July 10, 2024

Alberta Transportation and Economic Corridors
2nd Floor, 803 Manning Road N.E.
Calgary, Alberta
T2E 7M8

Alex Frotten, P.Eng.
Construction Engineer – Delivery Services Division (Southern Region)

Dear Mr. Frotten:

CON0022161 Southern Region GRMP Instrumentation Monitoring
Site S002; H22:14, km 12.95 Priddis
Section C – 2024 Spring Readings

1 GENERAL

Three vibrating wire piezometers (VWPs) (VW98081, VW98077, and VW98079) and two slope inclinometers (SI#9 and SI#11) were read at the S002 site in the Southern Region on July 3, 2024, by Mr. Peter Roy, P.Eng., of Klohn Crippen Berger Ltd. (KCB). These instruments were read as part of the Southern Region Geohazard Risk Management Program (GRMP). The site is located on Hwy 22:14, approximately 10 km southeast of Bragg Creek, Alberta. The approximate site coordinates are 5642649 N, 678037 E (UTM Zone 11, NAD 83) and the legal land description for the site is NE 22-19-08-W5. A site plan is presented in Figure 1.

The geohazard at the S002 site consists of a slope failure on the north side of the highway, which is impacting the westbound lane and north shoulder. Previous remedial actions at this site include installing a concrete pile wall in 1992, along the north shoulder (westbound lane) of Hwy 22:14 in an effort to stabilize the highway. Additionally, a row of gravel columns was installed on the upslope (south) side of the highway. Pumps were installed in two of the columns with water level activated switches (operable, but turned off during the winter months). Regular pavement patching has also been completed at the site.

Between the early 1990s and 2009, several geotechnical site investigations, some of which included installing instruments, were conducted at the S002 site by the previous consultants. The encountered stratigraphy at the site and construction drawings have not been provided to KCB.

1.1 Instrumentation

KCB has been reading the instruments at this site since 2016. Instrumentation installation details are tabulated in Table 1.1. Instrument locations are shown in Figure 1. Any instruments not included in

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Table 1.1 or shown in Figure 1 are assumed to be inoperable and are not presented or discussed herein.

Between the early 1990s and 2009, several SIs, piezometers, and a settlement gauge were installed at the site by the previous consultants to monitor movement, groundwater conditions, and the post-construction performance of the concrete pile wall and drainage improvements. Most of these instruments are now inoperable (e.g., destroyed, sheared, or lost).

The remaining operable instruments are protected by flush-mounted protectors.

The operable VWPs were read using an RST VW2106 vibrating wire readout. The VWPs were previously attached to data loggers. However, all three data loggers were found inoperable in October 2021, and manual readings will be taken moving forward.

The operable SIs were read using a metric RST Digital MEMS Inclinometer System.

Table 1.1 Instrument Installation Details[1]

Instrument ID	Instrument Type	Date Installed	UTM Coordinates[2]		Ground Surface Elevation[3] (m)	Stick Up (m)	Depth (mbgs[4])	Condition
			Northing	Easting				
SI#9	SI	Apr. 2001	5642597	677978	Unknown	-0.4	9.5	Operable
SI#11	SI	Jun. 2000	5642587	677956	Unknown	-0.3	10.0	Operable
VW98077	VWP	Mar. 2009	5642596	677998	1300	N/A	9.3	Operable
VW98079	VWP	Mar. 2009	5642641	677977	1300	N/A	8.7	Operable
VW98081	VWP	Apr. 2009	5642596	677998	1300	N/A	7.0	Operable
~~VW98083~~	~~VWP~~	~~Apr. 2009~~	~~5642641~~	~~677977~~	~~1300~~	~~N/A~~	~~10.9~~	~~Inoperable~~

Notes:
[1] Instrument installation details taken from reports and data files prepared or provided by the previous consultant(s) or Alberta Transportation and Economic Corridors.
[2] Coordinates confirmed by KCB with a handheld GPS. The handheld GPS has a horizontal accuracy of +/- 5 m.
[3] Elevations are relative to an approximate site datum reported by the previous consultant.
[4] Meters below ground surface (mbgs). Bottom reading depth for SIs and tip depth for piezometers.

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-groove).

For the operable 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.

Monthly precipitation data is also plotted with the piezometer data. The data was obtained from the Alberta Climate Information Service (ACIS) database, referencing legal subdivision TWP022-04-W5.

The piezometer and SI data 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.

2.2 Zones of Movement

Distributed movement was reported by the previous consultant near surface in SI#9 from approximately 0 m to 2 m below ground surface (approximately El. 1300 m to El. 1298 m) and in SI#11 from approximately 0 m to 3 m below ground surface (approximately El. 1300 m to El. 1297 m).

No discernible movement has been recorded in SI#9 and SI#11 since KCB began reading the instruments in 2016. Both SIs are located above (upslope of) the concrete pile wall.

2.3 Interpretation of Monitoring Results

With the majority of the movement in the SIs being recorded before 2014 (as reported by previous consultants), it appears as though the concrete pile wall has picked up load, stabilizing the sliding mass and reducing the rate of movement.

Since June 2023, water levels have been recorded to have increased between 0.2 m and 0.3 m in the three operable VWPs (VW98077, VW98079, and VW98081). Water levels recorded in the VWPs appear to fluctuate seasonally, with the spring readings typically being higher than fall readings.

Table 2.1 Slope Inclinometer Reading Summary

Instrument ID	Date				Ground Surface Elevation (m)	Depth of Movement (mbgs[1])	Direction of Movement	Movement (mm)				Rate of Movement (mm/year)		
	Initialized (re-initialized)	Previous Maximum Cumulative Movement Recorded[2]	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#9	Apr. 2001 (Jun. 13, 2016)[2]	N/A	Jun. 26, 2023	Jul. 3, 2024	1300	0.5 – 10.0	A-Direction	3.0[2]	0.8	3.8	-0.5	2.0	0.1	-0.2
SI#11	Jun. 2000 (Jun. 13, 2016)[2]	N/A	Jun. 26, 2023	Jul. 3, 2024	1300	0.5 – 10.0	A-Direction	17.0[2]	2.6	19.6	-1.7	22.0	3.6	5.2

Notes:
[1] Meters below ground surface (mbgs).
[2] SI#9 and SI#11 were re-initialized in June 2016 when KCB took over the readings from the previous consultant and changed the SI reading equipment. Movement recorded before 2016 was taken from reports prepared by the previous consultant.

Table 2.2 Vibrating Wire Piezometer Reading Summary

Instrument ID	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)
VW98077	Mar. 2009	Jun. 26, 2023	Jul. 3, 2024	1300	9.3	5.8	5.6	0.2
VW98079	Mar. 2009	Jun. 26, 2023	Jul. 3, 2024	1300	8.7	6.2	5.9	0.3
VW98081	Apr. 2009	Jun. 26, 2023	Jul. 3, 2024	1300	7.0	5.6	5.3	0.3

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

3 RECOMMENDATIONS

3.1 Future Work

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

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

3.2 Instrument Repairs and Maintenance

No instrument repairs are required.

SI#9 and SI#11 are recessed below the pavement surface in the westbound lane of Hwy 22:14. Fine-grained material (e.g., silt and sand) is regularly observed inside the flush-mounted casing protectors and the material must be removed to facilitate the instrument readings. Some of the material has entered the SI casing. Previous efforts of plugging the casing protector caps and sleeving the top of the SI casing with larger-diameter pipe to reduce the material migration have been moderately successful.

KCB should investigate alternative methods to reduce the amount of material entering the flush-mounted casing protectors (e.g., plugging the holes in the caps or replacing the casing protectors entirely, which has been recently completed successfully in the Central Region) and the SI casing, which could impact future reading. If necessary, the SIs should be cleaned out by injecting the SI casing with water and flushing out any sediment that has accumulated.

4 CLOSURE

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 Southern Region Geohazard Risk Management Program (Contract No. CON0022161), 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.

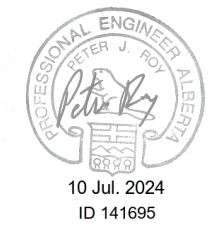
Use of or reliance upon this instrument of service by the Client is subject to the following conditions:

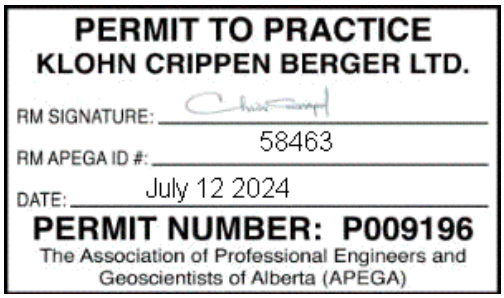
1. The report is to be read in full, with sections or parts of the report relied upon in the context of the whole report.
2. The observations, findings and conclusions in this report are based on observed factual data and conditions that existed at the time of the work and should not be relied upon to 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.

Please contact the undersigned if you have any questions or comments regarding this report.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

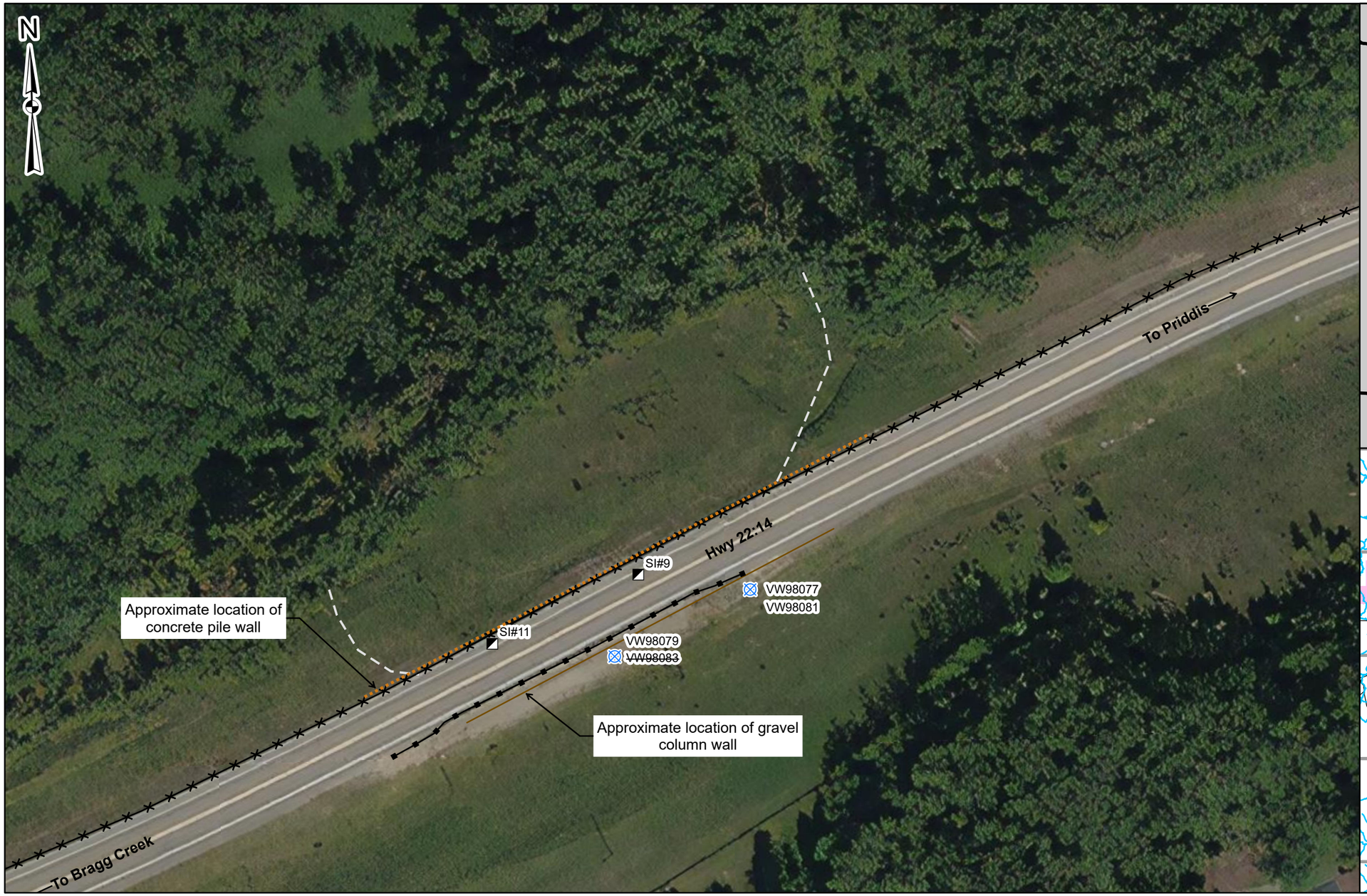


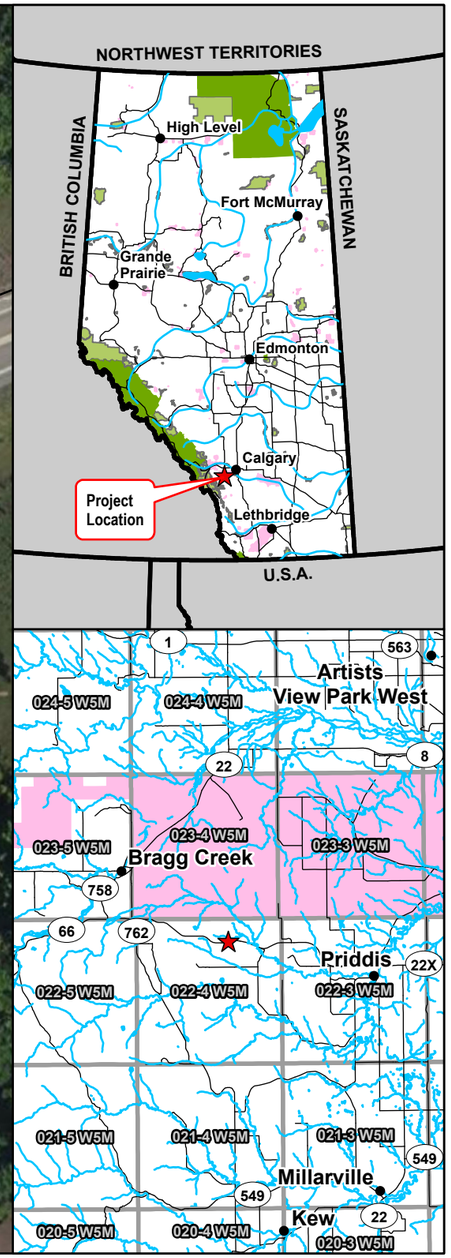


Peter Roy, P.Eng.
Civil Engineer

Attachments
Figure
Appendix I Instrumentation Plots

FIGURE





Legend

- Slope Inclinometer (SI)
- Vibrating Wire Piezometer (VW)
- Guardrail
- Fence
- Slide Extent
- Gravel Column Wall
- Concrete Pile Wall

0 50 Metres

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

CLIENT: Alberta

Klohn Crippen Berger

PROJECT: SOUTHERN REGION GEOHAZARD RISK MANAGEMENT PROGRAM

TITLE: Site Plan
S002 - Priddis
Hwy 22:14, km 12.95

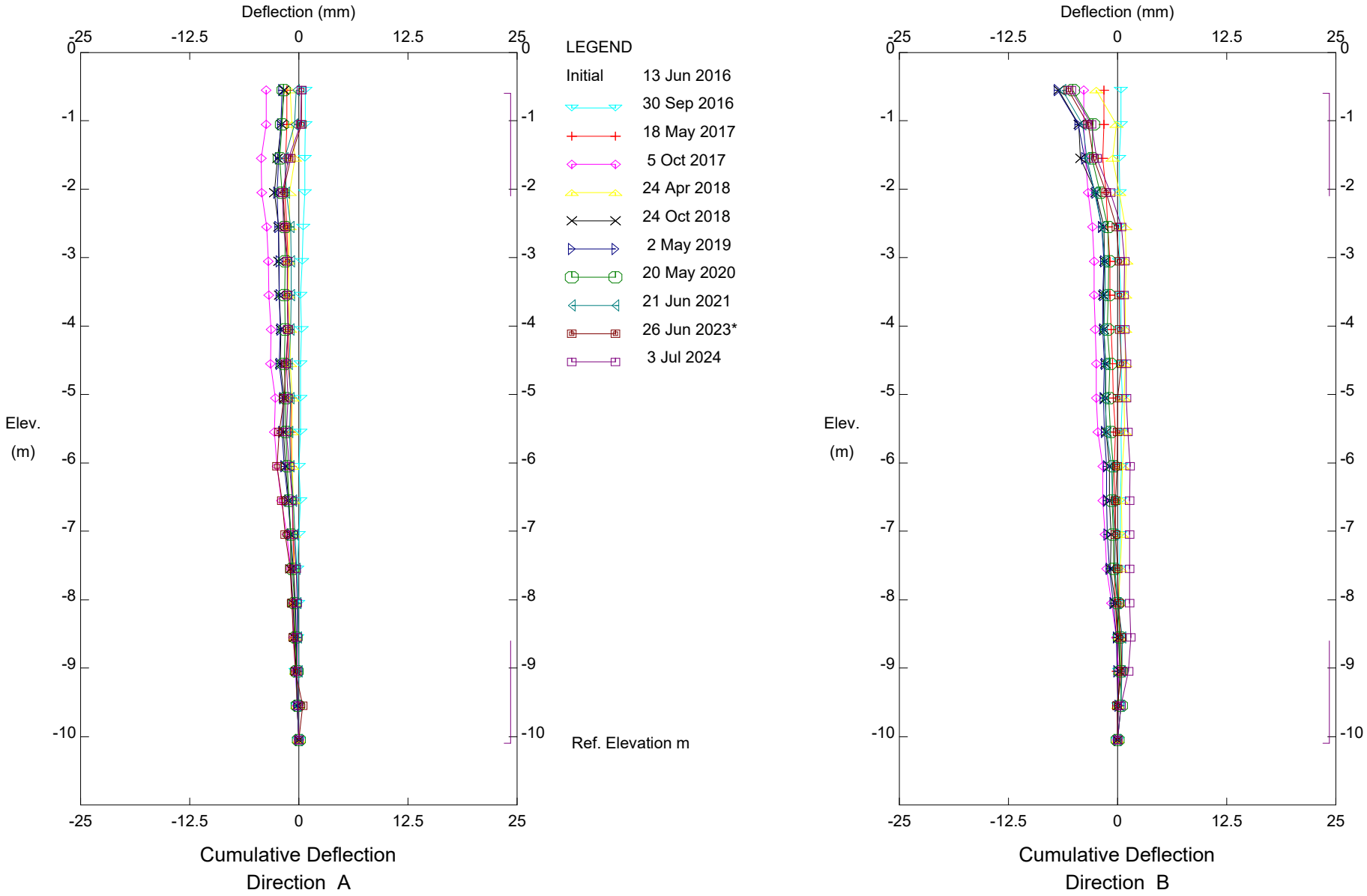
SCALE	PROJECT No.	FIG No.
1:800	A05116A03	1

File: Z:\AC\GY\Alberta\A05116A03 ABT Southern Region GRMP\400 Drawings\2022\Section C\Section C - Spring 2022\Section C - Spring 2022.aprx Date: Time: Creator: : aharrison

APPENDIX I

Instrumentation Plots

Klohn Crippen Berger Ltd. - Calgary, AB



S002; H22:14, Priddis, Inclinometer SI#9

Alberta Transportation

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

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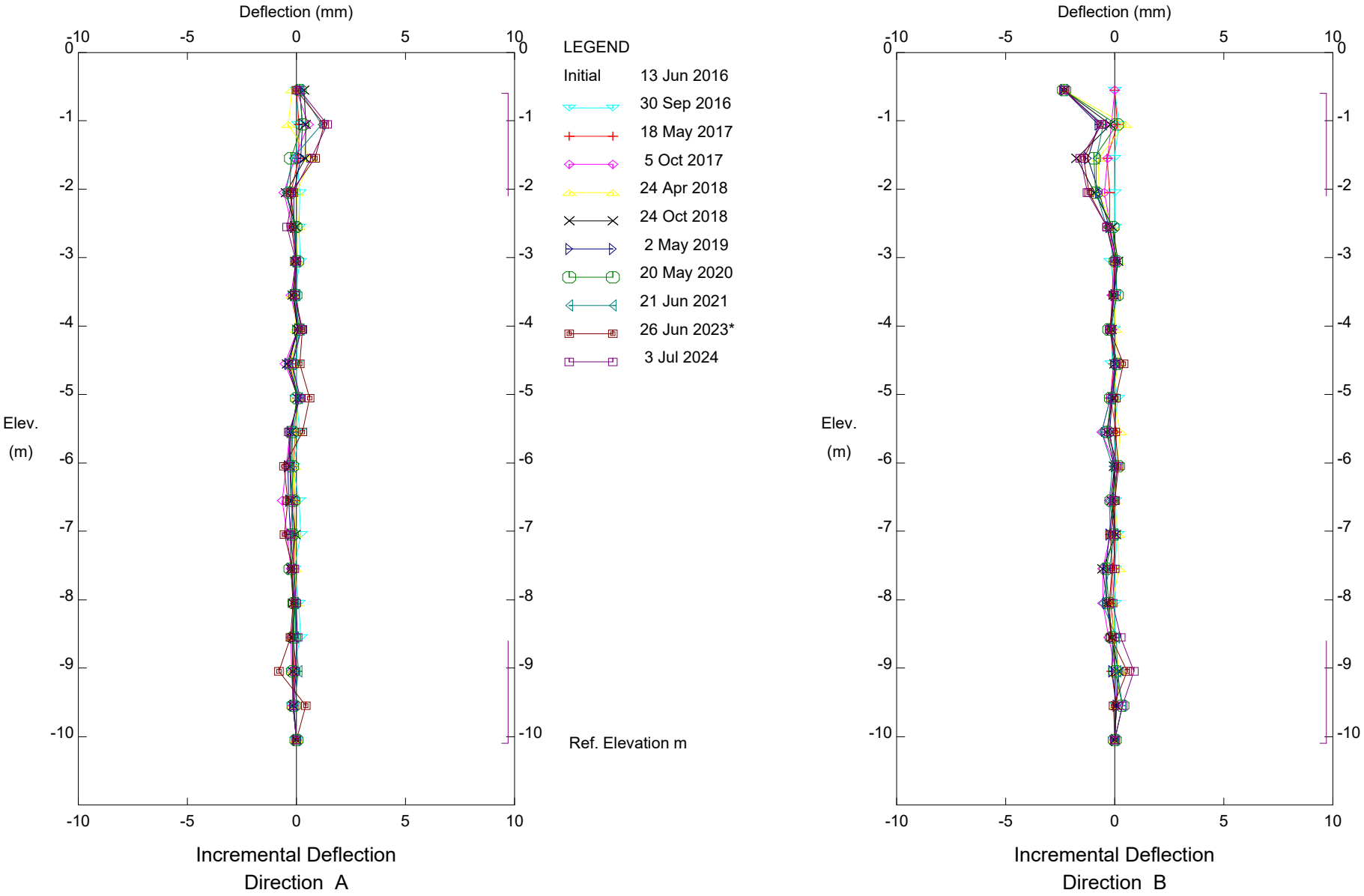
Klohn Crippen Berger Ltd. - Calgary, AB



S002; H22:14, Priddis, Inclinometer SI#9

Alberta Transportation

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

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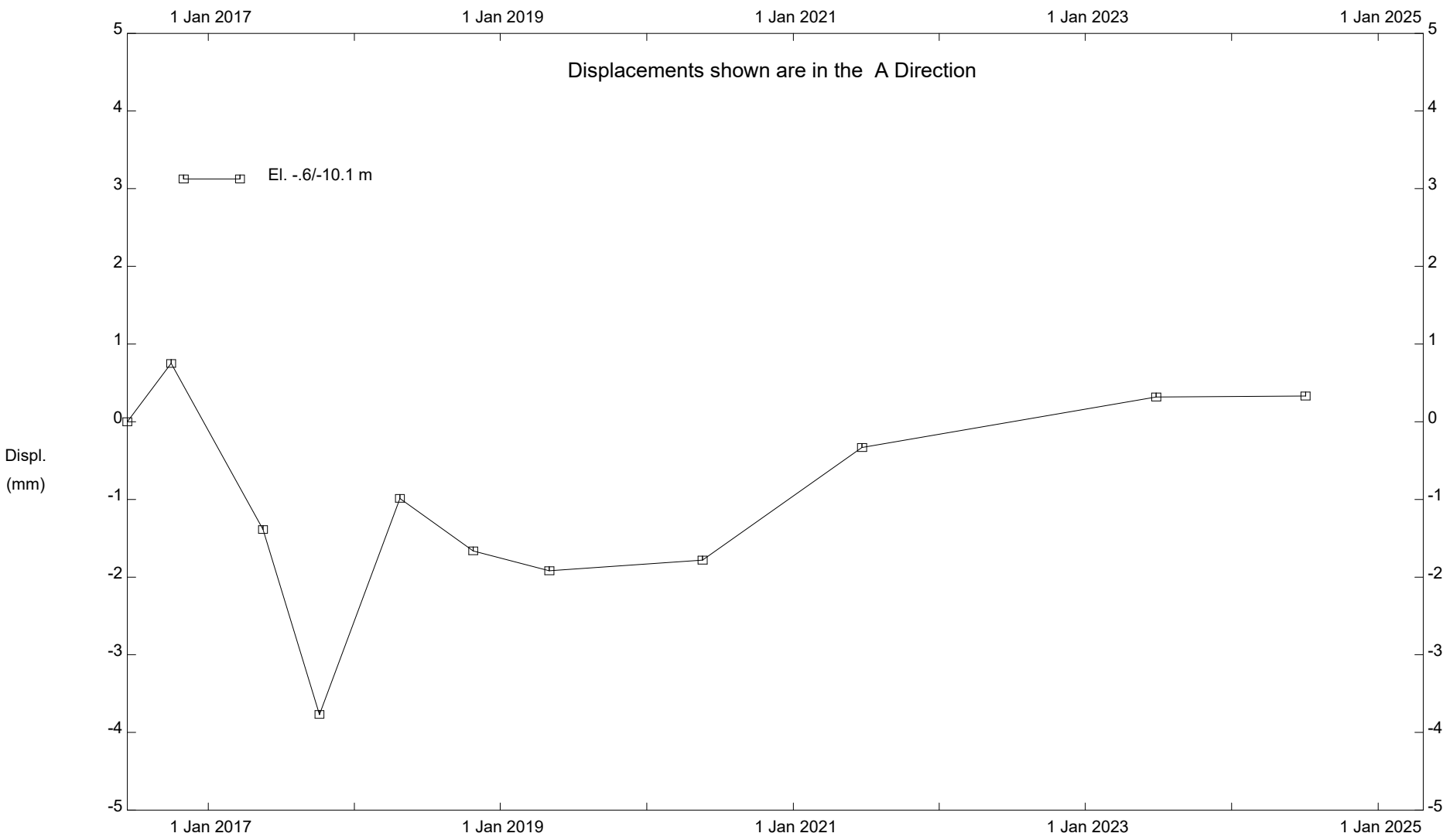
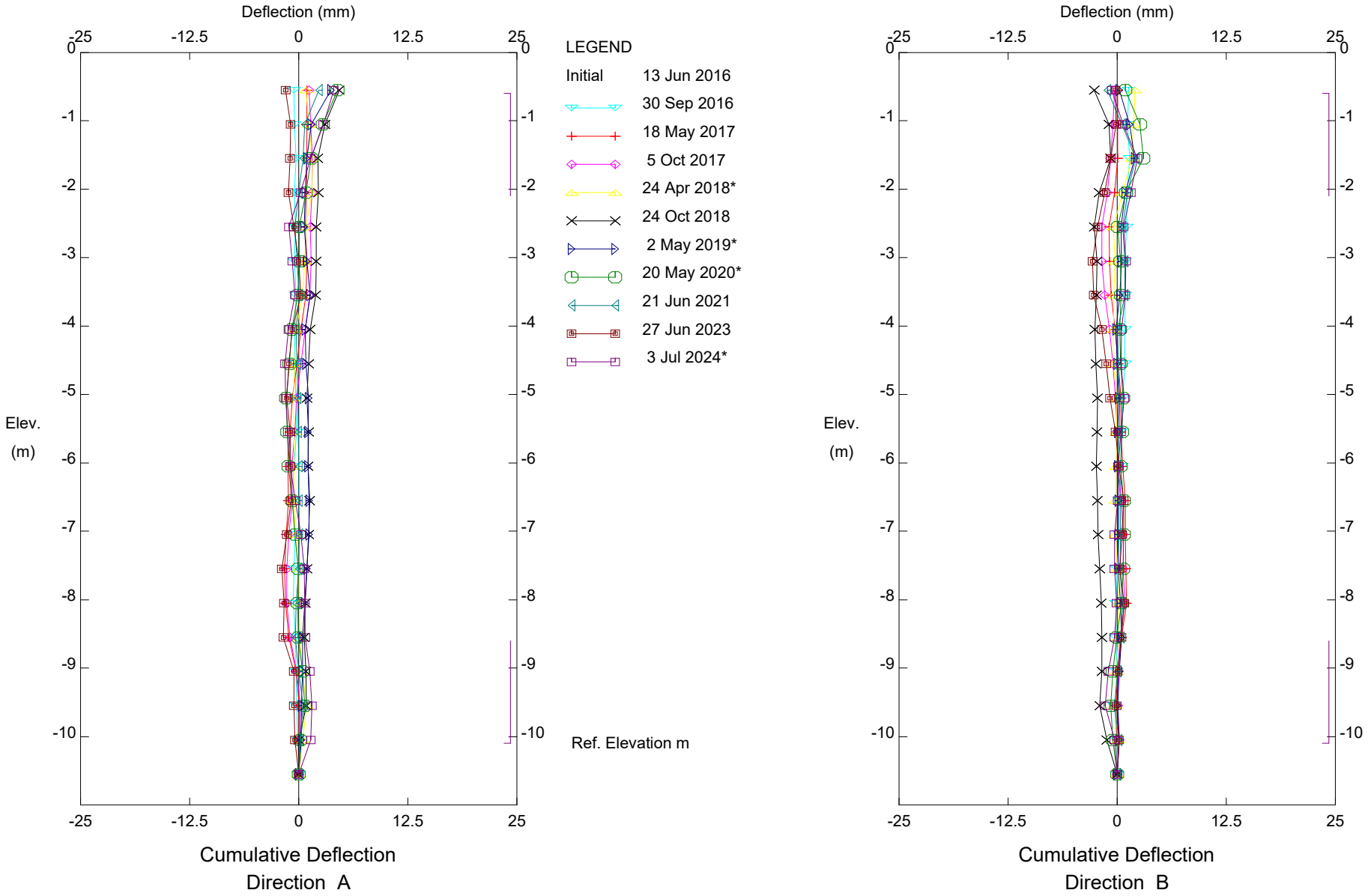
Klohn Crippen Berger Ltd. - Calgary, AB



S002; H22:14, Priddis, Inclinometer SI#9

Alberta Transportation

Klohn Crippen Berger Ltd. - Calgary, AB



S002; H22:14, Priddis, Inclinometer SI#11

Alberta Transportation

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

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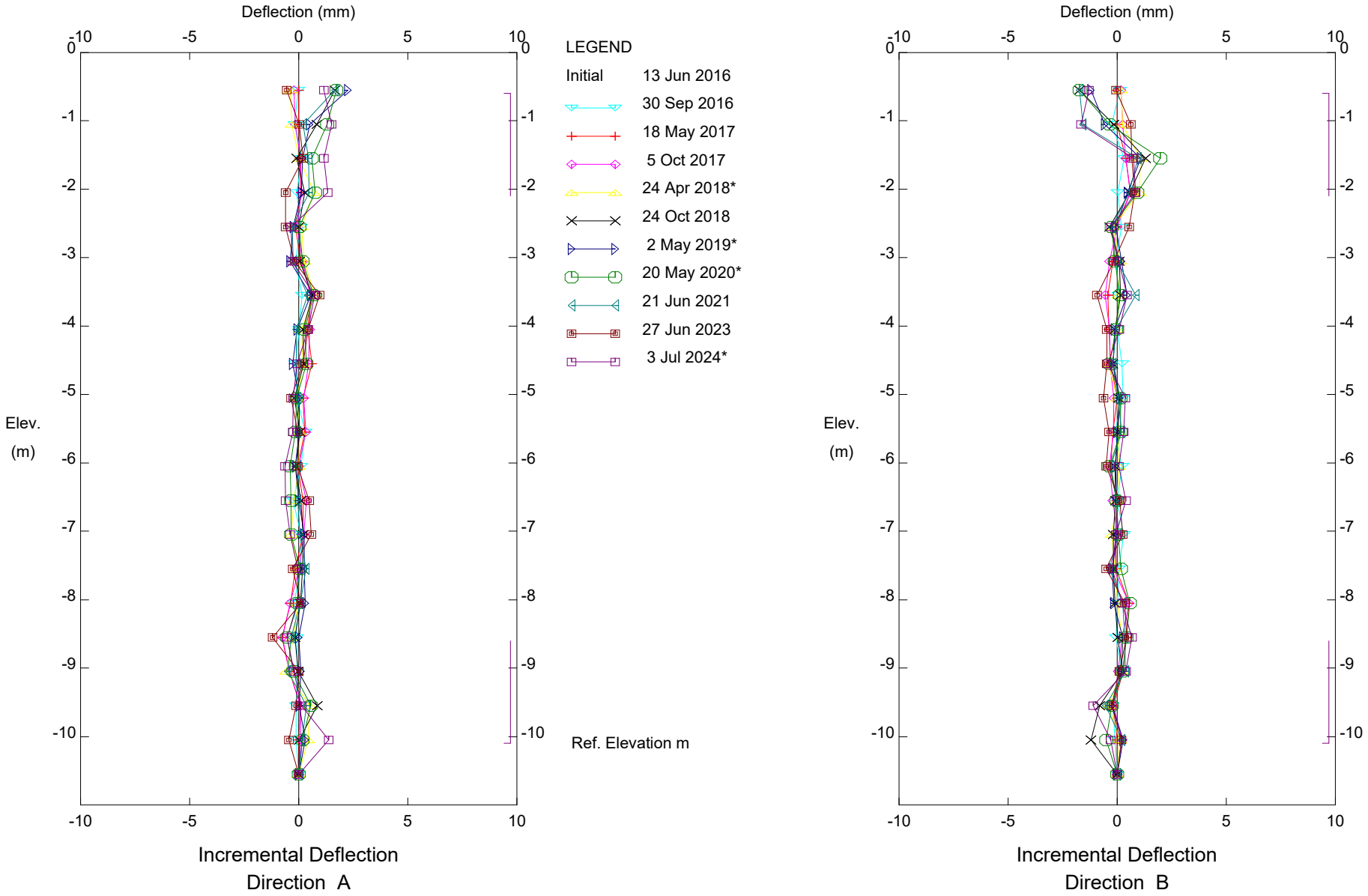
Klohn Crippen Berger Ltd. - Calgary, AB



S002; H22:14, Priddis, Inclinometer SI#11

Alberta Transportation

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

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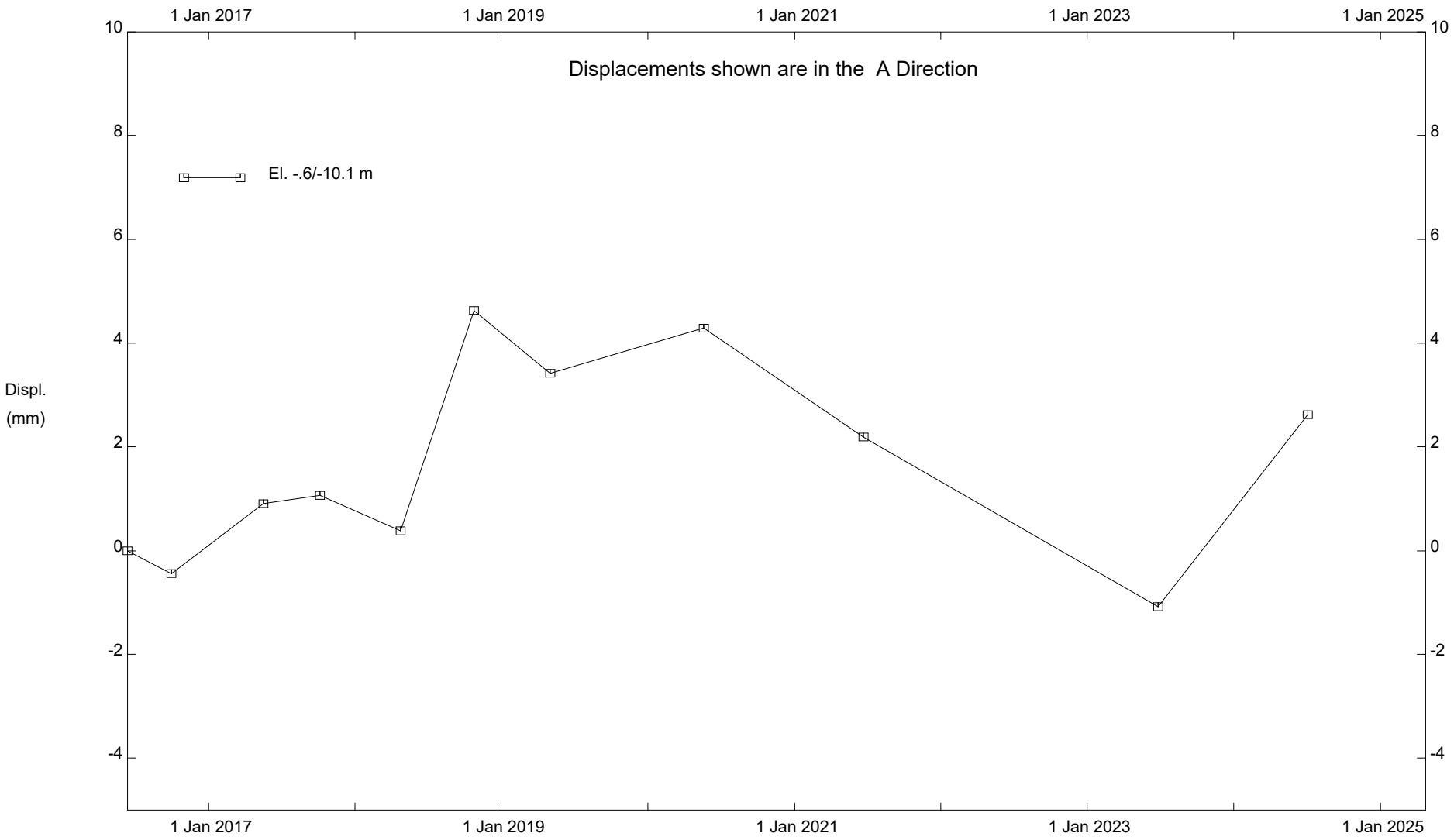
Klohn Crippen Berger Ltd. - Calgary, AB



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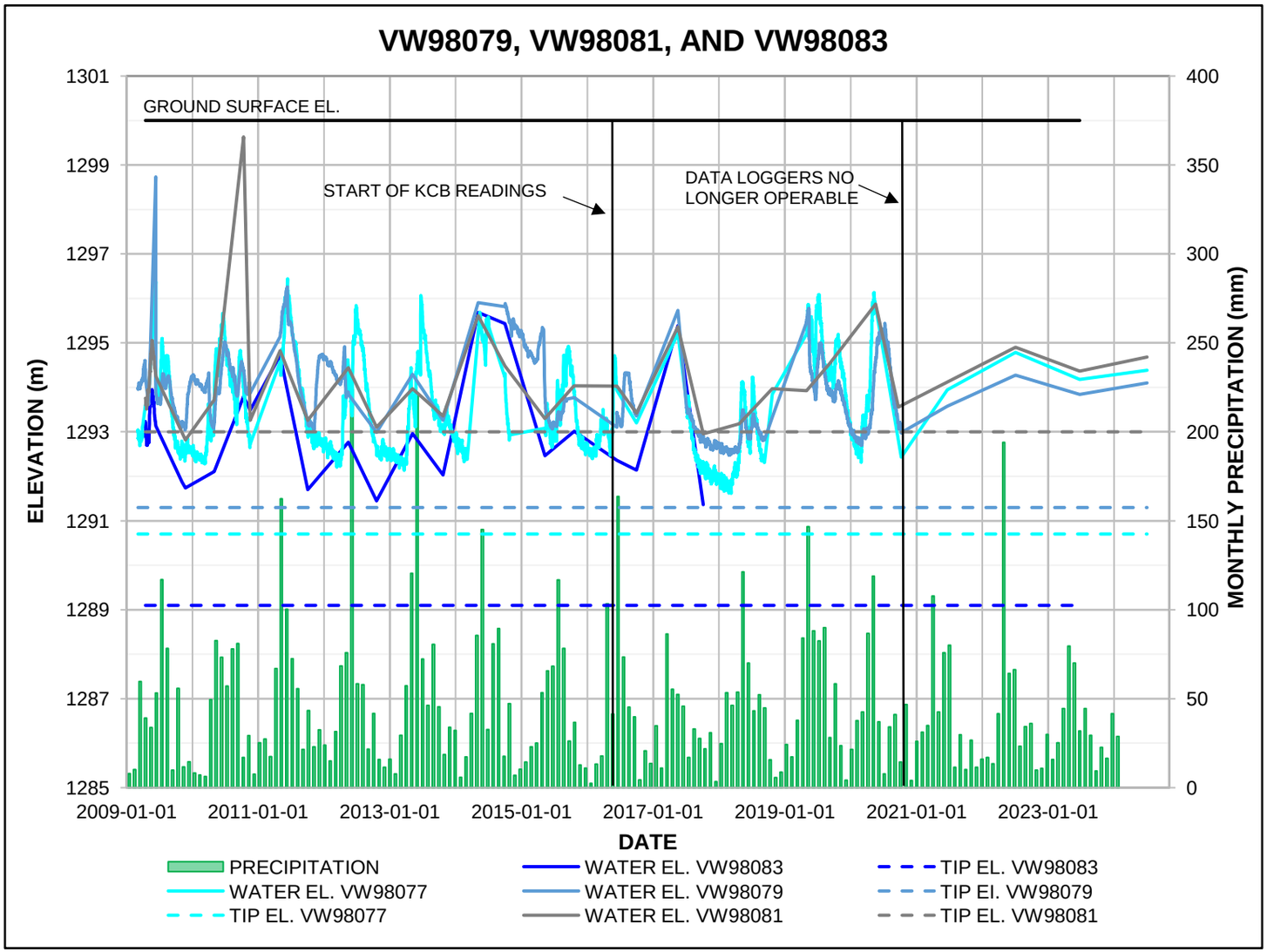
Alberta Transportation



NOTES:
1. MONTHLY PRECIPITATION DATA OBTAINED FROM THE ALBERTA CLIMATE INFORMATION SERVICE (ACIS) DATABASE, REFERENCING LEGAL SUBDIVISION T022R04W5.
2. VW98083 BECAME INOPERALBE BETWEEN THE FALL 2017 AND SPRING 2018 READINGS.

CLIENT: Alberta

Klohn Crippen Berger

PROJECT: SOUTHERN REGION GEOHAZARD RISK MANAGEMENT PROGRAM

TITLE: Piezometer Data
S002 - Priddis
Hwy 22:14, km 12.95

SCALE

PROJECT No. A05116A03

FIG No.