~	~~970.5~~	~~1.0~~	~~34.2~~	~~Inoperable[4]~~
	~~SI20-3~~	~~Jul. 23, 2020~~	~~5993917~~	~~373251~~	~~981.1~~	~~0.9~~	~~33.9~~	~~Inoperable[4]~~
	~~SI20-6~~	~~Jul. 27, 2020~~	~~5993875~~	~~373300~~	~~964.6~~	~~0.8~~	~~29.4~~	~~Inoperable[4]~~
	SI22-1	May 19, 2022	5993925	372803	965.0	0.4	40.3	Operable
	SI22-2	May 06, 2022	5993906	372920	966.0	0.6	40.6	Operable
	SI22-3	May 11, 2022	5993906	373081	971.0	0.6	49.1	Operable
	SI22-4	May 17, 2022	5993936	373239	980.0	0.2	54.6	Operable
PN	~~PN98-1~~	~~Mar. 10, 1998~~	~~5993897~~	~~372794~~	~~965.4~~	~~N/A~~	~~16.8~~	~~Inoperable[7]~~
	~~PN98-3~~	~~Mar. 05, 1998~~	~~5993519~~	~~372798~~	~~903.7~~	~~N/A~~	~~10.7~~	~~Inoperable[7]~~
	PN98-4	Oct. 24, 1998	5993908	372881	964.9	N/A	7.3	Operable
	PN98-5	Oct. 20, 1998	5993851	372889	954.5	N/A	11.3	Operable
	PN98-6	Oct. 22, 1998	5993878	373084	967.3	N/A	10.1	Operable
	PN98-7	Oct. 21, 1998	5993777	373101	943.5	N/A	4.6	Operable
	PN03-11A	Nov. 25, 2003	5993966	372951	991.5	N/A	6.1	Operable
	PN03-11B					N/A	15.2	Operable
	PN03-12A	Nov. 27, 2003	5993964	373058	991.4	N/A	6.6	Operable
	PN03-12B					N/A	14.9	Operable
	PN03-12C					N/A	22.7	Operable
	PN03-13A	Nov. 22, 2003	5994014	3373395	995.2	N/A	6.4	Operable
VWP[8]	VW20-2A	Jul. 28, 2020	5993885	373238	970.5	N/A	11.3	Operable
	VW20-2B					N/A	22.9	Operable
	VW20-3A	Jul. 23, 2020	5993917	373251	981.1	N/A	17.4	Operable
	VW20-3B					N/A	28.2	Operable
	VW20-6A	Jul. 27, 2020	5993875	373300	964.6	N/A	16.2	Operable
	VW20-6B					N/A	24.1	Operable
	VW22-1A	May 19, 2022	5993925	372803	965.0	N/A	29.2	Operable
	VW22-1B					N/A	32.9	Operable
	VW22-1C					N/A	40.0	Operable
	VW22-2A	May 06, 2022	5993906	372920	966.0	N/A	21.3	Operable
	VW22-2B					N/A	33.1	Operable
	VW22-2C					N/A	36.3	Operable
	VW22-2D					N/A	40.0	Operable
	VW22-3A	May 11, 2022	5993906	373081	971.0	N/A	19.9	Operable
	VW22-3B					N/A	37.9	Operable
	VW22-3C					N/A	42.5	Operable
	VW22-3D					N/A	49.4	Operable
	VW22-4A	May 17, 2022	5993936	373239	980.0	N/A	33.9	Operable
	VW22-4B					N/A	45.2	Operable
SP	SP20-1	Jul. 30, 2020	5993951	373592	961.8	0.9	7.5	Operable
SP[9]	SP20-4	Jul. 26, 2020	5993970	373309	976.5	0.9	19.5	Operable
	SP20-8	Jul. 30, 2020	5994000	373791	997.3	0.9	10.0	Operable

Notes:

[1] Instrument installation details were taken from reports and data files prepared or provided by the previous consultant(s) or TEC. Instruments installed in 1998, 2003, and 2020 were surveyed in 1998, 2004, and 2022, respectively. Coordinates and ground surface elevations for instruments installed in 2022 were taken with a handheld GPS (accuracy of ± 5 m).

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

[3] SI98-1 and SI98-3 are inoperable (damaged near the top of casing in 2006). Instruments last read in September 2005.

[4] SI98-2, SI98-5, SI20-2, SI20-3, and SI20-6 have sheared at approximate depths of 21.5, 22.0 m, 28.5 m, 24.9 m, and 27.0 m below ground surface (approximate elevations of 939.5 m, 932.5 m, 942.0 m, 956.2 m, and 937.6 m, respectively). Instruments last read in October 2001, September 2009, September 2022, September 2023, and September 2021, respectively.

[5] SI98-8 and SI03-13 are blocked at an approximate depth of 15.0 m (approximate elevation of 912.0 m) and 33.5 m below ground surface, respectively. It is unclear if these instruments sheared as no previous movement had been recorded in them. Instruments last read in May 2011 and September 2011, respectively.

[6] SI03-12 has been re-sleeved twice (i.e., had a smaller diameter casing installed in it) (dates unknown).

[7] PN98-1 and PN98-3 were reported as inoperable by a previous consultant. Instruments last read in September 2010 and September 2011, respectively.

[8] In 2022, multi-channel data loggers (Model No. DT2055B from RST Instruments Ltd.) were connected to the VWPs. The data loggers are programmed to record a reading of the instruments every 12 hours.

[9] In 2023, small-diameter VWPs connected to single-channel data loggers (Model No. DT2011B from RST Instruments Ltd.) were installed inside SP20-4 and SP20-8. The data loggers are programmed to record a reading of the instruments every 6 hours.

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-grooves) and, where applicable, the X-direction (i.e., the direction of maximum movement obtained at a skew angle from the A0-grooves). SI22-4 have a skew angle of 230 measured clockwise from the direction of the A0-grooves.

For the operable PNs and VWPs, 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 data plots are included in Appendix I, and a summary of the SI and piezometer data is provided in Table 2.1 through Table 2.3.

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 consultants and no reinitialization 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.

It is noted that the data for SI98-6, SI98-7, SI03-11, SI03-12, and SI22-4 is noisy and difficult to interpret. Based on the absolute plots for these instruments, SI98-6 has kinks in the casing at an approximate depth of 11.9 m and 13.9 m below ground surface (mbgs), SI98-7, SI03-11 and SI03-12 are tilted approximately 1.2 m to 1.5 m in the A direction, and SI22-4 is titled 1.7 m in the B-direction. SI98-12 has also been re-sleeved twice (i.e., had a small-diameter casing installed in it) (dates unknown).

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				
SI98-4	Oct. 25, 1998	N/A – No discernible movement recorded.	Jun. 03/04, 2025	Sep. 4, 2025	964.9	N/A – No discernible movement recorded.								
SI98-6[3]	Oct. 23, 1998 (Jun. 22, 2018)				967.3	N/A – No discernible discrete movement recorded, but some potential post-installation casing settlement/flexure recorded.								
SI98-7[3]	Oct. 23, 1998				943.5	N/A – No discernible discrete movement recorded.								
SI03-11	Dec. 07, 2003 (Jun. 12, 2016)[4]				991.5	N/A – No discernible discrete movement recorded.								
SI03-12[3]	May 24, 2007 (Jun. 12, 2016)				991.4	N/A – No discernible discrete movement recorded, but some potential post-installation casing settlement/flexure recorded.								
SI22-1	Jun. 22, 2022				965.0	N/A – No discernible discrete movement recorded, but some potential post-installation casing settlement/flexure recorded.								
SI22-2	Jun. 22, 2022	Jun. 03, 2025			966.0	6.6 – 10.6	A-direction	N/A		18.0	0.1	20.8	0.4	0.1
SI22-3	Jun. 21, 2022	N/A – No discernible movement recorded.	Jul. 02, 2025		971.0	N/A – No discernible movement recorded, but some potential post-installation casing settlement/flexure recorded								
SI22-4[3]	Jun. 21, 2022	Oct. 17, 2024			980.0	2.6 – 53.6	X-Direction, 230°	N/A		10.1	-6.5	46.5	-8.2	-54.7

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, data for SI98-6, SI98-7, SI03-11, SI03-12, and SI22-4 is noisy and difficult to interpret.
[4] A large data shift was previously recorded in SI03-11 between the May 2015 and June 2016 readings when the SI reading equipment was changed by the previous consultant. The data obtained by KCB is consistent with the data obtained after June 2016, so the instrument was re-initialized to the June 2016 reading.

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)
PN98-4	51191	Oct. 24, 1998	Jun. 04, 2025	Sep. 04, 2025	964.9	7.3	7.1	7.0	0.1
PN98-5	51190	Oct. 20, 1998			954.5	11.3	11.1	11.2	-0.1
PN98-6	51194	Oct. 22, 1998			967.3	10.1	9.7	9.7	0.0
PN98-7	51193	Oct. 21, 1998			943.5	4.6	4.5	4.2	0.3
PN03-11A	28835	Nov. 25, 2003			991.5	6.1	6.0	6.1	-0.1
PN03-11B	28828					15.2	15.2	15.2	0.0
PN03-12A	28902	Nov. 27, 2003			991.4	6.6	6.3	6.4	-0.1
PN03-12B	28899					14.9	14.8	14.8	0.0
PN03-12C	28827					22.7	22.7	22.7	0.0
PN03-13A	28834	Nov. 22, 2003			995.2	6.4	N/A – instrument is dry		

Notes:
[1] Meters below ground surface (mbgs).

Table 2.3 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)
SP20-1	Jul. 30, 2020	Jun. 04, 2025	Sep. 04, 2025	961.8	7.5	7.5	7.5	0.0
SP20-4[2]	Jul. 26, 2020			976.5	19.5	19.0	19.0	0.0
SP20-8[2]	Jul. 30, 2020			997.3	10.0	5.9	5.9	0.0

Notes:
[1] Meters below ground surface (mbgs).
[2] Small-diameter vibrating wire piezometers connected to single-channel data loggers are installed in SP20-4 and SP20-8. The data loggers are programmed to record a reading of the instruments every 6 hours.

Table 2.4 Vibrating Wire Piezometer Reading Summary[1]

Instrument ID	Serial No.	Date			Ground Surface Elevation (m)	Tip Depth (mbgs[2])	Water Level		
		Installed	Previous Reading	Most Recent Reading			Previous Reading (mbgs[2])	Most Recent Reading (mbgs[2])	Change from Previous Reading (m)
VW20-2A	67078	Jul. 28, 2020	Jun. 04, 2025	Sep. 04, 2025	970.5	11.3	10.3	10.2	0.1
VW20-2B	67099					22.9	14.0	14.0	0.0
VW20-3A	67093	Jul. 23, 2020			981.1	17.4	N/A – instrument is dry		
VW20-3B	67095					28.2	26.7	26.7	0.0
VW20-6A	67088	Jul. 27, 2020			964.6	16.2	15.0	15.1	-0.1
VW20-6B	67096					24.1	14.8	14.9	-0.1
VW22-1A	VW145733	May 19, 2022			965.0	29.2	12.7	12.6	0.1
VW22-1B	VW143171					32.9	N/A – instrument is dry		
VW22-1C	VW140853					40.0	N/A – instrument is dry		
VW22-2A	SN1910356	May 06, 2022			966.0	21.3	20.9	20.8	0.1
VW22-2B	VW145722					33.1	13.3	13.3	0.0
VW22-2C	VW145742					36.3	13.1	13.1	0.0
VW22-2D	VW140069					40.0	N/A – instrument is dry		
VW22-3A	VW145498	May 11, 2022			971.0	19.9	16.7	16.7	0.0
VW22-3B	VW145717					37.9	16.8	16.8	0.0
VW22-3C	VW145708					42.5	17.0	17.0	0.0
VW22-3D	VW143066					49.4	N/A – instrument is dry		
VW22-4A	VW145746	May 17, 2022			980.0	33.9	25.4	25.3	0.1
VW22-4B	VW139732					45.2	N/A – instrument is dry		

Notes:
[1] All vibrating wire piezometers are connected to multi-channel data loggers, which are programmed to record a reading of the instruments every 12 hours.
[2] Meters below ground surface (mbgs).

2.2 Zones of Movement

West End of Site

At the west end of the site, discrete movement (i.e., movement occurring on a defined failure plane) was recorded in SI98-2 and SI98-5 before the instruments sheared at approximate depths of 21.5 mbgs and 22.0 mbgs, respectively. SI98-2 was located along the south (eastbound) shoulder of the highway and SI98-5 was located below the highway along Wanyandie Road. No discernible movement has been recorded in SI98-4, which is still operable and located upslope of SI98-5 in the north (westbound) highway ditch. However, as discussed in Section 1.1, SI98-4 may not have been installed deep enough. In May 2022, a deeper SI (SI22-1) was installed adjacent to SI98-4. A "kink" has been recorded in SI22-1 at an approximate depth of 6.3 mbgs to 9.8 mbgs (elevation 958.7 m to 955.2 m), in a zone of softer material observed during drilling, which may indicate post-installation casing settlement/flexure.

Overall, the data recorded in SI98-4 and SI22-1 does not reflect the pavement distress (cracking and settlement) observed near the west end of the site and these instruments.

Middle of Site

Near the middle of the site, no discernible movement has been recorded in SI98-6, SI98-7, SI03-11, or SI03-12 since installation. Some possible movement maybe occurring in SI98-7 at an approximate depth of 22.1 mbgs and 24.1 mbgs (elevation 921.5 m and 919.5 m), but data for this instrument is noisy. SI98-6 is located along the south shoulder of the highway, SI03-11 and SI03-12 are located above the highway along the backslope, and SI98-7 is located below the highway along Wanyandie Road.

As discussed in Section 1.1, SI98-6, SI03-11, and SI03-12 may not have been installed deep enough. In May 2022, two deeper SIs (SI22-2 and SI22-3) were installed in the north highway ditch to assess if deeper movements are occurring near the middle of the site. Distributed movement has been recorded in SI22-2 from an approximate depth of 6.6 mbgs to 10.6 mbgs (elevation 959.4 m to 955.4 m), which is confined to the colluvium/till unit, and post-installation casing settlement/flexure has been recorded in SI22-3 to an approximate depth of 12 mbgs, which may be caused by grout loss in a more granular zone in the colluvium unit. It is noted that data recorded in SI22-3 is fluctuating with negative displacement sometimes being recorded.

Overall, the data recorded in SI-6, SI22-2, and SI22-3 does not reflect the increased pavement distress (cracking and settlement) observed near the middle of the site and these instruments since fall 2024.

East End of Site

At the east end of the site, discrete movement was being recorded in SI20-2, SI20-3, and SI20-6 before the instruments sheared at approximate depths of 28.5 mbgs, 24.9 mbgs, and 27.0 mbgs (elevation 942.0 m, 956.2 m, and 937.6 m). All three instruments were located on the south side of the highway.

In May 2022, a deeper SI (SI22-4) was installed on the north side of the highway to assess if deeper movements are occurring at the east end of the site. Distributed movement is being recorded along the entire length of the instrument (i.e., from near ground surface to the base of the instrument) since installation, with no discrete movement zones. It is noted that data recorded in SI22-4 is fluctuating with negative displacement sometimes being recorded.

Overall, the data recorded in SI22-4 does not reflect the increased pavement distress (cracking and settlement) observed near the east end of the site and this instrument since fall 2024.

2.3 Interpretation of Monitoring Results

Slope Inclinometer (SI) Data

Based on site observations and the SI data, portions of the landslide that appear most active coincide with areas of high fill at the west end of the site below and adjacent to the intersection with Wanyandie Road, and at the east end of the site near the deep gully. The landslide has generally appeared less active near the middle of the site, but increased pavement distress (cracking and settlement) has been observed near SI22-3 and SI-6 since fall 2024. There is no sign of recent landslide movements immediately above the highway in the backslope. However, relict landslide features have been observed by KCB and TEC during previous site visits on the natural slope uphill and downhill from Hwy 40.

Based on the surface expression of the 2005 bare-earth LiDAR data and historic air photos, the landslide appears most active downslope of Hwy 40:36 and Wanyandie Road at the west end of the site as shown on Figure 1. Ridges and troughs have been observed by KCB in this area and the area between Hwy 40:36 and Wanyandie Road, which could be the result of blocks sliding and eroding overtime with vegetation growth, becoming more rounded. The direction of movement recorded in SI98-2 and SI98-5 (before shearing) was towards the area of ridges and troughs downslope of Hwy 40:36 and Wanyandie Road.

As discussed in Section 2.2, no discernible movement has been recorded in SI98-4 installed upslope of SI98-5, or SI98-6 near the middle of the landslide, but these instruments may not have been installed deep enough. Three deeper SIs (SI22-1, SI22-2, and SI22-3) were installed and anchored in bedrock by KCB in 2022 near the west end and middle of the site to assess if deeper movements are occurring at these locations. No discernible movement has been recorded in SI22-1 or SI22-3 (excluding potential post-installation casing settlement/flexure). Distributed movement has been recorded in SI22-2 from an approximate depth of 6.6 mbgs to 10.6 mbgs (elevation 959.4 m to 955.4 m) at an overall rate of less than 10 mm/year. Movement at this elevation appears to be localized to this instrument, as it has not been recorded in SI98-4 or SI03-11, located west and north of SI22-2, respectively. Overall, the data recorded in these SIs does not reflect the pavement distress (cracking and settlement) observed near the west end and middle of the site. It is noted that ground cracking has also been observed in the north highway ditch during previous site visits.

SI20-2, SI20-3, and SI20-6 located on the south side of the highway, at the east end of the site, have previously sheared at an approximate elevation of 942.0 m, 956.2 m, and 937.6 m, respectively. The movement recorded in these instruments had an overall resultant towards the south to southeast and appeared to be in response to ground loading by the high fill in the ravine. Alternatively, the extent of valley-wall instability could be such that natural slope movements have A- and B-direction components due to the shape of the basal failure plane, potentially more stable zones, or other unknown factors. Since these instruments were anchored in clay till (not bedrock), a deeper SI (SI22-4) anchored in bedrock was installed on the north side of the highway by KCB in 2022 to assess if deeper movements are occurring at the east end of the site. Distributed movement has been recorded along almost the entire depth of SI22-4 at an overall approximate rate of less than 1 mm/year, but no discrete zones of movement have been recorded. Overall, the data recorded in this SI does not reflect the pavement distress (cracking and settlement) observed near the east end of the site and this instrument.

Fluctuations in the movement observed during site visits and the data recorded in the SIs could be attributed to seasonal variations in precipitation or freshet infiltration, possibly with a seasonal weakening occurring due to rising and falling groundwater levels. See further discussion below on the recorded piezometer data.

Less active portions of the landslide above the highway may not be as influenced by fill placement or water infiltration into the backscarp at highway level. However, without any changes to the slide or highway geometry, continued movement of the lower portions of the slide or an increase in groundwater levels (e.g., in response to prolonged periods of precipitation or freshet after a deeper-than-normal snowpack) could eventually result in movements further upslope.

Piezometer Data

Porewater pressures/water levels recorded in the SPs, VWPs, and PNs have been relatively steady (±1.0 m) or below tip elevation (i.e., dry) since installation.

The grout used to backfill the 2020 and 2022 boreholes may be muting the response of the VWPs to changing groundwater levels, or the groundwater level variations are too rapid (e.g., occurring in bedrock fractures or joints) to be recorded by the data loggers. However, the data loggers installed in SP20-4 and SP20-8, in February 2023, have also not captured short-term water level variations. As discussed in Section 2.6, addition sand-packed piezometers with data loggers could be installed to assess for short-term (e.g., seasonal) groundwater level variations in the overburden soils and bedrock.

2.4 Recommendations

2.5 Future Work

All operable instruments should continue to be read twice per year (spring and fall). 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.

2.6 Instrument Installs, Repairs, and Maintenance

The existing information for the site is not providing TEC with much information on groundwater levels and the movements recorded in the SIs are difficult to relate to the amount of highway distress (e.g., pavement cracking, settlement, and deflection) that is occurring.

An improved understanding of potential changes in groundwater levels might be achieved by installing additional piezometers, including deeper piezometers, backfilled with sand and sealed with bentonite (not grout) to assess for short-term (e.g., seasonal) groundwater level variations in the overburden soils and bedrock.

Deeper SIs could also be installed, but alternatively Interferometric Synthetic Aperture Radar (InSAR monitoring could be used to further study the slide and assess how the slope is moving and over what extent, particularly in difficult to assess areas with no instrumentation (e.g., above the highway where landslide terrain is visible on the surface expression of the 2005 bare-earth light detection and ranging, LiDAR, data).

The slide at the site is relatively large and understanding the relationship between movement at the toe of the slide where groundwater levels are high, on the mid slope between the highway and the toe, at the highway, and above the highway would be useful to understand how the slide is moving. The cost of completing an InSAR change detection survey every two or three years would be a similar order of magnitude to the instrument readings and may offer additional insight and forecasting of how slide movements might affect the highway.

No instrument repairs or maintenance is required. However, it is noted that the PNs are 22 years to 27 years old and more variability has been observed in the data recorded in these instruments in the past five years, which could indicate they are either sensitive to the reading equipment being used or perhaps starting to fail.

3 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.

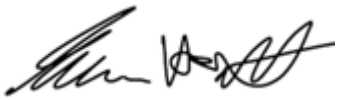
KCB has prepared this report in a manner consistent with the level of care, skill and diligence ordinarily provided by members of the same profession for projects of a similar nature at the time and place the services were rendered. KCB makes no warranty, express or implied.

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.

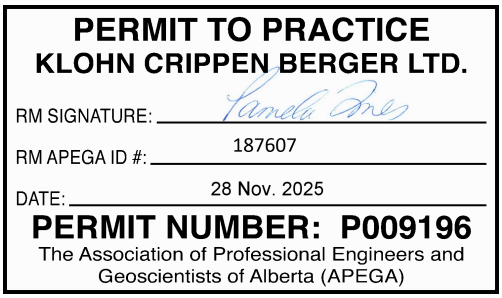


Courtney Mulhall, M.Sc., P.Eng.
Geotechnical Engineer

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

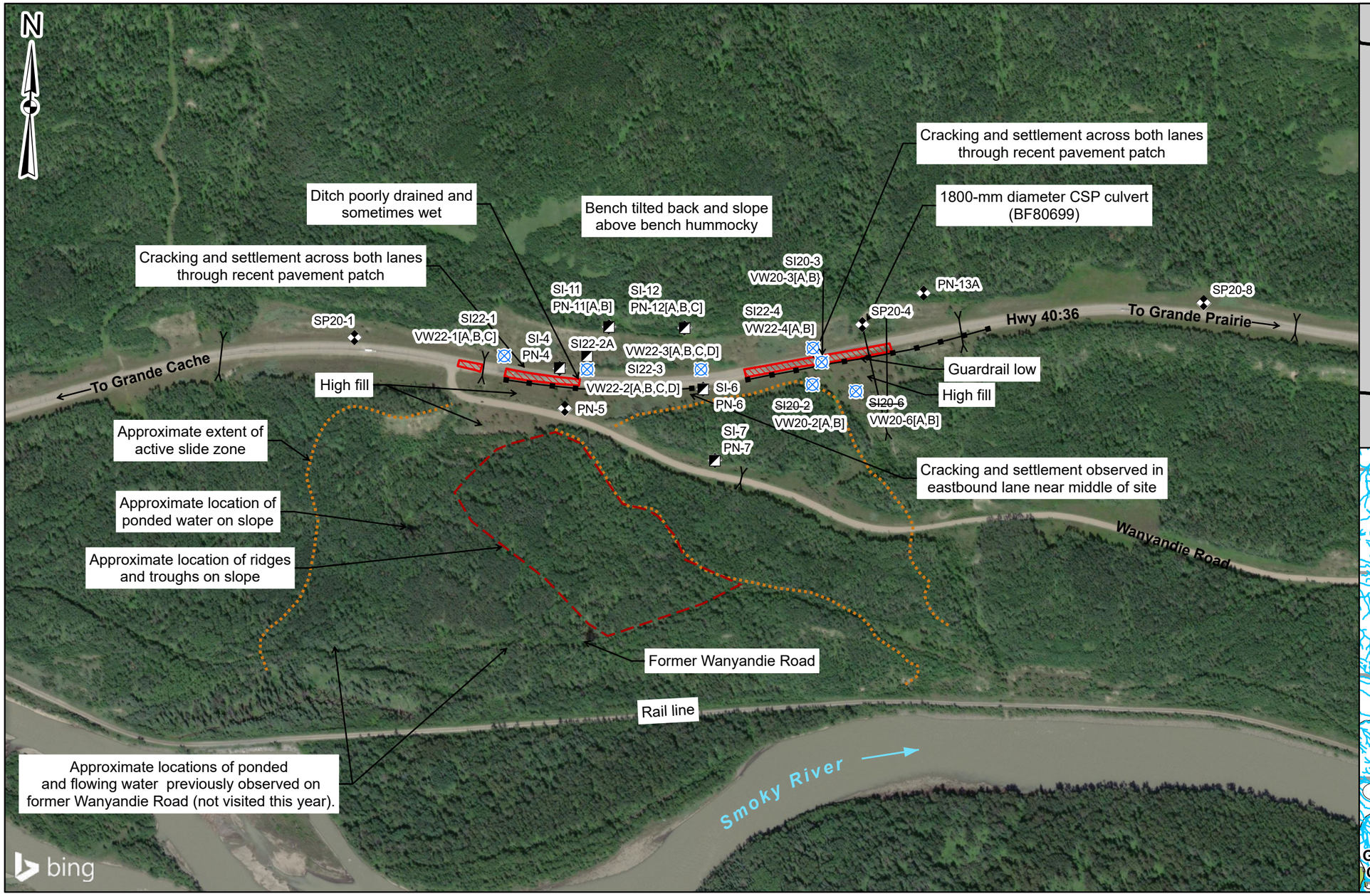
CM/EH:bb

Cc: Chris Gräpel, M.Eng., P.Eng.



ATTACHMENTS
Figure
Appendix I Instrumentation Plots

FIGURE



Legend

- Pneumatic Piezometer (PN)
- Slope Inclinometer (SI)
- Vibrating Wire Piezometer (VW)
- Flow Direction
- Culvert
- Guardrail
- Active Slide Zone
- Ridges and Troughs
- Pavement Patch

0 200 Metres

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

PROJECT: PEACE REGION (GRANDE PRAIRIE DISTRICT-SOUTH) GEOHAZARD RISK MANAGEMENT PROGRAM

TITLE: Site Plan
GP007 - Wanyandie Road Slide
Hwy 40:36, km 29.339

SCALE	PROJECT No.	FIG No.
1:6,000	A05116A01	1

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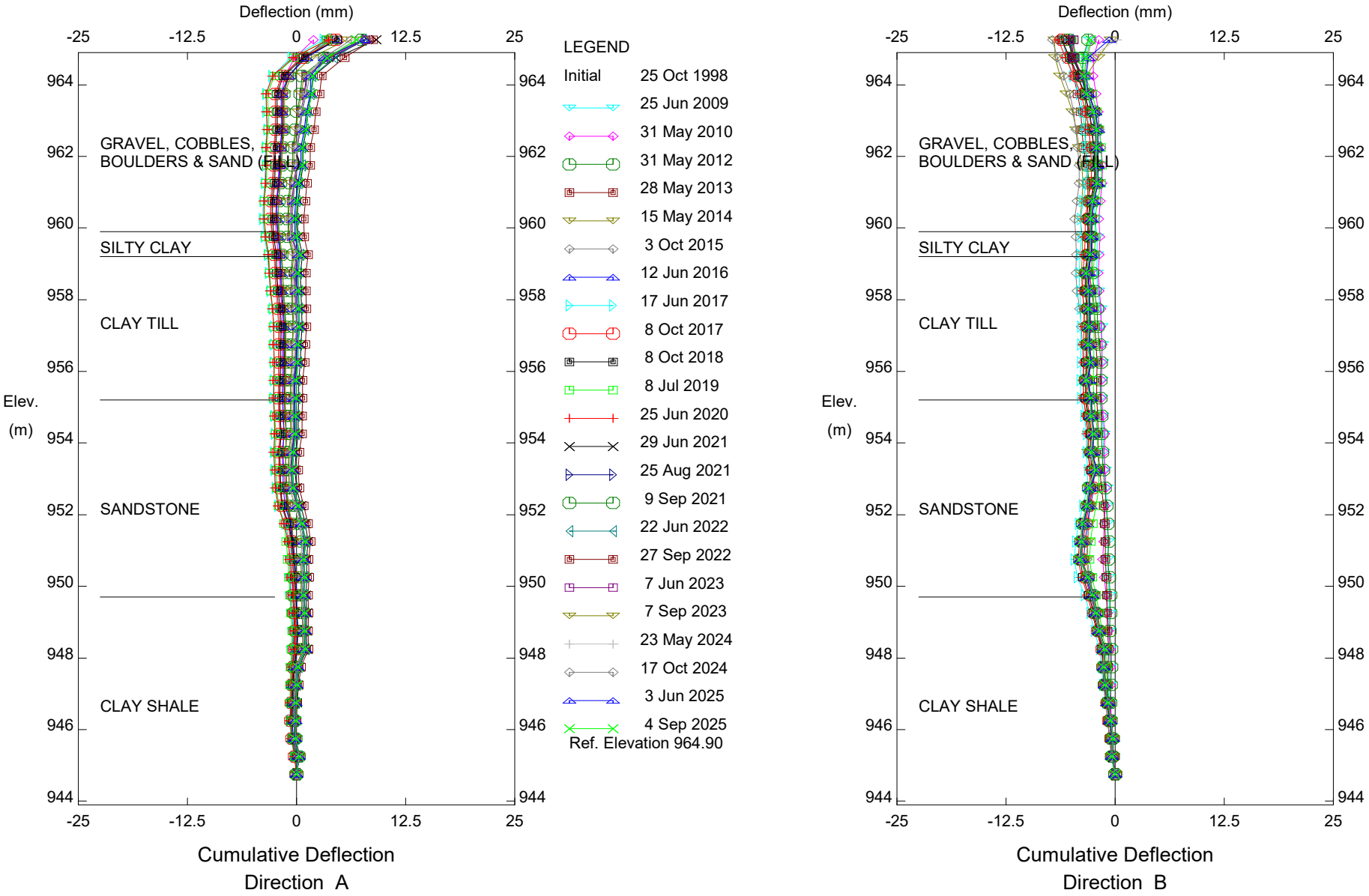
APPENDIX I

Instrumentation Plots

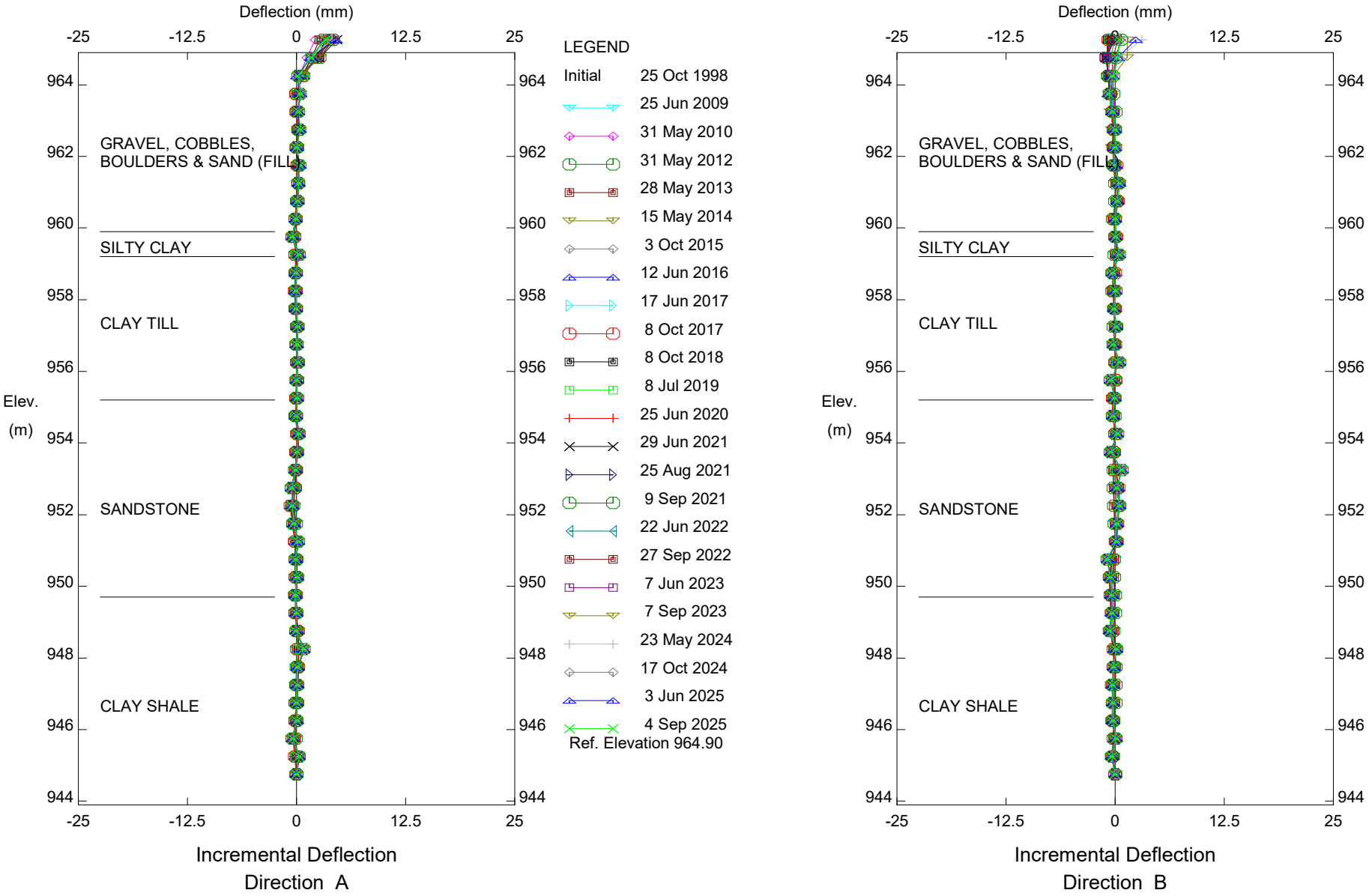
Klohn Crippen Berger - Edmonton



GP007; H40:36, Wanyandie Road Slide, Inclinometer SI98-04

Alberta Transportation

Klohn Crippen Berger - Edmonton



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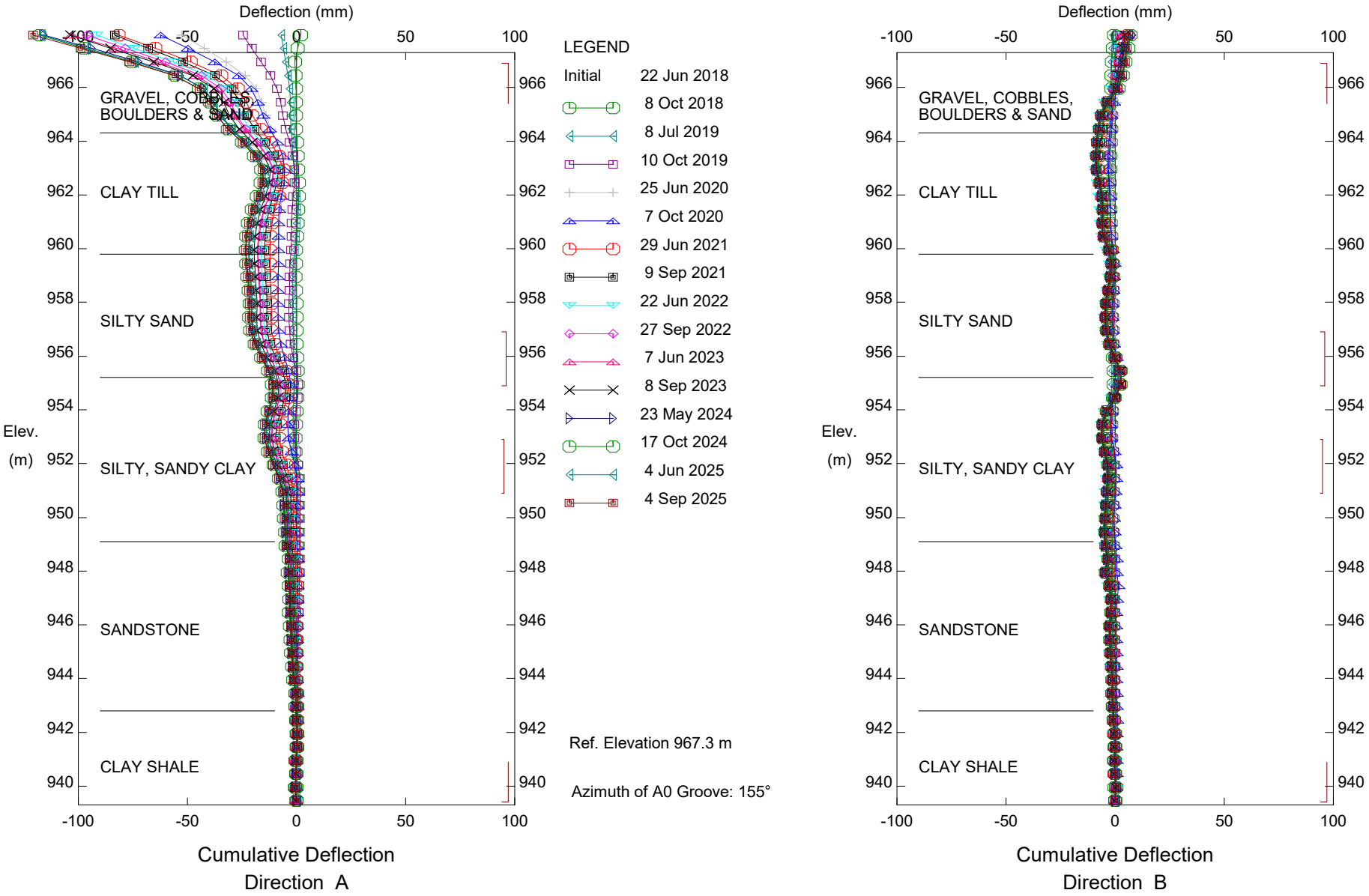
Alberta Transportation

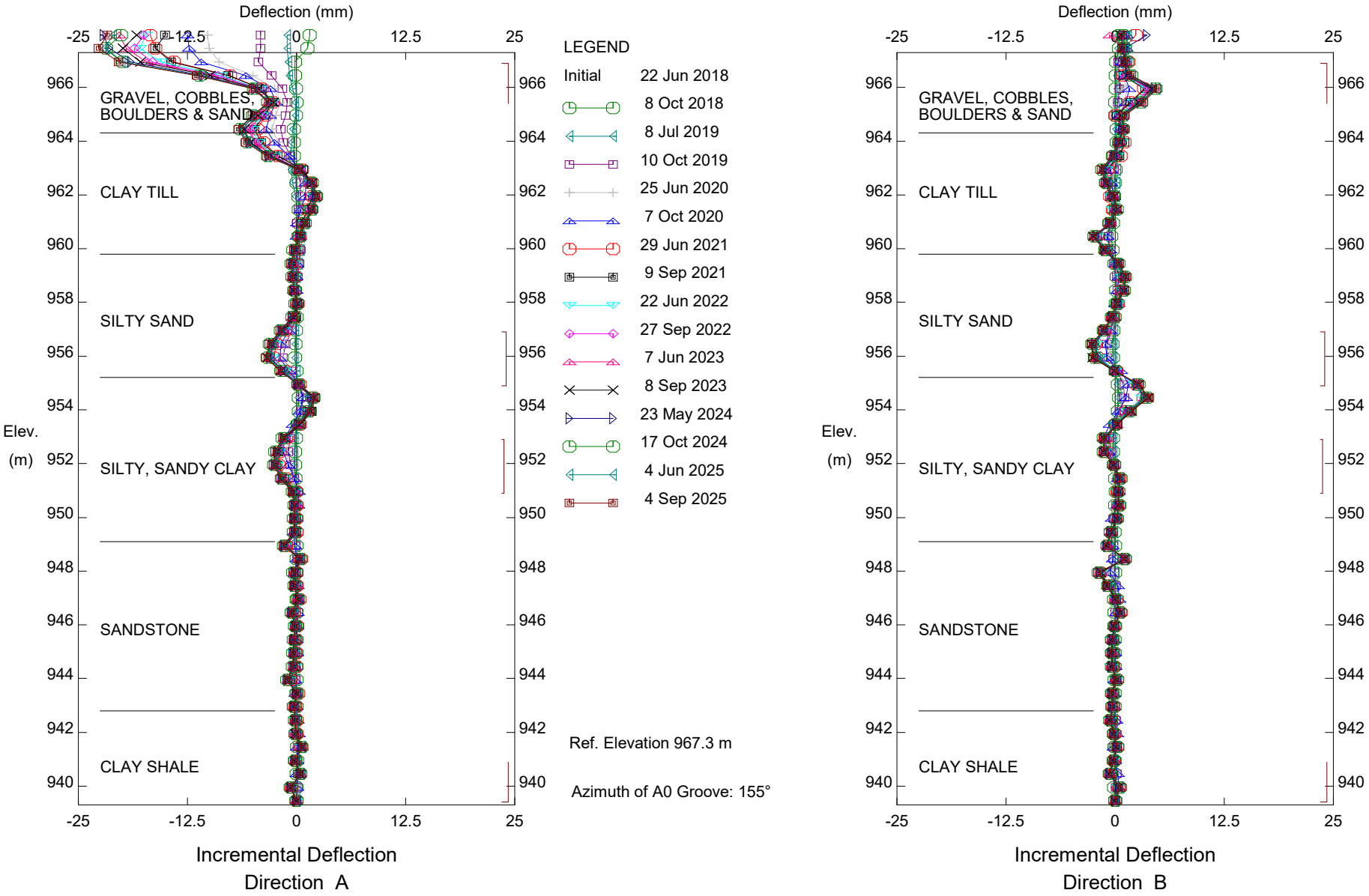
Klohn Crippen Berger - Edmonton



GP007; H40:36, Wanyandie Road Slide, Inclinometer SI98-06

Alberta Transportation

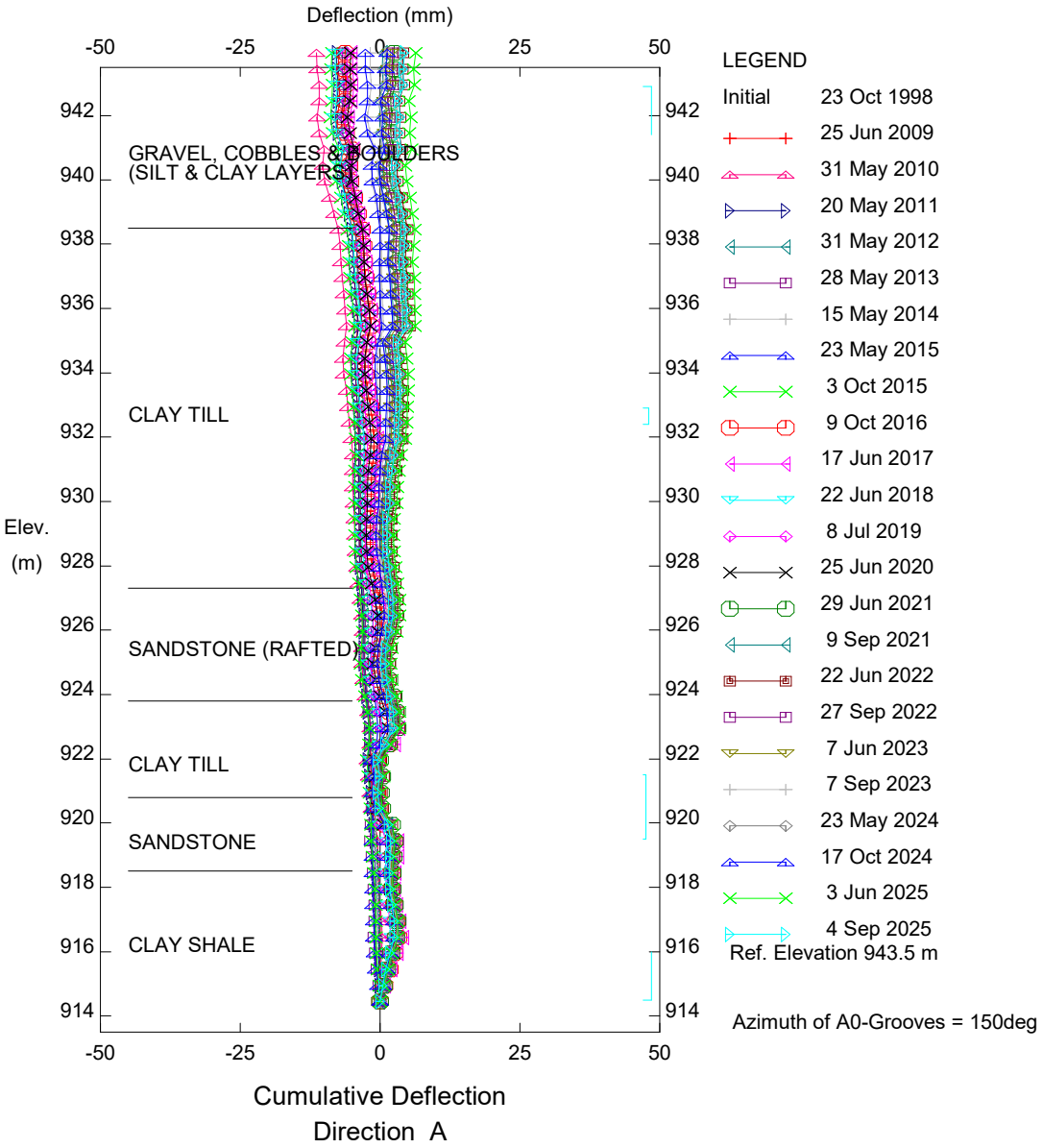
Klohn Crippen Berger - Edmonton



GP007; H40:36, Wanyandie Road Slide, Inclinometer SI98-06

Alberta Transportation

Klohn Crippen Berger - Edmonton

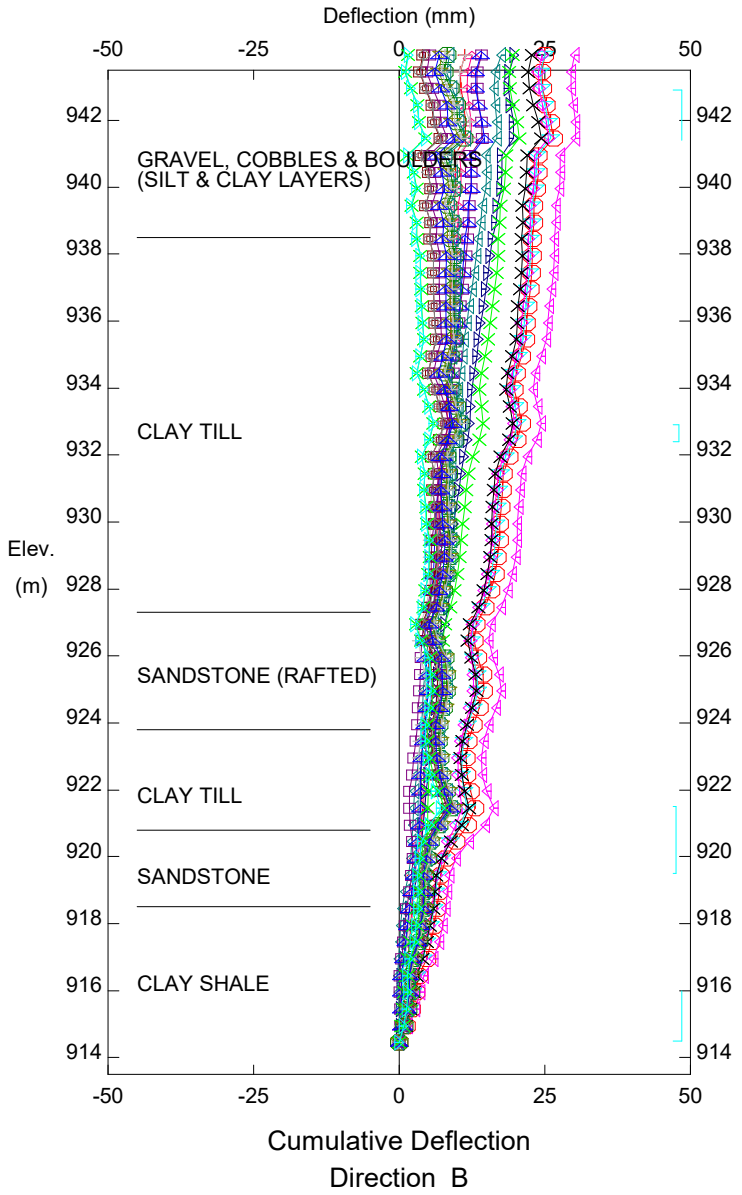


LEGEND

Initial	23 Oct 1998
	25 Jun 2009
	31 May 2010
	20 May 2011
	31 May 2012
	28 May 2013
	15 May 2014
	23 May 2015
	3 Oct 2015
	9 Oct 2016
	17 Jun 2017
	22 Jun 2018
	8 Jul 2019
	25 Jun 2020
	29 Jun 2021
	9 Sep 2021
	22 Jun 2022
	27 Sep 2022
	7 Jun 2023
	7 Sep 2023
	23 May 2024
	17 Oct 2024
	3 Jun 2025
	4 Sep 2025

Ref. Elevation 943.5 m

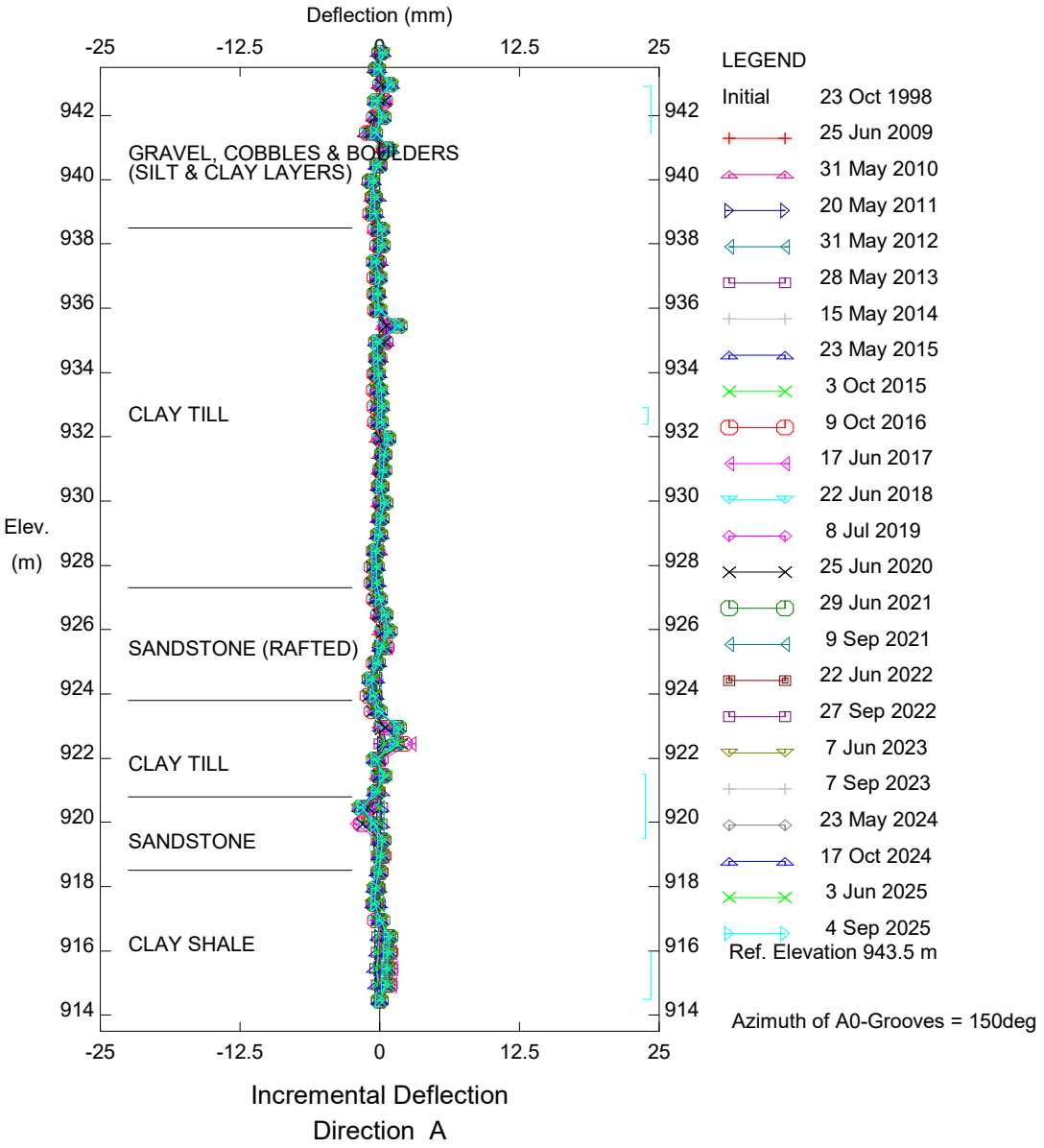
Azimuth of A0-Grooves = 150deg

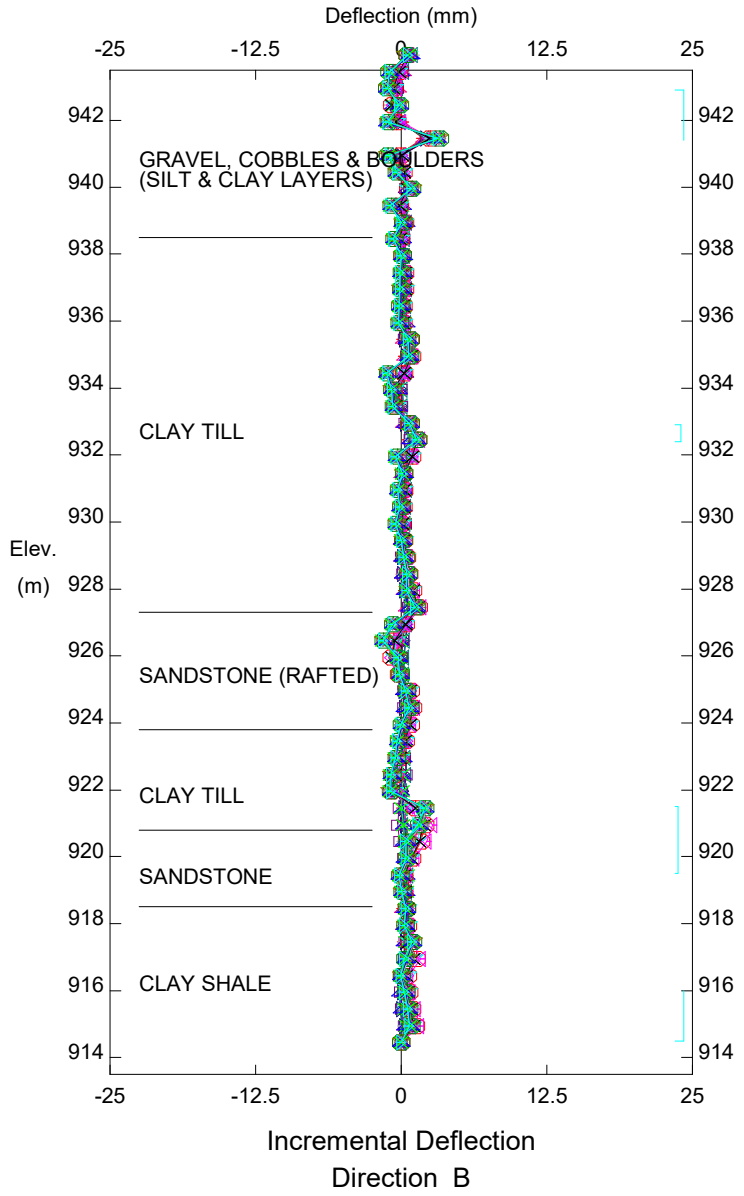


GP007; H40:36, Wanyandie Road Slide, Inclinometer SI98-07

Alberta Transportation

Klohn Crippen Berger - Edmonton

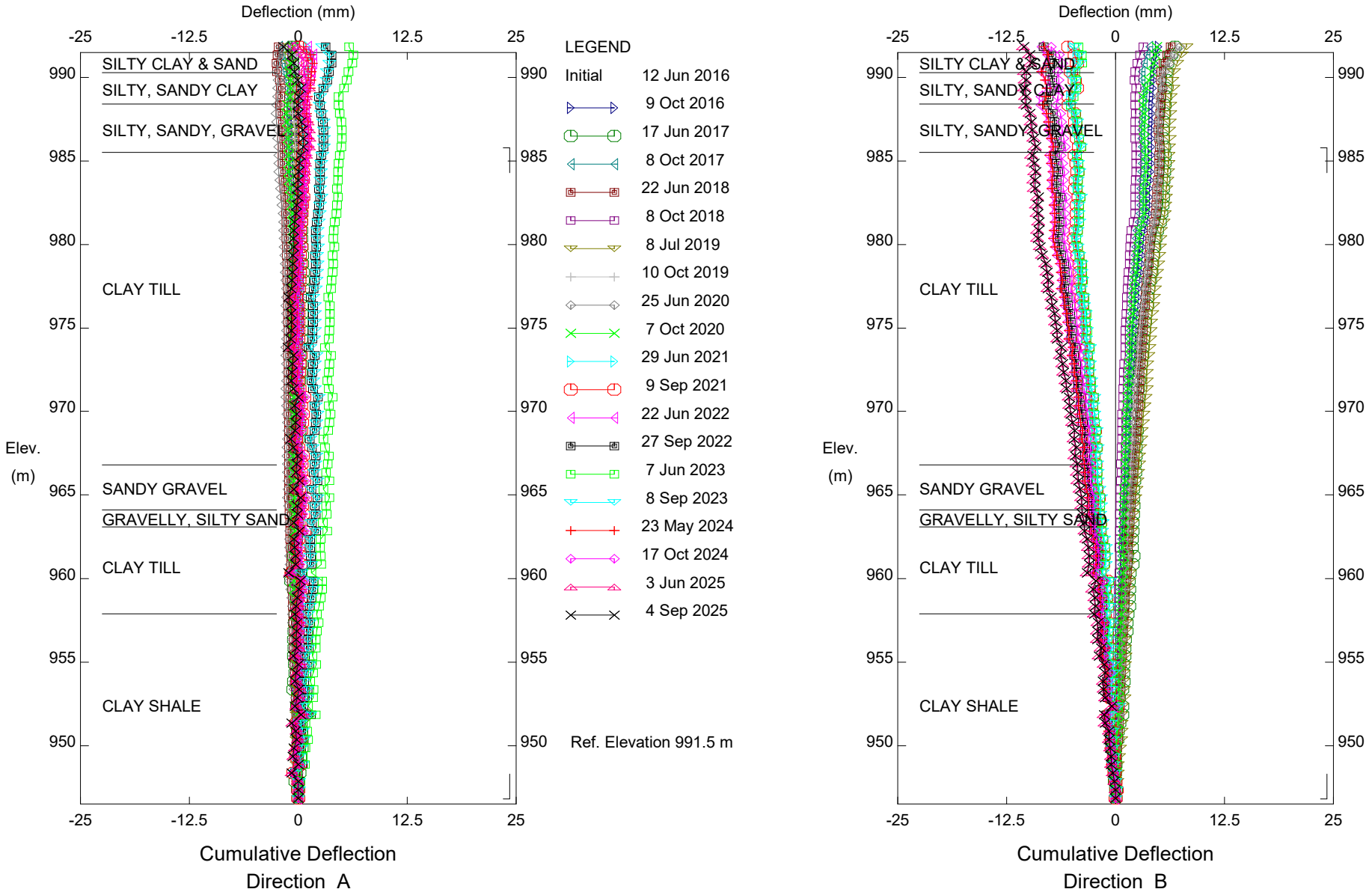




GP007; H40:36, Wanyandie Road Slide, Inclinometer SI98-07

Alberta Transportation

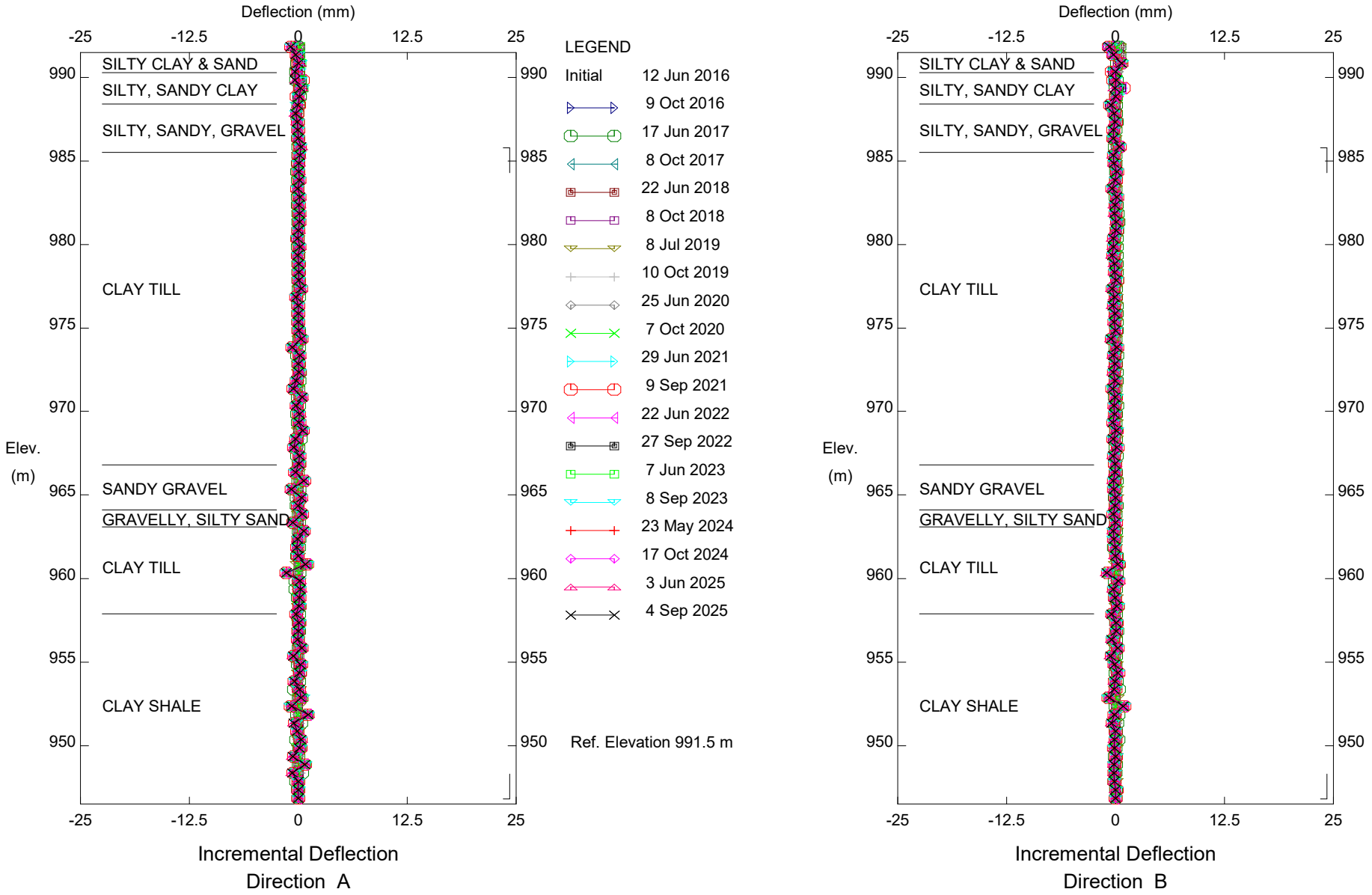
Klohn Crippen Berger - Edmonton



GP007; H40:36, Wanyandie Road Slide, Inclinometer SI03-11

Alberta Transportation

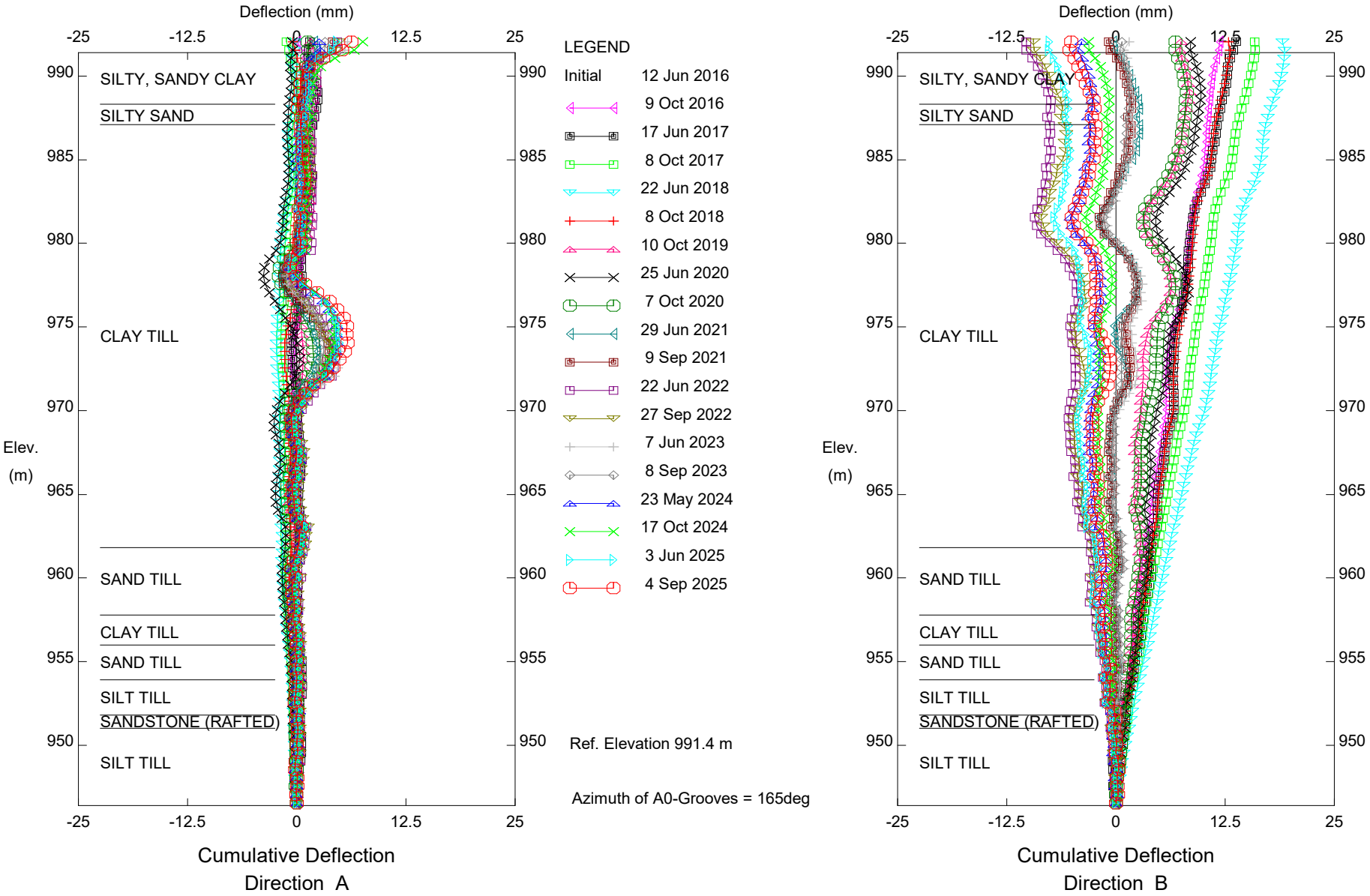
Klohn Crippen Berger - Edmonton



GP007; H40:36, Wanyandie Road Slide, Inclinometer SI03-11

Alberta Transportation

Klohn Crippen Berger - Edmonton



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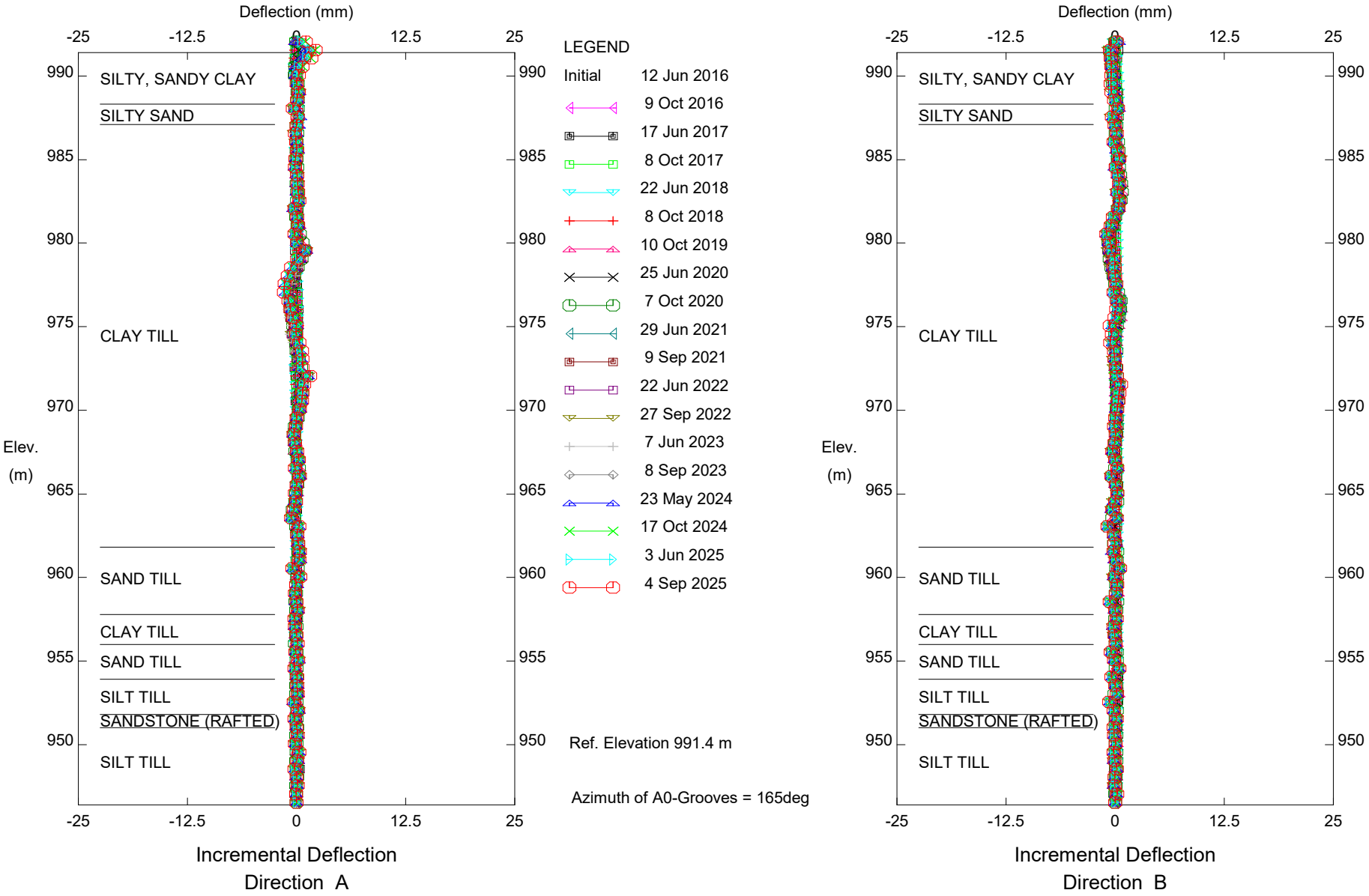
Alberta Transportation

Klohn Crippen Berger - Edmonton



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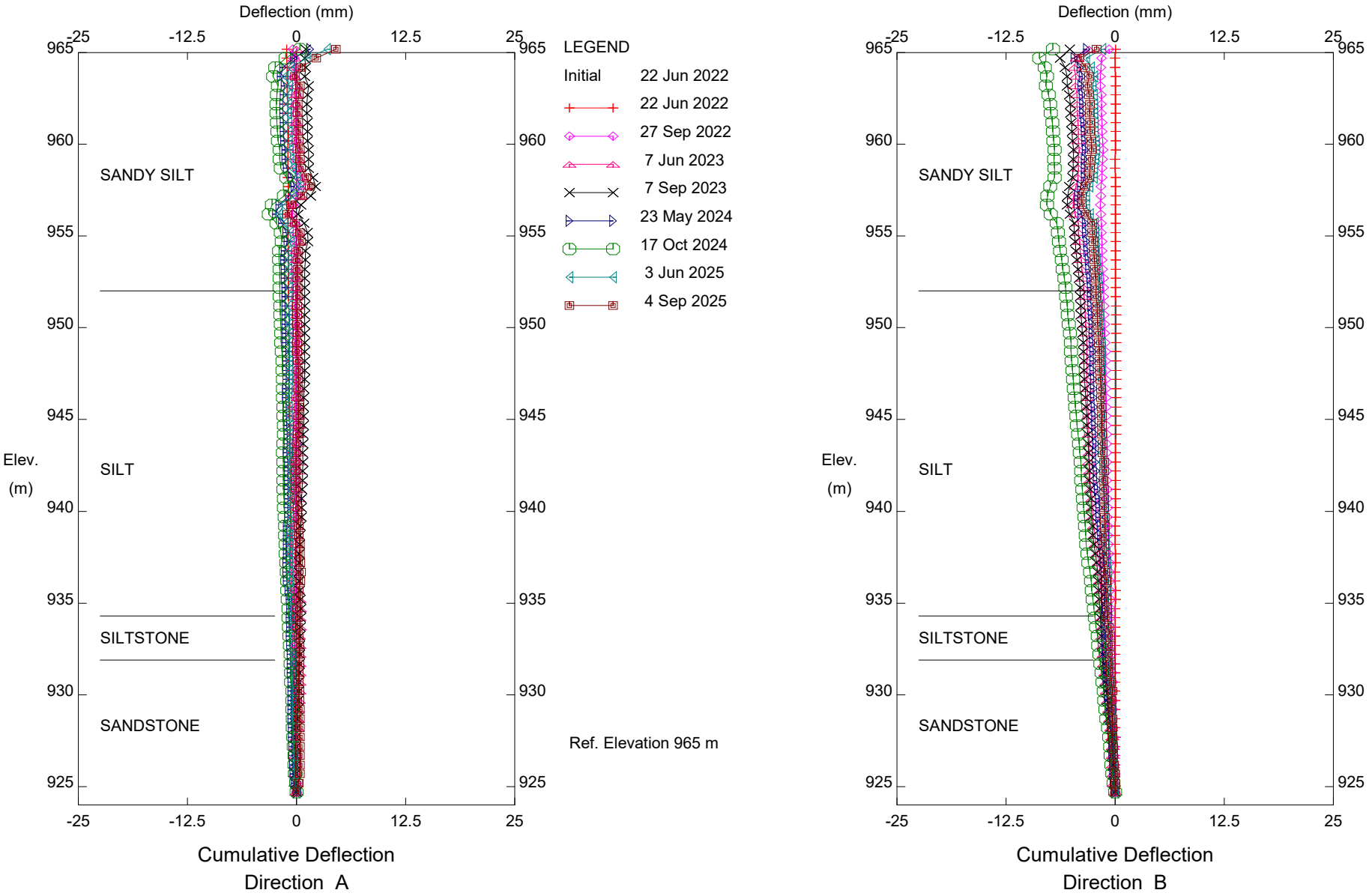
Alberta Transportation

Klohn Crippen Berger - Edmonton



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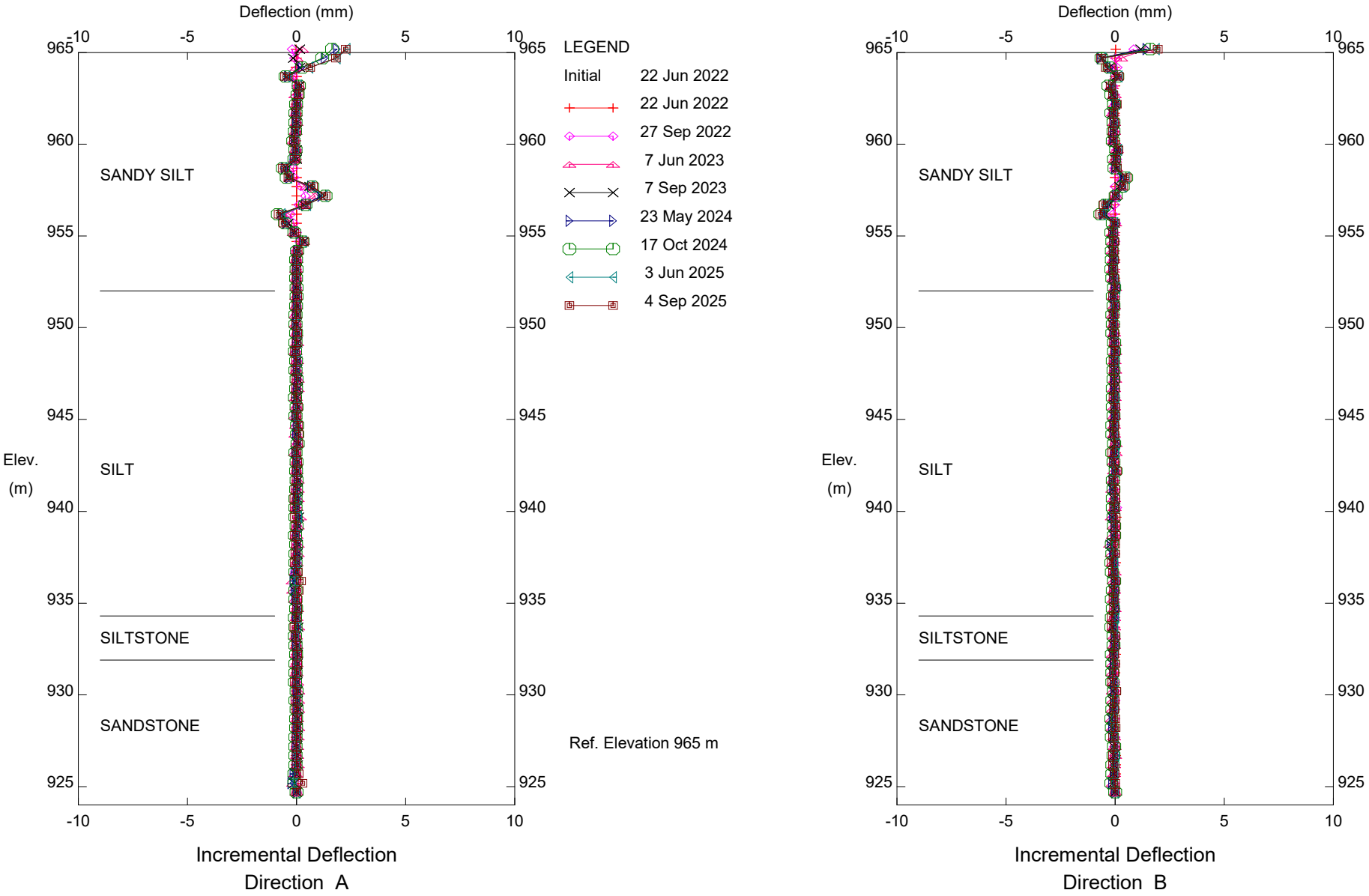
Alberta Transportation

Klohn Crippen Berger - Edmonton



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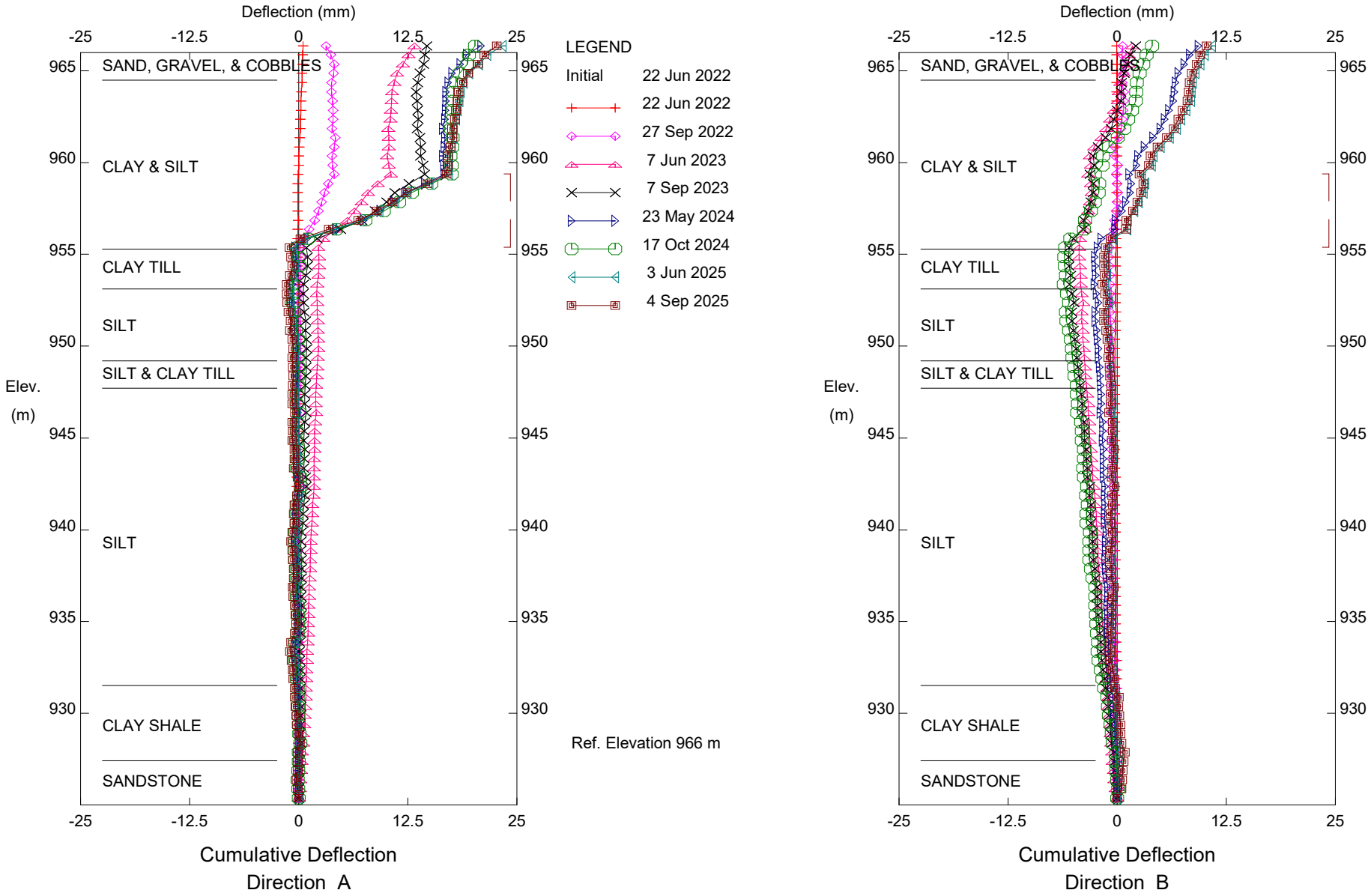
Alberta Transportation

Klohn Crippen Berger - Edmonton



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Alberta Transportation

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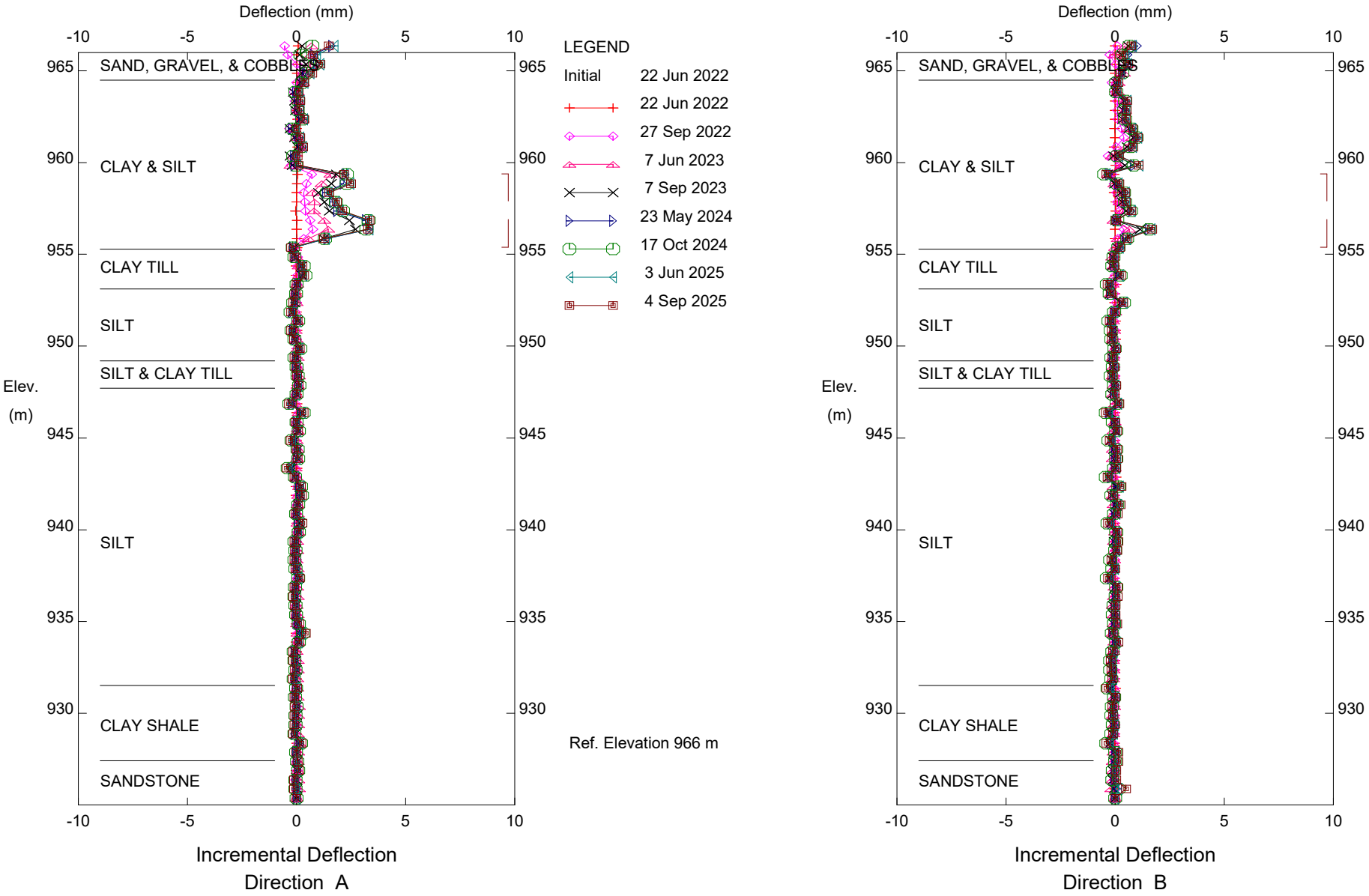

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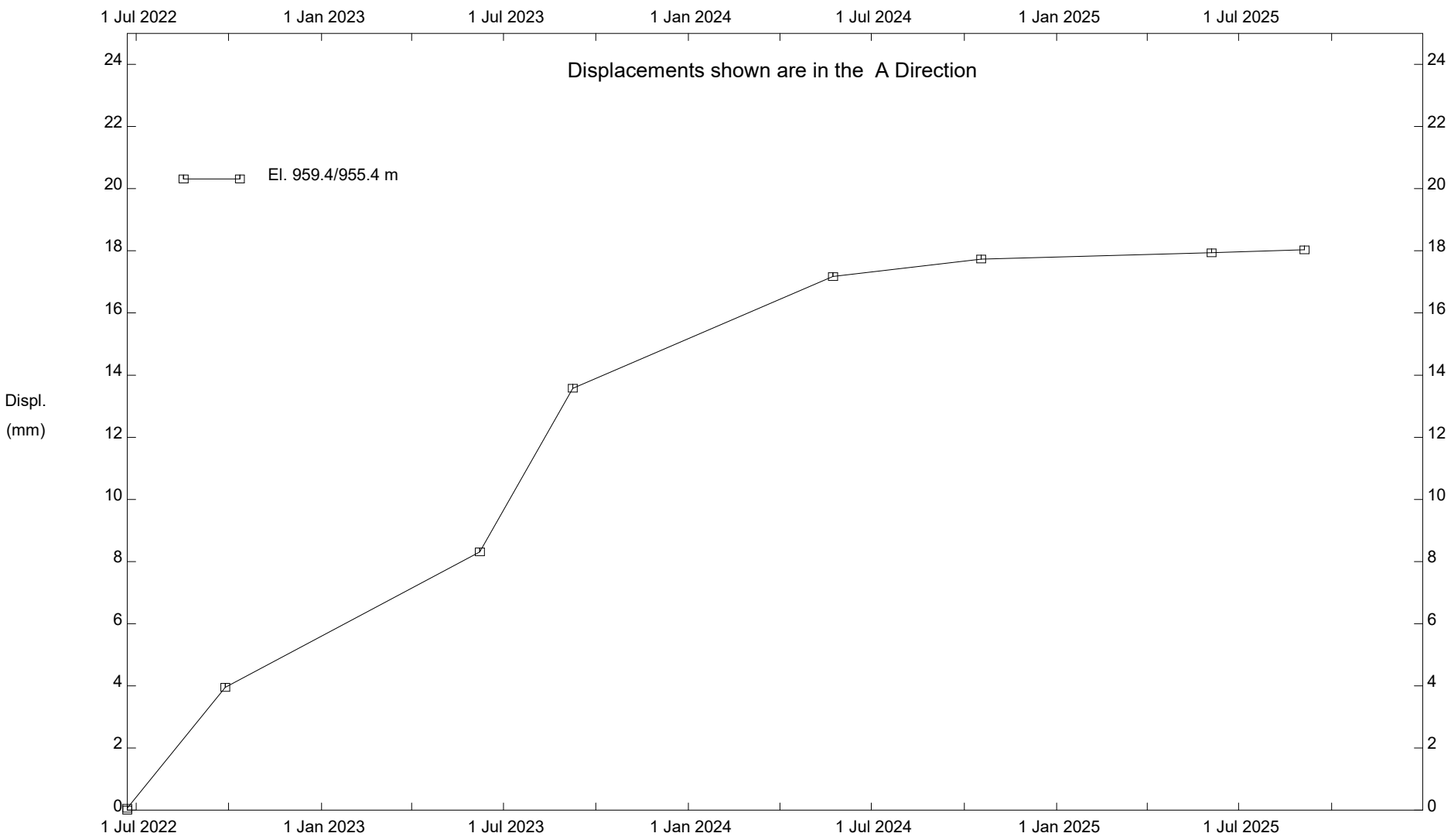

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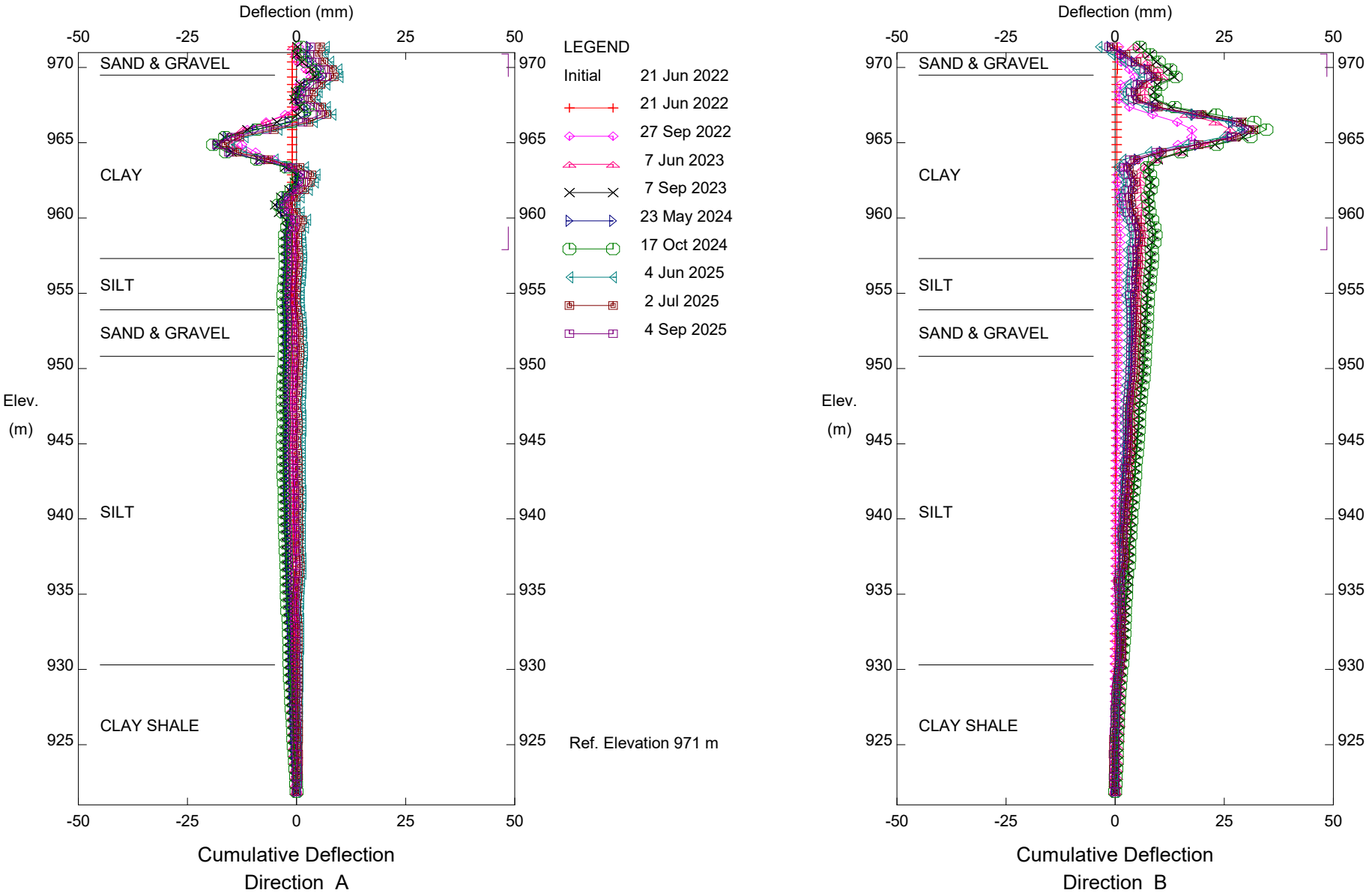

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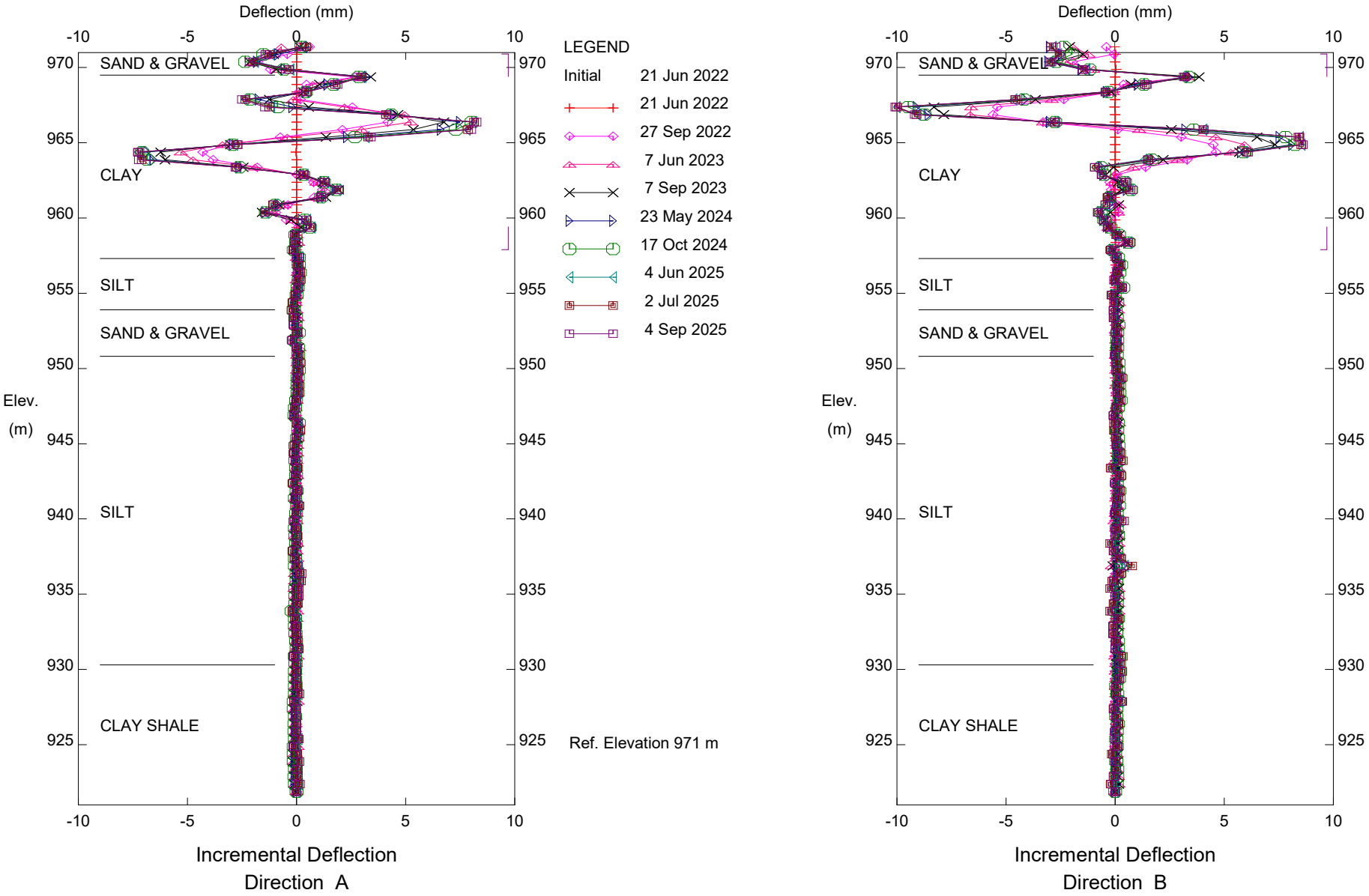
Alberta Transportation

Klohn Crippen Berger - Edmonton



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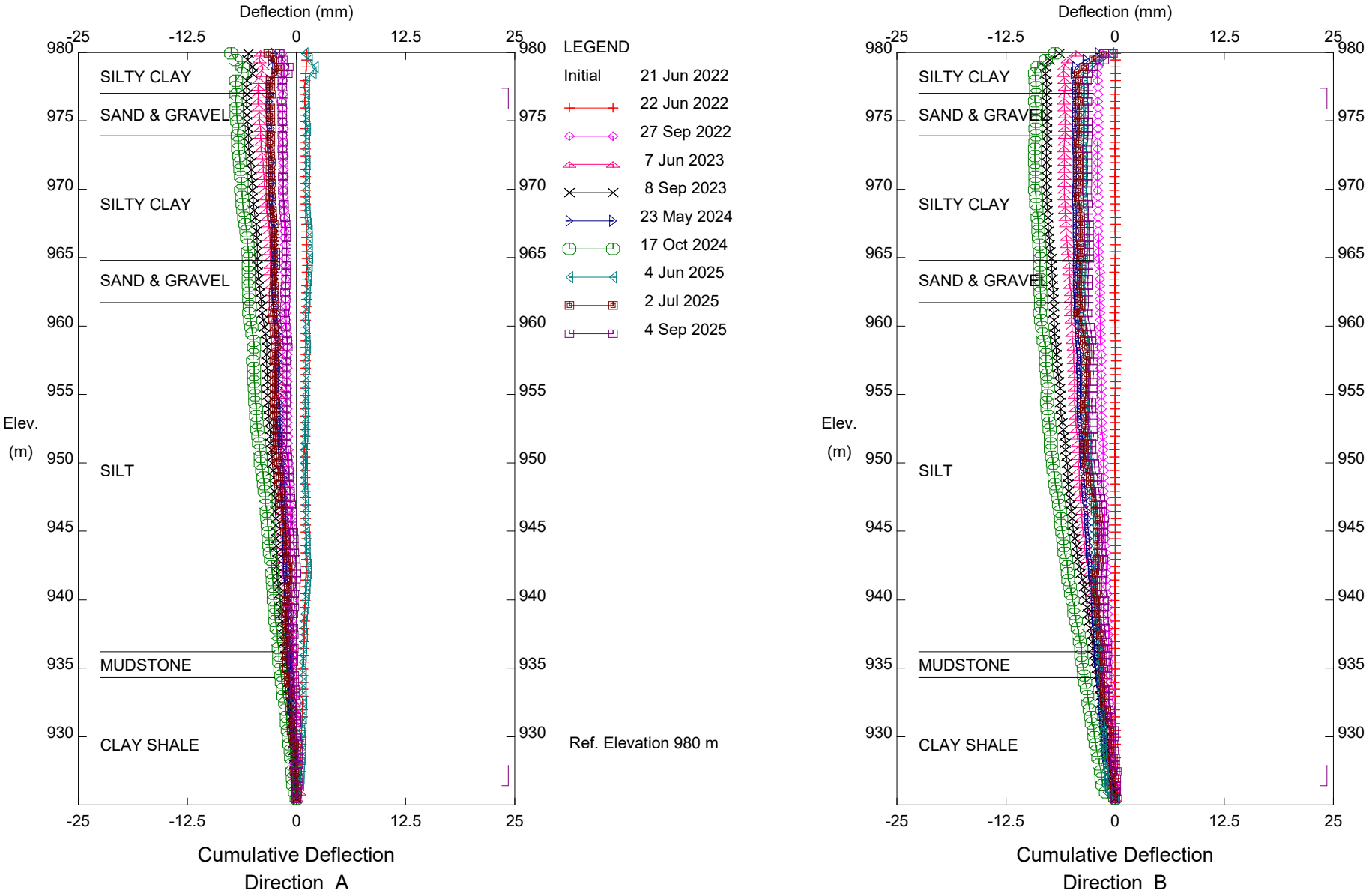
Alberta Transportation

Klohn Crippen Berger - Edmonton



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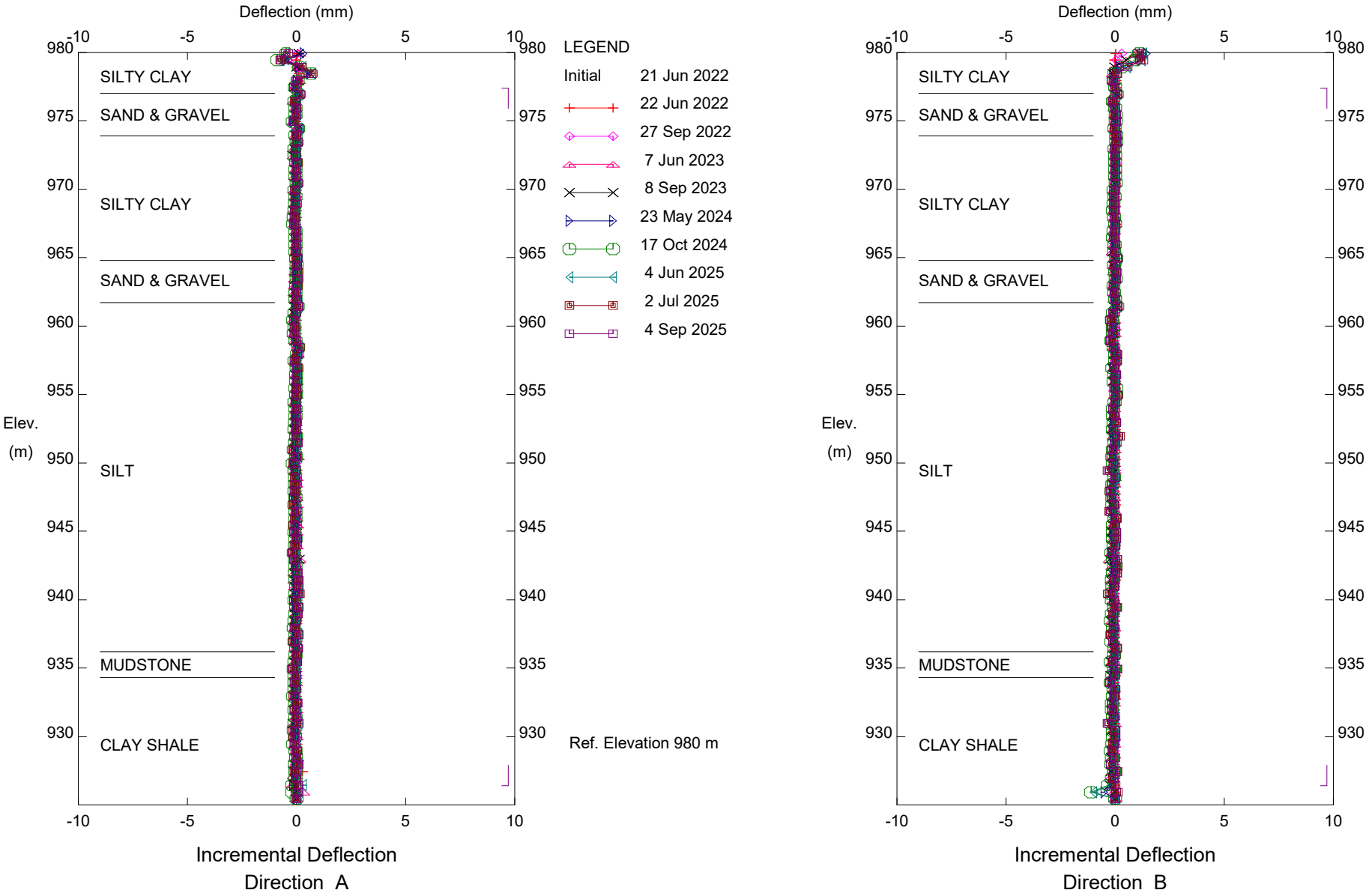
Alberta Transportation

Klohn Crippen Berger - Edmonton



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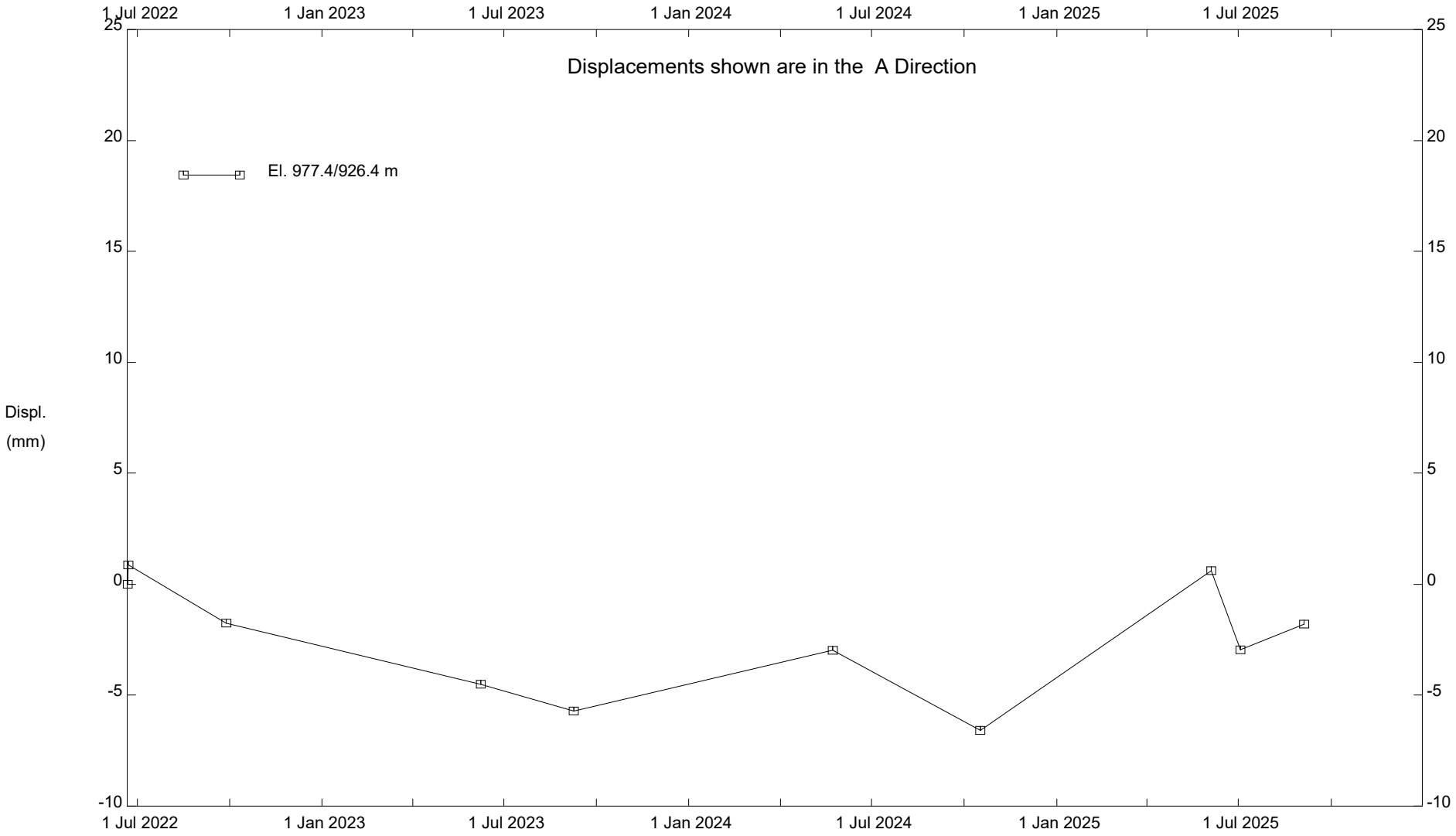
Klohn Crippen Berger - Edmonton



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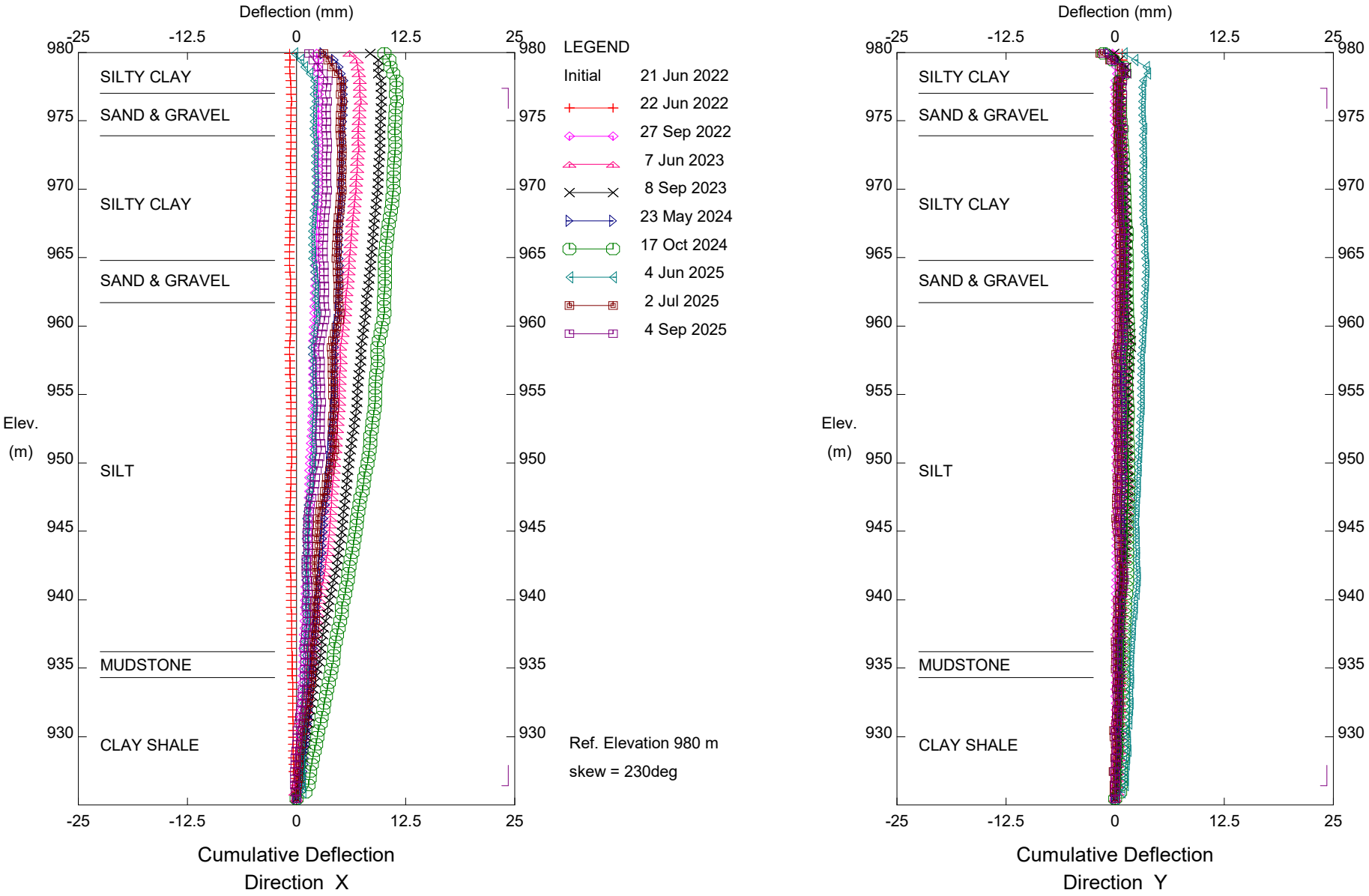
Alberta Transportation

Klohn Crippen Berger - Edmonton



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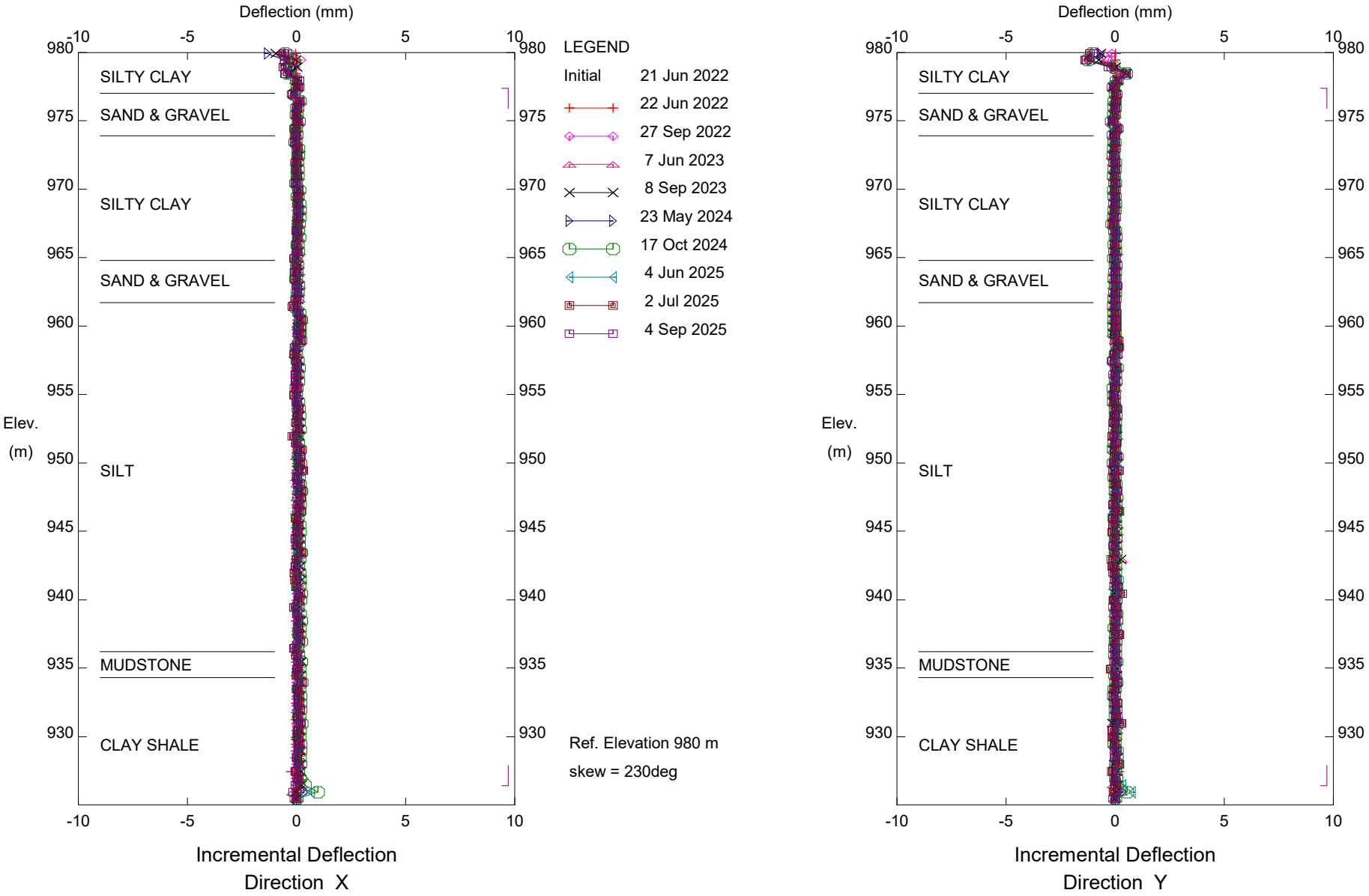
Alberta Transportation

Klohn Crippen Berger - Edmonton



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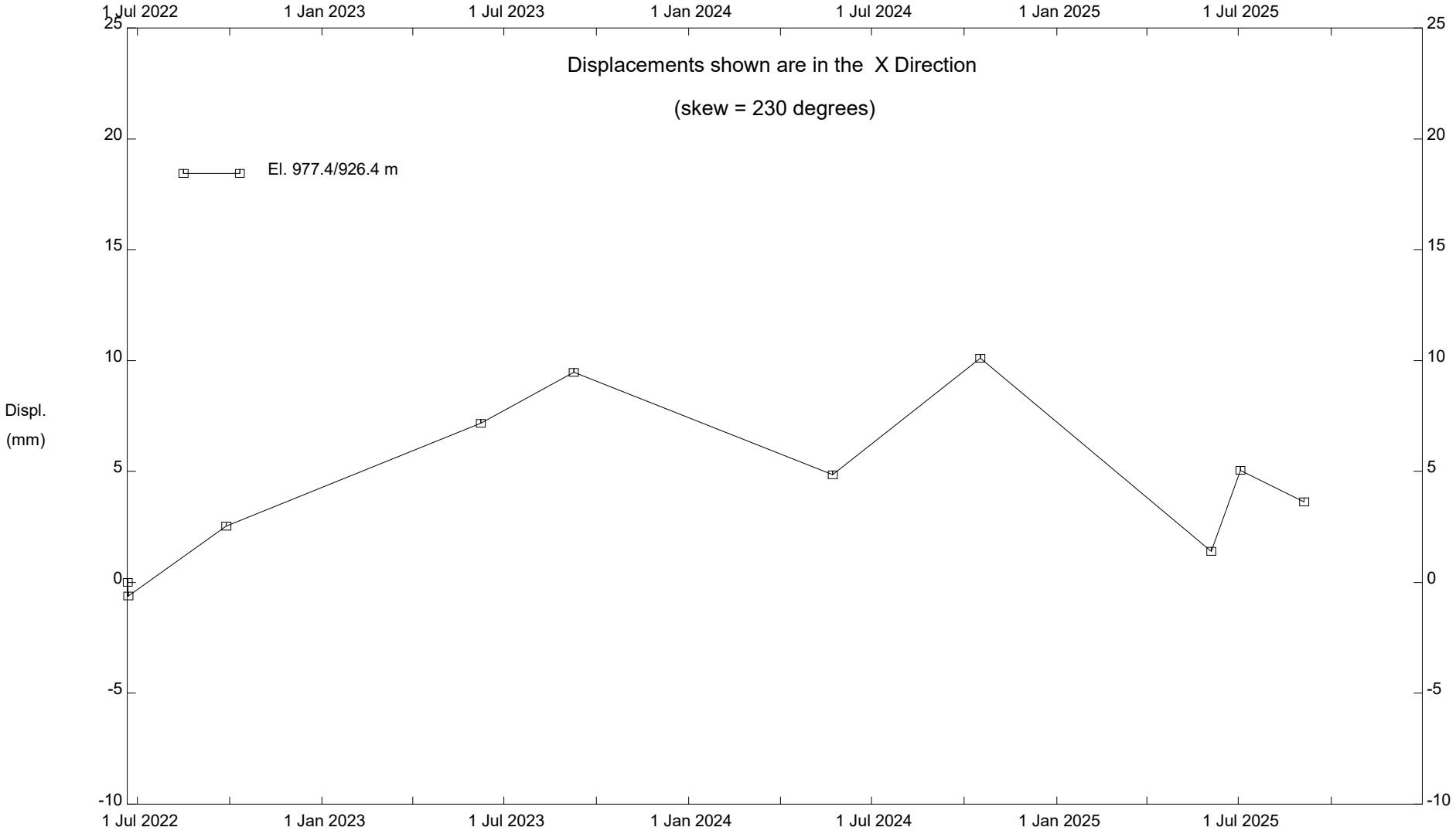
Alberta Transportation

Klohn Crippen Berger - Edmonton



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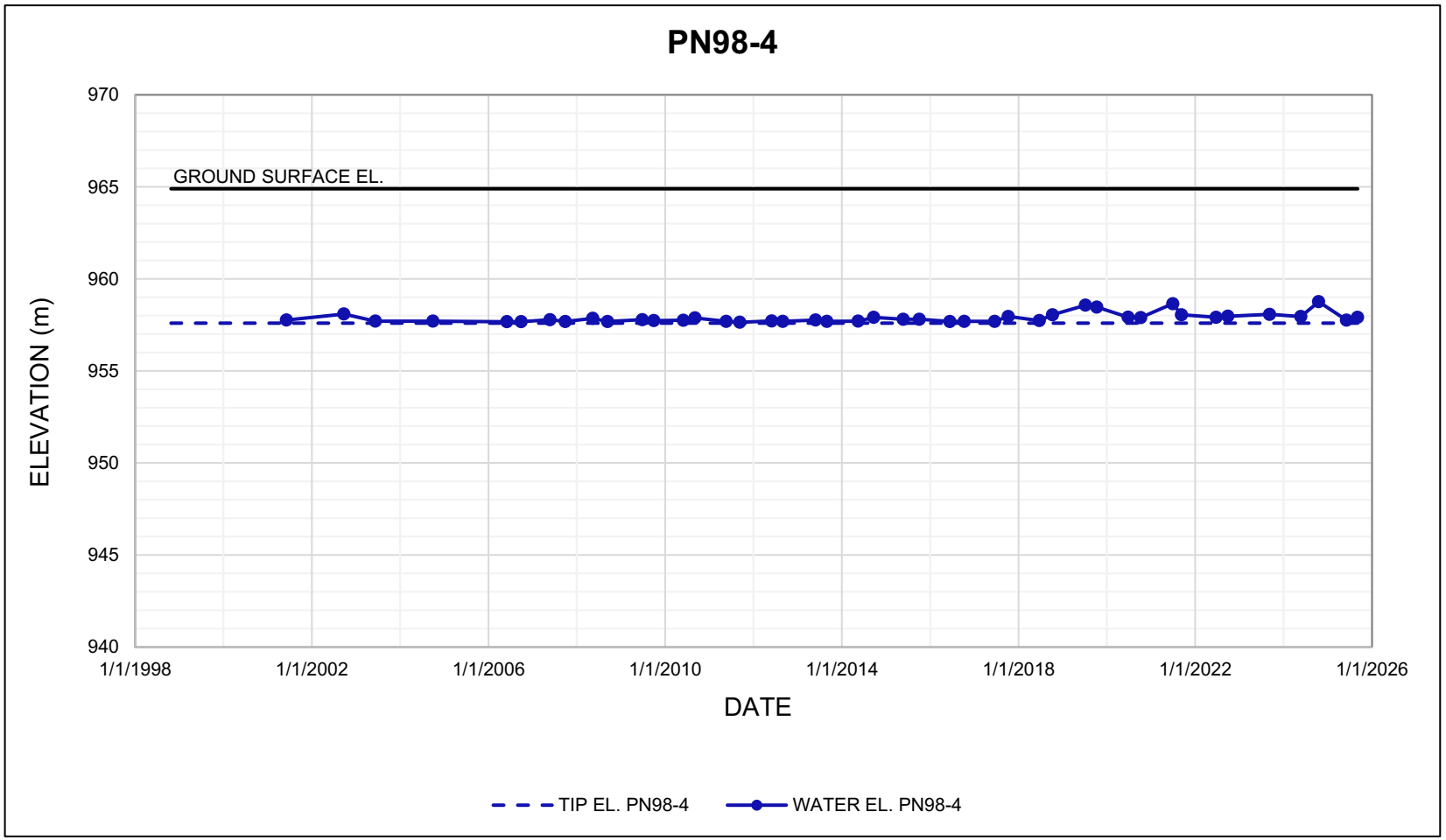
Alberta Transportation



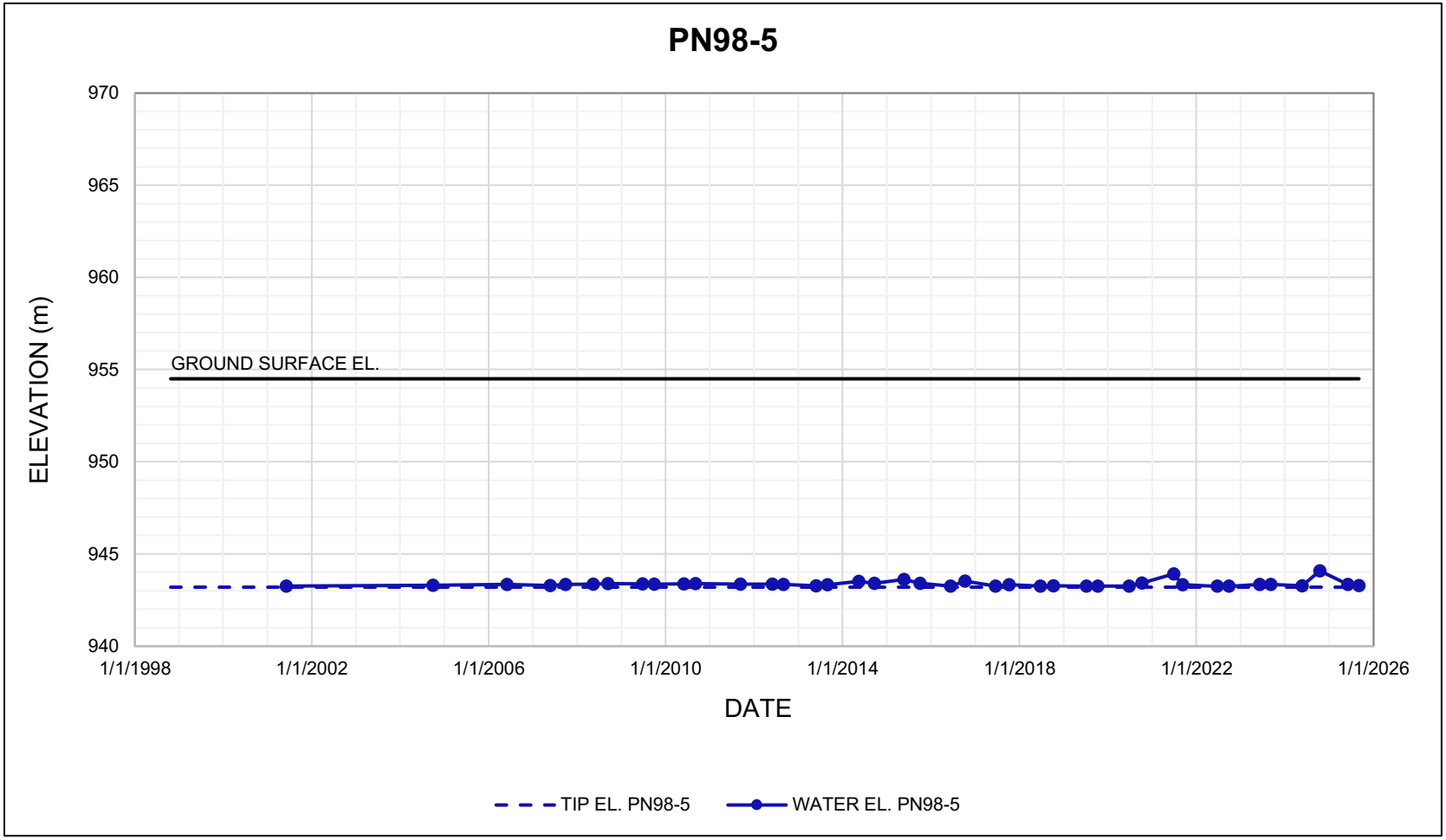
NOTES:
1. PIEZOMETER DATA OBTAINED BEFORE JUNE 29, 2021, PROVIDED TO KLOHN CRIPPEN BERGER LTD. (KCB) BY ALBERTA TRANSPORTATION AND ECONOMIC CORRIDORS (TEC) ON JUNE 25, 2021.

CLIENT
Alberta
Klohn Crippen Berger

PROJECT
PEACE REGION (GRANDE PRAIRIE DISTRICT - SOUTH)
GEOHAZARD RISK MANAGEMENT PROGRAM

TITLE
PIEZOMETER DATA
GP007 - WANYANDIE ROAD SLIDE
HWY 40:36, KM 29.339

SCALE	PROJECT No.	FIG No.
--	A05116A01	



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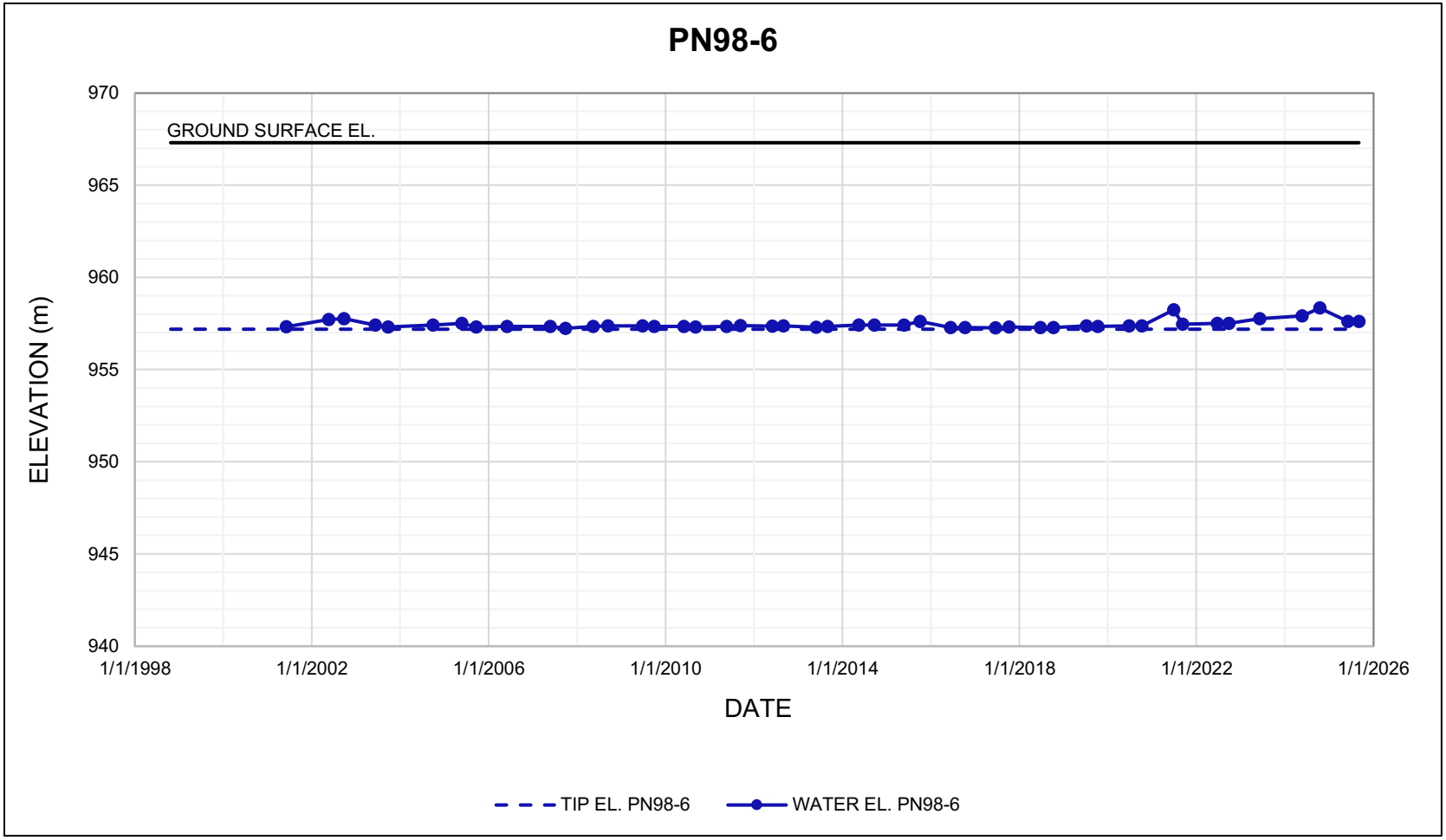
CLIENT
Alberta
Klohn Crippen Berger

PROJECT
PEACE REGION (GRANDE PRAIRIE DISTRICT - SOUTH)
GEOHAZARD RISK MANAGEMENT PROGRAM

TITLE
PIEZOMETER DATA
GP007 - WANYANDIE ROAD SLIDE
HWY 40:36, KM 29.339

SCALE	PROJECT No.	FIG No.
--	A05116A01	



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Alberta
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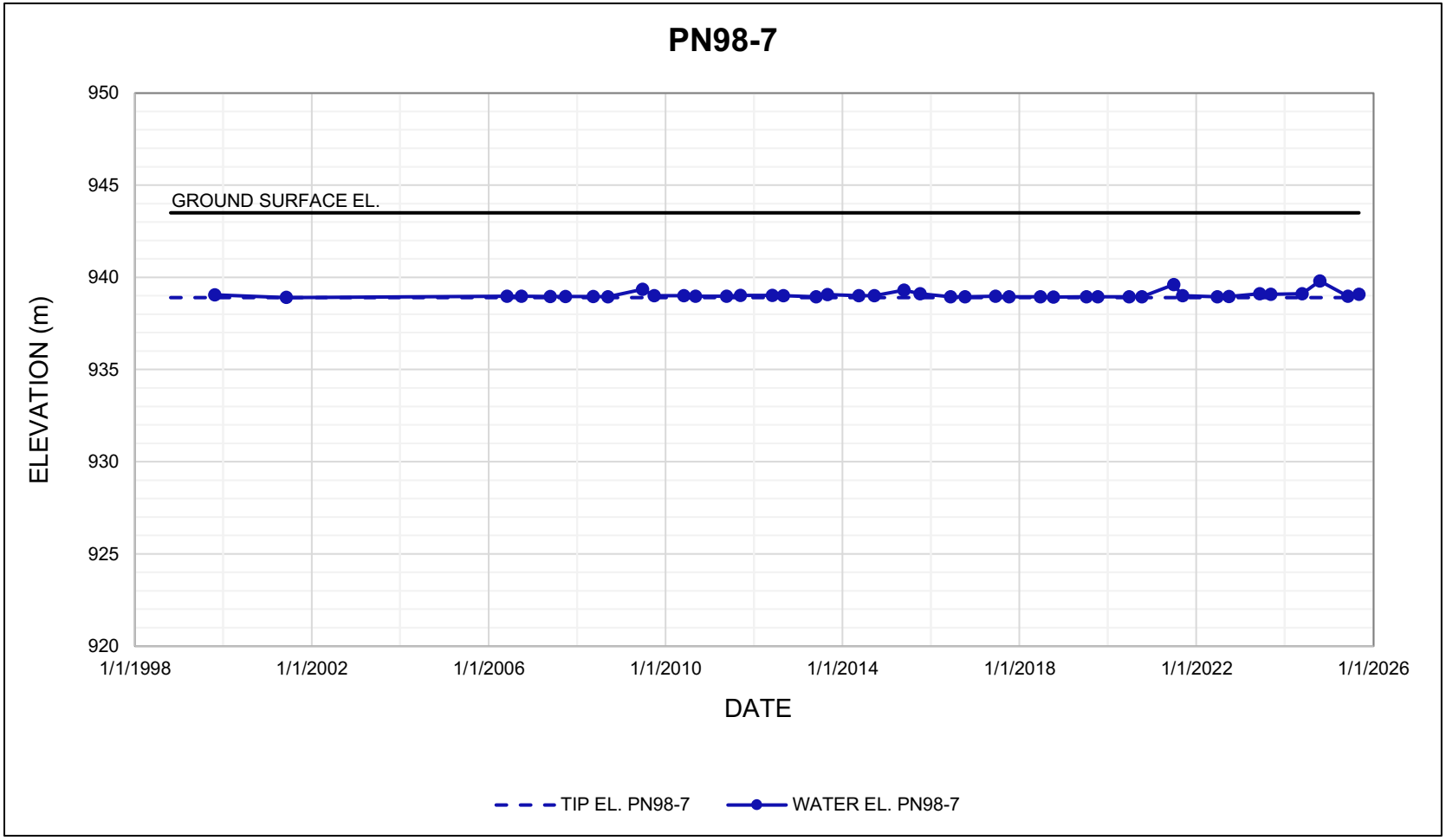
PROJECT
PEACE REGION (GRANDE PRAIRIE DISTRICT - SOUTH)
GEOHAZARD RISK MANAGEMENT PROGRAM

TITLE
PIEZOMETER DATA
GP007 - WANYANDIE ROAD SLIDE
HWY 40:36, KM 29.339

SCALE	PROJECT No.	FIG No.
--	A05116A01	



NOTES:
1. PIEZOMETER DATA OBTAINED BEFORE JUNE 29, 2021, PROVIDED TO KLOHN CRIPPEN BERGER LTD. (KCB) BY ALBERTA TRANSPORTATION AND ECONOMIC CORRIDORS (TEC) ON JUNE 25, 2021.

CLIENT

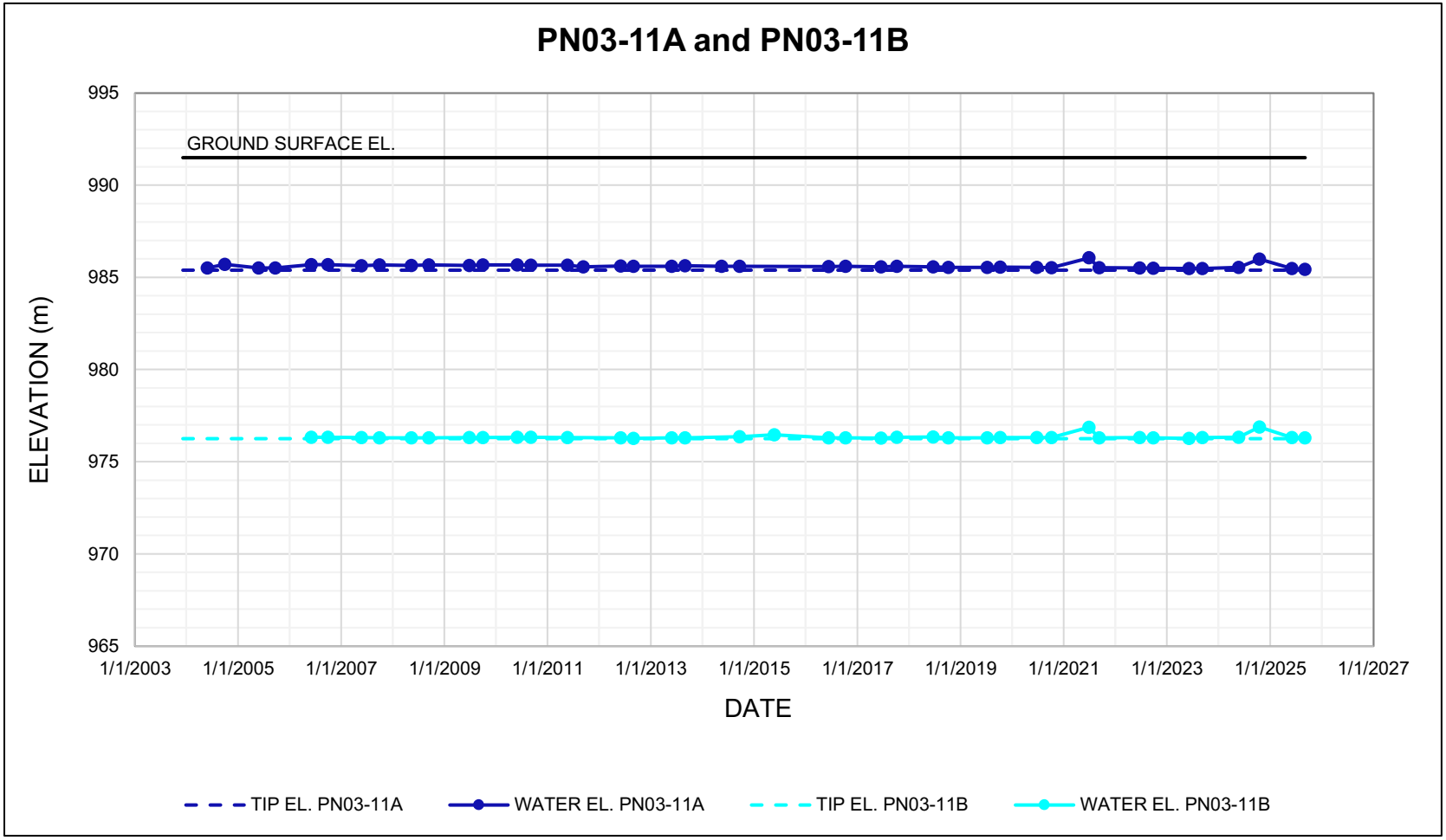
Alberta

Klohn Crippen Berger

PROJECT
PEACE REGION (GRANDE PRAIRIE DISTRICT - SOUTH)
GEOHAZARD RISK MANAGEMENT PROGRAM

TITLE
PIEZOMETER DATA
GP007 - WANYANDIE ROAD SLIDE
HWY 40:36, KM 29.339

SCALE	PROJECT No.	FIG No.
--	A05116A01	



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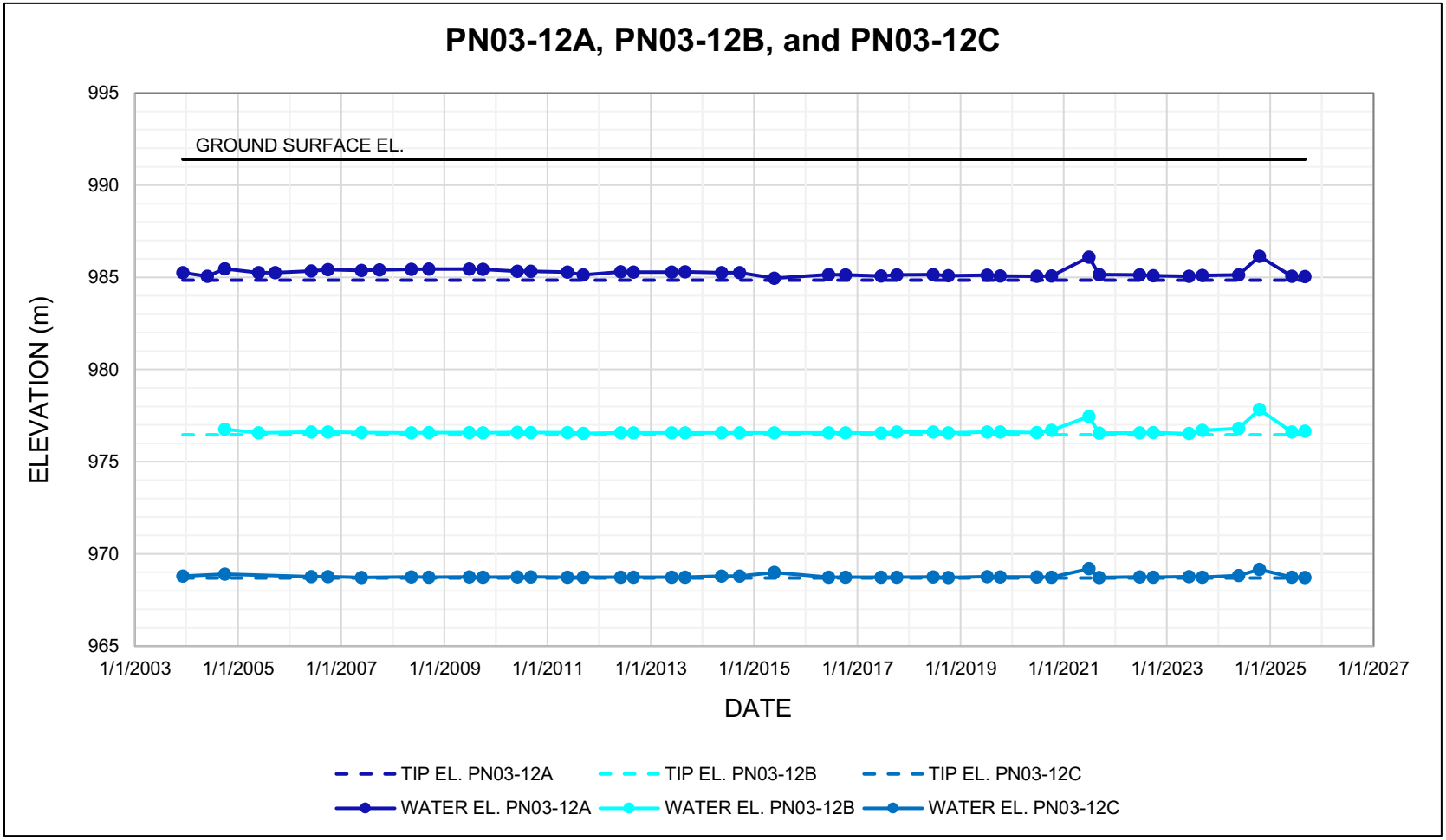
PIEZOMETER DATA
GP007 - WANYANDIE ROAD SLIDE
HWY 40:36, KM 29.339

SCALE	PROJECT No.	FIG No.
--	A05116A01	



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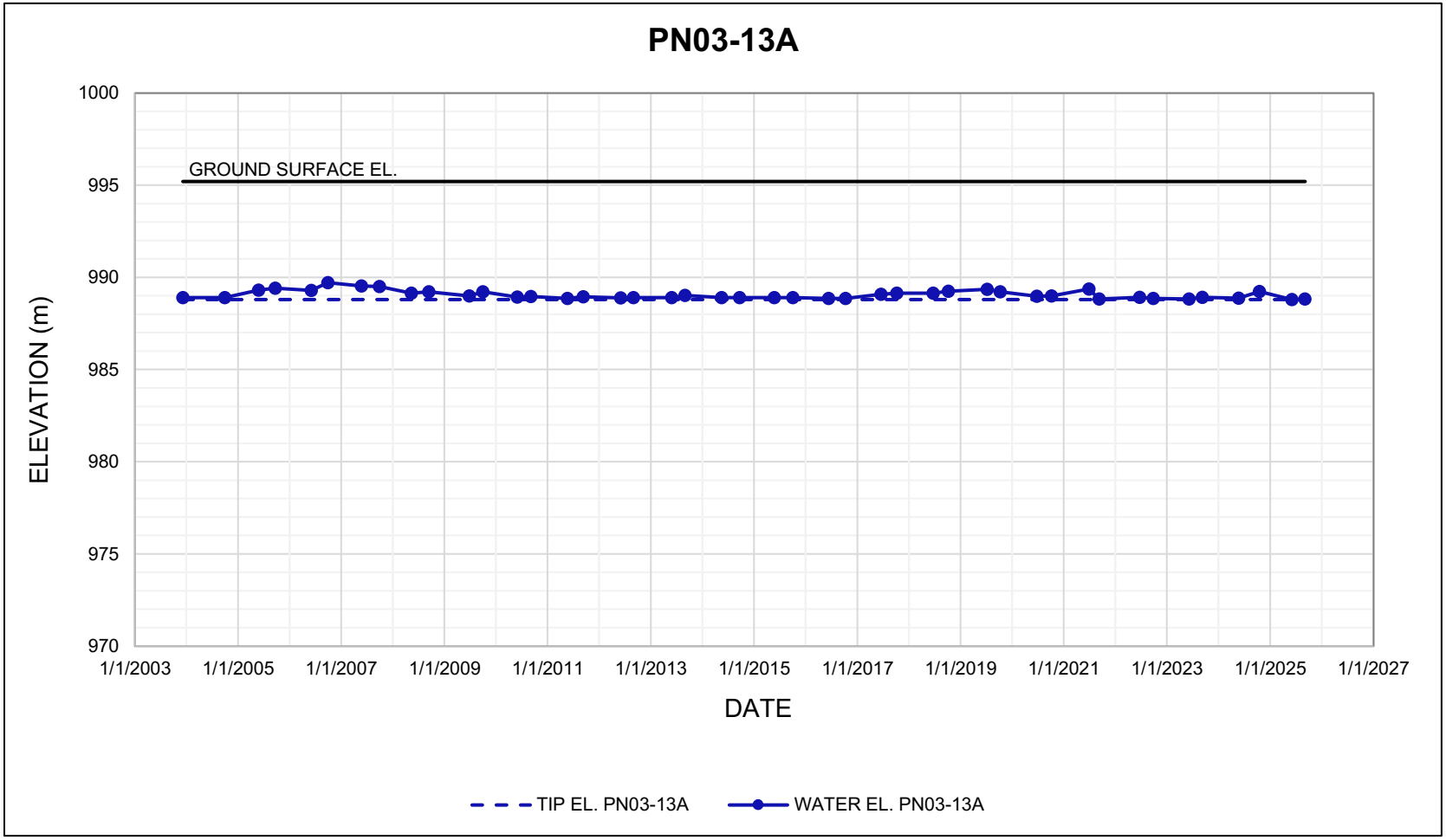
PIEZOMETER DATA
GP007 - WANYANDIE ROAD SLIDE
HWY 40:36, KM 29.339

SCALE	PROJECT No.	FIG No.
--	A05116A01	



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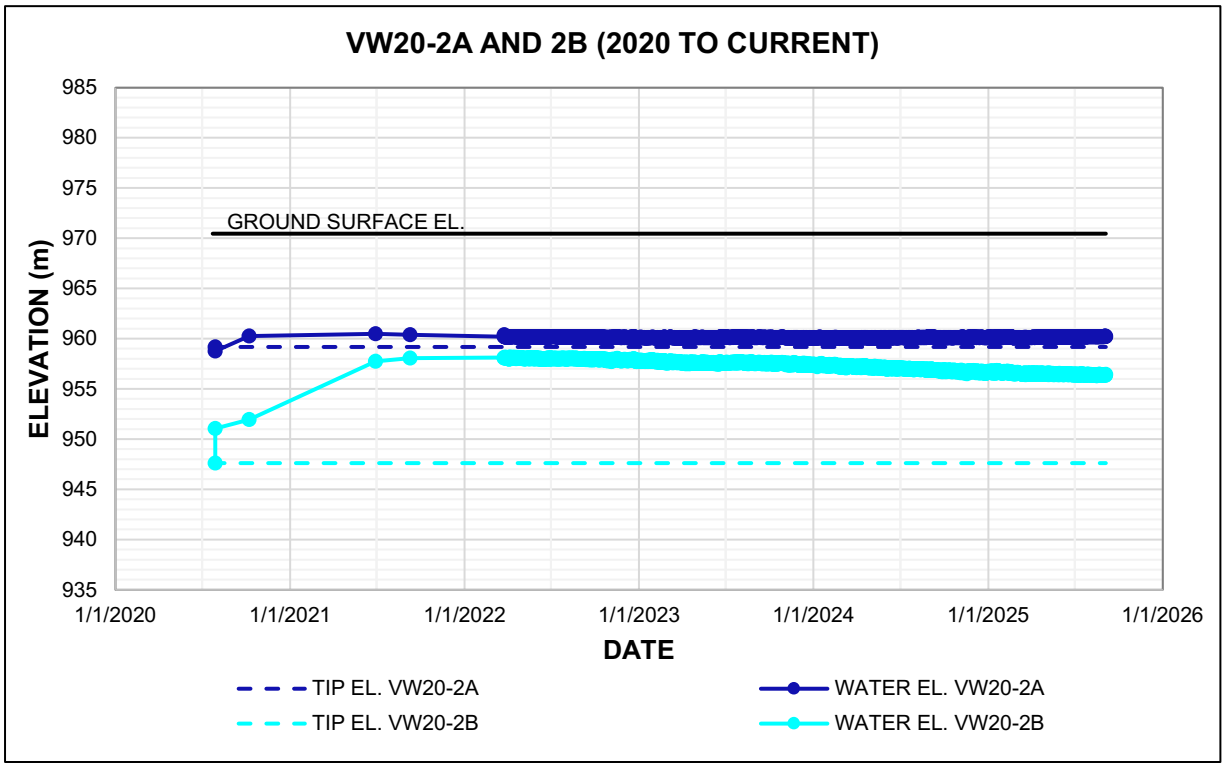
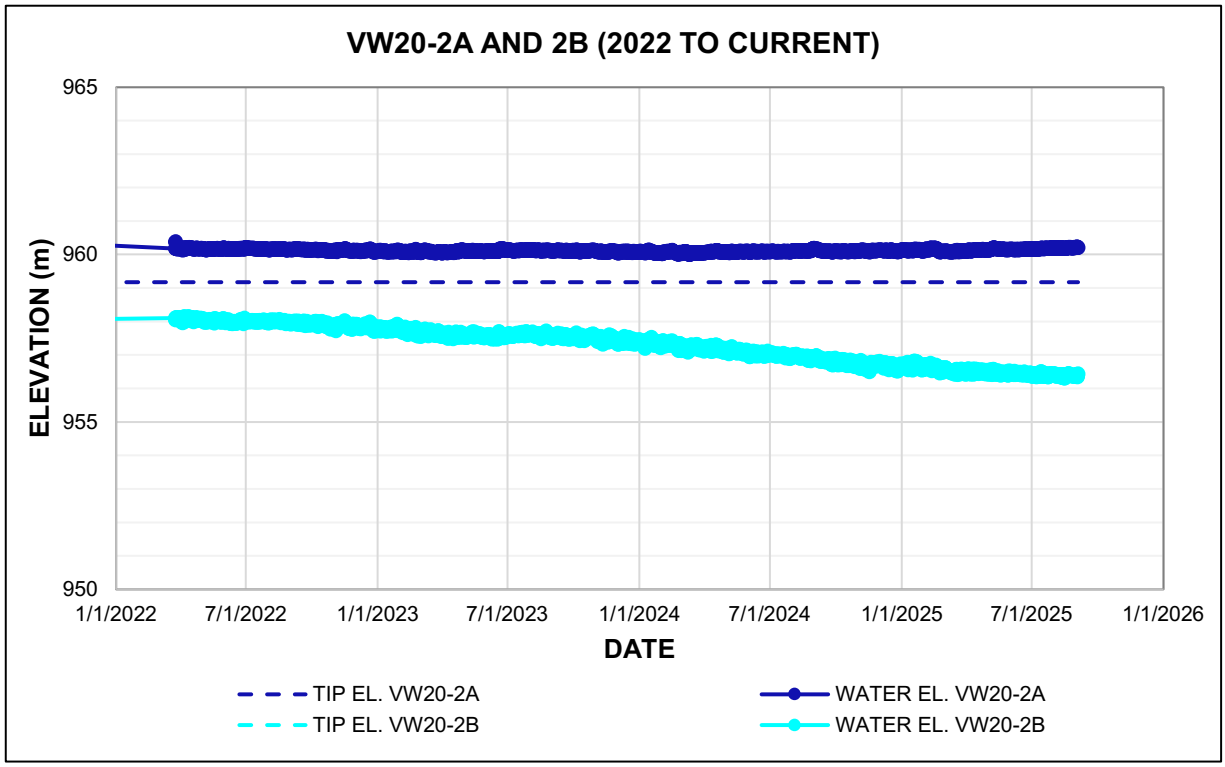
GP007 - WANYANDIE ROAD SLIDE
HWY 40:36, KM 29.339

SCALE	PROJECT No.	FIG No.
--	A05116A01	





NOTES:
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2. MULTI-CHANNEL DATA LOGGER CONNECTED TO THESE INSTRUMENTS IN MARCH 2022.

CLIENT

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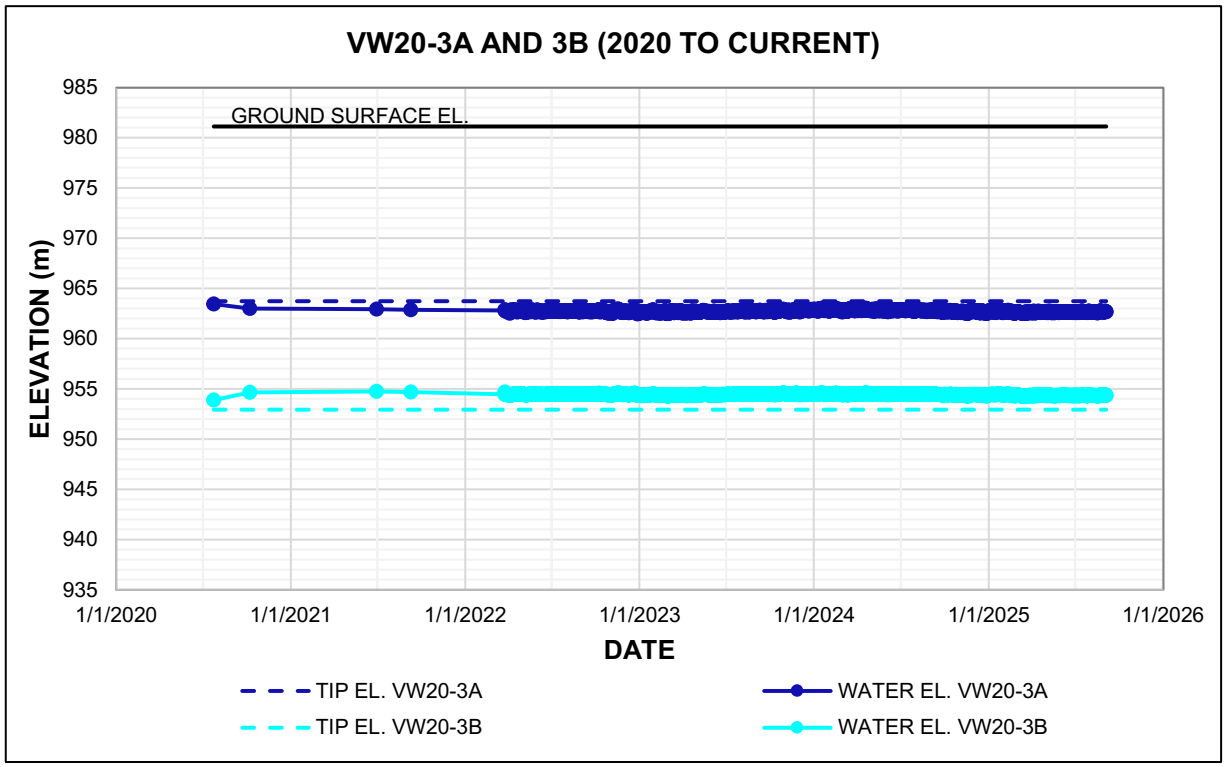
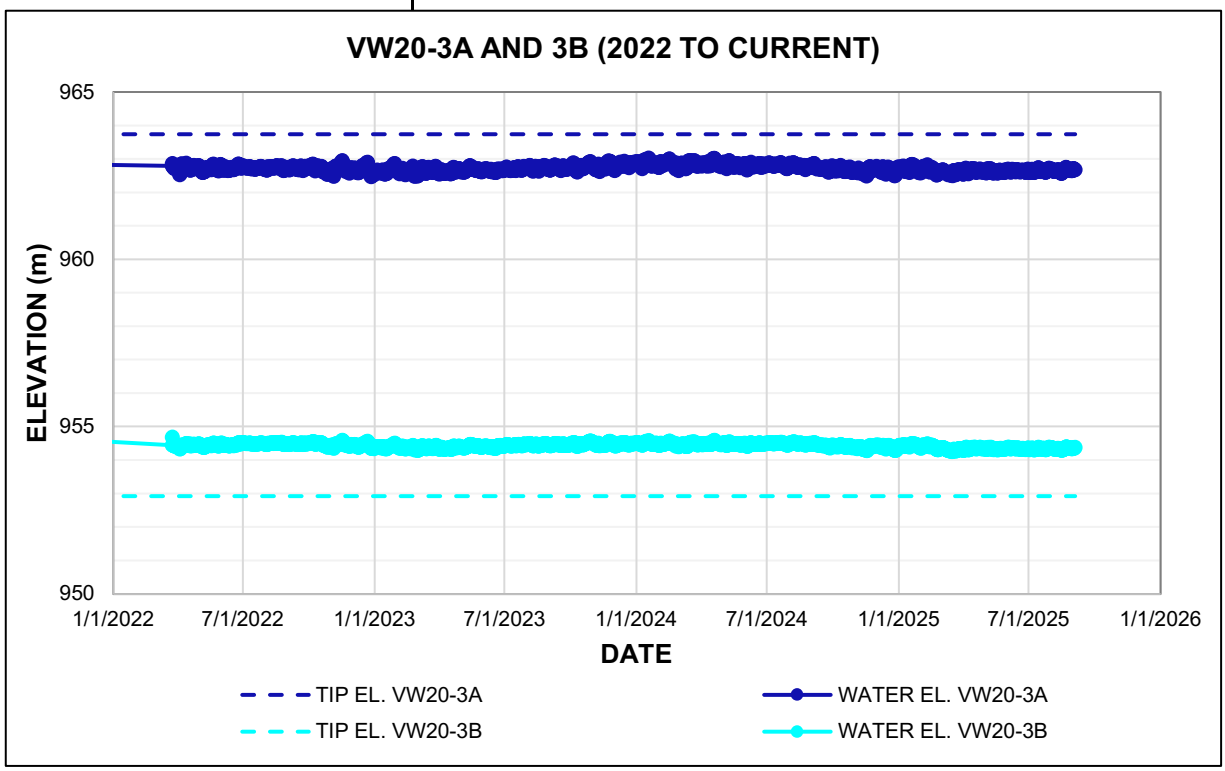
PROJECT
PEACE REGION (GRANDE PRAIRIE DISTRICT - SOUTH)
GEOHAZARD RISK MANAGEMENT PROGRAM

TITLE
Piezometer Data
GP007 - Wanyandie Road Slide
Hwy 40:36, km 29.339

SCALE	PROJECT No.	FIG No.
--	A05116A01	





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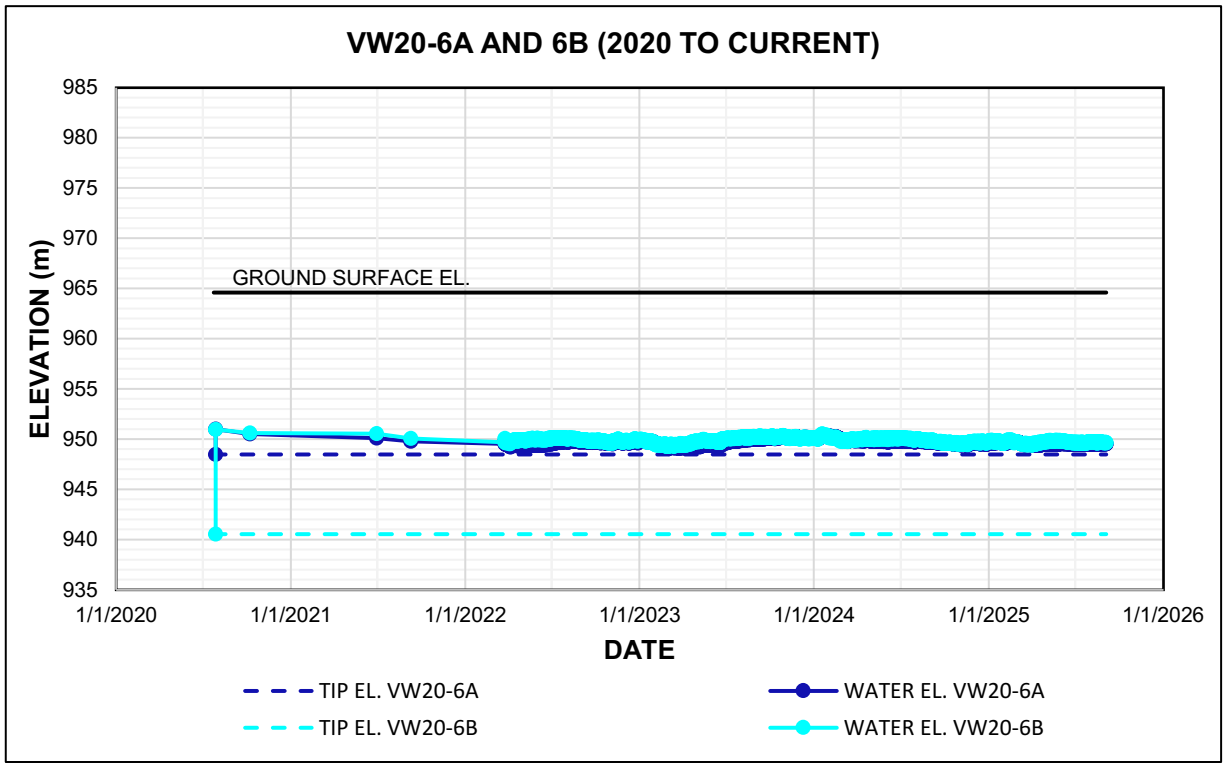
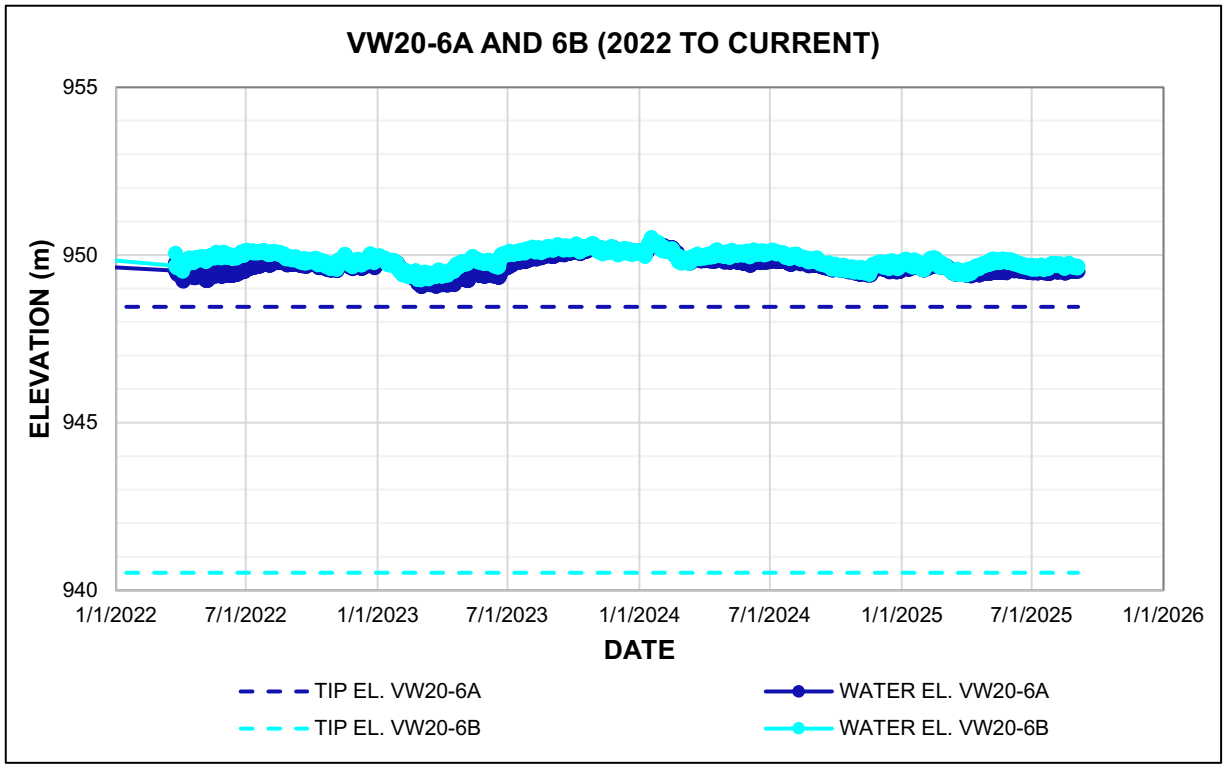
TITLE
Piezometer Data
GP007 - Wanyandie Road Slide
Hwy 40:36, km 29.339

SCALE	PROJECT No.	FIG No.
--	A05116A01	





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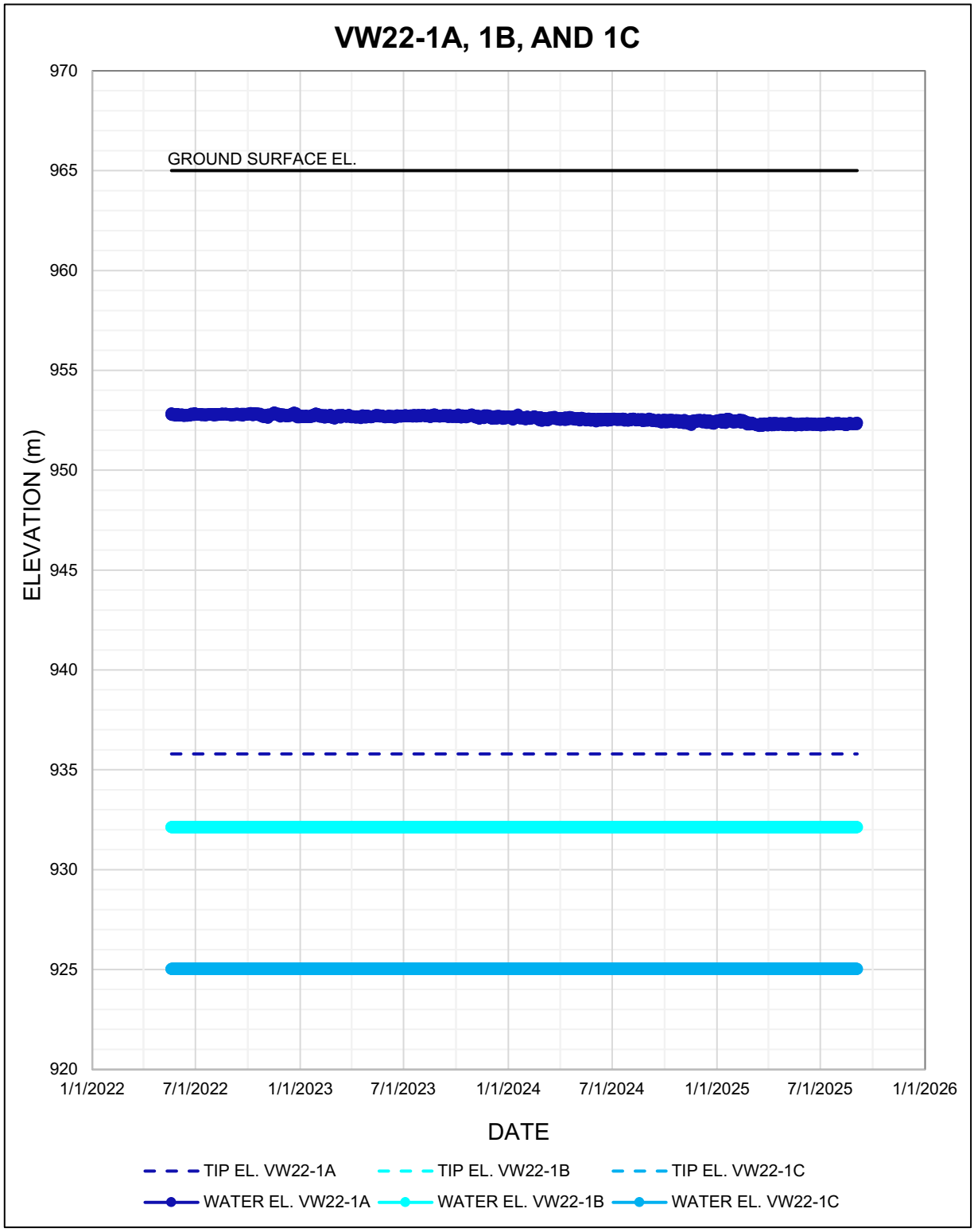
TITLE
Piezometer Data
GP007 - Wanyandie Road Slide
Hwy 40:36, km 29.339

SCALE	PROJECT No.	FIG No.
--	A05116A01	



NOTES:
1. MULTI-CHANNEL DATA LOGGER CONNECTED TO THESE INSTRUMENTS IN MAY 2022.
2. GROUND SURFACE ELEVATION ESTIMATED FROM LiDAR DATA.

CLIENT

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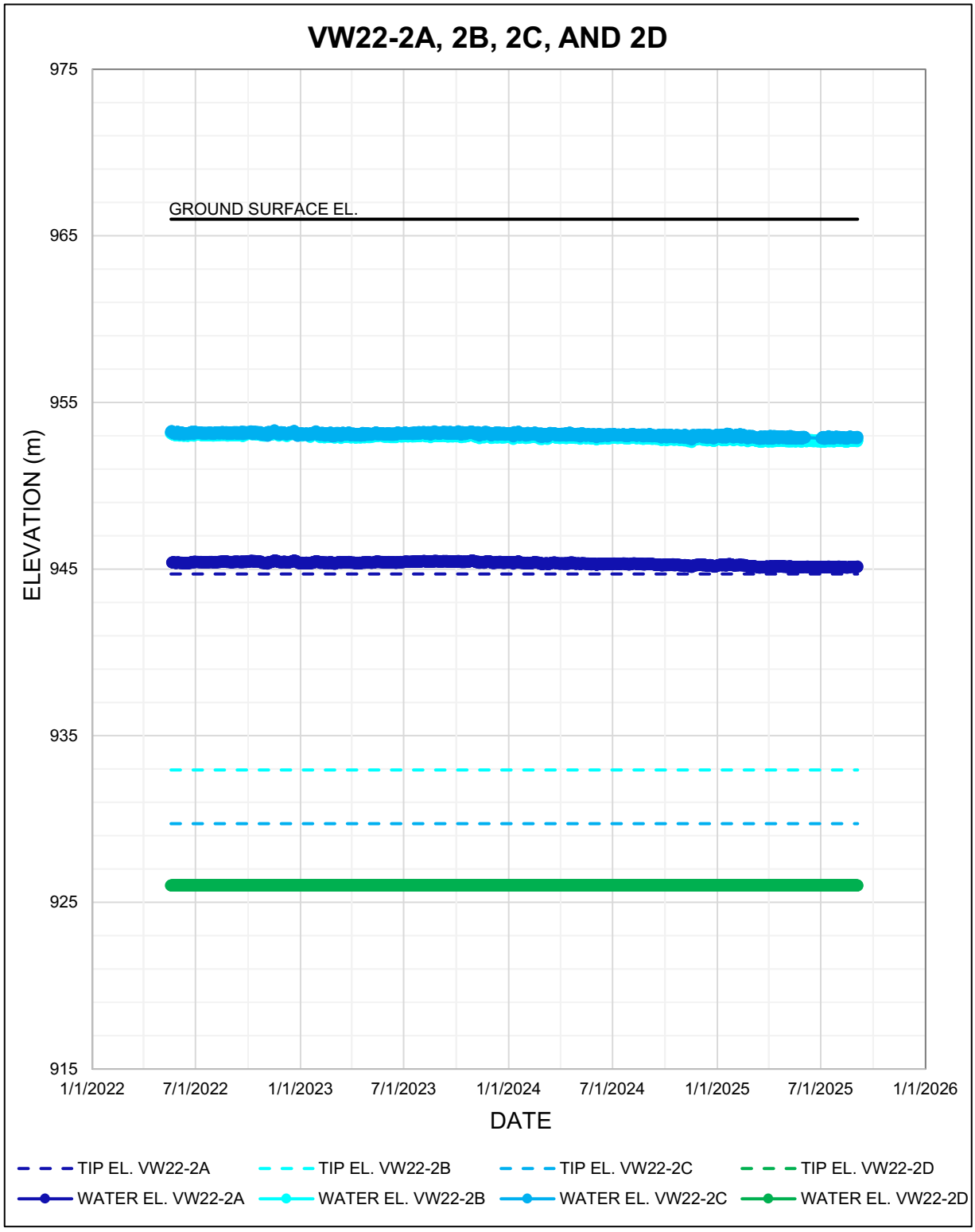
PROJECT

PEACE REGION (GRANDE PRAIRIE DISTRICT - SOUTH)
GEOHAZARD RISK MANAGEMENT PROGRAM

TITLE

Piezometer Data
GP007 - Wanyandie Road Slide
Hwy 40:36, km 29.339

SCALE	PROJECT No.	FIG No.
--	A05116A01	



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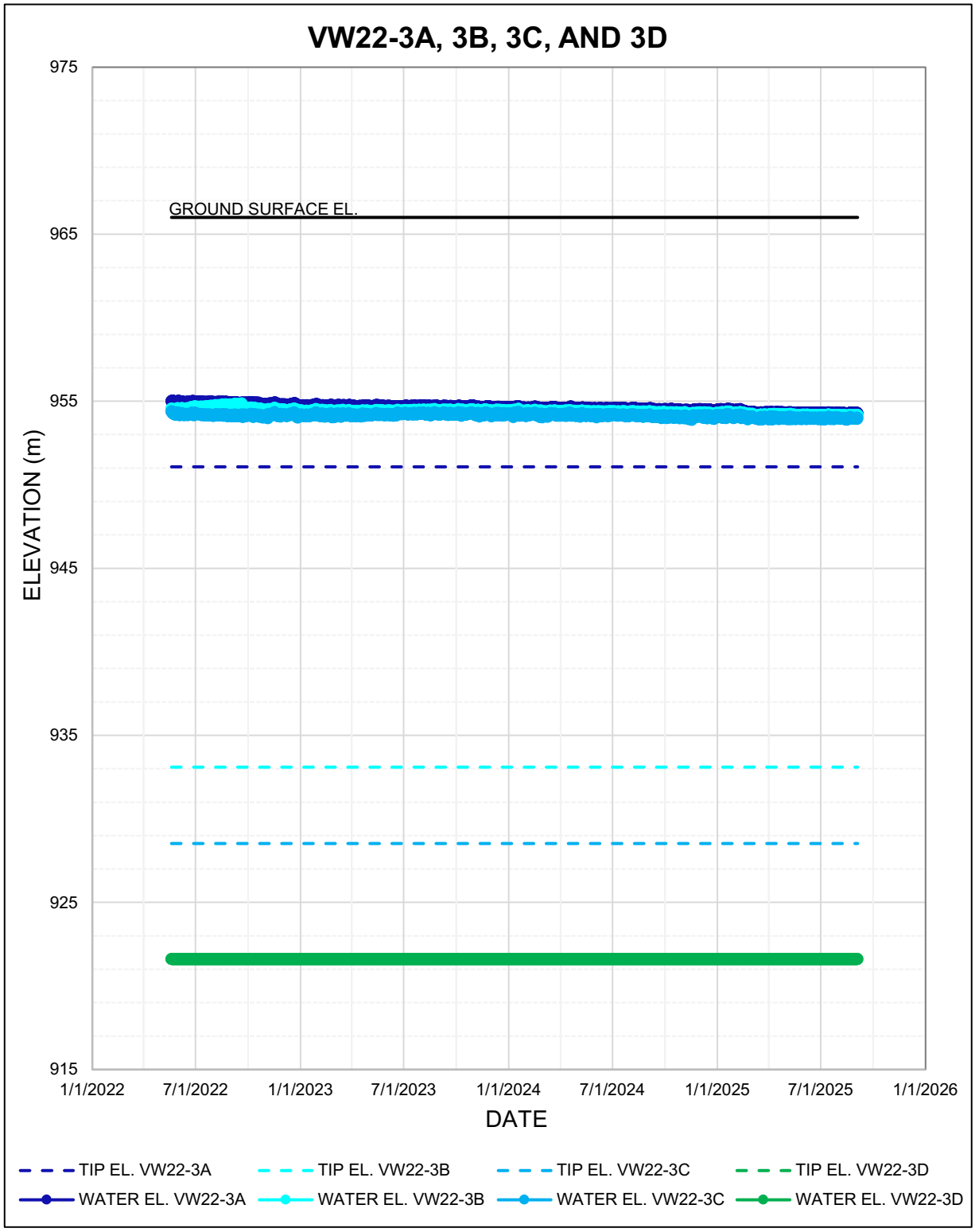
Piezometer Data
GP007 - Wanyandie Road Slide
Hwy 40:36, km 29.339

SCALE	PROJECT No.	FIG No.
--	A05116A01	



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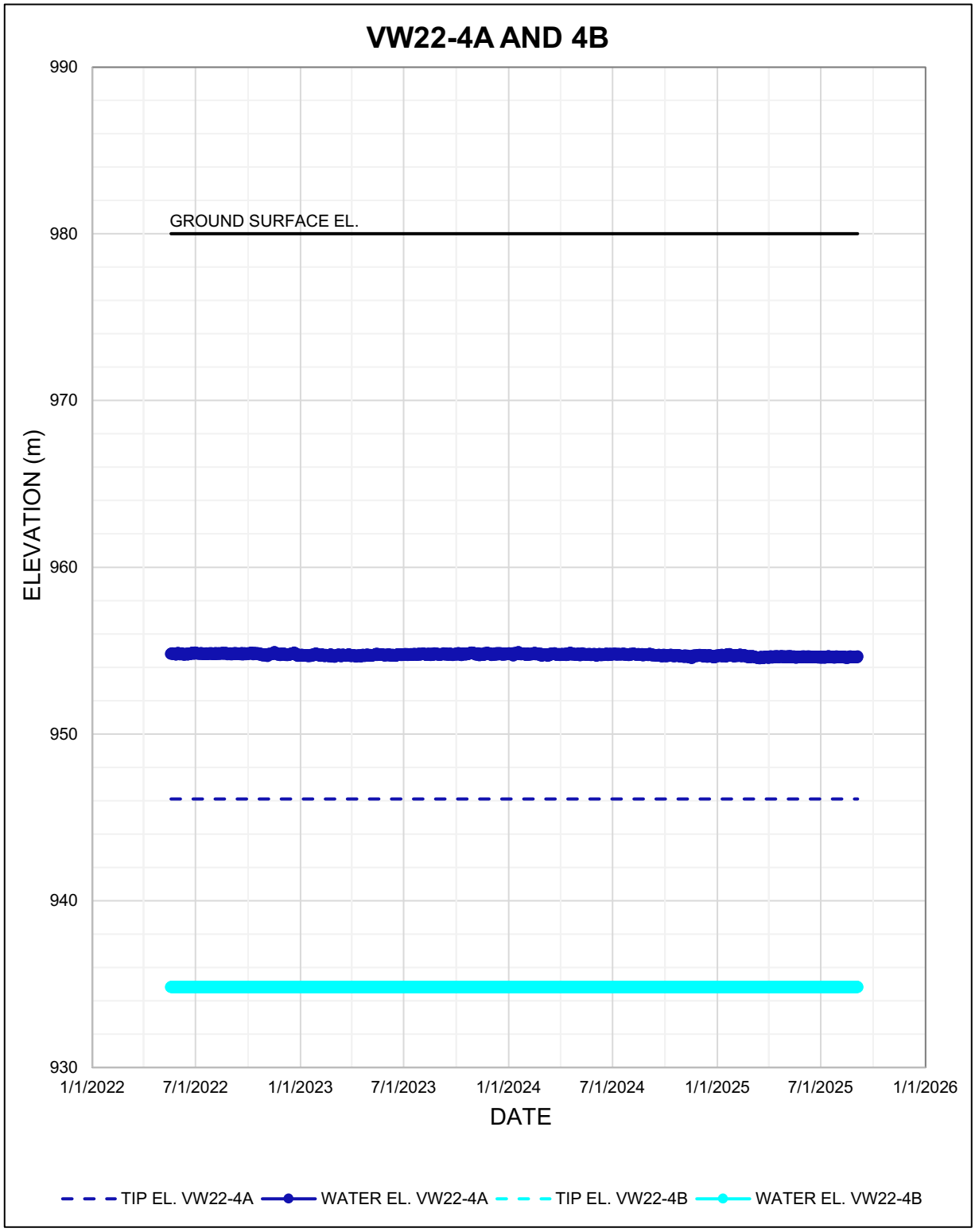
SCALE	PROJECT No.	FIG No.
--	A05116A01	



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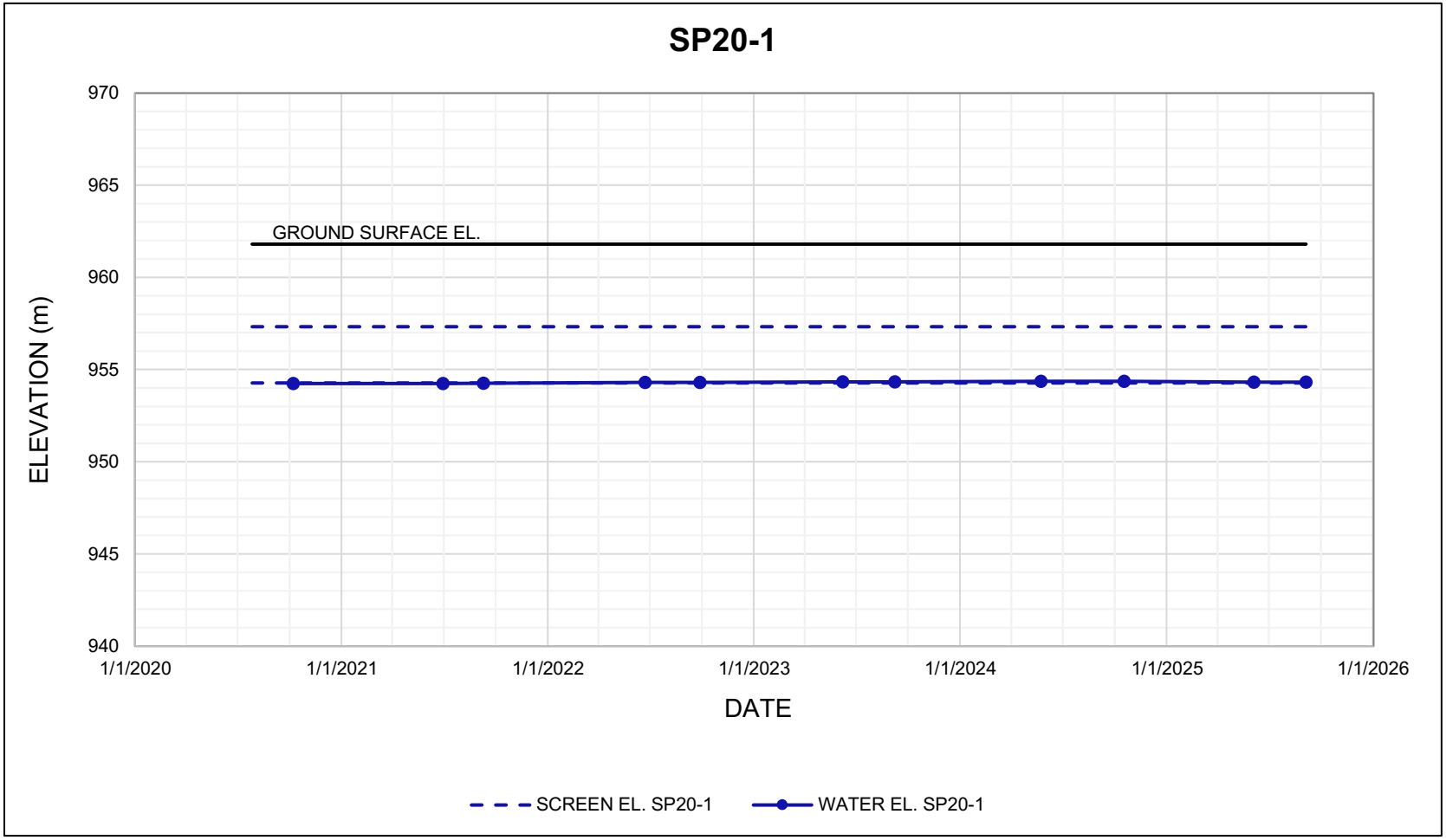
Piezometer Data
GP007 - Wanyandie Road Slide
Hwy 40:36, km 29.339

SCALE	PROJECT No.	FIG No.
--	A05116A01	



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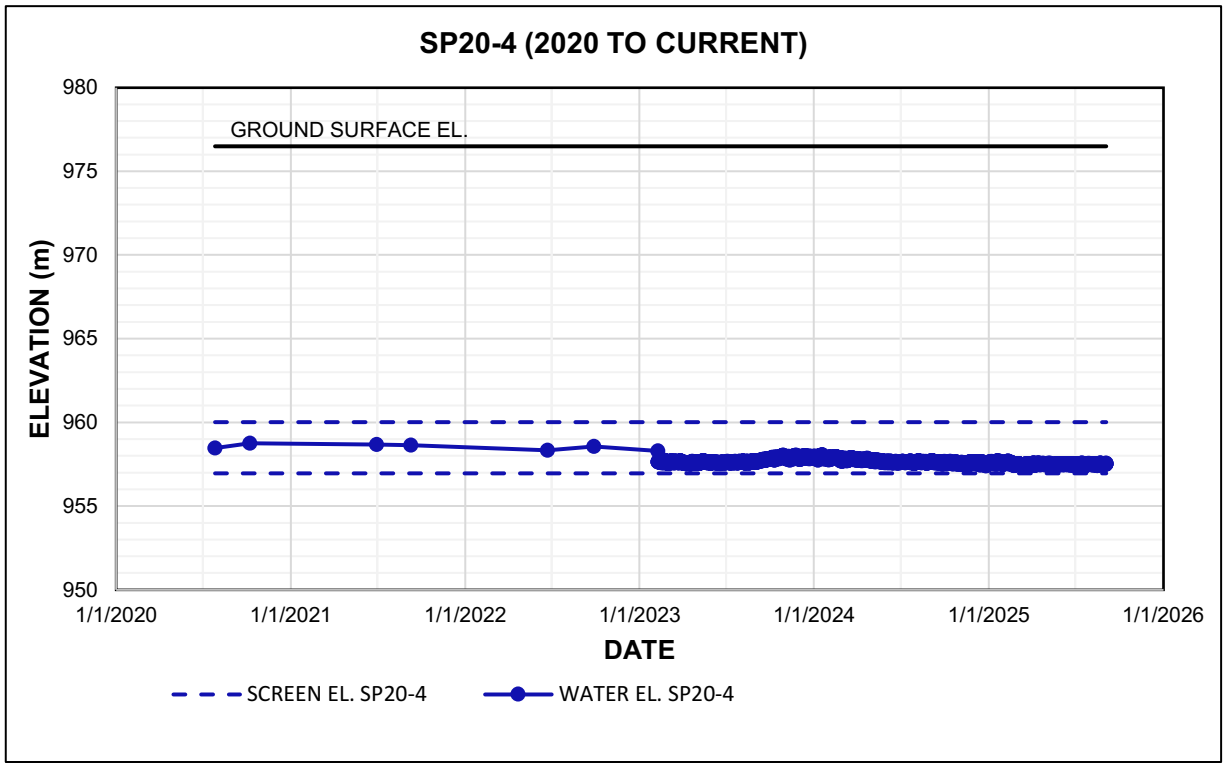
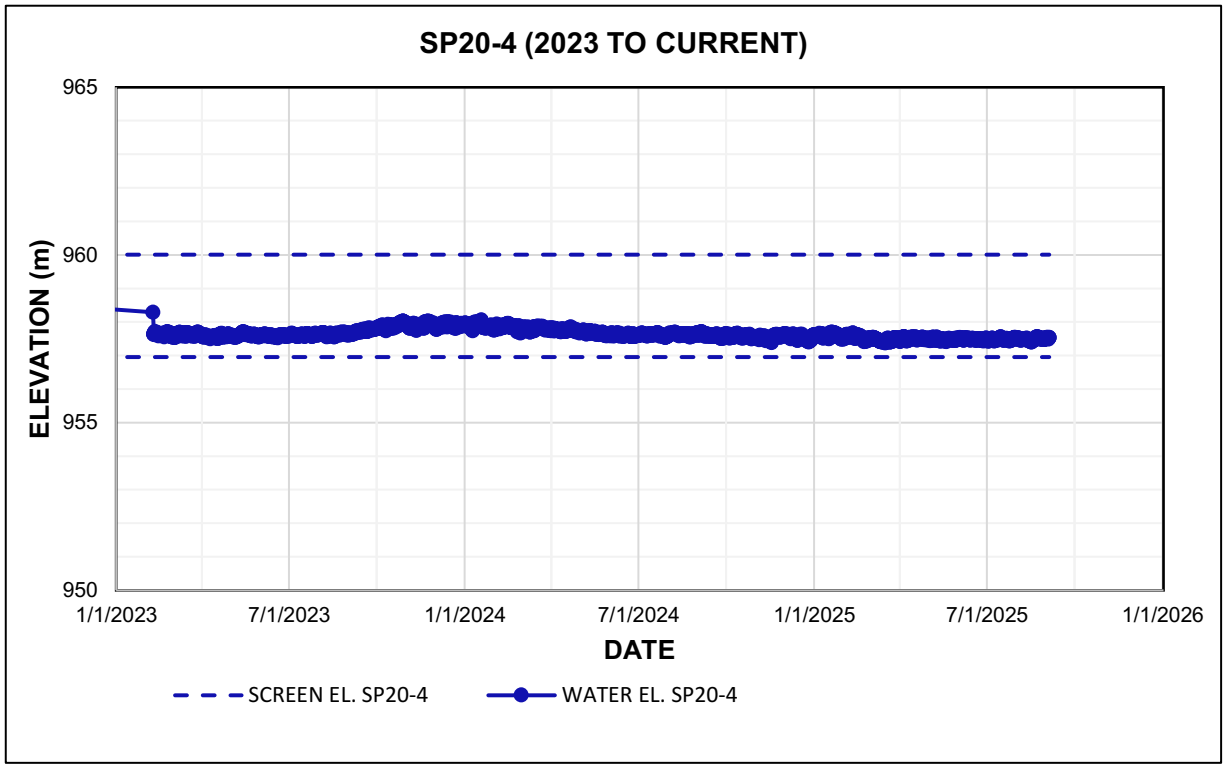
GP007 - WANYANDIE ROAD SLIDE
HWY 40:36, KM 29.339

SCALE	PROJECT No.	FIG No.
--	A05116A01	





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2. A SMALL-DIAMETER VIBRATING WIRE PIEZOMETER CONNECTED TO A SINGLE-CHANNEL DATA LOGGER INSTALLED IN INSTRUMENT CASING IN FEBRUARY 2023.

CLIENT

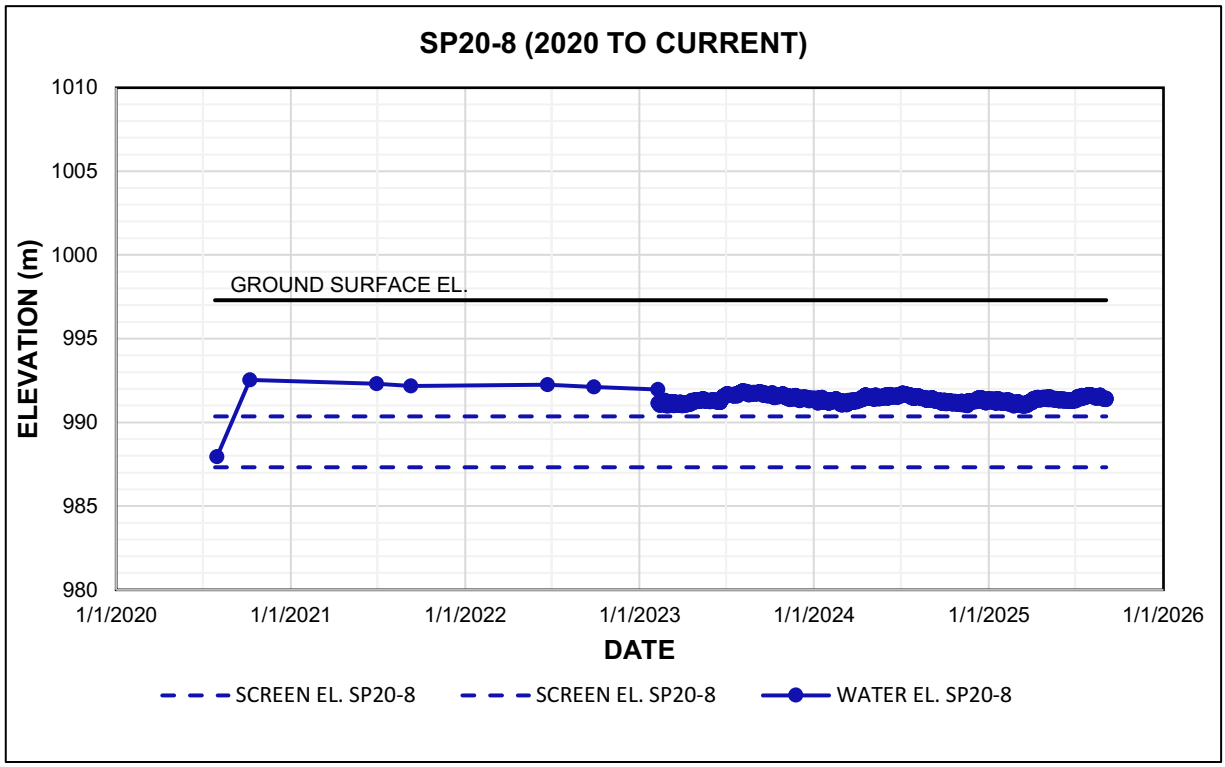
Alberta

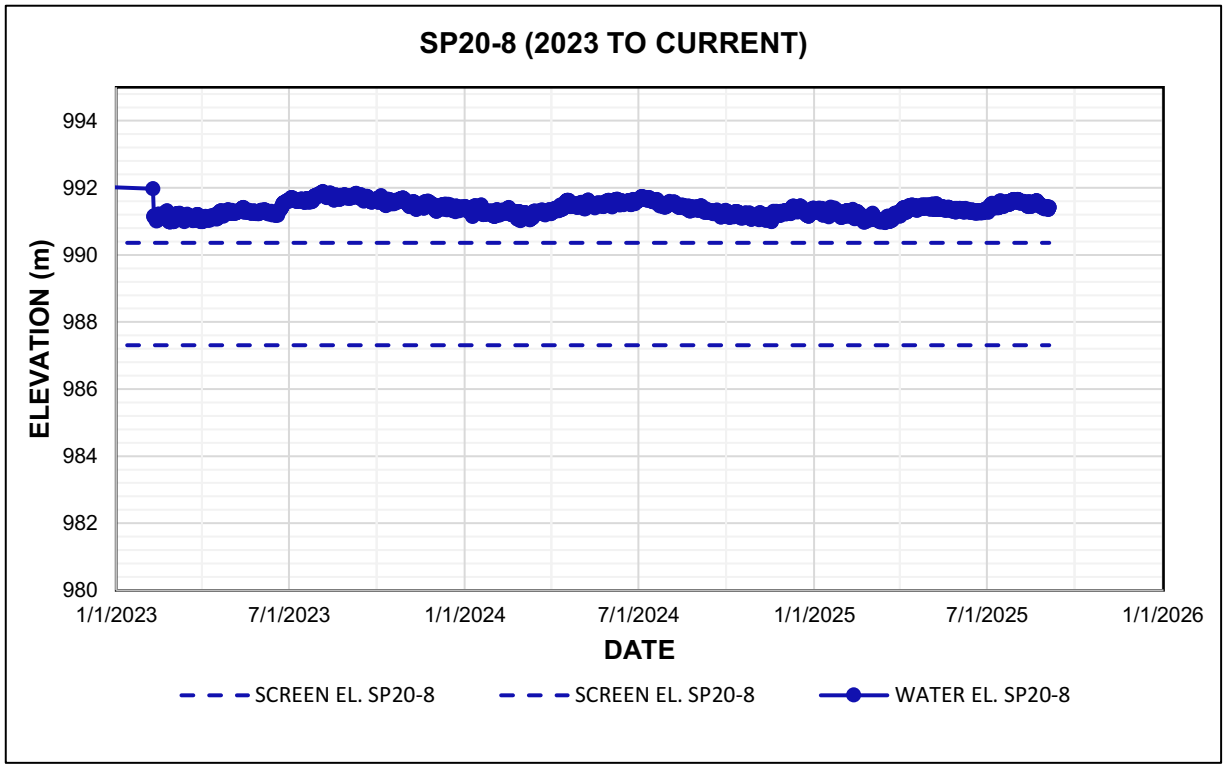
Klohn Crippen Berger

PROJECT
PEACE REGION (GRANDE PRAIRIE DISTRICT - SOUTH)
GEOHAZARD RISK MANAGEMENT PROGRAM

TITLE
Piezometer Data
GP007 - Wanyandie Road Slide
Hwy 40:36, km 29.339

SCALE	PROJECT No.	FIG No.
--	A05116A01	





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SCALE	PROJECT No.	FIG No.
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