Klohn Crippen Berger

January 10, 2022

Alberta Transportation
Main Floor, Provincial Building
9621 96 Avenue
Peace River, Alberta
T8S 1T4

Ed Szmata
Construction Technologist

Dear Mr. Szmata:

CON0022166 Peace Region (Grande Prairie District – South) GRMP Instrumentation Monitoring Site GP038-I; H40:38; km 25.831 North of Kakwa River Bridge (North Little Prairie Creek) Section C – 2021 Spring Readings

1 GENERAL

One slope inclinometer (SI) (SI17-1), four pneumatic piezometers (PNs) (PN17-1A, PN17-2A, PN17-2B, and PN17-3B), and one standpipe piezometer (SP) (SP17-1) were read at the GP038 site in the Peace Region (Grande Prairie District – South) (GP South) on June 28, 2021 by Mr. James Lyons, E.I.T. and Ms. Amy Miller, 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 40:38, km 25.831. The site coordinates are 6033163 N, 398377 E (UTM zone 11, NAD 83). A site plan is presented in Figure 1.

The geohazard at the GP038-I and -II sites consist of two repaired landslides in the highway embankment fill 2 km and 1.6 km north of the Kakwa River bridge, respectively. Construction to remediate the landslides was completed in 2018, with post-construction hairline diagonal pavement cracking at the GP038-I site and post-construction pavement patch settlement at the GP038-II site.

1.1 Instrumentation

Instrumentation installation details are tabulated in Table 1.1. Instrument locations are shown in Figure 1.

In February 2-17, three SIs (SI17-1 through SI17-3), six PNs (PN-1A through PN-3A and PN-1B through PN-3B), and two SPs (SP17-1 and SP17-2) were installed. The SIs and piezometers were installed to monitor depth of movement and groundwater conditions, respectively. Some of these instruments have since become inoperable (e.g., destroyed, sheared, or lost), including:

- SI17-2 and SI17-3 have sheared at an approximately depth of 12.2 m and 11.0 m, respectively;
- PN17-1B is inoperable;

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- PN17-3A has not stabilized since June 2018; and
- SP17-2 was destroyed in 2017.

The instruments are protected with above-ground casing protectors.

Before spring 2021, the SIs were being read by another consultant, who was using an imperial RST Digital Inclinometer System. KCB uses a metric RST Digital Inclinometer System and moving forward, the metric system will be used to read the SI.

The PNs and SP were read using an RST C109 pneumatic piezometer readout and RST Water Level Meter, respectively. Prior to the spring 2021 monitoring program, PNs and SPs were read using an RST C108 pneumatic piezometer readout and a DGSI dipmeter, respectively.

Table 1.1 Instrumentation Installation Details

Instrument ID	Instrument Type	Date Installed	Coordinates[1] (m)		Ground Surface Elevation (m)	Stick Up (m)	Depth Below Ground Surface (m)	Condition
			Northing	Easting				
SI17-1	SI	Feb. 8, 2017	6033126	398415	845	0.8	18.5	Operational
~~SI17-2~~	~~SI~~	~~Feb. 8, 2017~~	~~Unknown~~	~~Unknown~~	~~Unknown~~	~~Unknown~~	~~Unknown~~	~~Inoperable[2]~~
~~SI17-3~~	~~SI~~	~~Feb. 8, 2017~~	~~Unknown~~	~~Unknown~~	~~Unknown~~	~~Unknown~~	~~Unknown~~	~~Inoperable[3]~~
PN17-1A	PN	Feb. 4, 2017	6033126	398415	845	N/A	7.2	Operational
~~PN17-1B~~	~~PN~~	~~Feb. 4, 2017~~	~~6033126~~	~~398415~~	~~845~~	~~N/A~~	~~15.9~~	~~Inoperable~~
PN17-2A	PN	Feb. 4, 2017	6033103	398444	842	N/A	7.6	Operational
PN17-2B	PN	Feb. 4, 2017	6033103	398444	842	N/A	12.6	Operational
~~PN17-3A~~	~~PN~~	~~Feb. 3, 2017~~	~~6033083~~	~~398433~~	~~839~~	~~N/A~~	~~8.9~~	~~Inoperable~~
PN17-3B	PN	Feb. 3, 2017	6033083	398433	839	N/A	13.9	Operational
SP17-1	SP	Feb. 3, 2017	6032882	398720	822	0.95	10.4	Operational
~~SP17-2~~	~~SP~~	~~Feb. 2, 2017~~	~~6032873~~	~~398710~~	~~822~~	~~1.00~~	~~14.9~~	~~Inoperable~~

Notes:
[1]Coordinates of the instruments were provided by AT and the previous consultant.
[2]SI17-2 is sheared at 12.2 mbgs.
[3]SI17-3 is sheared at 11.0 mbgs.

2 INTERPRETATION

2.1 General

For the one operational SI at the GP038-I site, the cumulative displacement, incremental displacement, and displacement-time data was plotted in the A-direction (i.e., the direction of the A0-groove) and the X-direction (i.e., the direction of maximum movement obtained at a skew angle from the A0-grooves). SI17-1 has a skew angle of 348°, measured clockwise from the direction of the A0-grooves.

For the piezometers, the water level data was plotted relative to ground surface elevation and each instrument's tip elevation.

The SI and piezometer plots are included in Appendix I, and a summary of the SI, PN, and SP data is provided in Table 2.1, Table 2.2, and **Error! Reference source not found.**, respectively.

Table 2.1 Slope Inclinometer Reading Summary (GP038-I site)

Instrument ID	Date Initialized	Date of Previous Reading	Date Previous Maximum Cumulative Movement Recorded	Date of Most Recent Reading	Ground Surface Elevation (m)	Depth of Movement (mbgs[1])	Maximum Cumulative Movement Recorded (mm)	Incremental Movement Recorded Since Previous Maximum Cumulative Movement Recorded (mm)	Rate of Movement (mm/year)		
									Previous Maximum	Current	Change from Previous Reading
SI17-1	Feb. 8, 2017	Oct. 8, 2020	Oct. 10, 2019	Jun. 28, 2021	844.7	10.0 – 12.5	28.6	-0.3	6.4	-1.0	-1.0
			Jun. 25, 2020			15.0 – 17.0	2.3	-0.1	5.8	-0.5	-0.5

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

Table 2.2 Pneumatic Piezometer Reading Summary (GP038-I site)

Instrument ID	Date Installed	Date of Previous reading	Date of Most Recent Reading	Ground Surface Elevation (m)	Tip Depth (mbgs[1])	Previous Water Level (mbgs[1])	Current Water Level (mbgs[1])	Change from Previous Reading (m)
PN17-1A	Feb. 4, 2017	Oct. 8, 2020	Jun. 28, 2021	845	7.2	0.7	-0.1	0.8
PN17-2A	Feb. 4, 2017	Oct. 8, 2020	Jun. 28, 2021	842	7.6	0.0	0.1	-0.1
PN17-2B	Feb. 4, 2017	Oct. 8, 2020	Jun. 28, 2021	842	12.6	0.6	0.0	0.6
PN17-3B	Feb. 3, 2017	Oct. 8, 2020	Jun. 28, 2021	839	13.9	1.7	1.0	0.7

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

Table 2.3 Standpipe Piezometer Reading Summary (GP038-II site)

Instrument ID	Date Installed	Date of Previous reading	Date of Most Recent Reading	Ground Surface Elevation (m)	Tip Depth (mbgs[1])	Previous Water Level (mbgs[1])	Current Water Level (mbgs[1])	Change from Previous Reading (m)
SP17-1	Feb. 3, 2017	Oct. 8, 2020	Jun. 28, 2021	822	10.4	2.4	1.8	0.6

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

KCB reviewed the instrumentation data provided by the previous consultant and removed corrections applied to the historical SI data based on our experience. The instrumentation data obtained by KCB is consistent with the data obtained by the previous consultant and no reinitialization of the SI is recommended. The SI data plots presented herein include data for readings taken with both the previous consultants' and KCB's equipment.

2.2 Zones of Movement

SI17-1 is recording two zones of movement. There is a deeper zone of movement from approximately El. 828.5 m to El. 829.5.0 m (in the upper portion of the clay underlying clay till) and a more-shallow zone of distributed movement from approximately El. 832.0 m to El. 843.5 m (lower portion of the clay till foundation unit).

2.3 Interpretation of Monitoring Results

GP038-I Site

There was an increased rate of movement recorded in SI17-1 between June 2017 and June 2018 (27 mm/year). However, in 2017 and 2018, the CSP culvert was extended, and a toe berm was built to stabilize the highway embankment. Since construction, the rate of movement has attenuated (less than 1 mm/year). The movements recorded in SI17-1 do not appear to be influenced yet by the slowly rising pore pressures recorded by PN17-1A.

All of the active piezometers (PN17-1A, PN17-2A and -2B, PN17-3B) are recorded water level near ground (fill) surface elevation. Four of the five piezometers recorded water level increases (0.6 m to 0.8 m), excluding PN17-2A, which recorded a 0.1 m decrease. The relatively high-water level could result in the embankment having reduced stability and explain the hairline cracks showing up on the pavement surface in previous years. Continued erosion or increases in water levels could result in reactivation of slope instability.

GP038-II Site

The water level recorded in SP17-1 in the upslope ditch is relatively high. The settlement of the pavement may be unrelated to the water level recorded in SP17-1, being more likely to be minor settlement of recently placed fill.

3 RECOMMENDATIONS

3.1 Future Work

All operational 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 GP South GRMP Section B inspections.

3.2 Instrument Repairs

No instrument repairs are 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 (Client) for the specific application to the Peace Region 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. KCB should be consulted regarding the interpretation or application of the findings and recommendations in the report.

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

Yours truly,

KLOHN CRIPPEN BERGER LTD.

PROFESSIONAL ENGINEER ALBERTA
CHRIS GRÄPEL

2022-01-10

PERMIT TO PRACTICE
KLOHN CRIPPEN BERGER LTD.
RM SIGNATURE:
RM APEGA ID #: 187607
DATE: 10 Jan. 2022
PERMIT NUMBER: P009196
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

James Lyons, E.I.T.
Civil Engineer

Chris Gräpel, M.Eng., P.Eng.
Senior Civil Engineer, Associate

JL:bb

ATTACHMENTS
Figure
Appendix I Instrumentation Plots

FIGURE

Legend

- Pneumatic Piezometer (PN)
- Slope Inclinometer (SI)
- Standpipe Piezometer (SP)

Metres
0 125

NOTES:
1. HORIZONTAL DATUM: NAD83
2. GRID ZONE: UTM Zone 11N
3. IMAGE SOURCE: Microsoft Bing

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

TITLE
Site Plan
GP034-I and -II - North Little Prairie Creek Slide
Hwy 40:38, km 25.831

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APPENDIX I

Instrumentation Plots

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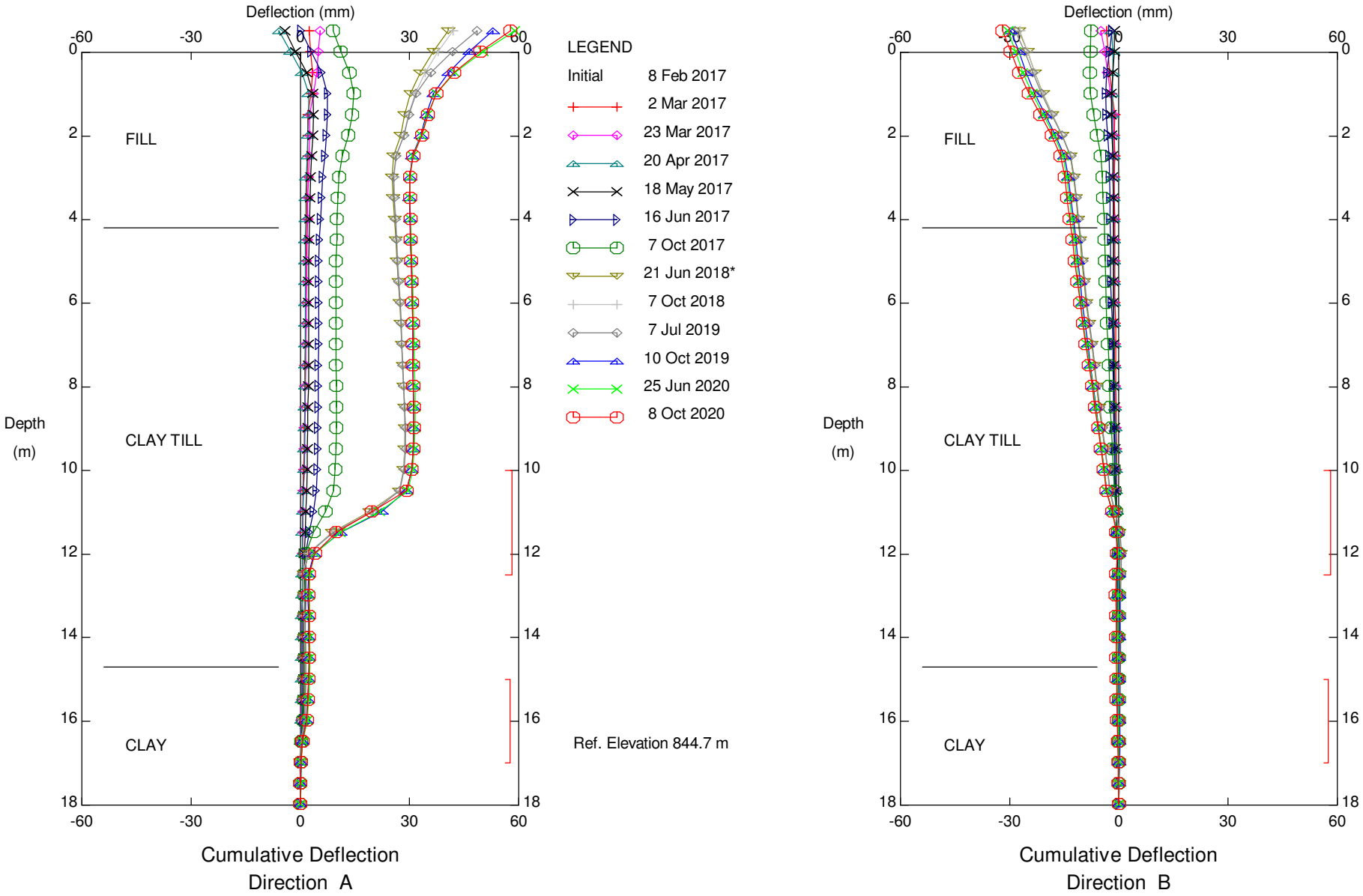

GP038-I; H40:38, Kakwa River Bridge, Inclinometer SI17-1

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

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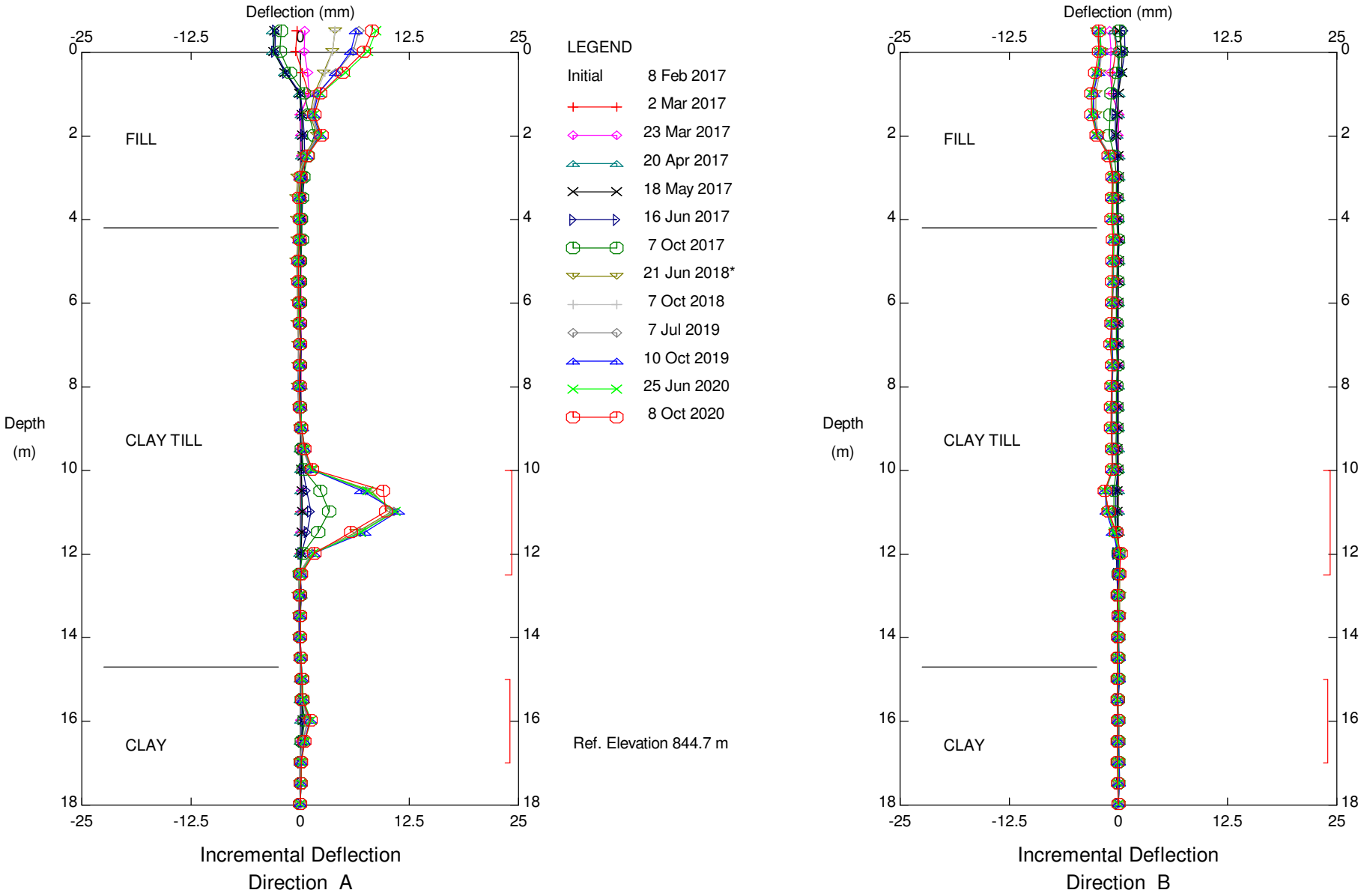

GP038-I; H40:38, Kakwa River Bridge, Inclinometer SI17-1

Alberta Transportation

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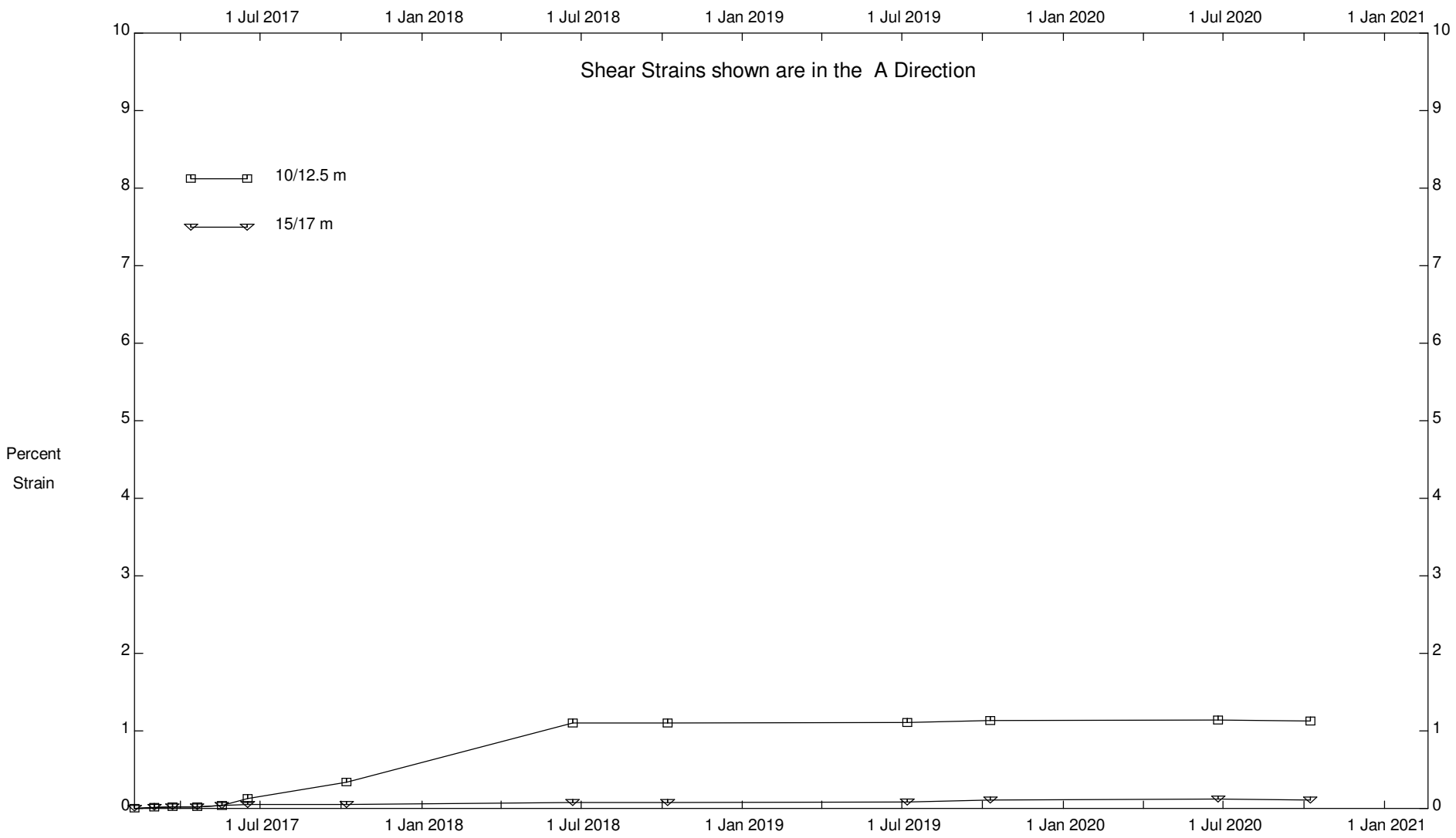

GP038-I; H40:38, Kakwa River Bridge, Inclinometer SI17-1

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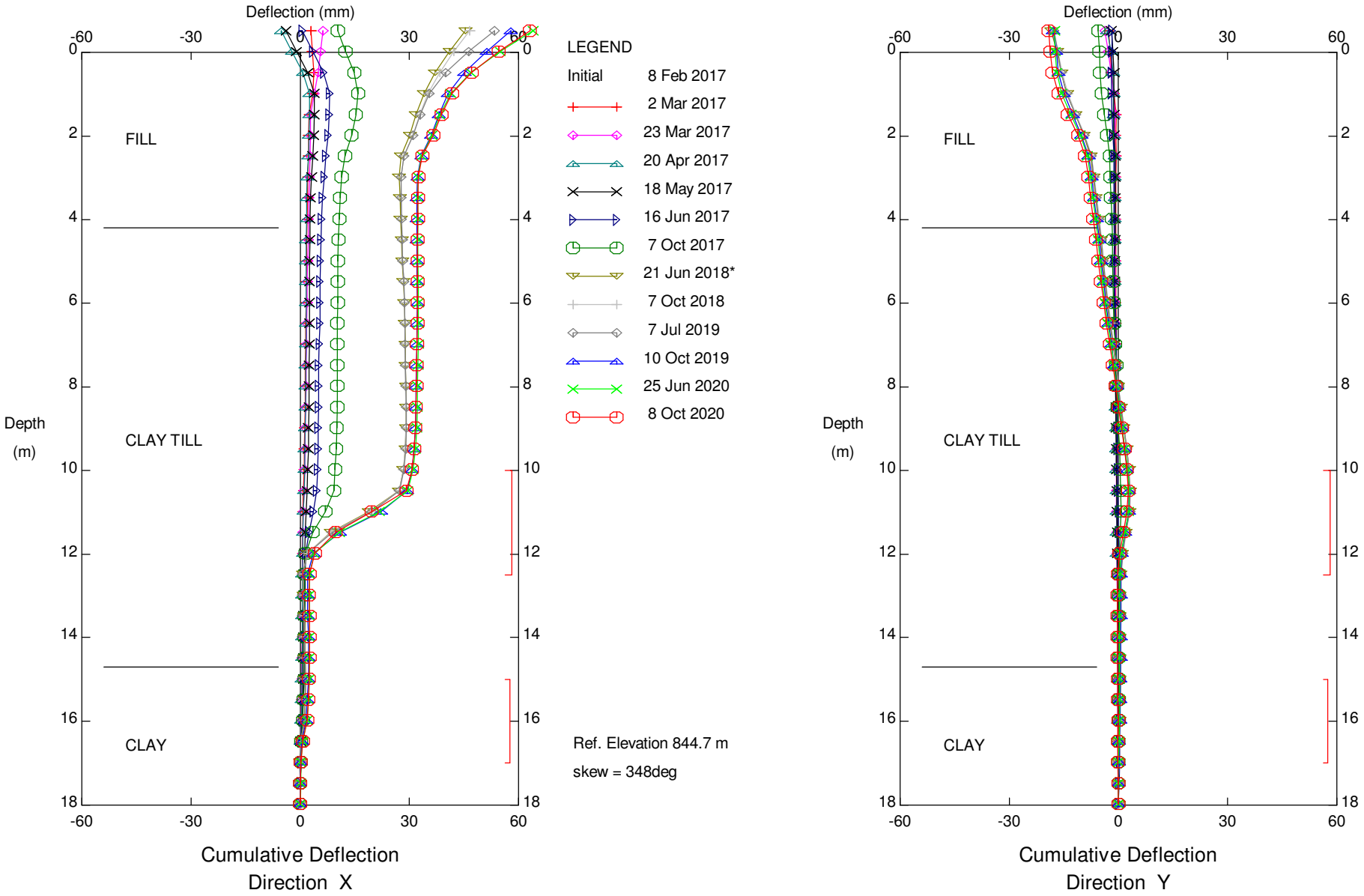

GP038-I; H40:38, Kakwa River Bridge, Inclinometer SI17-1

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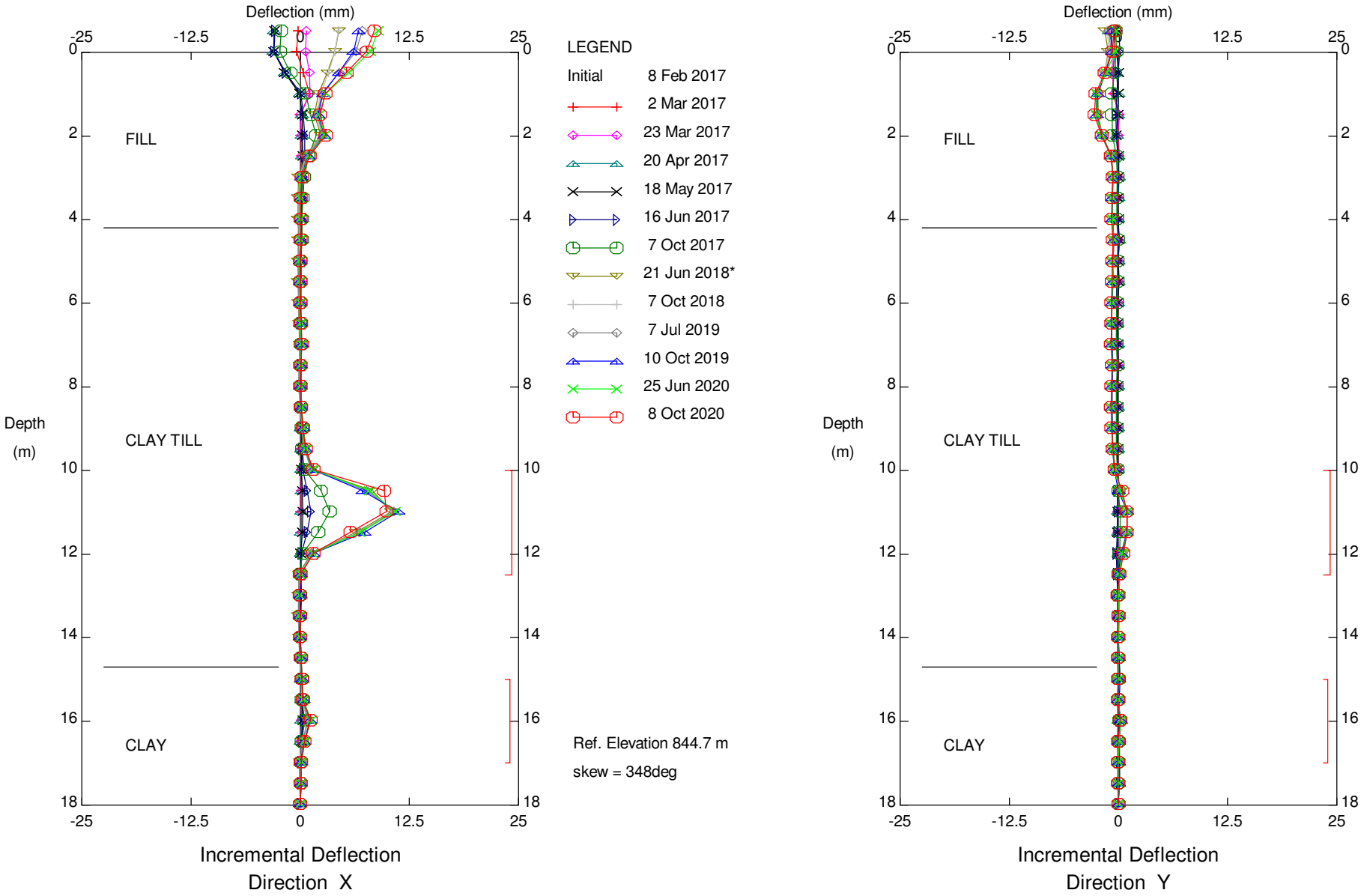

GP038-I; H40:38, Kakwa River Bridge, Inclinometer SI17-1

Alberta Transportation

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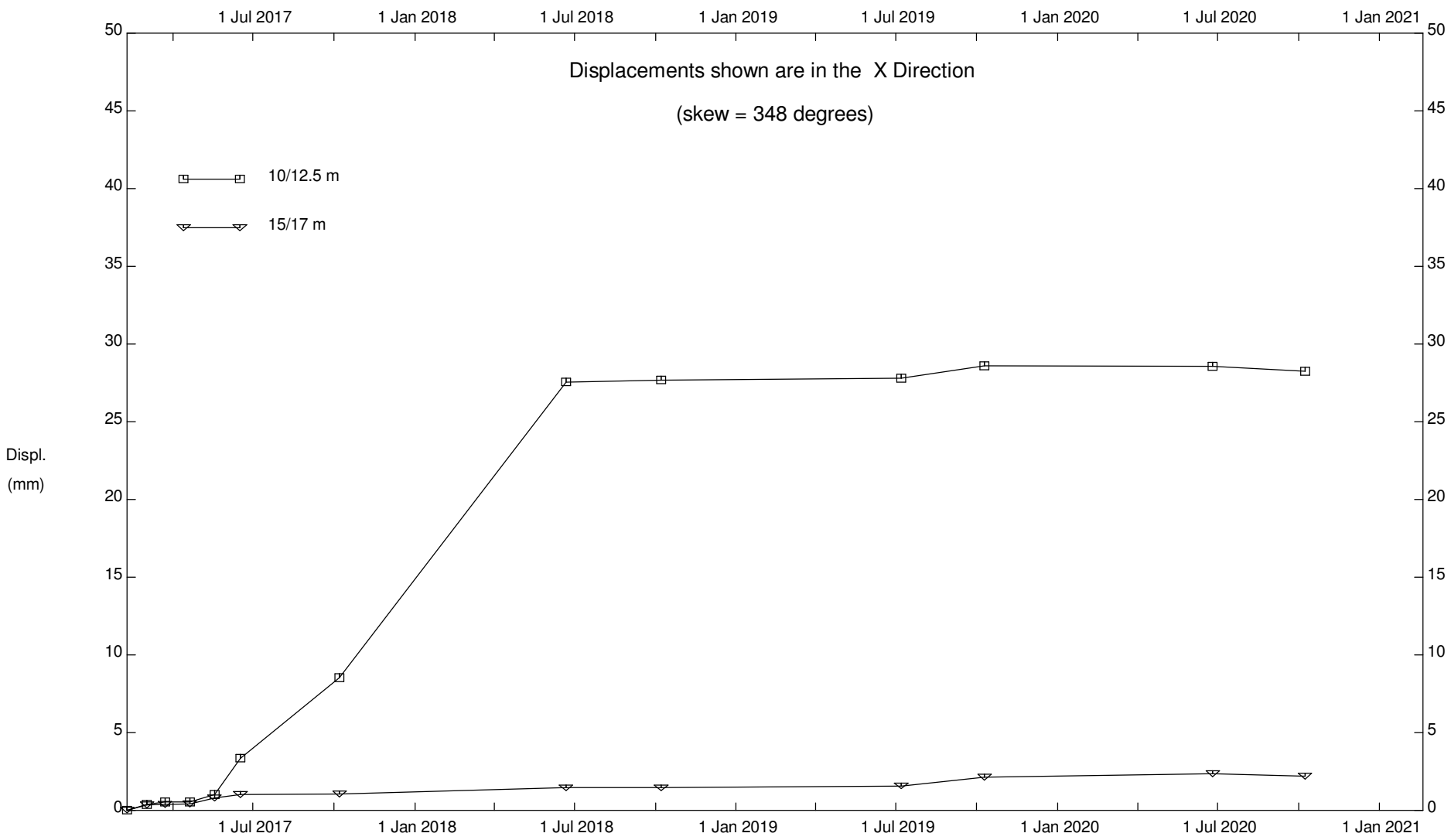

GP038-I; H40:38, Kakwa River Bridge, Inclinometer SI17-1

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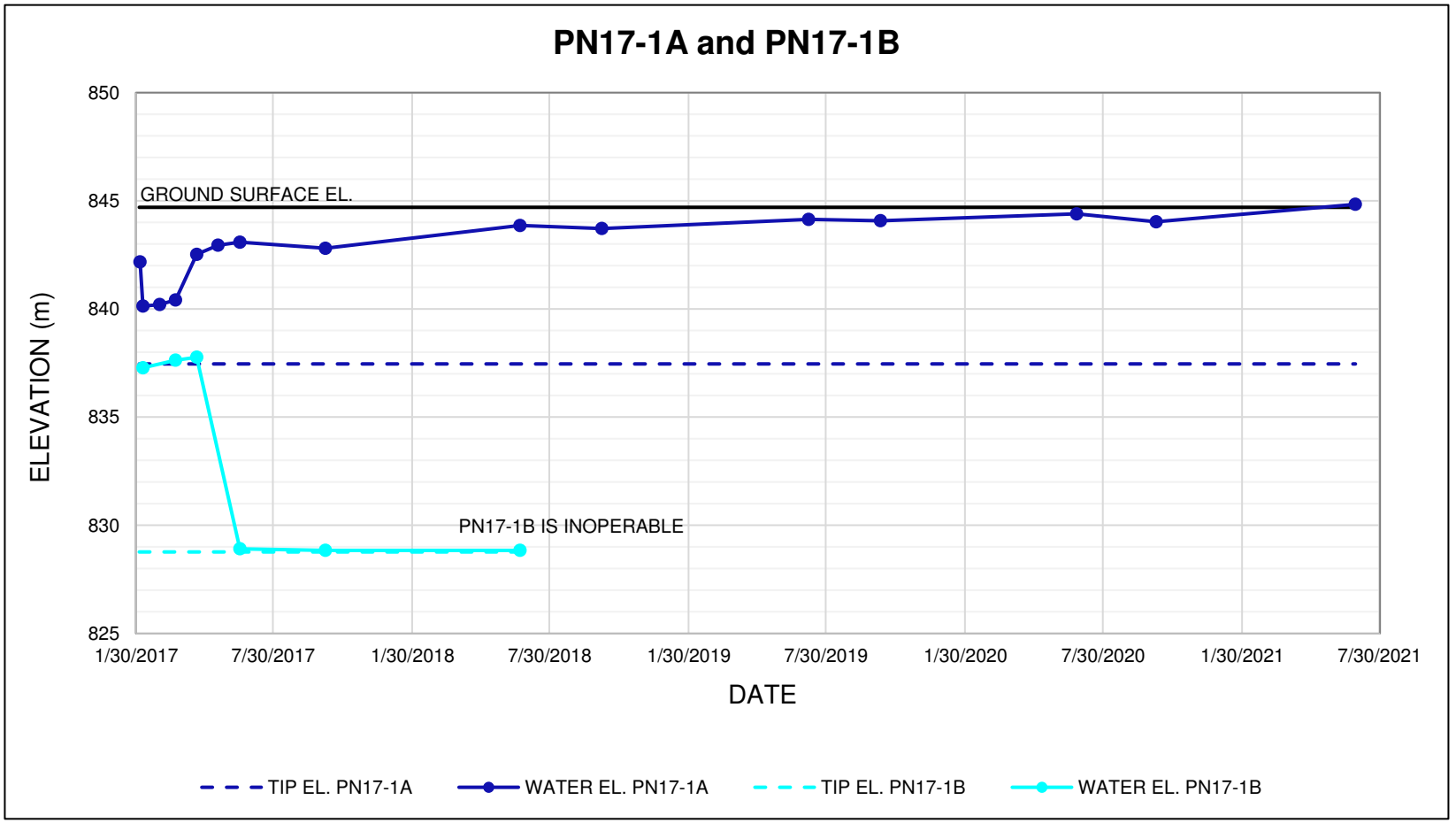

Notes:
1. Piezometer data obtained before the spring 2021 reading on June 28, 2021 was provided to KCB by Alberta Transportation (AT) on June 25, 2021.

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

TITLE
Piezometer Data
GP038 - Kakwa River Bridge
Hwy 40:38, km 25.831

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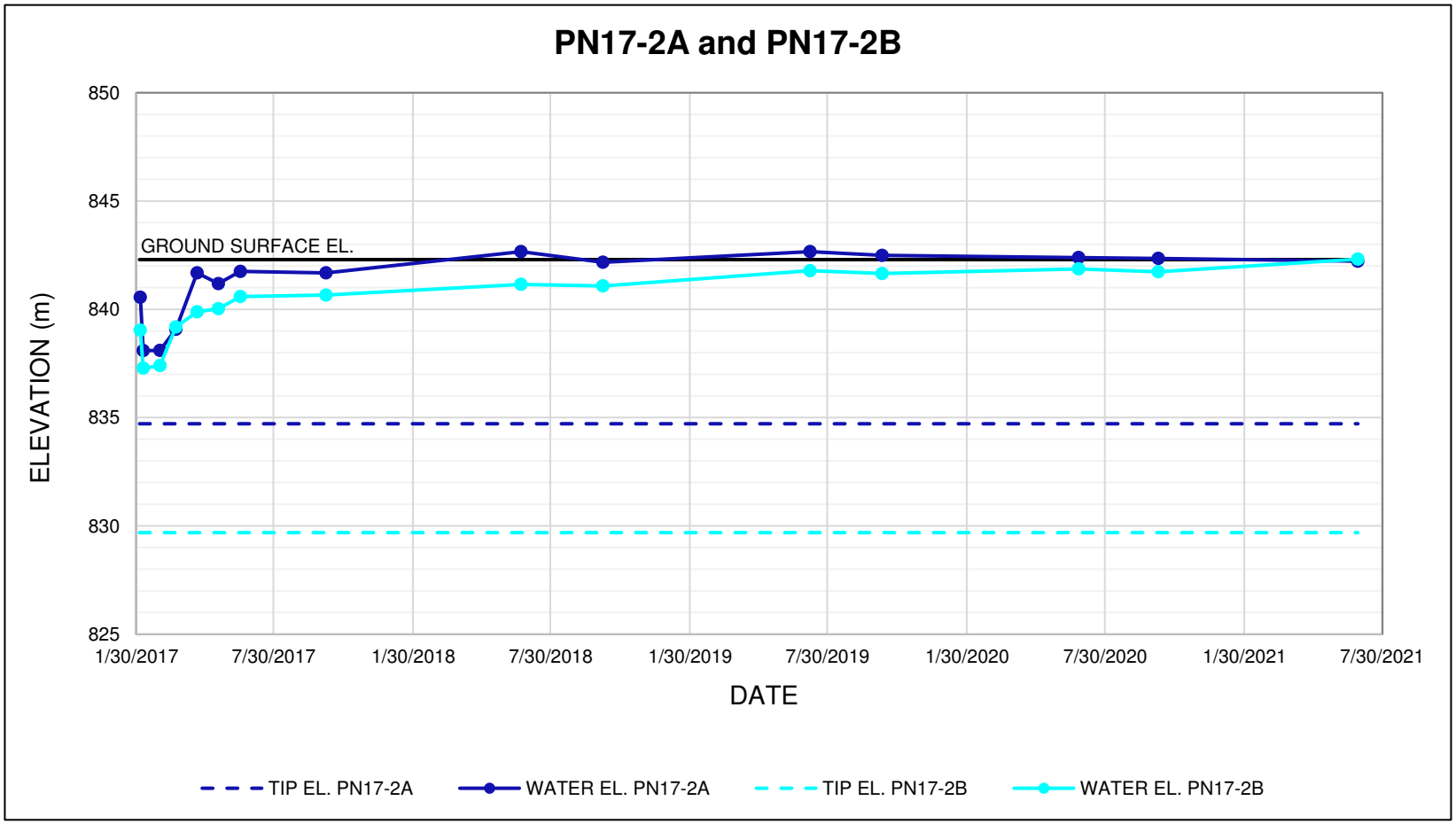

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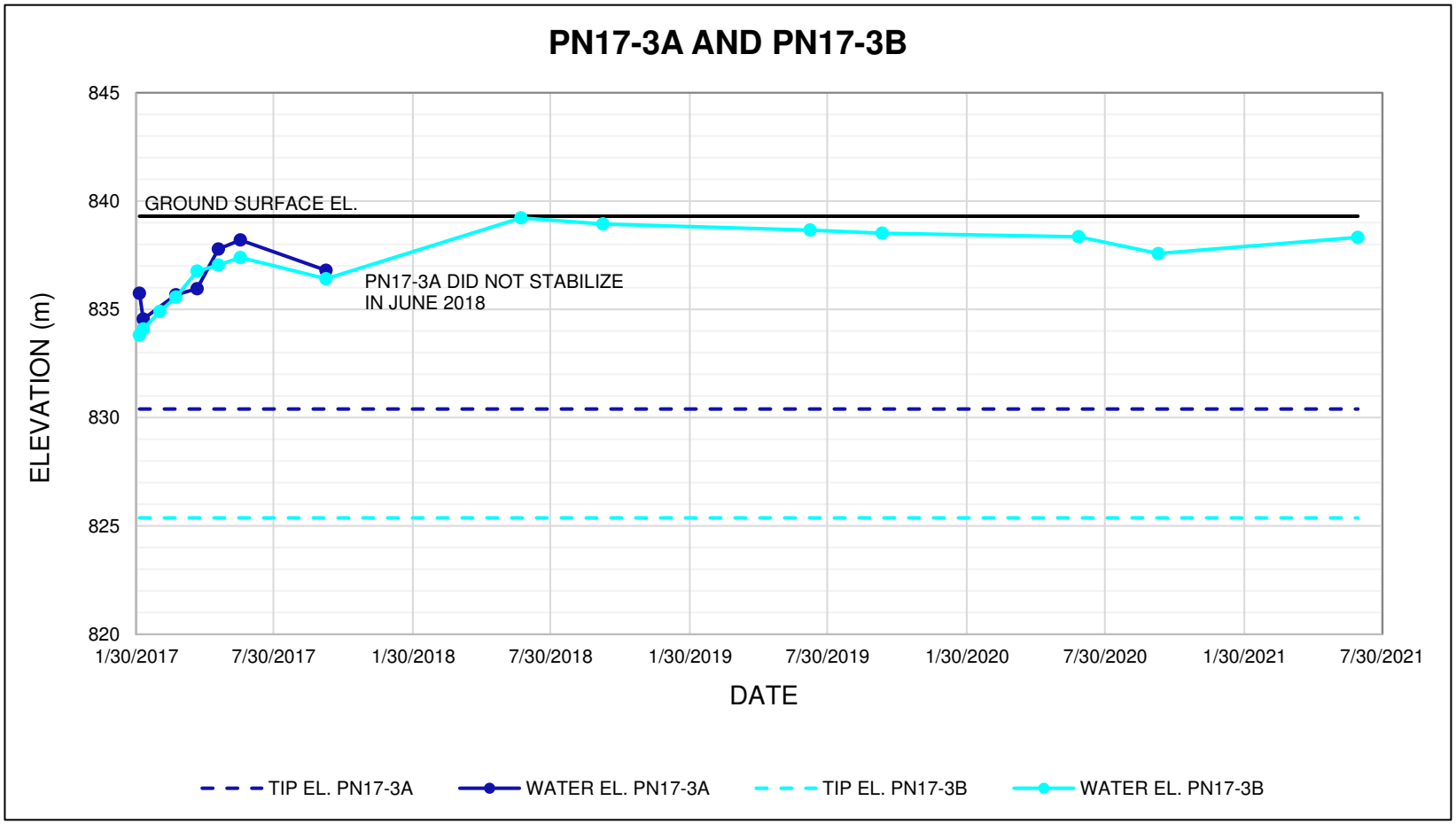

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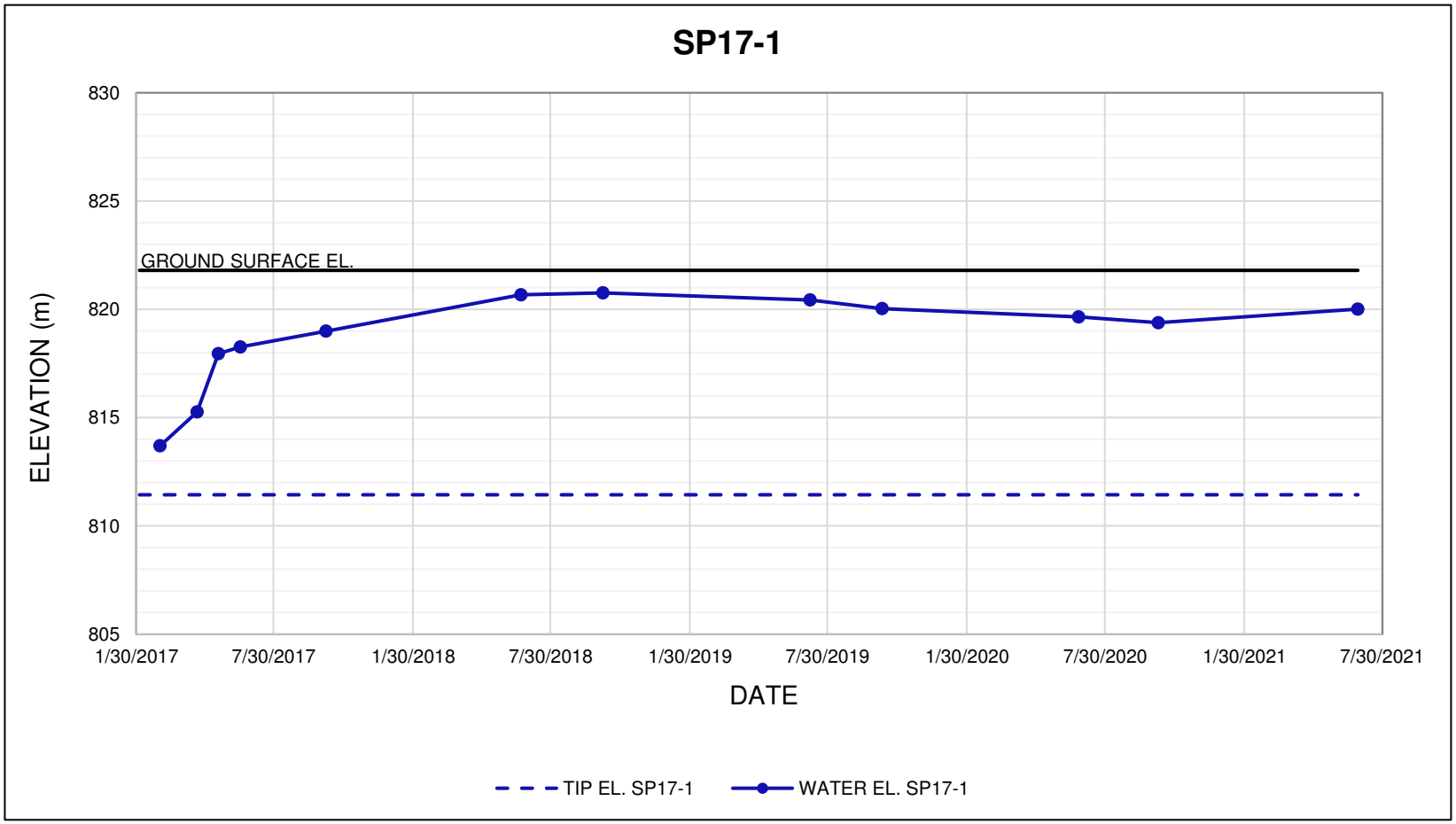

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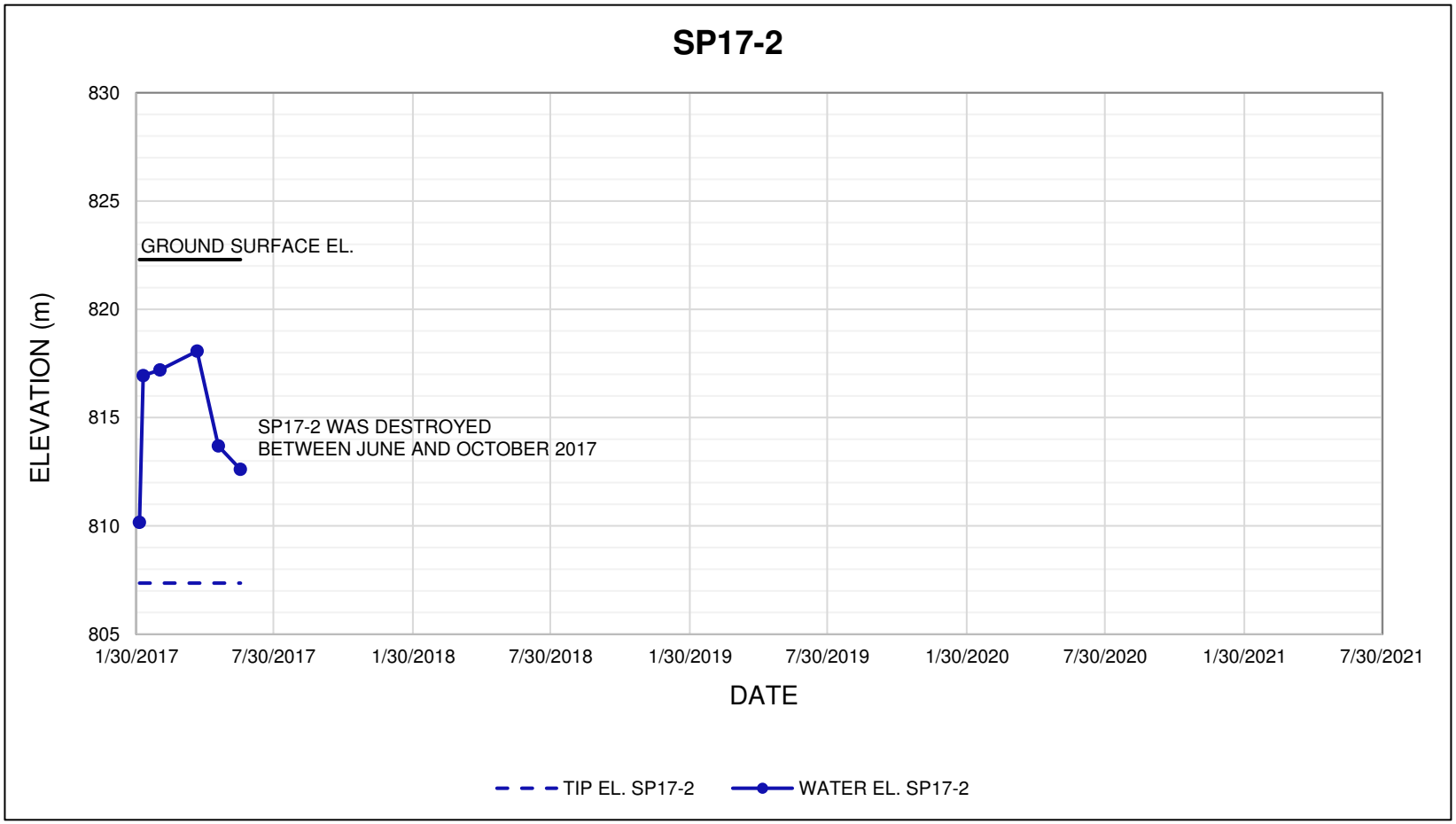

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