

July 15, 2024

Alberta Transportation and Economic Corridors
4th Floor, Provincial Building
4920 51 Street
Red Deer, Alberta
T4N 6K8

Tony Penney, P.Eng.
Construction Engineer

Dear Mr. Penney:

**CON0022160 Central Region GRMP Instrumentation Monitoring
Site C042; H579:02 km 36.540 West of Water Valley Slide
Section C – 2024 Spring Readings**

1 GENERAL

Two slope inclinometers (SIs) (SI05-05 and SI05-07) were read at the C042 site in the Central Region on May 13, 2024 by Aden Shipton, E.I.T. of Klohn Crippen Berger Ltd. (KCB). Data was also downloaded from a data logger installed in standpipe piezometer (SP) (SP05-08). These instruments were read as part of the Central Region Geohazard Risk Management Program (GRMP). The site is located on Hwy 579:02, km 36.540, approximately 4 km west of Water Valley, Alberta and 300 m east of Little Red Deer River bridge. The approximate site coordinates are 5709031 N, 661849 E (UTM Zone 11, NAD 83). A site plan is presented in Figure 1.

The geohazard at the C042 site consists of a series of valley slope and embankment fill slides along Hwy 579:02 that predominately impact the south side (eastbound lane) of the highway. Following a slide in 1995, a portion of the slope was excavated and backfilled with granular fill. A drainage blanket was placed at the base of the excavation, and a drain was placed in a groundwater spring. In 2011, a section of Hwy 579:02 was realigned north (upslope) towards the backslope.

In 2005, AMEC conducted a geotechnical site investigation at the C042 site. The encountered stratigraphy was as follows: fill (granular, overlying silt and clay), overlying medium plastic clay till, overlying bedrock (siltstone).

1.1 Instrumentation

KCB has been reading the instruments since 2016. Instrumentation installation details are tabulated in Table 1.1. Instrument locations are presented in Figure 1.

In 2005, AMEC installed five SPs (SP05-01 through -04, and SP05-08), one pneumatic piezometer (PN) (PN05-06), and two SIs (SI05-05 and SI05-07) in the main slide area to monitor for groundwater and slope movement, respectively. Currently, only one SP and two SIs are operable. The other instruments are inoperable either due to shearing of the instrument or because they were lost due to ongoing road maintenance (e.g., covered in pavement). The remaining operable instruments were installed in boreholes recessed below ground surface and capped with flush-mounted casing protectors. SI05-05 is in the north ditch of Hwy 579:02 and SI05-07 and SP05-08 are on the south shoulder of Hwy 579:02, aligned with the centre of the main slide area.

The SIs were read using the same metric RST Digital MEMS Inclinometer System that has been used to read the SIs since June 2021.

A Heron Instruments (Heron) vented-dipperLog data logger was installed by KCB in SP05-08 on May 28, 2020 to a depth of 12.3 m below ground surface. The data logger was programmed to take a reading every 24 hours to assess if short-term fluctuations (i.e., increases and decreases) in water level are occurring in response to periods of heavy or prolonged rainfall or freshet infiltration between readings. The data logger was removed on May 13, 2024, to be relocated at another GRMP site in the future.

Table 1.1 Instrumentation Installation Details

Instrument ID	Instrument Type	Date Installed	UTM Coordinates ¹ (m)		Ground Surface Elevation (m)	Stick Up (m)	Depth (mbgs ²)	Condition
			Northing	Easting				
SI05-05	SI	Sep. 2005	661862	5709058	115.0	0.0	14.5	Operable
SI05-07	SI	Sep. 2005	661842	5709028	115.5	0.0	15.0	Operable
SP05-01	SP	Sep. 2005	Unknown	Unknown	Unknown	Unknown	Unknown	Inoperable
SP05-02	SP	Sep. 2005	Unknown	Unknown	Unknown	Unknown	Unknown	Inoperable
SP05-03	SP	Sep. 2005	Unknown	Unknown	Unknown	Unknown	Unknown	Inoperable
SP05-04	SP	Sep. 2005	Unknown	Unknown	Unknown	Unknown	Unknown	Inoperable
SP05-08	SP with logger ³	Sep. 2005	661842	5709025	115.5	0.0	15.2	Inoperable
PN05-06	PN	Sep. 2005	Unknown	Unknown	Unknown	Unknown	Unknown	Inoperable

Notes:

- ¹ Coordinates and ground surface elevations have not been surveyed and were estimated based on record drawings and location plan.
- ² Meters below ground surface (mbgs).
- ³ A Heron Instruments Vented-dipperLog data logger is installed in SP05-08 to a depth of 12.3 m below ground surface. The data logger became inoperable on January 7, 2022 and a replacement data logger was installed on Sept. 10, 2022. The logger was removed on May 13, 2024, to be relocated to another GRMP site.

2 INTERPRETATION

2.1 General

For the SIs, the cumulative displacement, incremental displacement, and displacement-time data was plotted in the A-direction (i.e., the direction of the A0-grooves). The A0-grooves in the SIs are aligned approximately with the direction of maximum movement, in the downslope direction.

For the operable SP, the recorded water levels were converted to an equivalent water/piezometric elevation and plotted relative to ground surface elevation and the instruments screen elevation on two separate plots:

- on the first data plot (Figure I in Appendix I), water level data recorded between October 2005 and May 2020 using a water level meter is plotted; and
- on the second data plot (Figure II in Appendix I), water level data recorded between May 2019 and May 2023 using a water level meter and by the Heron data logger is plotted with precipitation data downloaded from the Alberta Climate Information Service (ACIS) website for the Water Valley Station.

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.

2.2 Zones of Movement

No discernible movement has been recorded in SI05-05 since installation.

Discrete movement is being recorded in SI05-07 at an approximate depth of 5.8 m below ground surface, in the highway embankment fill.

2.3 Interpretation of Monitoring Results

Previous assessments of the slope failure suggest that movement is likely in response to periods of heavy or prolonged rainfall, creek erosion at the toe of the slope, and high groundwater conditions. In June 2005, after a period of heavy rainfall, movements along the south side of the highway resulted in the eastbound lane of Hwy 579:02 being closed after it settled approximately 1.5 m.

After the 2005 geotechnical site investigation, AMEC concluded that the slope failure consisted of a rotational failure in the highway embankment fill that extended into the foundation. It was believed that the movement was a result of lower slope failures, triggered by creek erosion at the toe of the slope, retrogressing up the slope, and possibly high groundwater conditions within the slope.

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	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
SI05-05	Oct. 24, 2005	N/A – no discernible movement	May 09, 2023	May 13, 2024	115.0	N/A – no discernible movement						
SI05-07	Oct. 24, 2005	May 09, 2023	May 09, 2023	May 13, 2024	115.5	4.2 – 6.2	A-Direction	64.7	0.7	17.5	0.7	0.0

Notes:

¹ Meters below ground surface (mbgs).

Table 2.2 Standpipe Piezometer Reading Summary

Instrument ID ²	Date			Ground Surface Elevation (m)	Screen Depth (mbgs ¹)	Water Level			
	Installed	Previous Reading	Most Recent Reading			Previous Reading (mbgs ¹)	Range Recorded by Data Logger Between previous and Most Recent Readings (mbgs ¹)	Most Recent Reading (mbgs ¹)	Change from Previous Reading (m)
SP05-08	Oct. 2005	May 09, 2023	May 12, 2024	115.5	12.2 – 15.2	1.0	0.8 – 11.1	3.3	-2.3

Notes:

¹ Meters below ground surface (mbgs).

²SP05-08 Data Logger was removed from the C042 Site on May 14, 2024.

Historically, movement was recorded in SI05-07 at a rate of less than 10 mm/year, except between August 2013 and June 2015, when the rate of movement increased to approximately 17.5 mm/year. Since June 2015, the rate of movement being recorded in SI05-07 is generally negligible during the winter months (i.e., between the fall and spring readings) and up to 10 mm/year (overall) during the summer months (i.e., between the spring and fall readings).

The rate of movement recorded since spring 2021 has been slow (less than 1 mm/year). This was likely due to relatively dry weather throughout the past 3 years (excluding June and July 2022, see the precipitation data plotted on the piezometer plots). For comparison, the rate of movement in the previous wet year (2020) was approximately 7 mm/year. Increased movement may occur in response to periods of heavy or prolonged rainfall, resulting in higher groundwater conditions.

Upon review of the data obtained from the Heron data logger between May 2020 and May 2024, there appears to be a relatively strong relationship between precipitation (heavy or prolonged rainfall, or spring freshet) and water level response recorded in SP05-08 (e.g., water level increases in response to increased rainfall in fall 2021). There are multiple precipitation events where there is no response recorded in SP05-08. However, these events were during winter months when the ground was frozen and there was no infiltration. Since we have a better understanding of the groundwater response to precipitation events, the Heron data logger was removed during the spring 2024 reading, to be installed at a different GRMP site.

The water level fluctuations (resulting in a water level above ground surface) may be due to condensation in the venting of the instrument cap and modification to the vent cap will be considered to see if there is a more muted response in water level.

3 RECOMMENDATIONS

3.1 Future Work

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

The site has not experienced movement in several years. As a result, no further work is recommended at this time. If site conditions change resulting in deformations or erosion that affects or threatens further the highway surface, additional recommendations will be prepared.

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

3.2 Instrument Repairs and Maintenance

The flush-mounted casing protectors installed in the south shoulder of Hwy 579:02 to protect SI05-07 is missing a cover (Photo 1). KCB attempted to attach a new cover during the spring 2022 readings. However, it could not be attached to the existing flush-mounted casing protector. The old flush-mounted casing protector should be replaced.

Photo 1 Flush-mounted casing protector installed in the south shoulder of Hwy 579:02 to protect the SI05-07.



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 Central Region Geohazard Risk Management Program (Contract No. CON0022160), 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.



James Lyons, P.Eng.
Civil Engineer

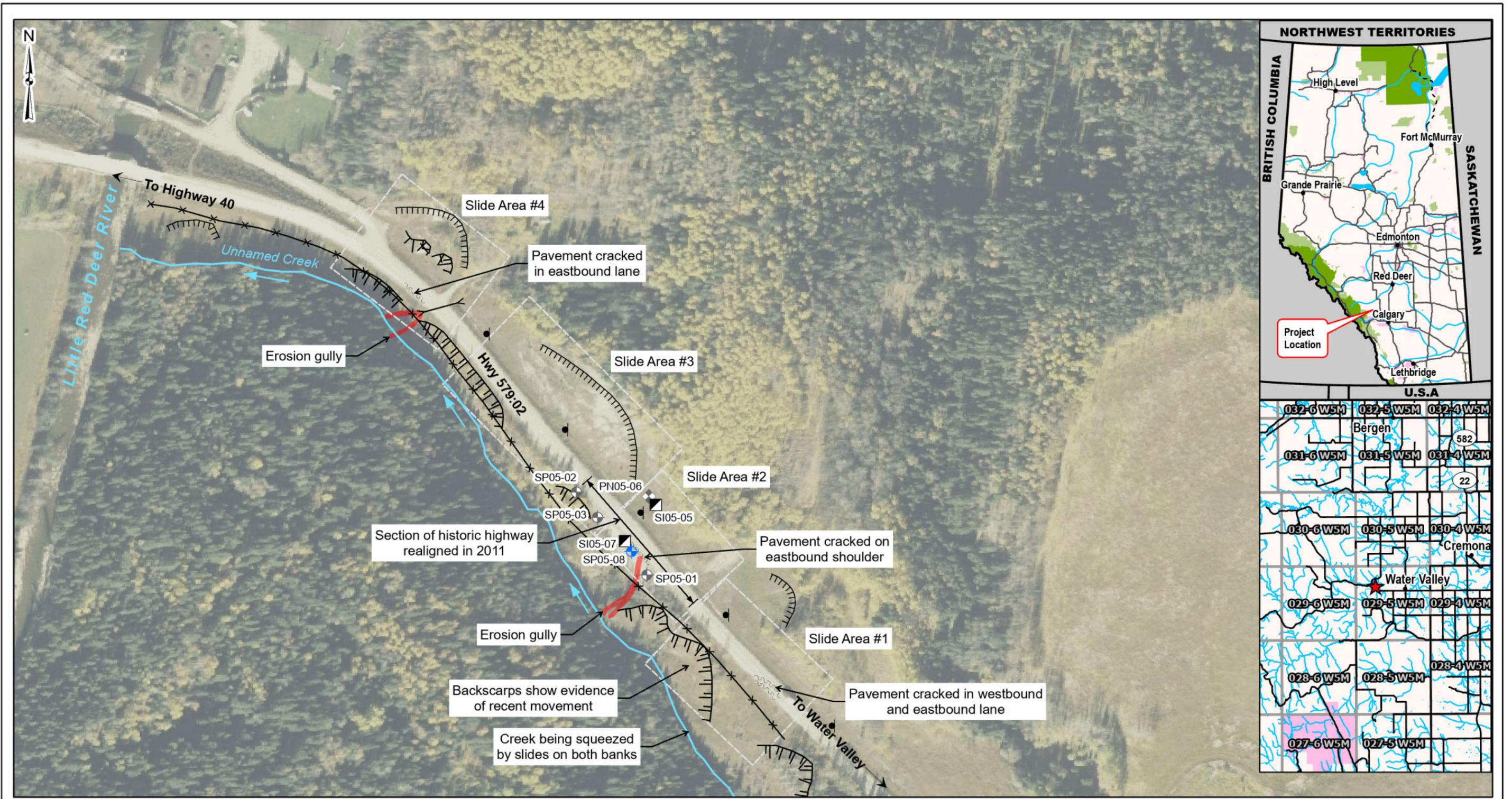
Aden Shipton, E.I.T.
Civil Engineer in Training

JL:bb

ATTACHMENTS

Figure
Appendix I Instrumentation Plots

FIGURE



Legend

- ◆ Pneumatic Piezometer (PN) (inoperable) × Fence — Creek
- ⊕ Standpipe Piezometer (SP) (inoperable) > Culvert — Flow Direction
- ▣ Slope Inclinometer (SI) ▤▤▤▤ Crest of Slope ■ Erosion
- ⊕ Standpipe Piezometer (SP) ▤▤▤▤ Scarp
- Power Pole ~~~~~ Crack

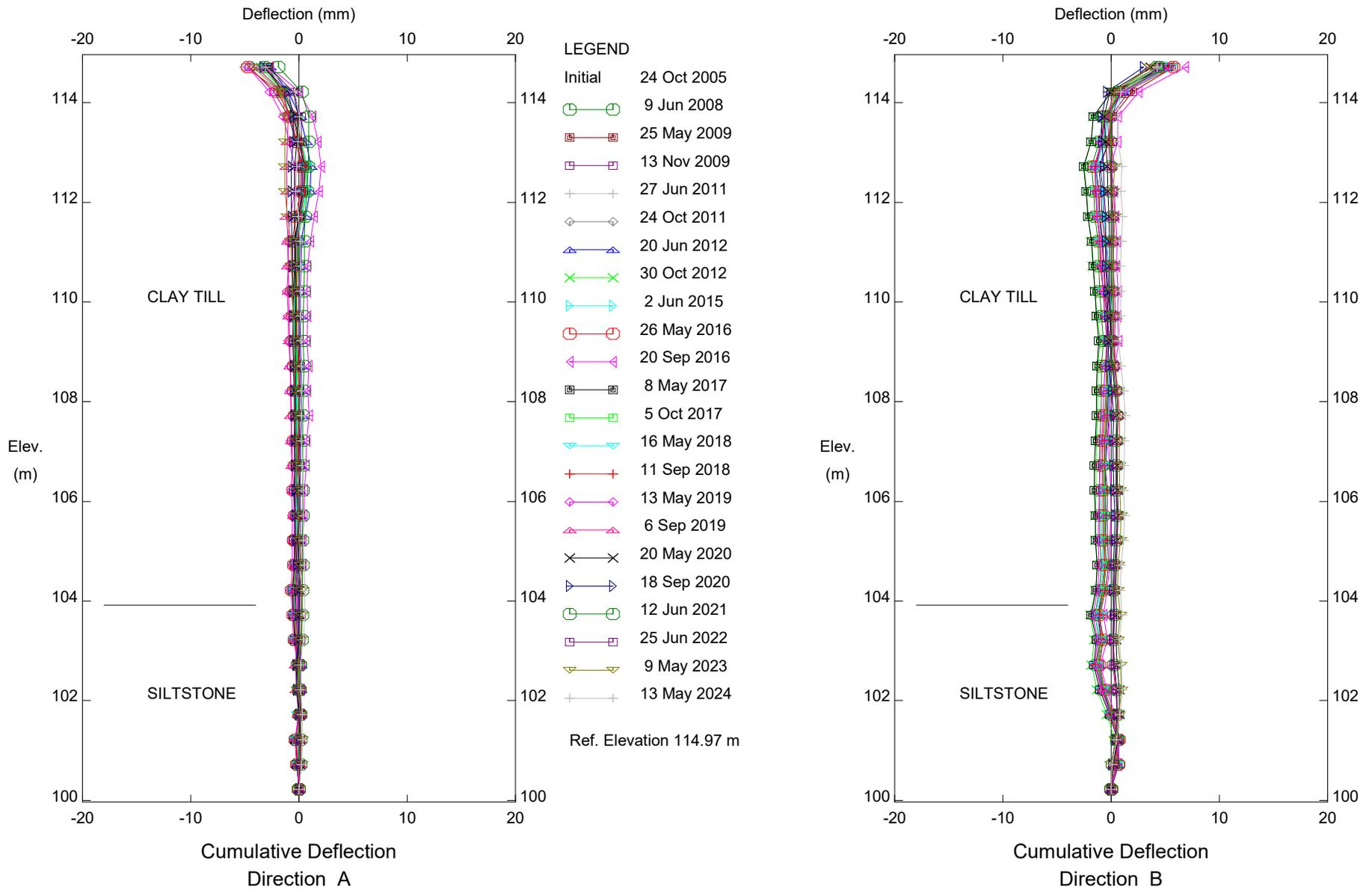


<p>NOTES:</p> <ol style="list-style-type: none"> 1. HORIZONTAL DATUM: NAD83 2. GRID ZONE: UTM Zone 11N 3. IMAGE SOURCE: Abacus Datagraphics Ltd. Image dated July 30, 2013 to October 14, 2013 4. Location of instruments is approximate (not surveyed) 5. SP05-08 Data Logger was removed from site on May 14, 2024. 	<p>CLIENT</p>	<p>PROJECT</p> <p>CENTRAL REGION GEOHAZARD RISK MANAGEMENT PROGRAM</p> <hr/> <p>TITLE</p> <p style="text-align: center;">Site Plan C042 - West of Water Valley Slide H579:02, km 36.540</p> <hr/> <p>SCALE: 1:2,500 PROJECT No. A05116A02 FIG No. 1</p>
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APPENDIX I

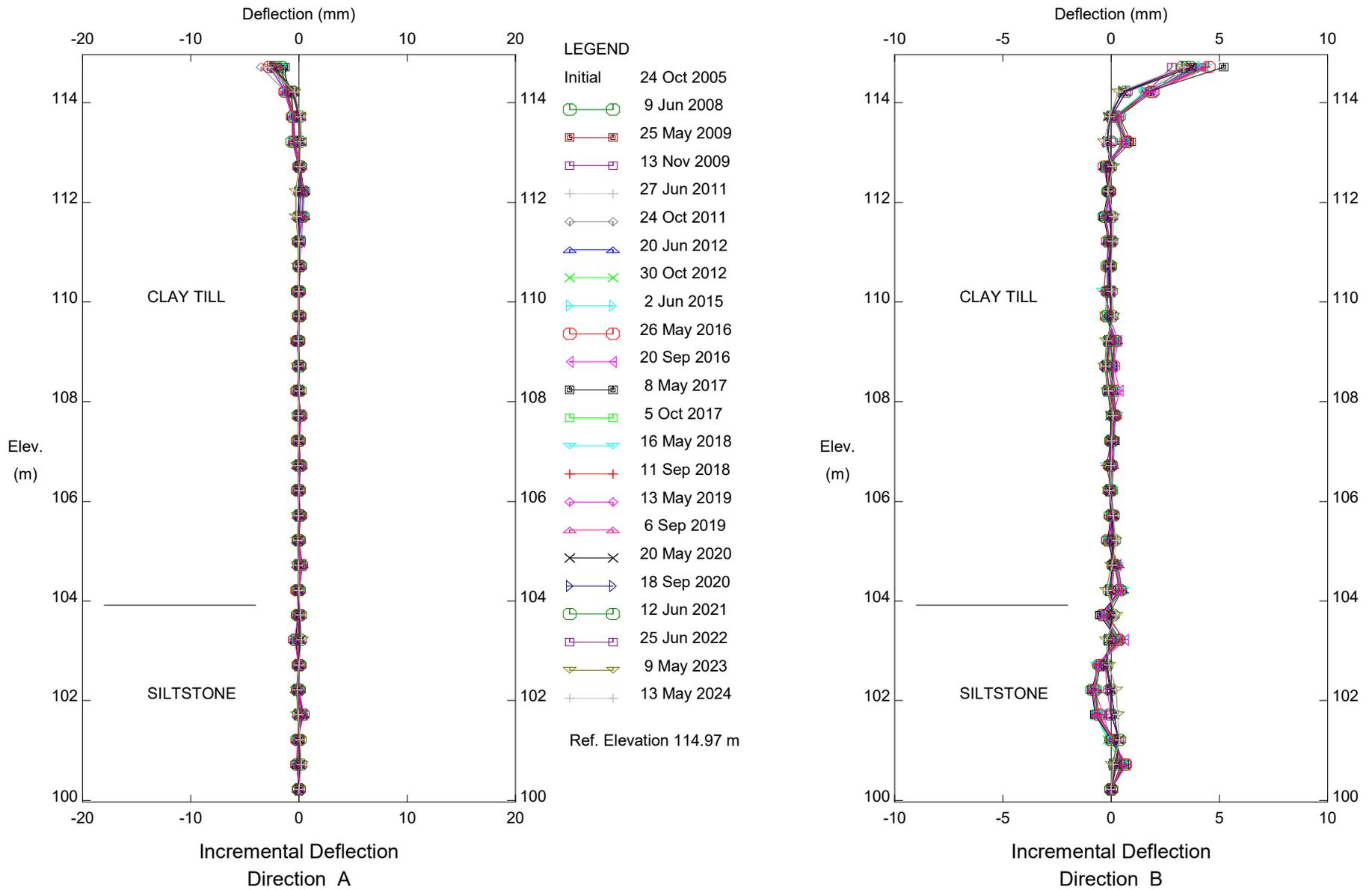
Instrumentation Plots

Klohn Crippen Berger - Calgary



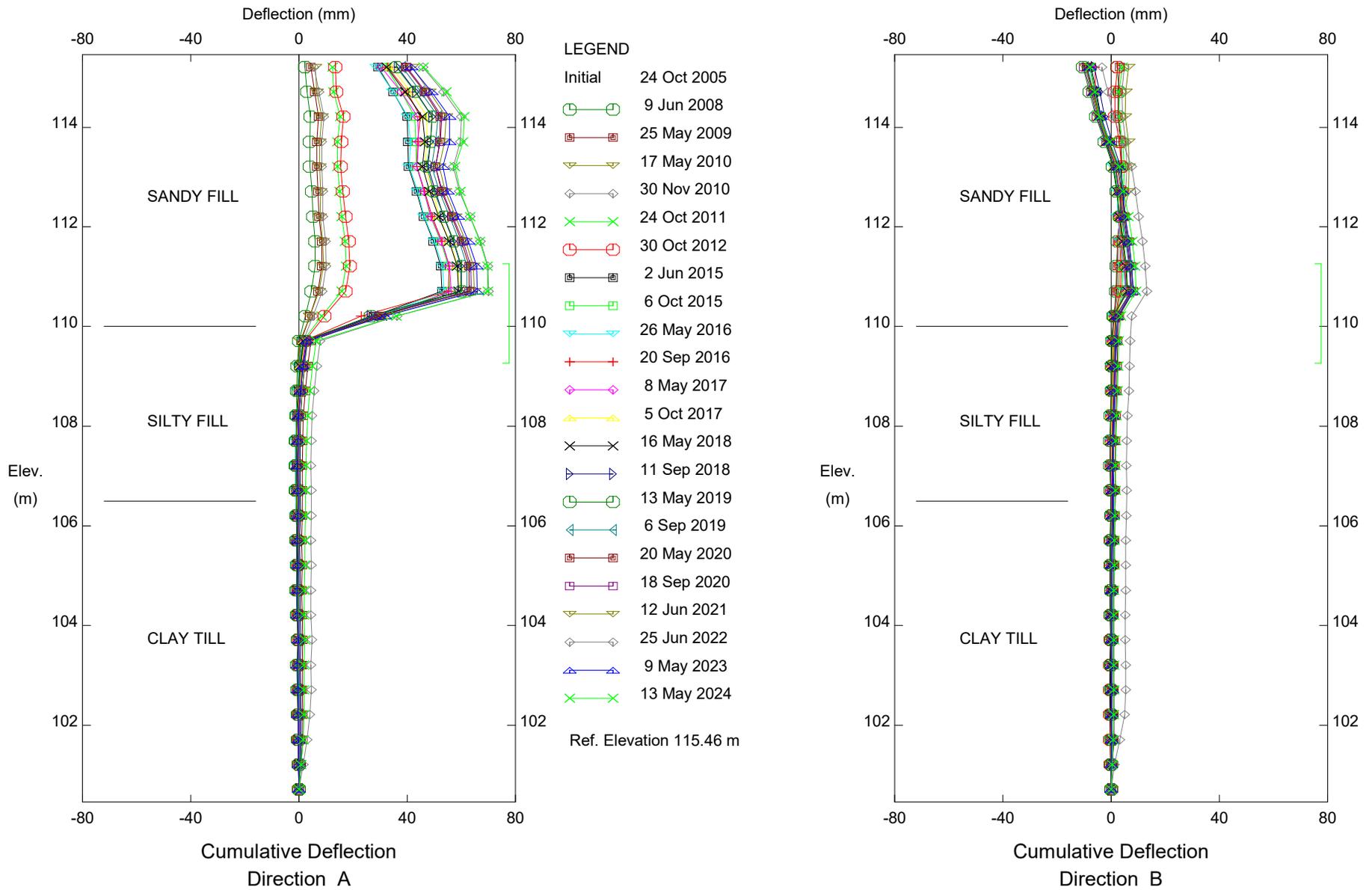
C042; H579:02, West of Water Valley Slide, Inclinometer SI05-05
 Alberta Transportation

Klohn Crippen Berger - Calgary



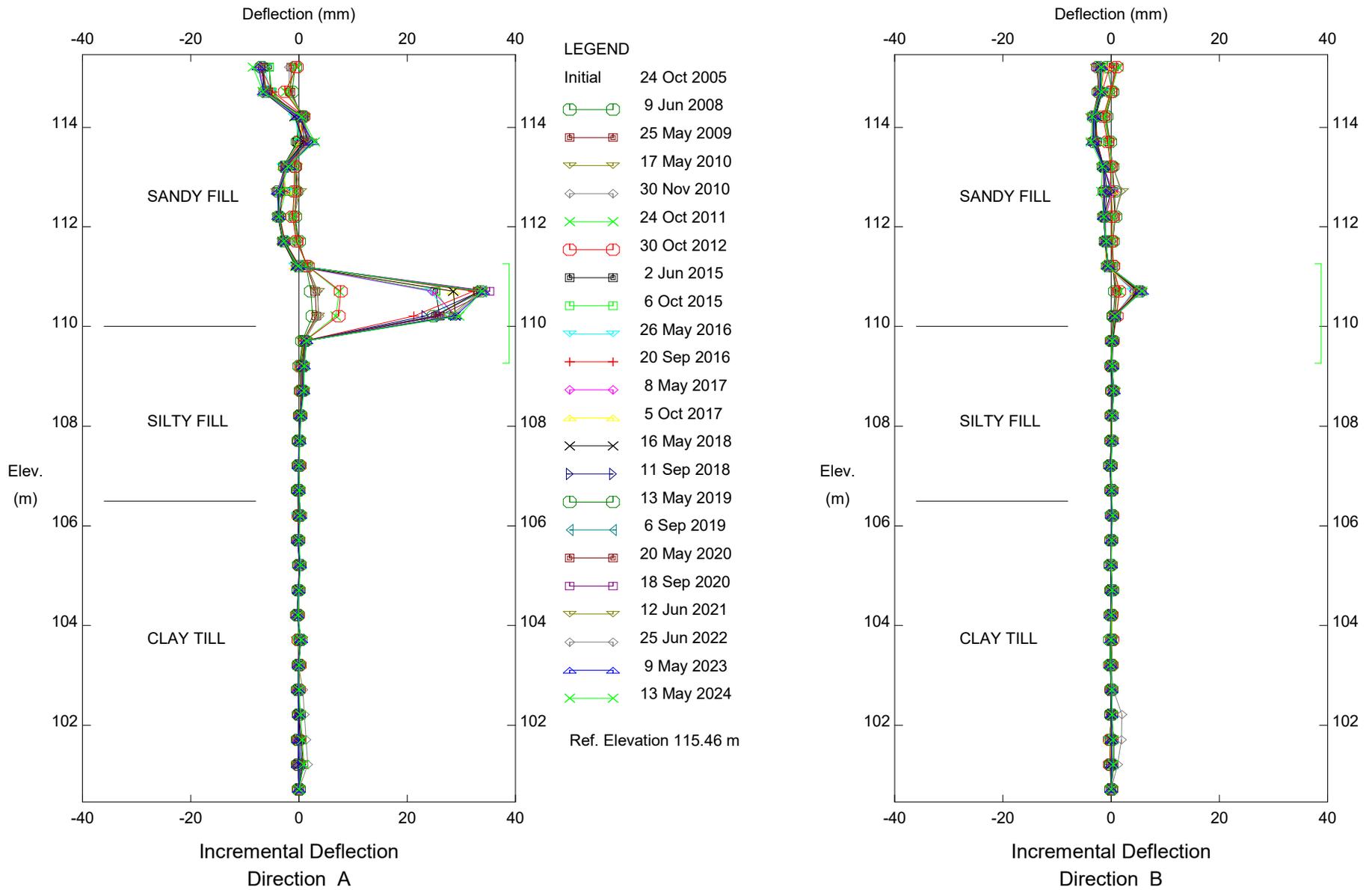
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 Alberta Transportation

Klohn Crippen Berger - Calgary



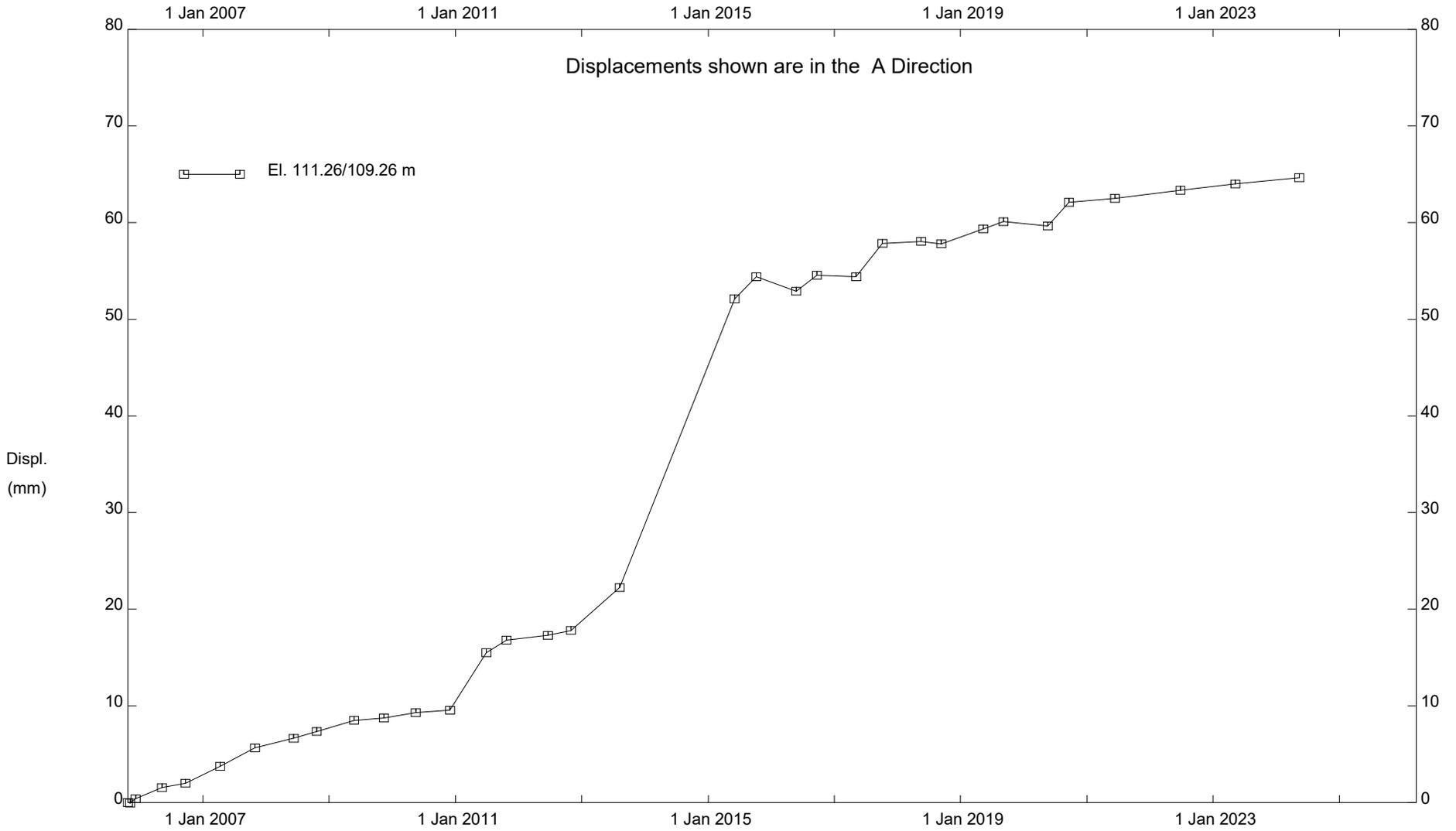
C042; H579:02, West of Water Valley Slide, Inclinometer SI05-07
 Alberta Transportation

Klohn Crippen Berger - Calgary



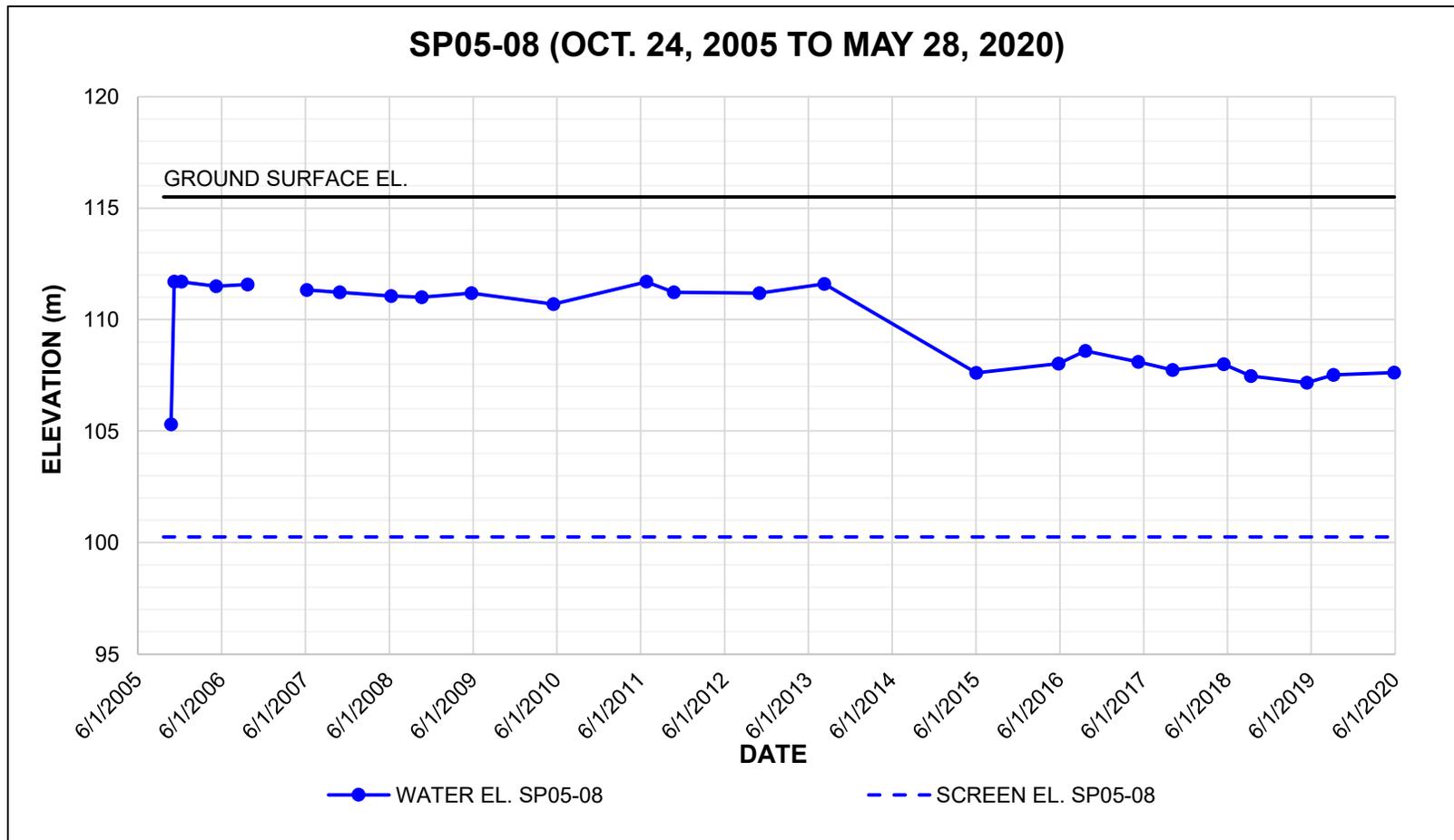
C042; H579:02, West of Water Valley Slide, Inclinometer SI05-07
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C042; H579:02, West of Water Valley Slide, Inclinometer SI05-07

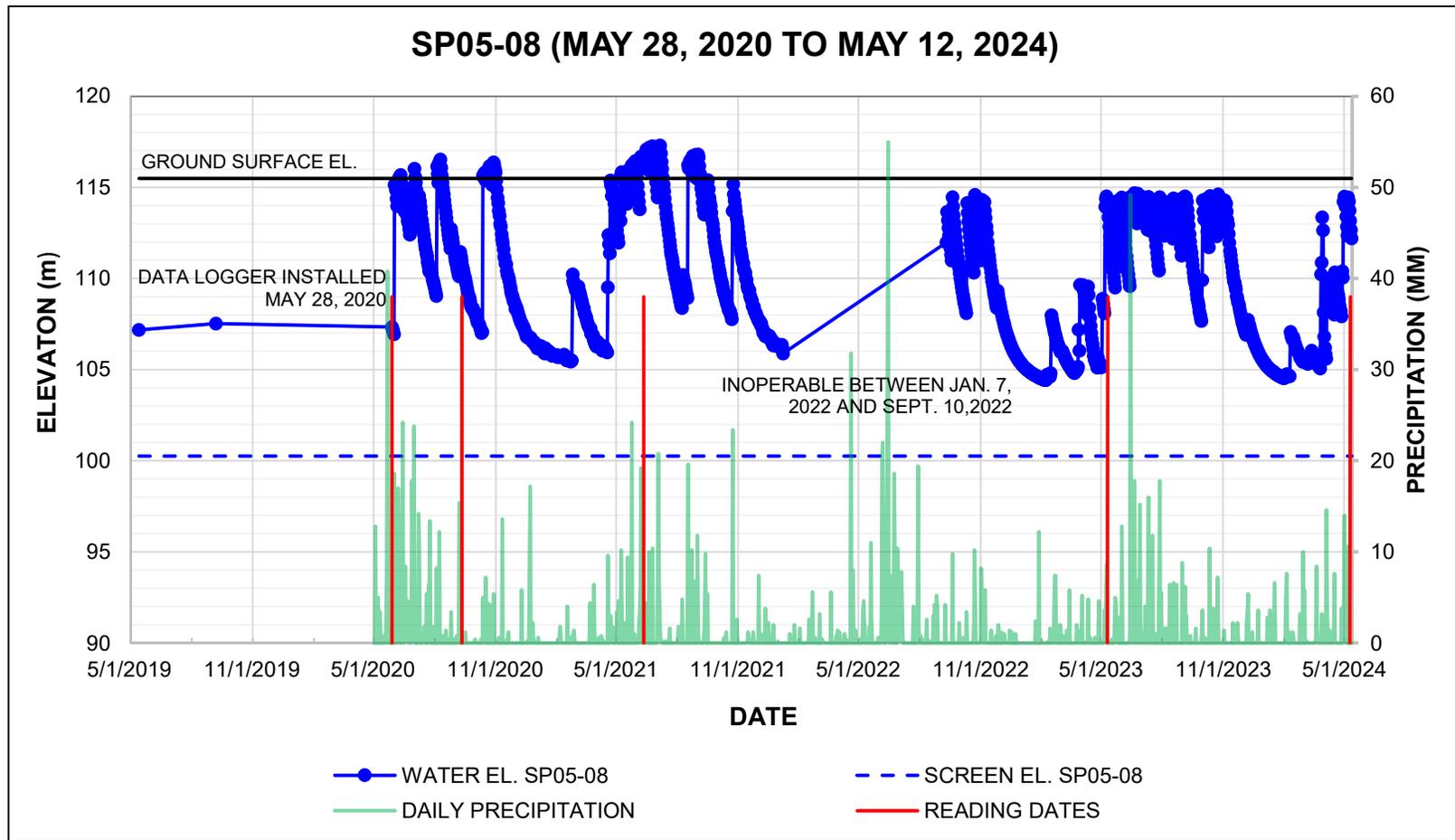
Alberta Transportation



NOTES:

1. PRECIPITATION DATA OBTAINED FROM ALBERTA ENVIRONMENT AND PARKS' WATER VALLEY WEATHER STATION ON MAY 22, 2024.
2. SP05-08 DATA LOGGER WAS REMOVED FROM C042 SITE ON MAY 14, 2024.

CLIENT  	PROJECT CENTRAL REGION GEOHAZARD RISK MANAGEMENT PROGRAM	
	TITLE Piezometer Data C042 - West of Water Valley Slide Hwy 579:02, km 36.540	
SCALE	PROJECT No. A05116A02	FIG No. I-1



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CLIENT 	PROJECT CENTRAL REGION GEOHAZARD RISK MANAGEMENT PROGRAM <hr/> TITLE Piezometer Data C042 - West of Water Valley Slide Hwy 579:02, km 36.540 <hr/> SCALE PROJECT No. A05116A02 FIG No. I-2
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