

November 19, 2021

Alberta Transportation  
Main Floor, Provincial Building  
9621 – 96<sup>th</sup> Avenue  
Peace River, Alberta  
T8S 1T4

**Ed Szmata**  
**Construction Technologist**

Dear Mr. Szmata:

**CON0022166 Peace Region (Grande Prairie District – South) GRMP Instrumentation Monitoring Site GP042; H40:36, km 37.524 Slide 9 km North of Wanyandie Road Section C – 2021 Fall Readings**

## **1 GENERAL**

Two slope inclinometers (SIs) (TH20-DS2 and TH20-DS5), twenty vibrating wire piezometers (VWPs) (VW20-P1A and P1B; VW20-P2 through P6; VW20-S1 through S3; VW20-D1; VW20-DS1A through DS4A; VW20-DS1B, DS2B, and DS4B; VW20-5; and VW20-DS6A), and one standpipe piezometer (SP) (TH20-D6) were read at the GP042 site in the peace region (Grande Prairie District – South) (GP South region) on September 10, 2021 by Messrs. James Lyons, E.I.T. and Jacques Bernier, 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 37.524. The approximate site coordinates are 5996853 N, 379884 E (UTM Zone 11, NAD 83). A site plan is presented in Figure 1.

The geohazard at the GP042 site consists of a landslide in the embankment fill on the east side of Hwy 40:36. Construction began at this site in September 2021 and will consist of flattening the backslope and installing a pile wall.

### **1.1 Instrumentation**

KCB has been reading the instruments at this site since the spring of 2021. Instrumentation installation details provided by Alberta Transportation (AT) and the previous consultant are tabulated in Table 1.1. Instrument locations are shown in Figure 1. Any instruments not included in Table 1.1 or shown in Figure 1 are assumed to be inoperable. It is noted that the ground surface elevations included in Table 1.1 were measured before construction started in September 2021 and need to be updated.

In 2020, two SIs (TH20-DS2 and TH20-DS5), twenty-four VWPs (VW20-P1A and P1B; VW20-P2 through P6; VW20-S1 through S3; VW20-D1 through D4; VW20-DS1A through DS4A; VW20-DS1B, DS2B, and DS4B; VW20-5; and VW20-DS6A and DS6B), and six SPs (TH20-D5 and D6, and TH20-B1

through B4) were installed by the previous consultant. The SIs were installed in the slide mass to assess the depth of movement. The piezometers were installed in the slide mass and adjacent to the slide mass to understand groundwater conditions. Two VWPs (VW20-D3 and D4) and five SPs (TH20-D5, and TH20-B1 through B4) were destroyed in 2021 during construction.

The instruments are protected by above-ground casing protectors.

The operational 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 VWPs and SPs were read using an RST VW2106 vibrating wire readout and RST Water Level Meter, respectively.

**Table 1.1 Instrumentation Installation Details**

Instrument ID	Instrument Type	Date Installed <sup>1</sup>	Coordinates <sup>1</sup> (m)		Ground Surface Elevation <sup>1,2</sup> (m)	Stick Up <sup>1</sup> (m)	Depth <sup>1,2</sup> (mbgs <sup>3</sup> )	Condition
			Northing	Easting				
TH20-DS2	SI	Jul. 06, 2020	997067	380002	1134.4	0.8	23.4	Operational
TH20-DS5	SI	Jul. 09, 2020	997209	380061	1141.4	1.0	17.3	Operational
VW20-P1A	VWP	Jun. 23, 2020	5996932	379925	1128.1	N/A	6.4	Operational
VW20-P1B	VWP	Jun. 23, 2020	5996932	379925	1128.1	N/A	17.7	Operational
VW20-P2	VWP	Jun. 25, 2020	5997067	379983	1138.0	N/A	9.8	Operational
VW20-P3	VWP	Jun. 26, 2020	5997093	379994	1141.0	N/A	14.9	Operational
VW20-P4	VWP	Jun. 29, 2020	5997156	380022	1142.0	N/A	7.9	Operational
VW20-P5	VWP	Jul. 03, 2020	5997194	380040	1148.2	N/A	13.1	Operational
VW20-P6	VWP	Jul. 04, 2020	5997221	380051	1159.8	N/A	8.8	Operational
VW20-S1	VWP	Jun. 28, 2020	5996995	379955	1133.0	N/A	16.8	Operational
VW20-S2	VWP	Jul. 10, 2020	5997282	380085	1152.3	N/A	12.5	Operational
VW20-S3	VWP	Jul. 11, 2020	5997343	380125	1152.9	N/A	12.7	Operational
VW20-D1	VWP	Jun. 23, 2020	5996938	379991	1127.8	N/A	6.4	Operational
<del>VW20-D2</del>	<del>VWP</del>	<del>Jun. 27, 2020</del>	<del>5997078</del>	<del>379971</del>	<del>1145.0</del>	<del>N/A</del>	<del>5.2</del>	<del>Inoperable</del>
<del>VW20-D3</del>	<del>VWP</del>	<del>Jun. 27, 2020</del>	<del>5997154</del>	<del>380008</del>	<del>1144.0</del>	<del>N/A</del>	<del>10.7</del>	<del>Inoperable<sup>4</sup></del>
<del>VW20-D4</del>	<del>VWP</del>	<del>Jun. 30, 2020</del>	<del>5997200</del>	<del>388027</del>	<del>1148.1</del>	<del>N/A</del>	<del>11.6</del>	<del>Inoperable<sup>4</sup></del>
VW20-DS1A	VWP	Jun. 24, 2020	5996898	379928	1121.8	N/A	4.6	Operational
VW20-DS1B	VWP	Jun. 24, 2020	5996898	379928	1121.8	N/A	11.4	Operational
VW20-DS2A	VWP	Jul. 12, 2020	5997067	380002	1134.2	N/A	8.2	Operational
VW20-DS2B	VWP	Jul. 12, 2020	5997067	380002	1134.2	N/A	22.2	Operational
VW20-DS3A	VWP	Jul. 06, 2020	5997151	380041	1139.4	N/A	10.7	Operational
VW20-DS4A	VWP	Jul. 07, 2020	5997188	380057	1140.4	N/A	4.9	Operational
VW20-DS4B	VWP	Jul. 07, 2020	5997188	380057	1140.4	N/A	20.7	Operational
VW20-DS5	VWP	Jul. 09, 2020	5997209	380061	1141.4	N/A	5.0	Operational
VW20-DS6A	VWP	Jul. 05, 2020	5997159	380098	1121.0	N/A	6.1	Operational
<del>VW20-DS6B</del>	<del>VWP</del>	<del>Jul. 5, 2020</del>	<del>5997159</del>	<del>380098</del>	<del>1121.0</del>	<del>N/A</del>	<del>21.3</del>	<del>Inoperable</del>
TH20-D5	SP	Jun. 30, 2020	5997232	380040	1150.3	0.8	3.1	Inoperable <sup>4</sup>
TH20-D6	SP	Jul. 01, 2020	5997360	380102	1156.6	0.9	8.6	Operational
TH20-B1	SP	Jul. 9, 2020	5996956	379865	1148.2	0.9	12.2	Inoperable <sup>4</sup>
TH20-B2	SP	Jul. 9, 2020	5997032	379925	1150.2	0.9	13.6	Inoperable <sup>4</sup>
TH20-B3	SP	Jul. 10, 2020	5997176	379968	1165.3	1.1	3.7	Inoperable <sup>4</sup>
TH20-B4	SP	Jul. 10, 2020	5997244	380009	1168.7	1.0	4.5	Inoperable <sup>4</sup>

**Notes:**

<sup>1</sup> Installation details were provided by AT and the previous consultant.

<sup>2</sup> Ground surface elevations were measured prior to construction and need to be updated.

<sup>3</sup> Meters below ground surface (mbgs). Bottom reading depth for SIs and tip or screen depth for piezometers.

<sup>4</sup> VW20-D3 and D2, TH20-D5, and TH20-B1 through B4 were destroyed in 2021 during construction.

## 2 INTERPRETATION

### 2.1 General

For the operational SIs, the cumulative displacement, incremental displacement, and displacement-time data was plotted in the A-direction (i.e., the direction of the A0-groove) and, where applicable, the X-direction (i.e., the direction of maximum movement obtained at a skew angle from the A0-grooves). TH20-DS2 and TH20-DS5 have skew angles of 345° and 30°, respectively, measured clockwise from the direction of the A0-grooves.

Azimuths of the SI A0-grooves were not provided. It is difficult for KCB to review the previously applied skew angles and to interpret the resultant direction of movement for the SIs. KCB will confirm the azimuths of the A0-grooves with a compass in the spring of 2022.

For the operational VWPs, the recorded porewater pressures were converted to an equivalent water/piezometric elevation, and plotted relative to ground surface elevation and each instrument's tip elevation.

For the operational SP, the water level data was plotted relative to ground surface elevation and the instrument's screen elevation.

The SI and piezometer plots are included in Appendix I, and a summary of the SI and piezometer data is provided in Table 2.1 through Table 2.2.

**Table 2.1 Slope Inclinometer Reading Summary**

Instrument ID	Date				Ground Surface Elevation <sup>2</sup> (m)	Depth of Movement (mbgs <sup>1,2</sup> )	Direction of Movement <sup>3</sup>	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	Current	Change from Previous Reading
TH20-DS2	Jul. 13, 2020	Oct. 20, 2020	Jun. 28, 2021	Sep. 10, 2021	1134.2	7.4 – 8.9	X-direction, 345°	44.6	0.2	187.3	0.7	1.6
TH20-DS5	Jul. 13, 2020	Jun. 28, 2021	Jun. 28, 2021	Sep. 10, 2021	1141.4	3.3 – 4.3	X-direction, 30°	25.8	0.6	670.8	3.0	-5.0

**Notes:**

<sup>1</sup> Meters below ground surface (mbgs).

<sup>2</sup> Ground surface elevations were measured prior to construction and need to be updated.

<sup>3</sup> Skew angle of X-direction measured clockwise from the A-direction.

**Table 2.2 Vibrating Wire Piezometer Reading Summary**

Instrument ID	Approximate Location	Date Installed	Date of Previous Reading	Date of Most Recent Reading	Ground Surface Elevation <sup>2</sup> (m)	Tip Depth (mbgs <sup>1,2</sup> )	Previous Water Level (mbgs <sup>1,2</sup> )	Current Water Level (mbgs <sup>1,2</sup> )	Change from Previous Reading (m)
VW20-P1A	Highway Shoulder	Jun. 23, 2020	Aug. 25, 2021	Sep. 10, 2021	1128.1	6.4	6.8	6.7	0.1
VW20-P1B		Jun. 23, 2020	Aug. 25, 2021	Sep. 10, 2021	1128.1	17.7	14.0	14.0	0.0
VW20-P2		Jun. 25, 2020	Aug. 25, 2021	Sep. 10, 2021	1138.0	9.8	4.4	4.4	0.0
VW20-P3		Jun. 26, 2020	Aug. 25, 2021	Sep. 10, 2021	1141.0	14.9	10.5	10.6	-0.1
VW20-P4		Jun. 29, 2020	Aug. 25, 2021	Sep. 10, 2021	1142.0	7.9	8.0	8.1	-0.1
VW20-P5		Jul. 03, 2020	Aug. 25, 2021	Sep. 10, 2021	1148.2	13.1	13.0	13.0	0.0
VW20-P6		Jul. 04, 2020	Aug. 25, 2021	Sep. 10, 2021	1159.8	8.8	8.8	8.6	0.2
VW20-S1	Within Slide	Jun. 28, 2020	Jun. 28, 2021	Sep. 10, 2021	1133.0	16.8	13.5	14.1	-0.6
VW20-S2		Jul. 10, 2020	Jun. 28, 2021	Sep. 10, 2021	1152.3	12.5	12.8	12.8	0.0
VW20-S3		Jul. 11, 2020	Jun. 28, 2021	Sep. 10, 2021	1152.9	12.7	8.3	8.3	0.0
VW20-D1	Ditch	Jun. 23, 2020	Jun. 28, 2021	Sep. 10, 2021	1127.8	6.4	5.9	6.0	-0.1
VW20-DS1A	Highway Embankment Slope	Jun. 24, 2020	Jun. 28, 2021	Sep. 10, 2021	1121.8	4.6	4.7	4.7	0.0
VW20-DS1B		Jun. 24, 2020	Jun. 28, 2021	Sep. 10, 2021	1121.8	11.4	11.3	11.4	-0.1
VW20-DS2A		Jul. 12, 2020	Jun. 28, 2021	Sep. 10, 2021	1134.2	8.2	3.0	3.4	-0.4
VW20-DS2B		Jul. 12, 2020	Jun. 28, 2021	Sep. 10, 2021	1134.2	22.2	19.4	20.1	-0.7
VW20-DS3A		Jul. 06, 2021	Oct. 07, 2020	Sep. 10, 2021	1139.4	10.7	9.4	8.2	1.2
VW20-DS4A		Jul. 07, 2020	Jun. 28, 2021	Sep. 10, 2021	1140.4	4.9	3.7	4.3	-0.6
VW20-DS4B		Jul. 07, 2020	Jun. 28, 2021	Sep. 10, 2021	1140.4	20.7	10.9	12.3	-1.4
VW20-DS5		Jul. 09, 2020	Jun. 28, 2021	Sep. 10, 2021	1141.4	5.0	3.9	4.2	-0.3
VW20-DS6A		Jul. 05, 2020	Jun. 28, 2021	Sep. 10, 2021	1121.0	6.1	4.1	4.0	0.1

**Notes:**

<sup>1</sup> Meters below ground surface (mbgs).

<sup>2</sup> Ground surface elevations were measured prior to construction and need to be updated.

**Table 2.3 Standpipe Piezometer Reading Summary**

Instrument ID	Approximate Location	Date Installed	Date of Previous Reading	Date of Most Recent Reading	Ground Surface Elevation <sup>2</sup> (m)	Screen Depth (mbgs <sup>1,2</sup> )	Previous Water Level (mbgs <sup>1,2</sup> )	Current Water Level (mbgs <sup>1,2</sup> )	Change from Previous Reading (m)
TH20-D6	Backslope	Jul. 01, 2020	Jun. 28, 2020	Sep. 10, 2021	1156.6	8.6	8.3	8.4	-0.1

**Notes:**

<sup>1</sup> Meters below ground surface (mbgs).

<sup>2</sup> Ground surface elevations were measured prior to construction and need to be updated.

The instrumentation data obtained by KCB is relatively consistent with the data obtained by the previous consultant, except for some reading “noise” (i.e., data with high checksums) that was recorded in TH20-DS5 between an approximate depth of 3.3 m and 4.3 m below ground surface. It is unclear if the noise being recorded in TH20-DS5 is due to changing the SI equipment or continued slide movements damaging the casing. These instruments were only read twice before KCB took over the readings in June 2021. More data is needed to assess trends for these instruments. KCB will assess if reinitialization of the SIs is needed in the spring of 2022 after construction is complete. 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

Discrete movement is being recorded in:

- TH20-DS2 between an approximate depth of 7.4 m and 8.9 m below ground surface; and
- TH20-DS5 between an approximate depth of 3.3 m and 4.3 m below ground surface.

## 2.3 Interpretation of Monitoring Results

Since installation in 2020, approximately 45 mm and 26 mm of discrete movement has been recorded in TH20-DS2 and TH20-DS5, respectively, with most of the movement occurring before October 2020. Since October 2020, the rate of movement being recorded in TH20-DS2 and TH20-DS5 has either halted or decreased to less than 10 mm/year. However, the rate of movement may increase in response to periods of heavy or prolonged rainfall, and/or elevated groundwater levels. Construction activity could result in increased rate of movement, or lateral expansion of zones of movement. More data is needed to assess trend for the instruments installed in 2020.

Generally, the porewater pressures/water levels recorded in the piezometers were steady ( $\pm 0.3$  m) and consistent with previous reading for these instruments, except:

- A 0.6 m decrease recorded in one VWP installed in the slide (VW20-S1);
- A 0.3 m to 1.4 m decrease recorded in five VWPs installed in the highway embankment (VW20-DS2A, DS2B, DS4A, DS4B, and DS5); and
- A 1.2 m increase recorded in one VWP installed in the highway embankment (VW20-DS3A). However, this instrument was last read in October 2020.

The recorded decreases in pore pressure (and associated decrease in the rate of movement recorded in the SIs) are likely a result of a drier than typical summer. More data is needed to assess trend for the instruments installed in 2020. Ground response to construction (underway at the time of preparation of this report) will likely result in changes to the data trends recorded to date.

### **3 RECOMMENDATIONS**

#### **3.1 Future Work**

All operational instruments should continue to be read twice per year, once in the spring and once in the fall.

Construction at this site is underway and instruments operational in the fall of 2021 may be destroyed by construction activities. The construction completion report should identify what post-construction instrumentation and monitoring will be required and if any existing instruments have been extended and by how much.

In the spring of 2022, KCB will confirm the instrument coordinates and ground surface elevations with a handheld GPS (accuracy of  $\pm 5$  m), and where applicable, sticks up and reading depths with a tape measure, and azimuths of the SI A0-grooves with a compass.

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.

#### **3.2 Instrument Repairs**

No instrument repairs are required.

KCB to assess reinitializing the SIs in the spring of 2022 after construction is complete.

## 4 CLOSING

This report is an instrument of service of Klohn Crippen Berger Ltd. (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.**

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

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

CM:ap

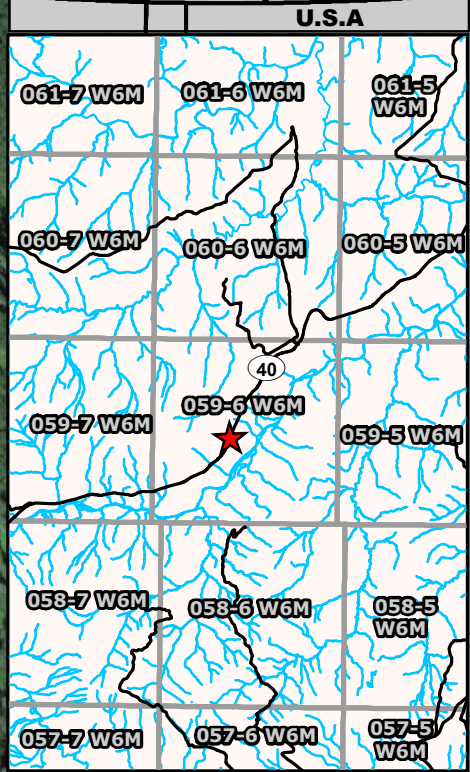
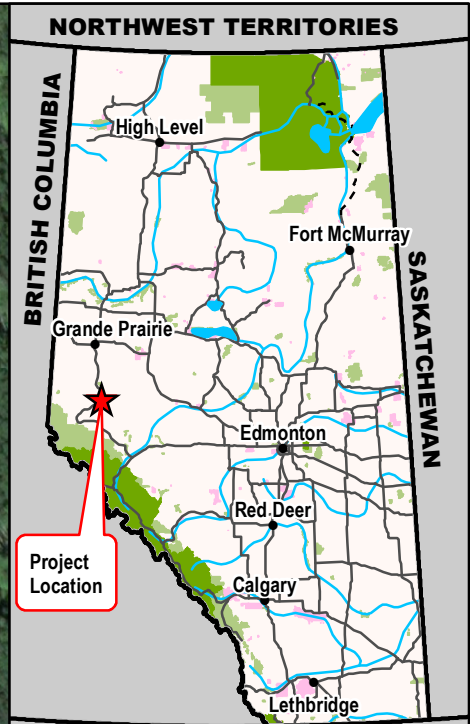
### Attachments

Figure  
Appendix I      Instrumentation Plots

## FIGURE

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© 2017 DigitalGlobe © 2017 GeoEye © 2017 Microsoft Corporation

- Legend**
- ▣ Slope Incliner (TH20-DS)
  - ⊕ Standpipe Piezometer (TH20-B, TH20-D)
  - ⊗ Vibrating Wire Piezometer (VW)



NOTES: 1. HORIZONTAL DATUM: NAD83 2. GRID ZONE: UTM Zone 11N 3. IMAGE SOURCE: Microsoft Bing 4. Strikethrough indicates instrument is inoperable.	CLIENT 	PROJECT PEACE REGION (GRANDE PRAIRIE DISTRICT-SOUTH) GEOHAZARD RISK MANAGEMENT PROGRAM
		TITLE Site Plan GP042 - Slide 9 km N. of Wanyandie Road Hwy 40:36, km 37.524
	SCALE 1:3,137	PROJECT No. A05116A01
		FIG No. 1

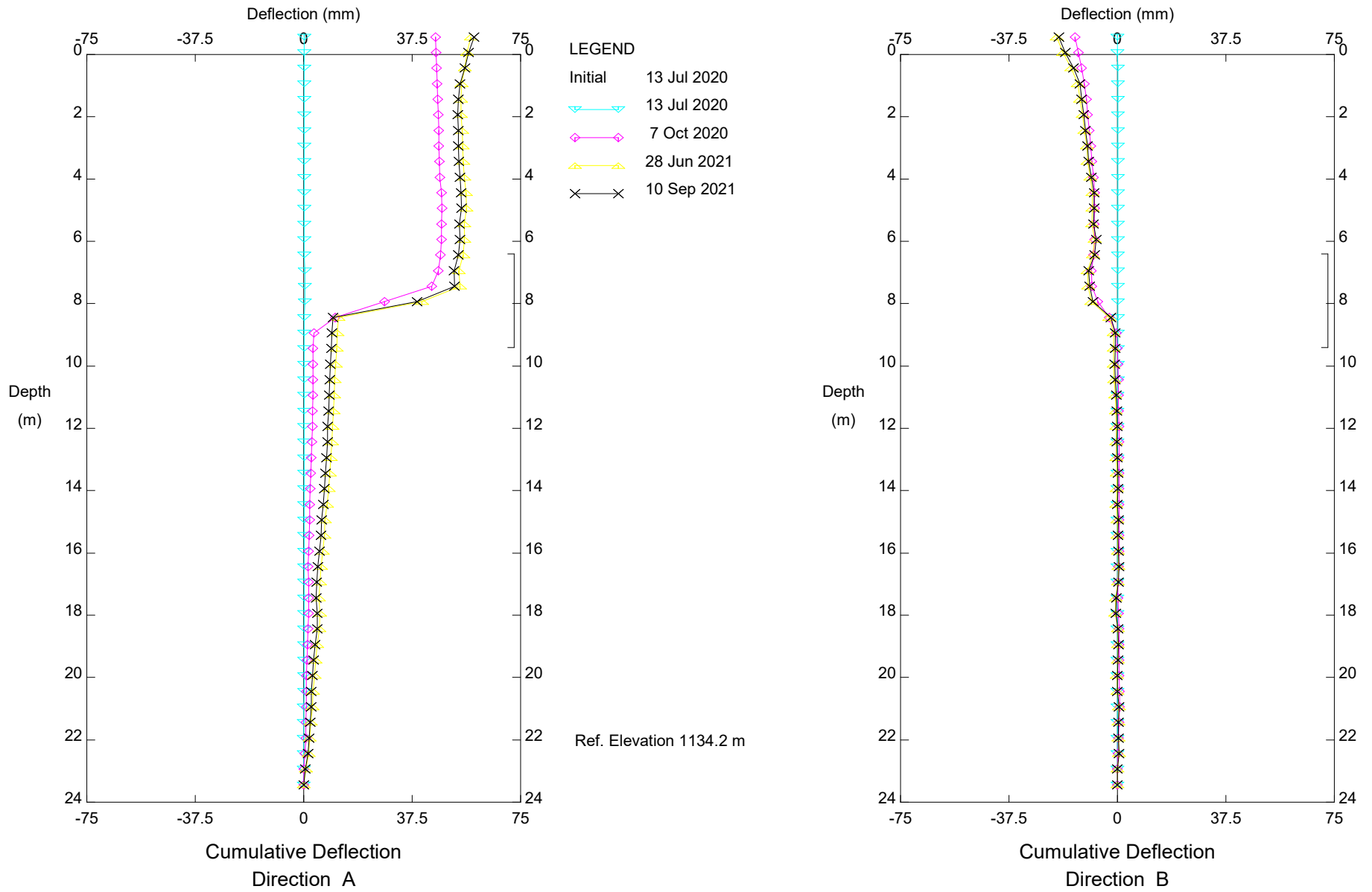
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# APPENDIX I

## Instrumentation Plots

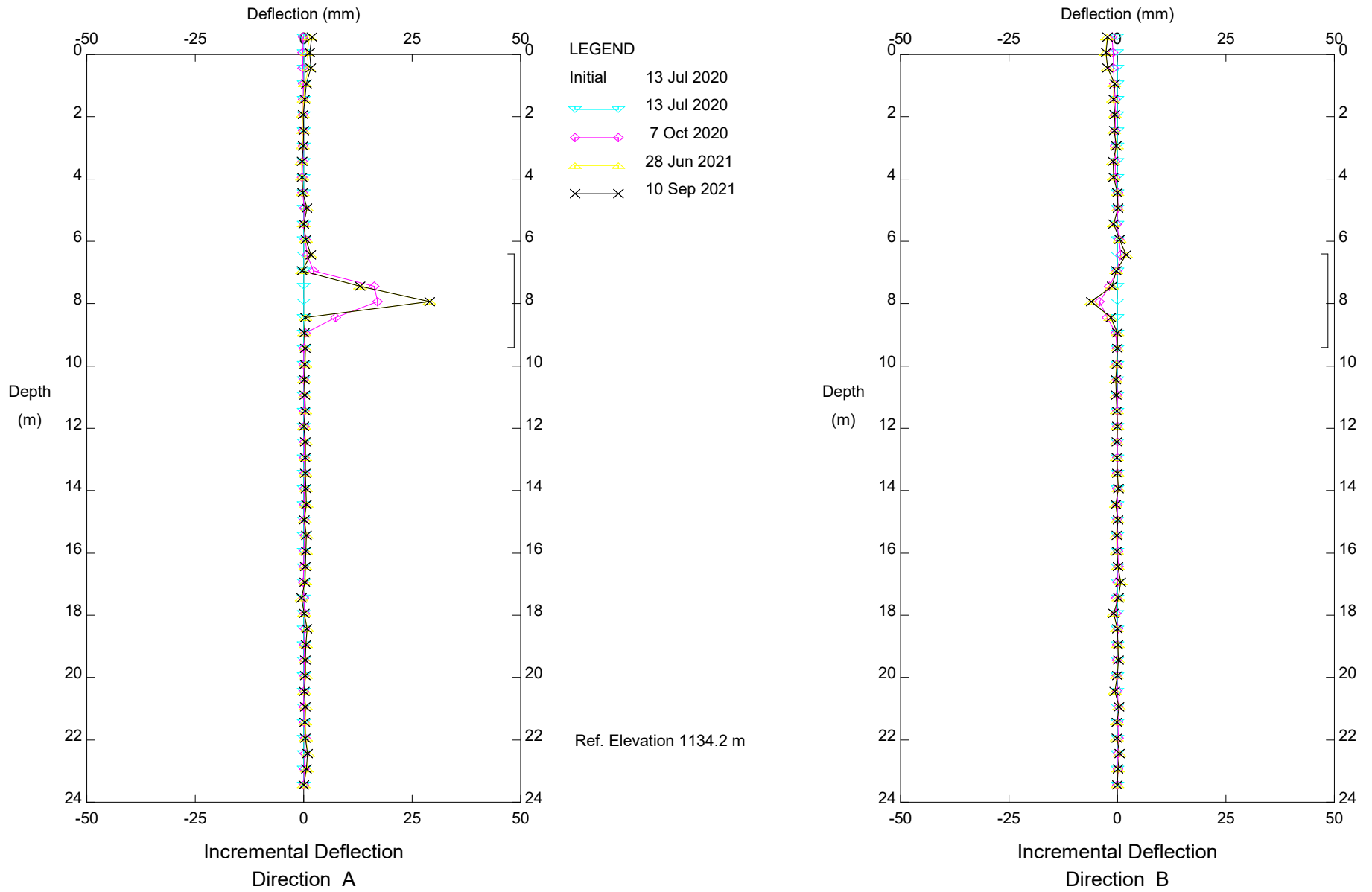
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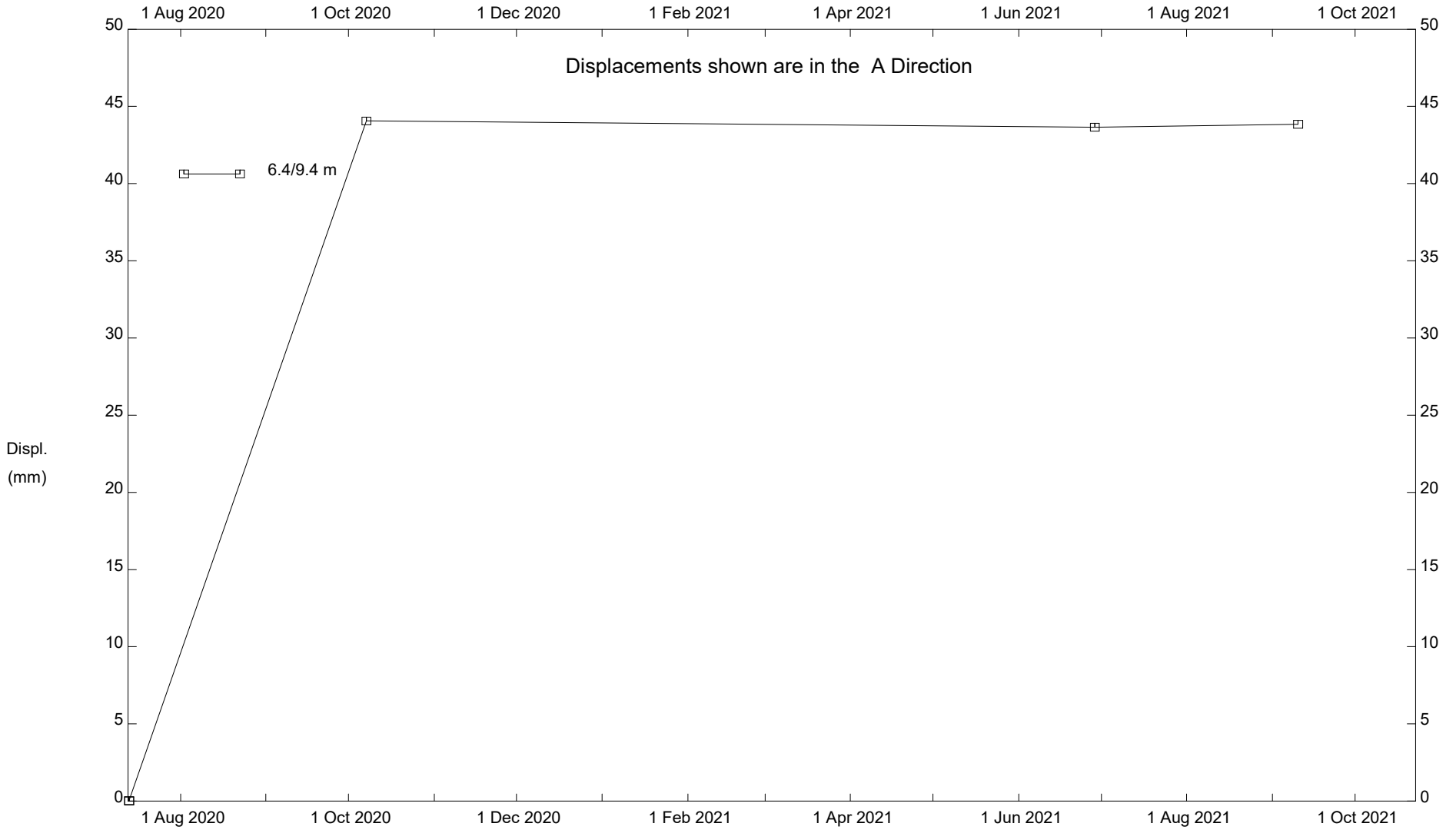
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 Slide 9 km North of Wanyandie Road  
 Alberta Transportation

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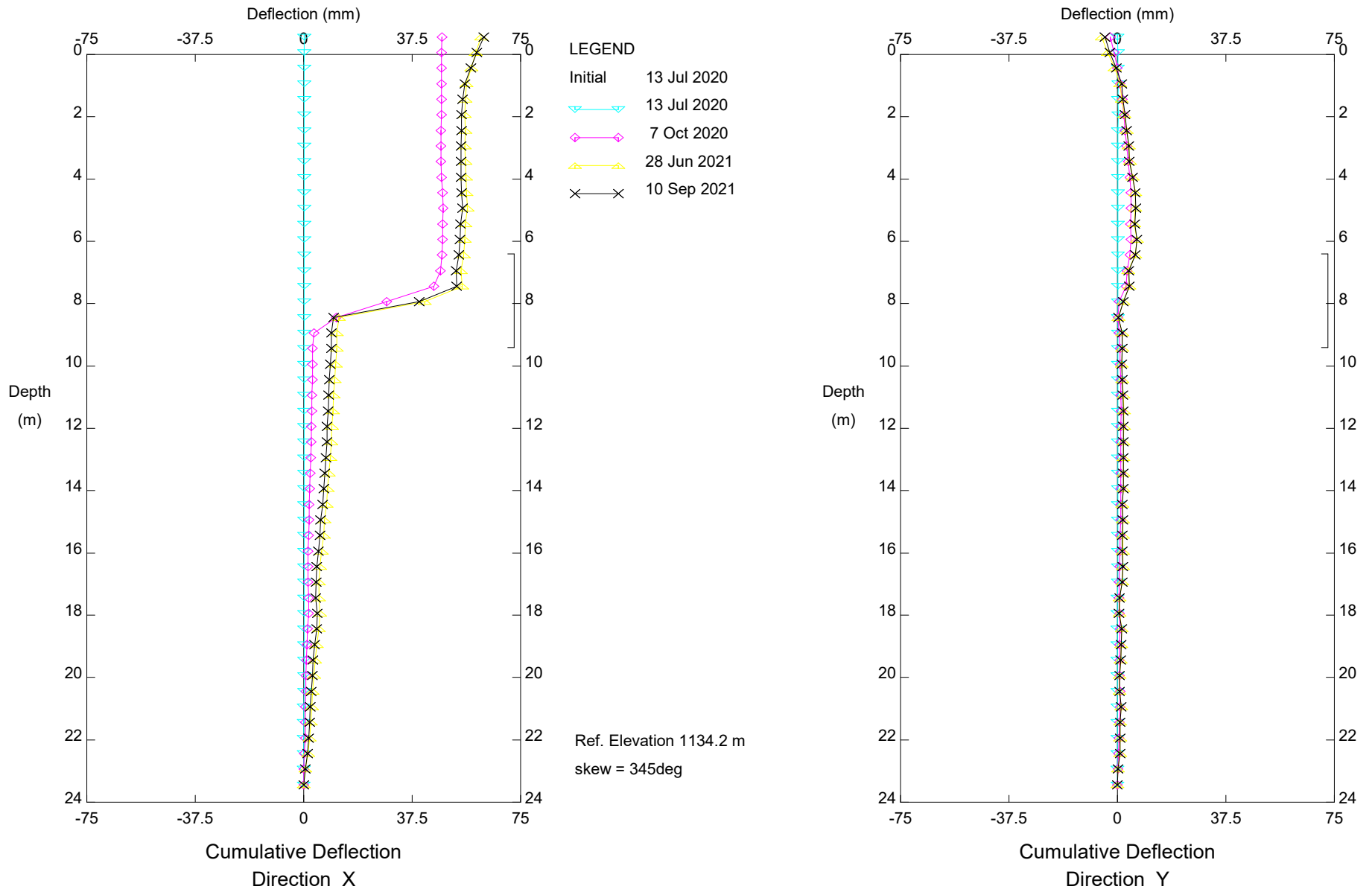
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Alberta Transportation

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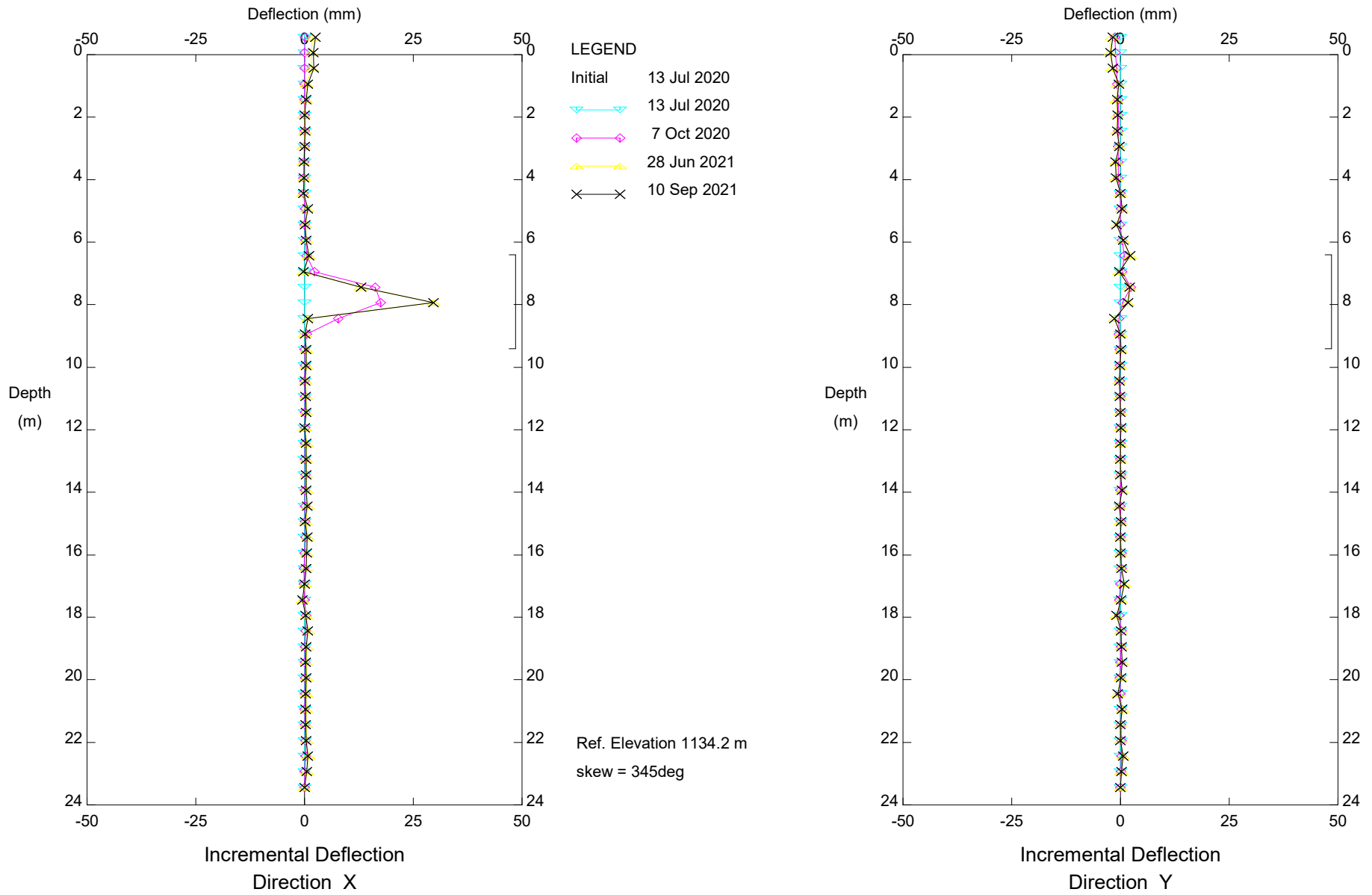
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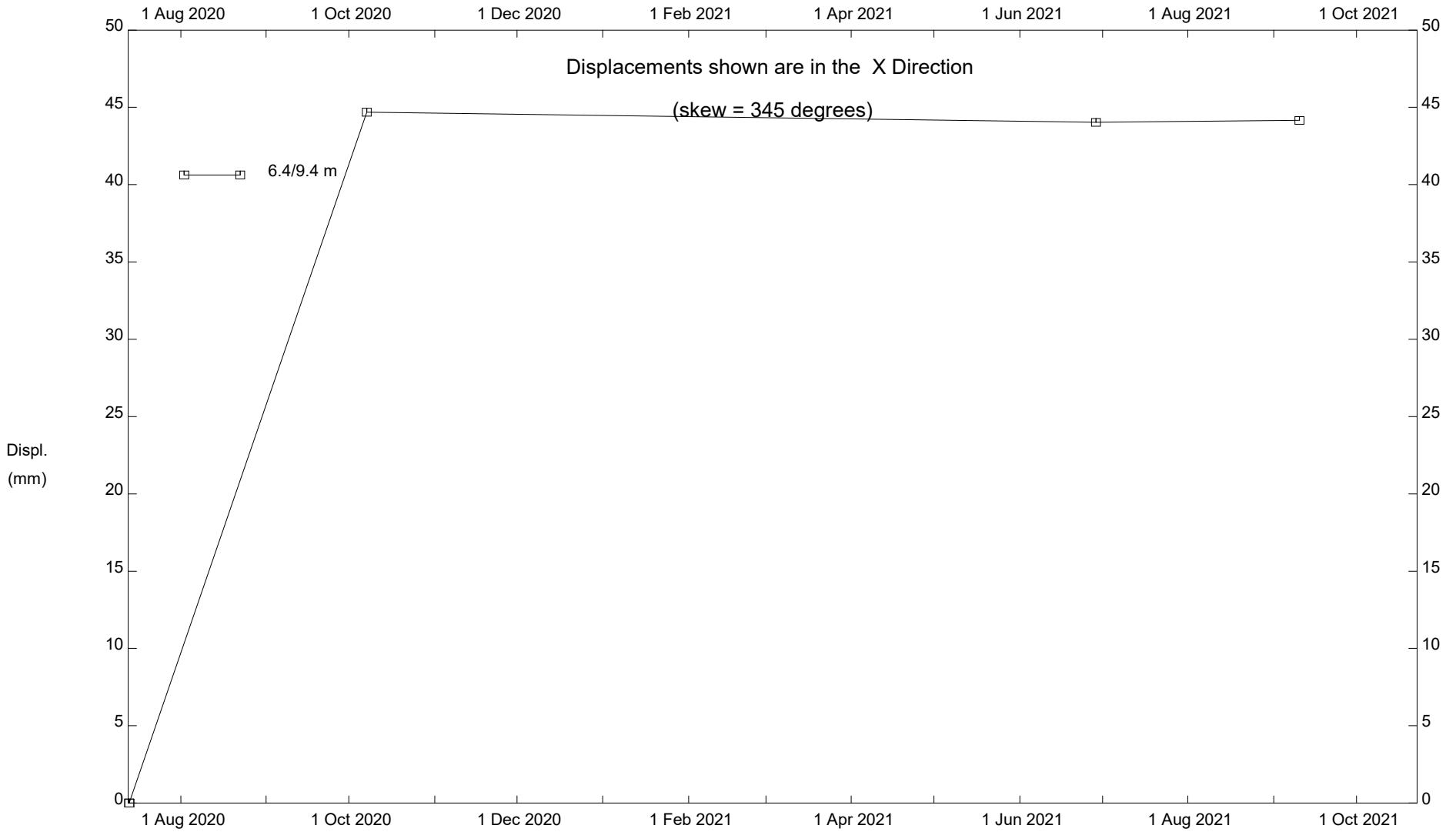
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Slide 9 km North of Wanyandie Road  
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Slide 9 km North of Wanyandie Road  
Alberta Transportation

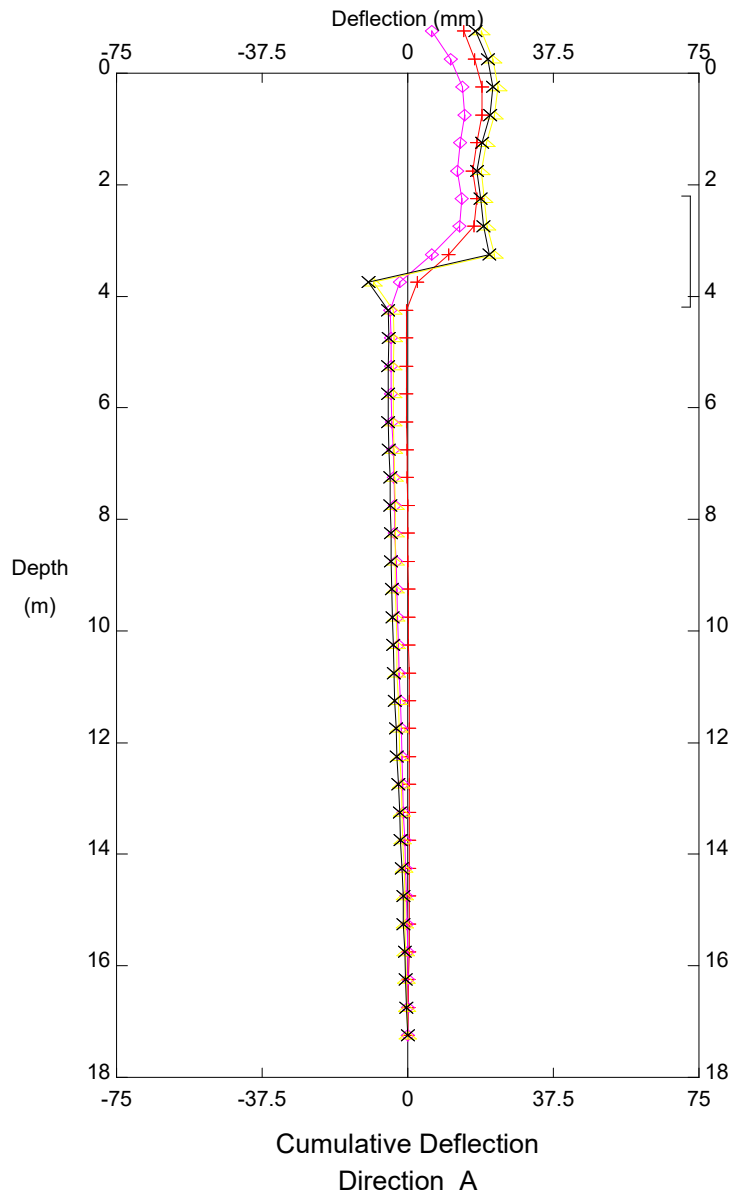
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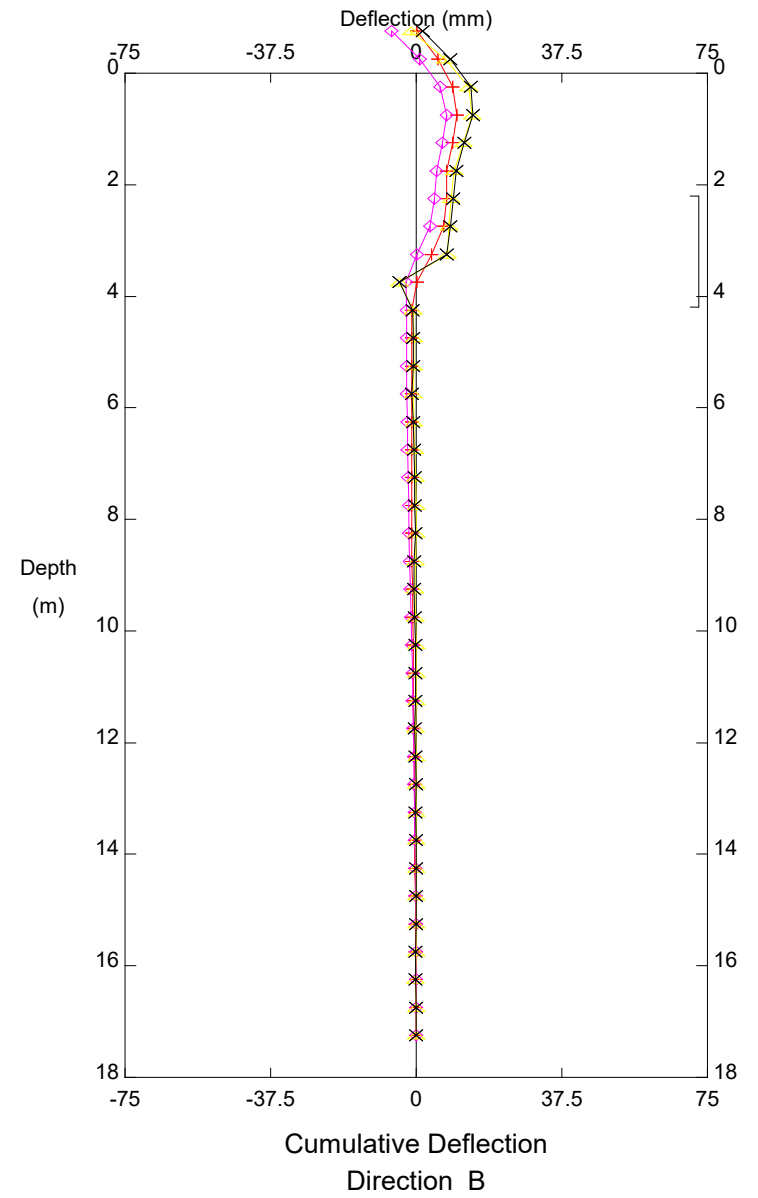


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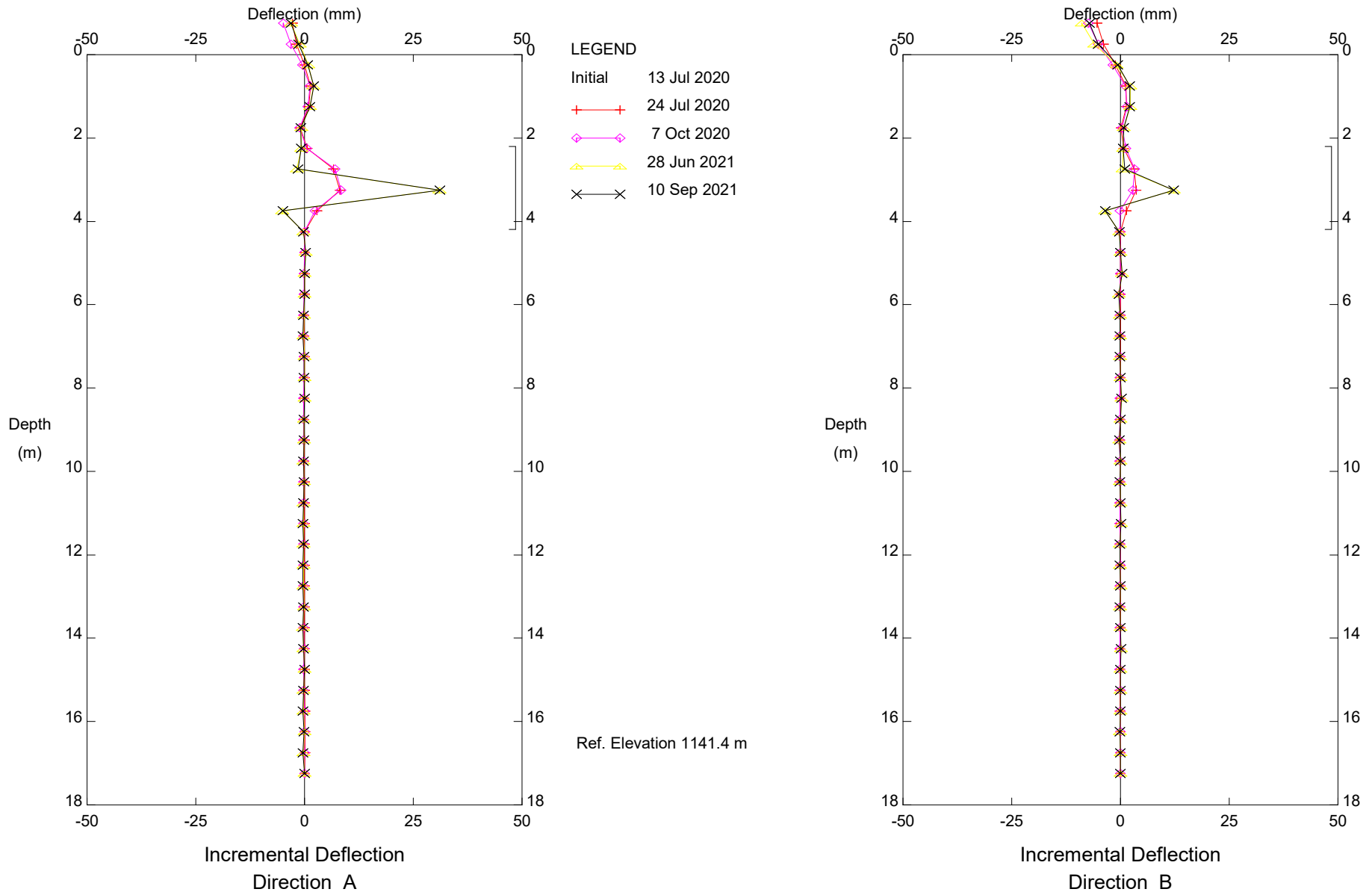
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  - 24 Jul 2020
  - 7 Oct 2020
  - 28 Jun 2021
  - 10 Sep 2021

Ref. Elevation 1141.4 m



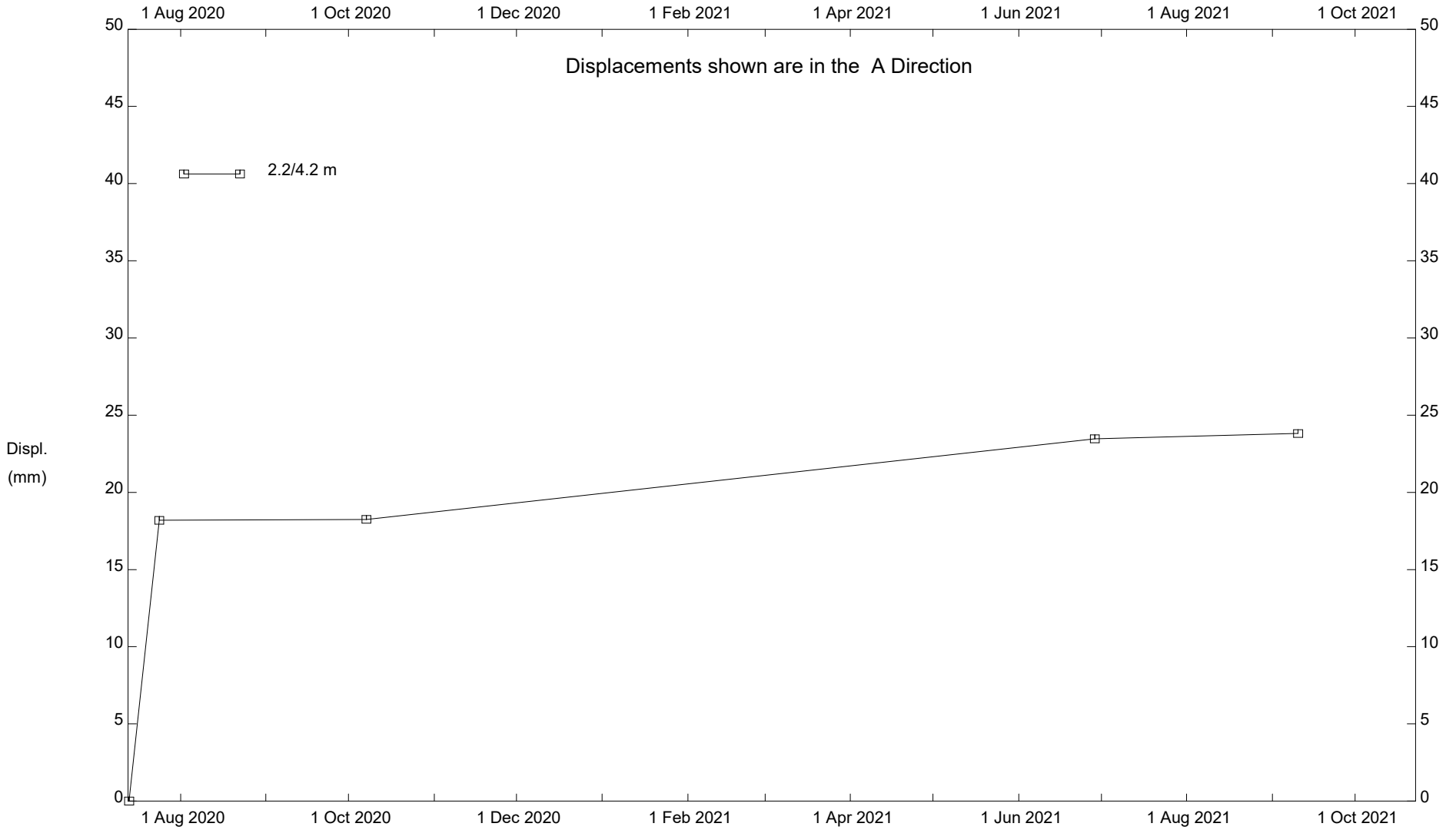
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Slide 9 km North of Wanyandie Road  
Alberta Transportation

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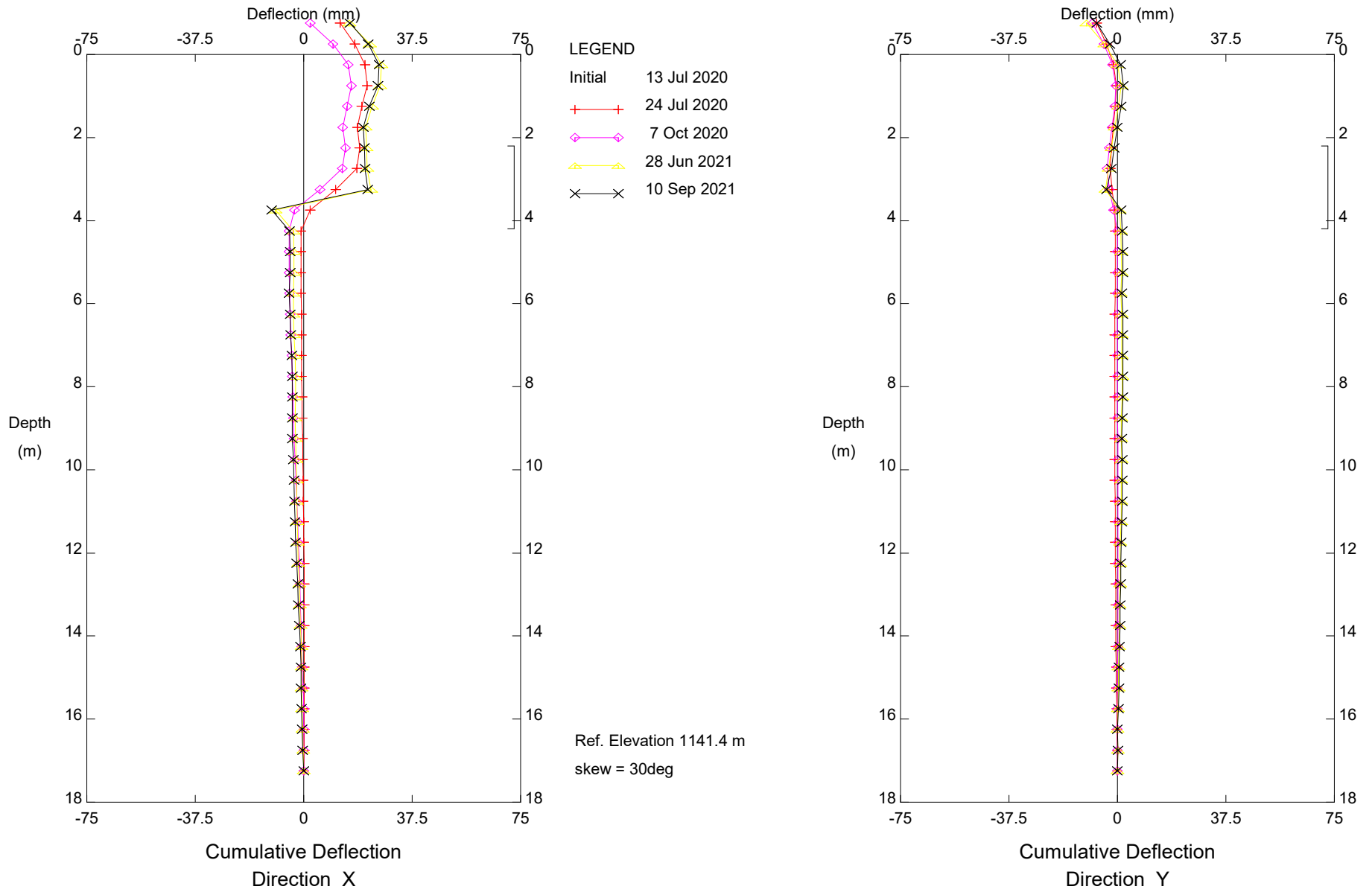
GP042; H40:36, Inclinator TH20-DS5  
 Slide 9 km North of Wanyandie Road  
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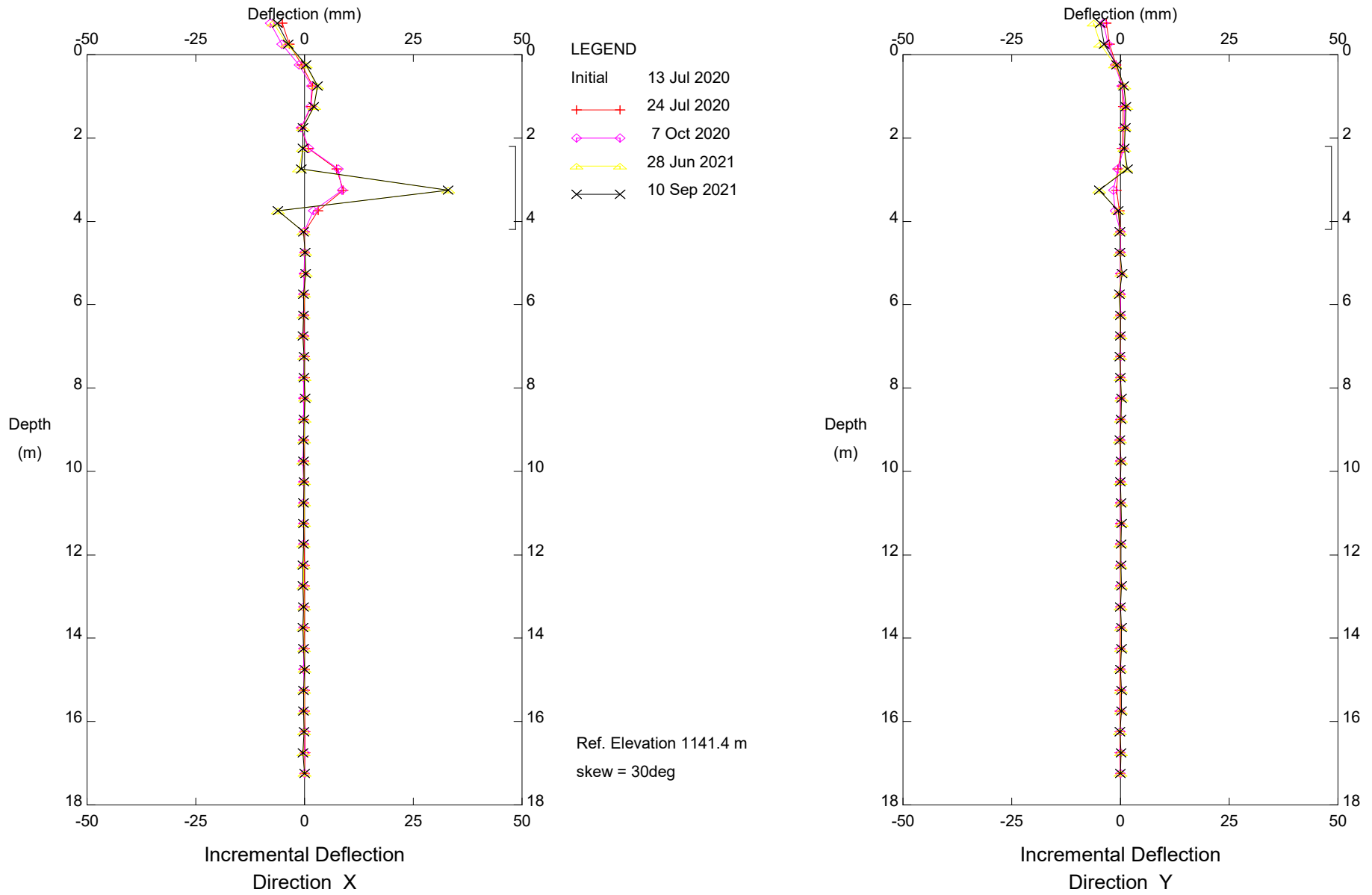
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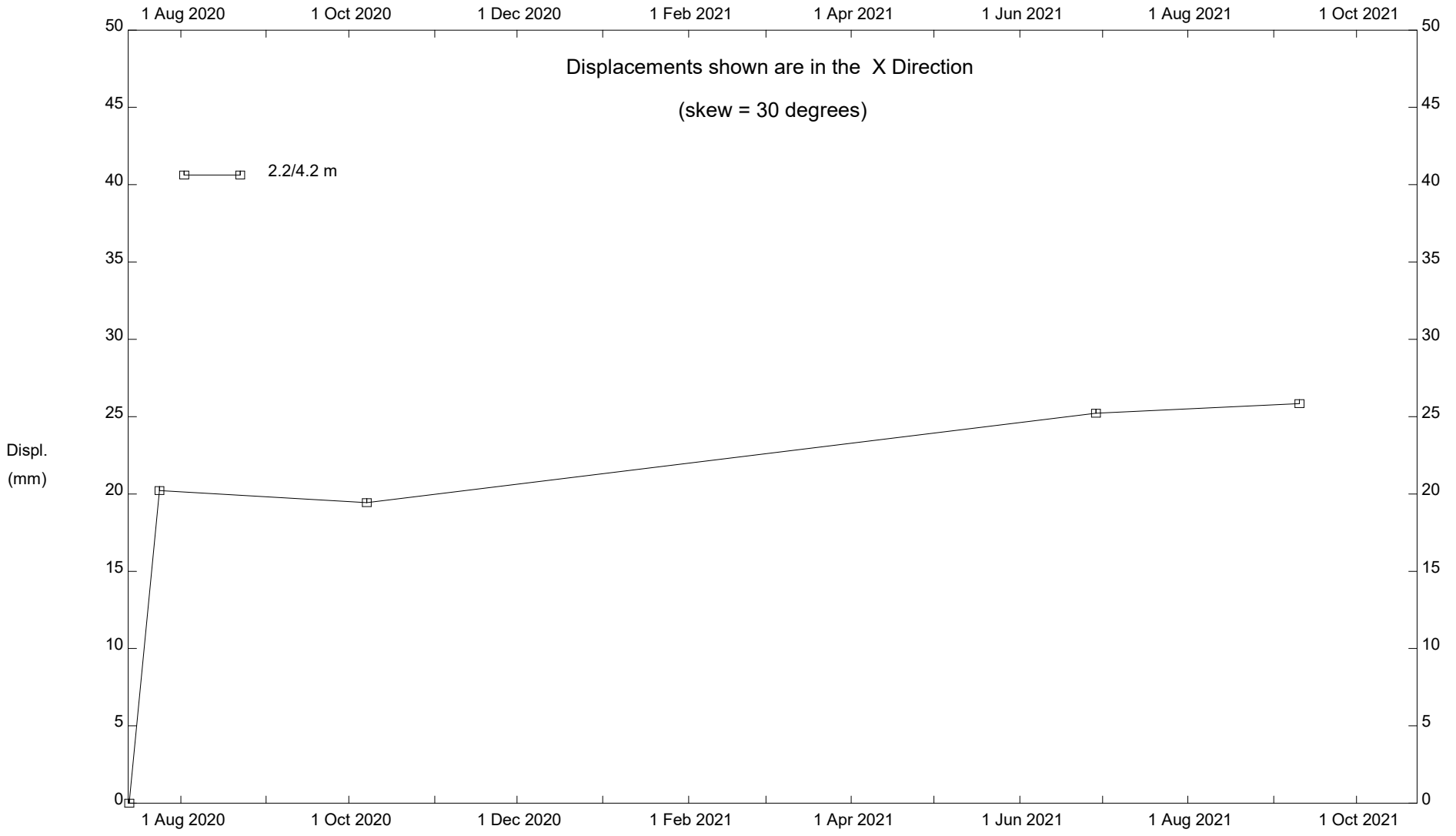
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 Slide 9 km North of Wanyandie Road  
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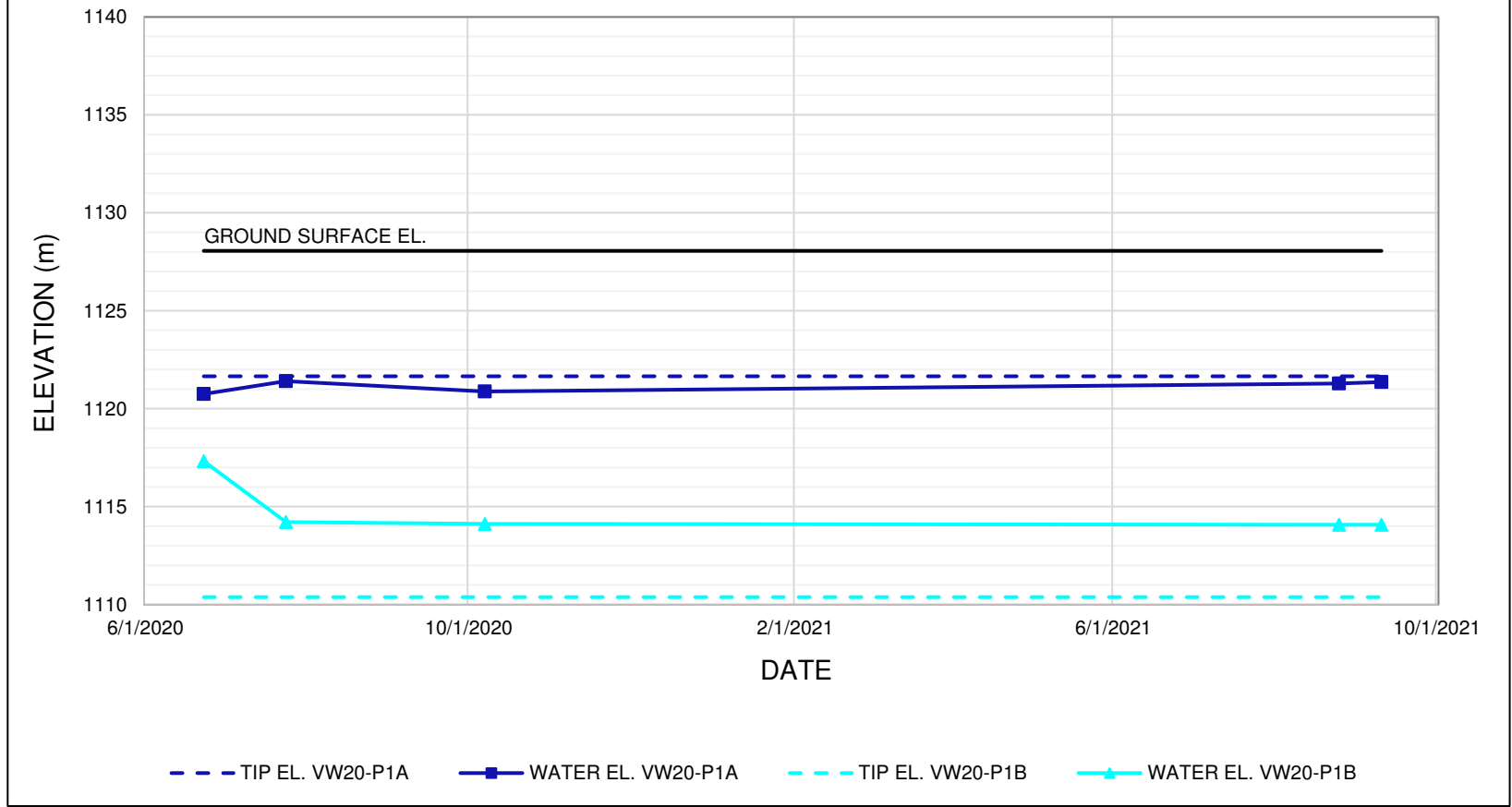
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Slide 9 km North of Wanyandie Road  
Alberta Transportation

Klohn Crippen Berger - Calgary





GP042; H40:36, Inclinator TH20-DS5

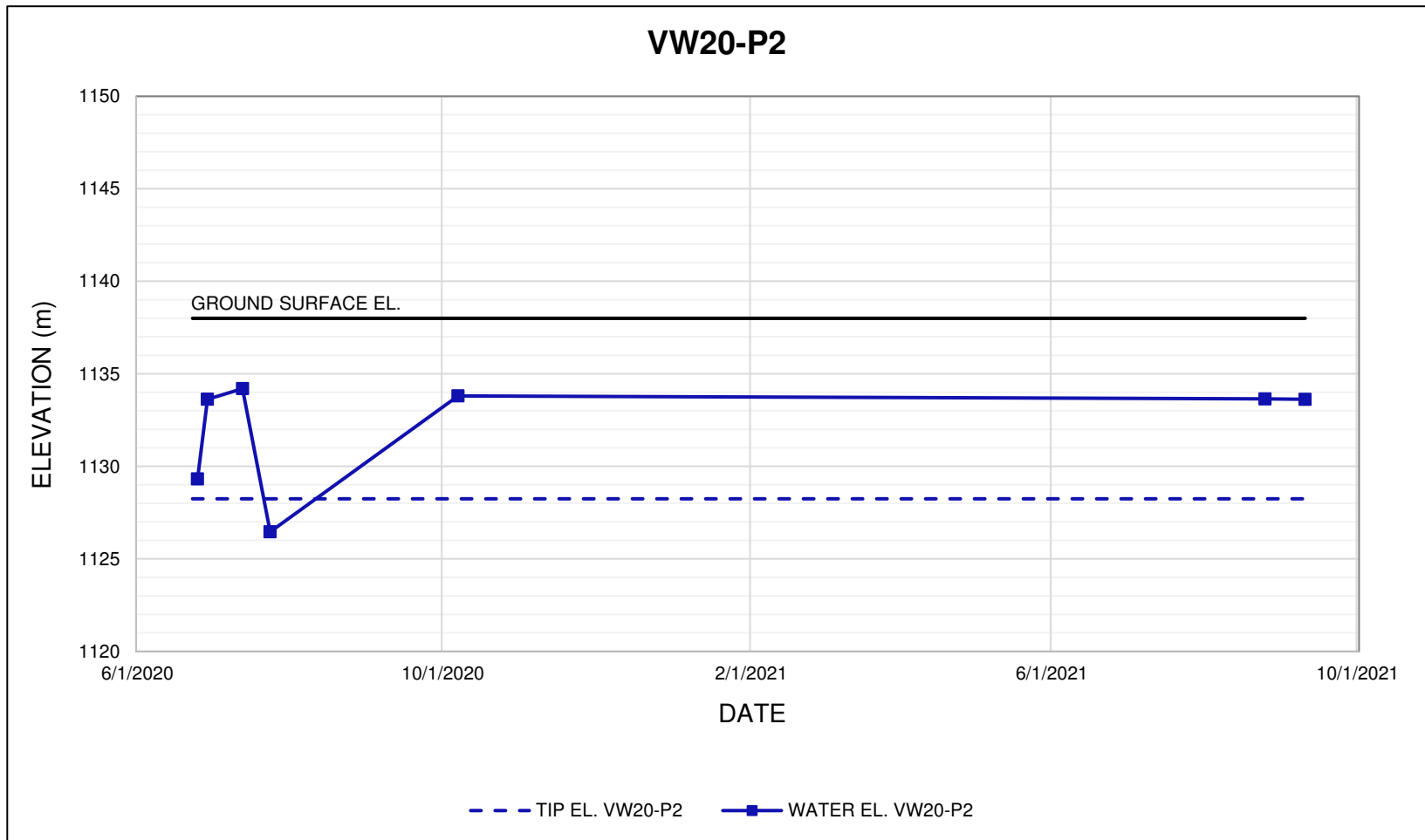
### VW20-P1A and VW20-P1B



**Notes:**



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CLIENT 	PROJECT PEACE REGION (GRANDE PRAIRIE DISTRICT - SOUTH) GEOHAZARD RISK MANAGEMENT PROGRAM		
	TITLE Piezometer Data GP042 - Slide 9 km N of Wanyandie Road Hwy 40:36, km 37.524		
	SCALE	PROJECT No. A05116A01	FIG No.

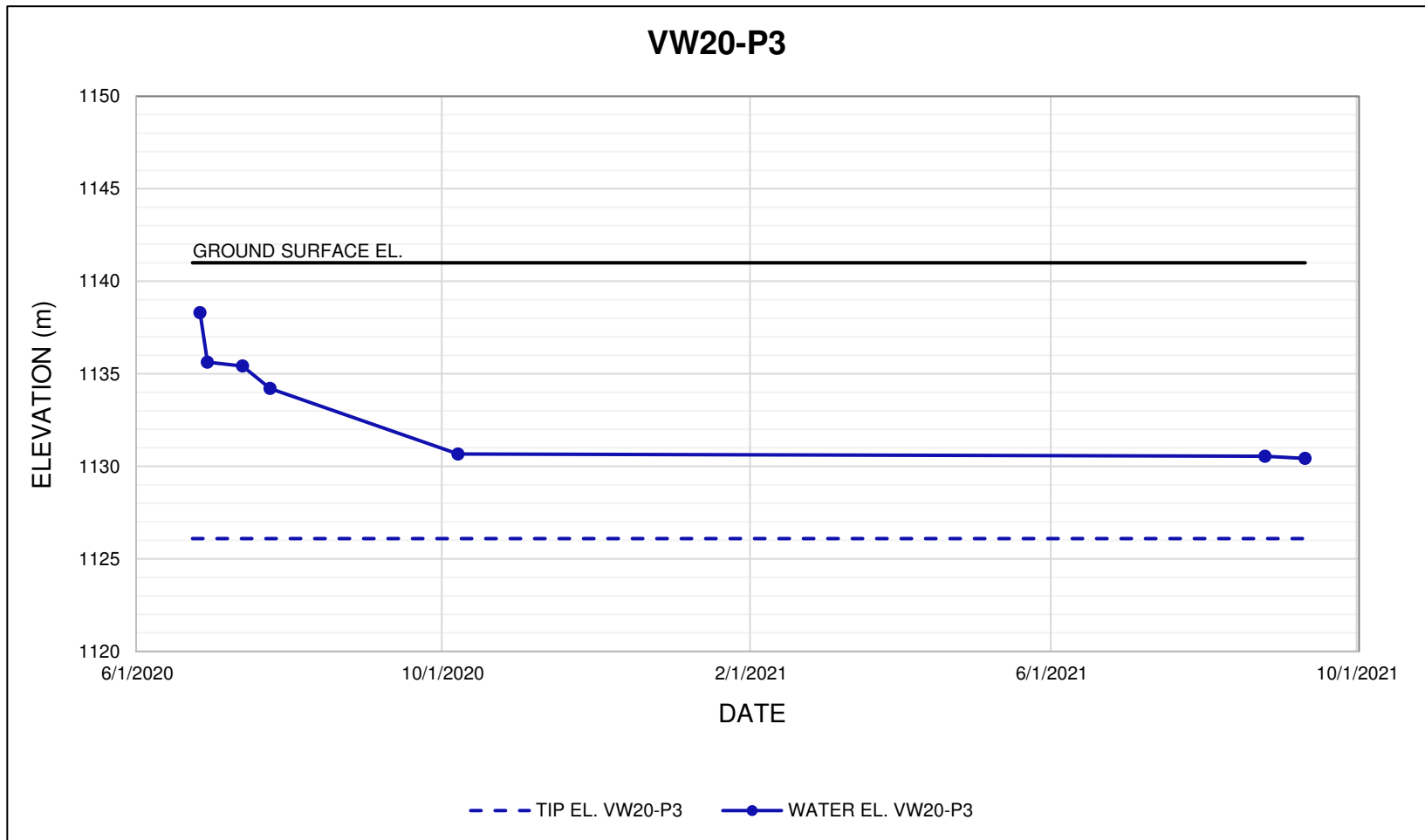


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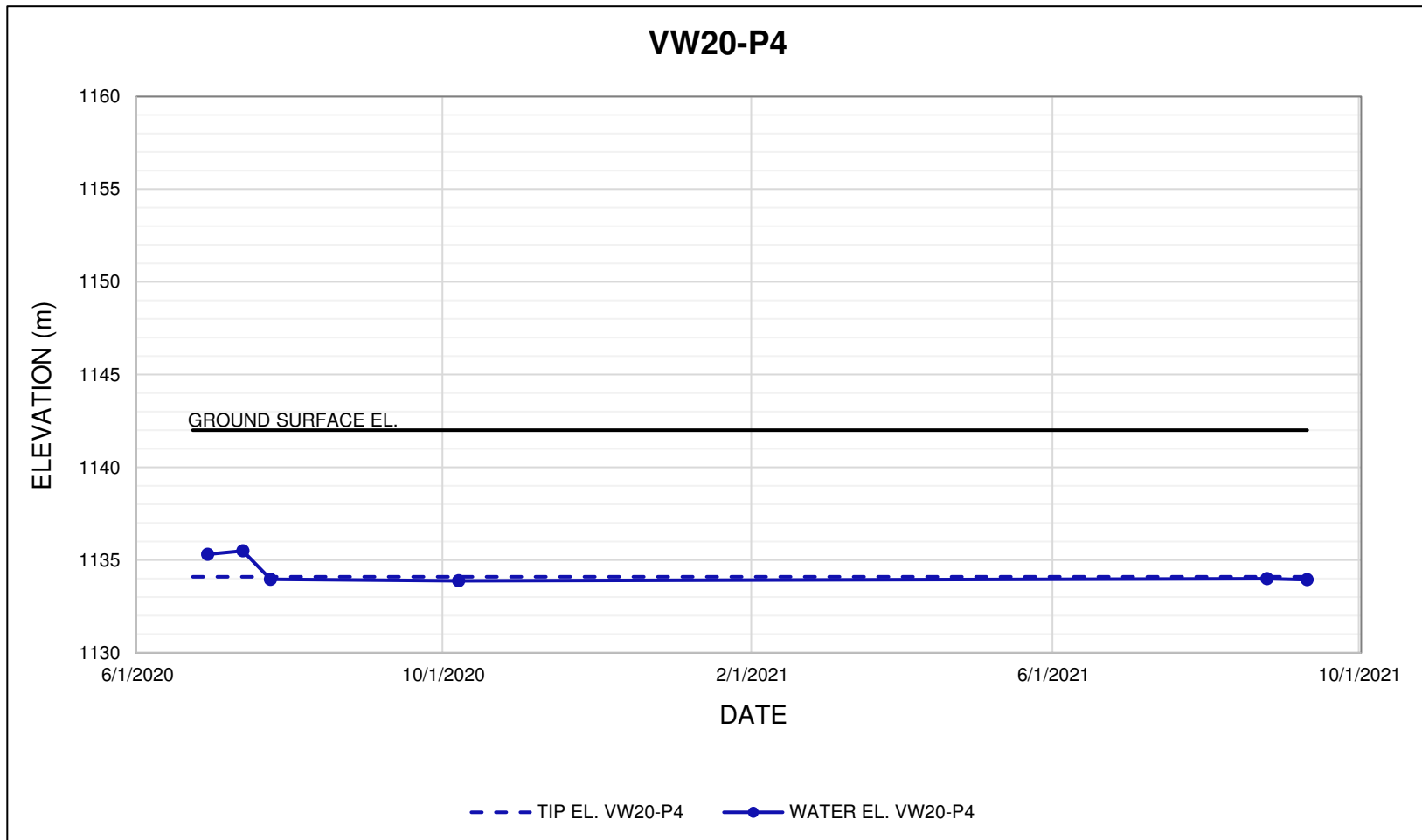




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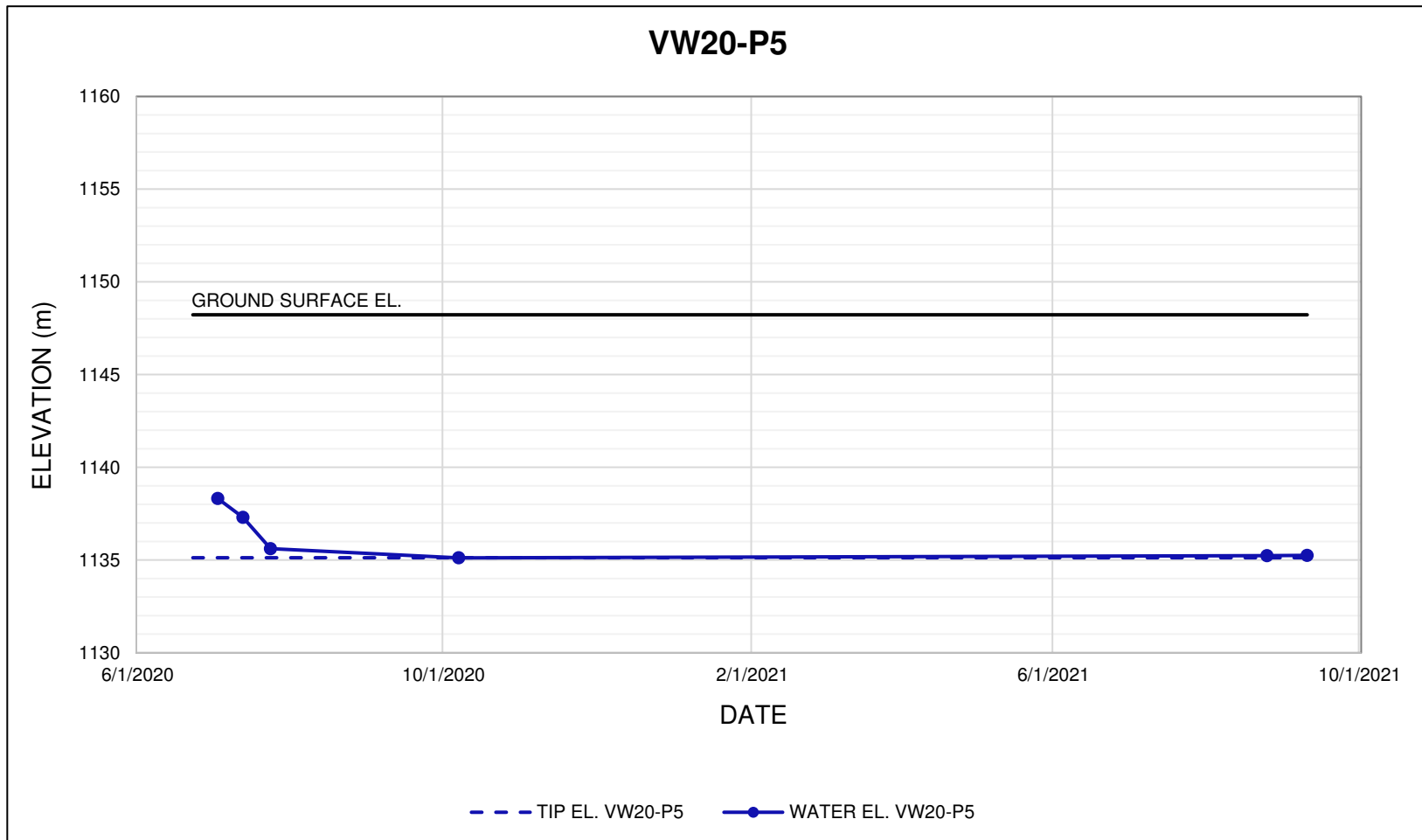
CLIENT 	PROJECT PEACE REGION (GRANDE PRAIRIE DISTRICT - SOUTH) GEOHAZARD RISK MANAGEMENT PROGRAM		
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		A05116A01	



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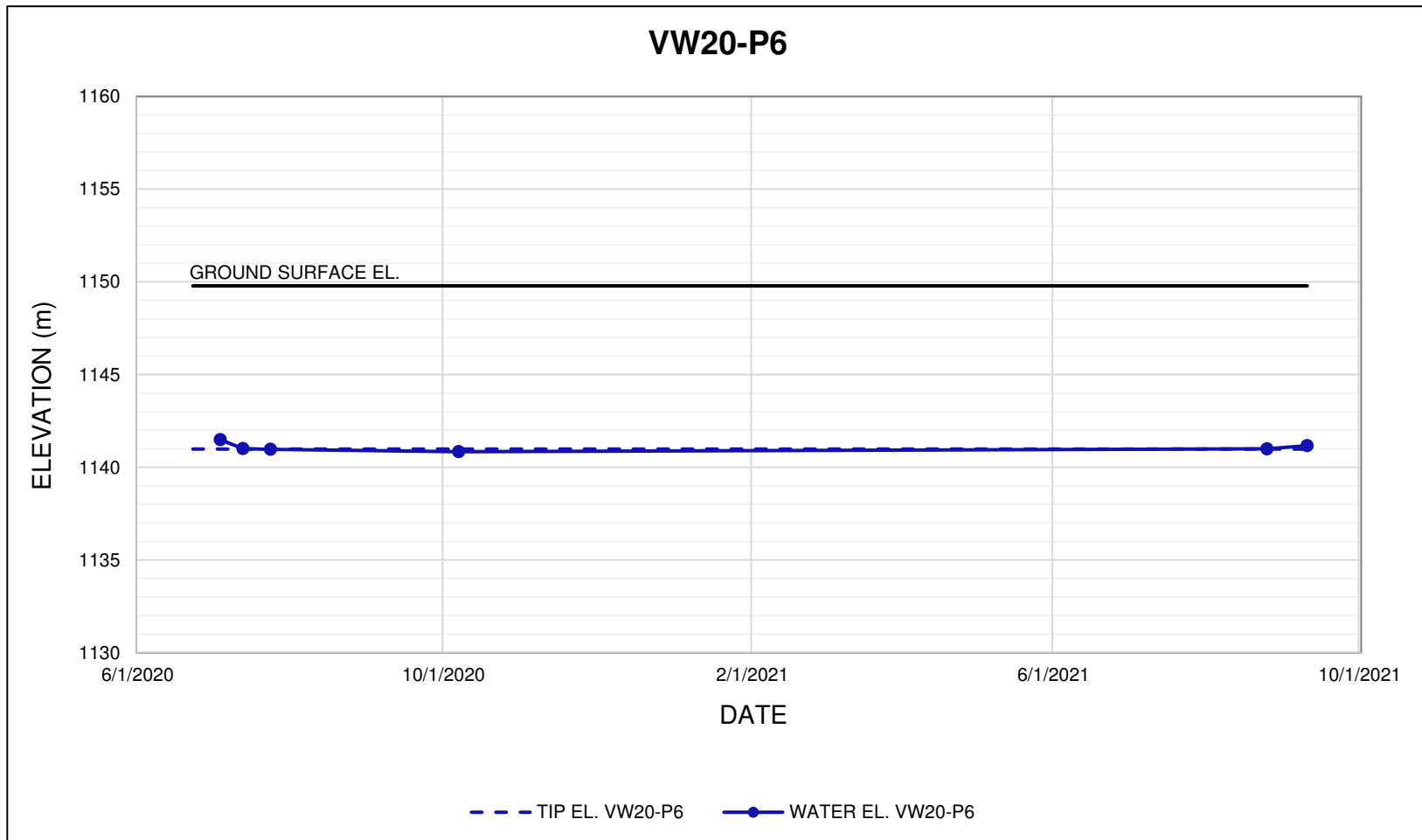
CLIENT 	PROJECT PEACE REGION (GRANDE PRAIRIE DISTRICT - SOUTH) GEOHAZARD RISK MANAGEMENT PROGRAM		
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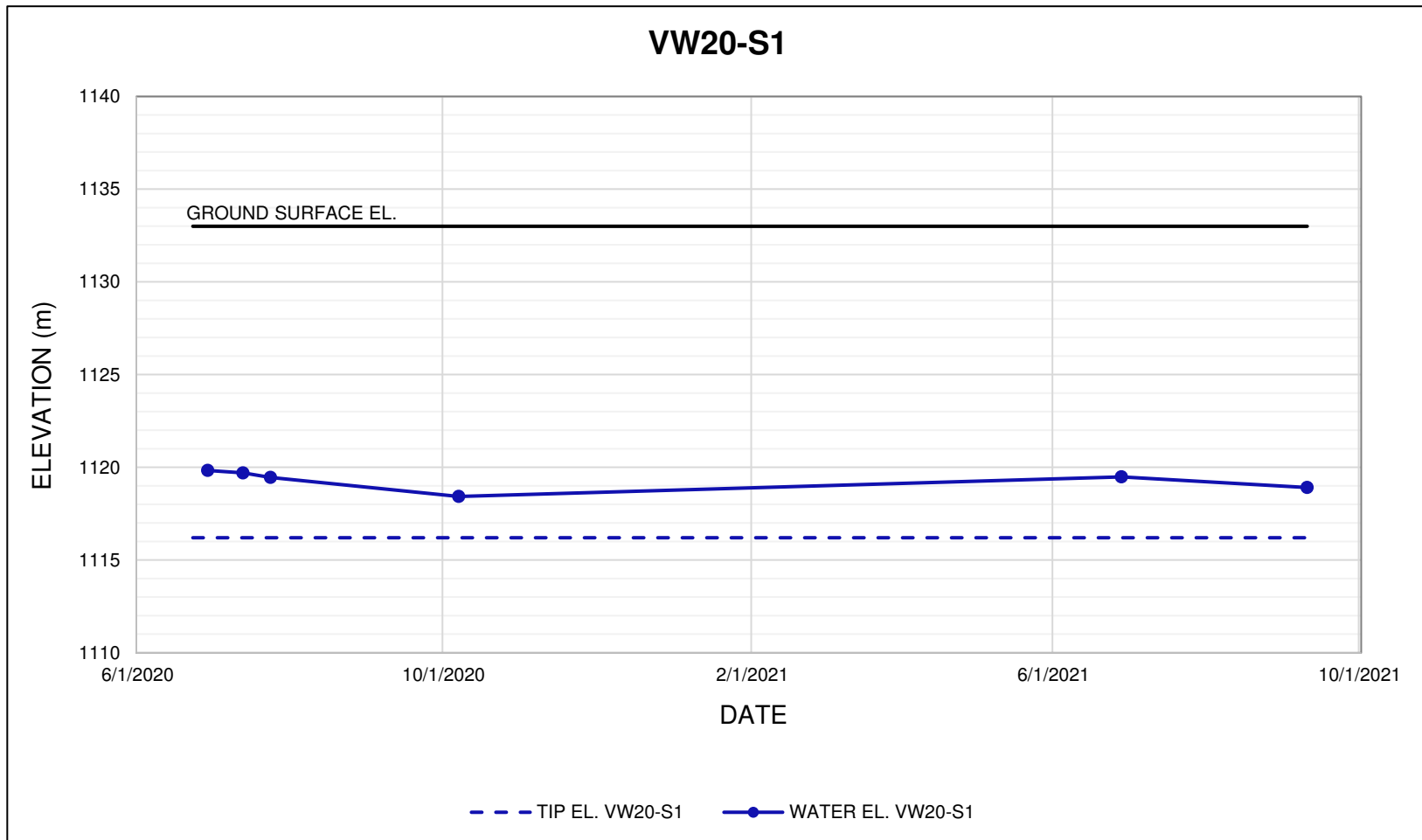
CLIENT 	PROJECT PEACE REGION (GRANDE PRAIRIE DISTRICT - SOUTH) GEOHAZARD RISK MANAGEMENT PROGRAM		
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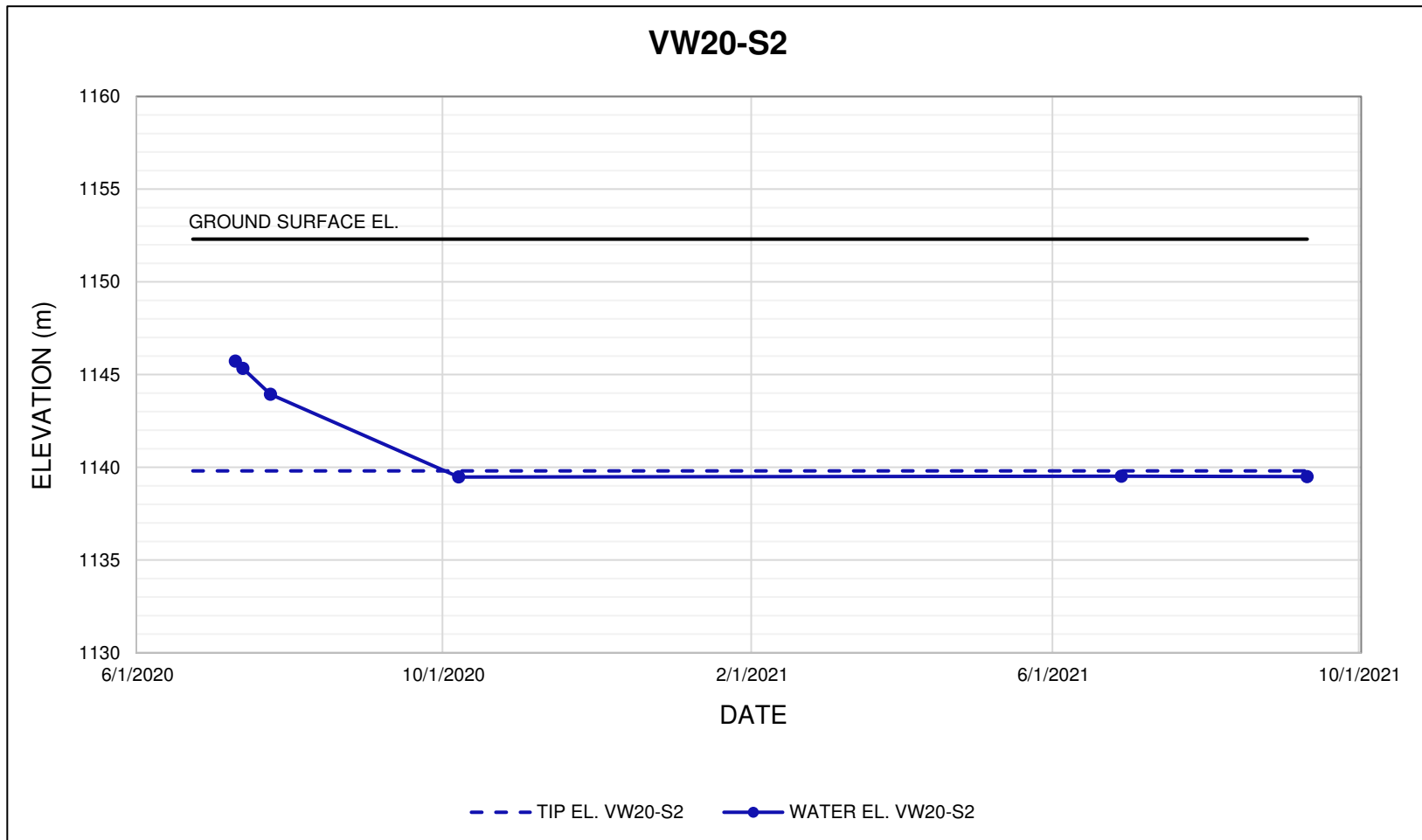
CLIENT 	PROJECT PEACE REGION (GRANDE PRAIRIE DISTRICT - SOUTH) GEOHAZARD RISK MANAGEMENT PROGRAM		
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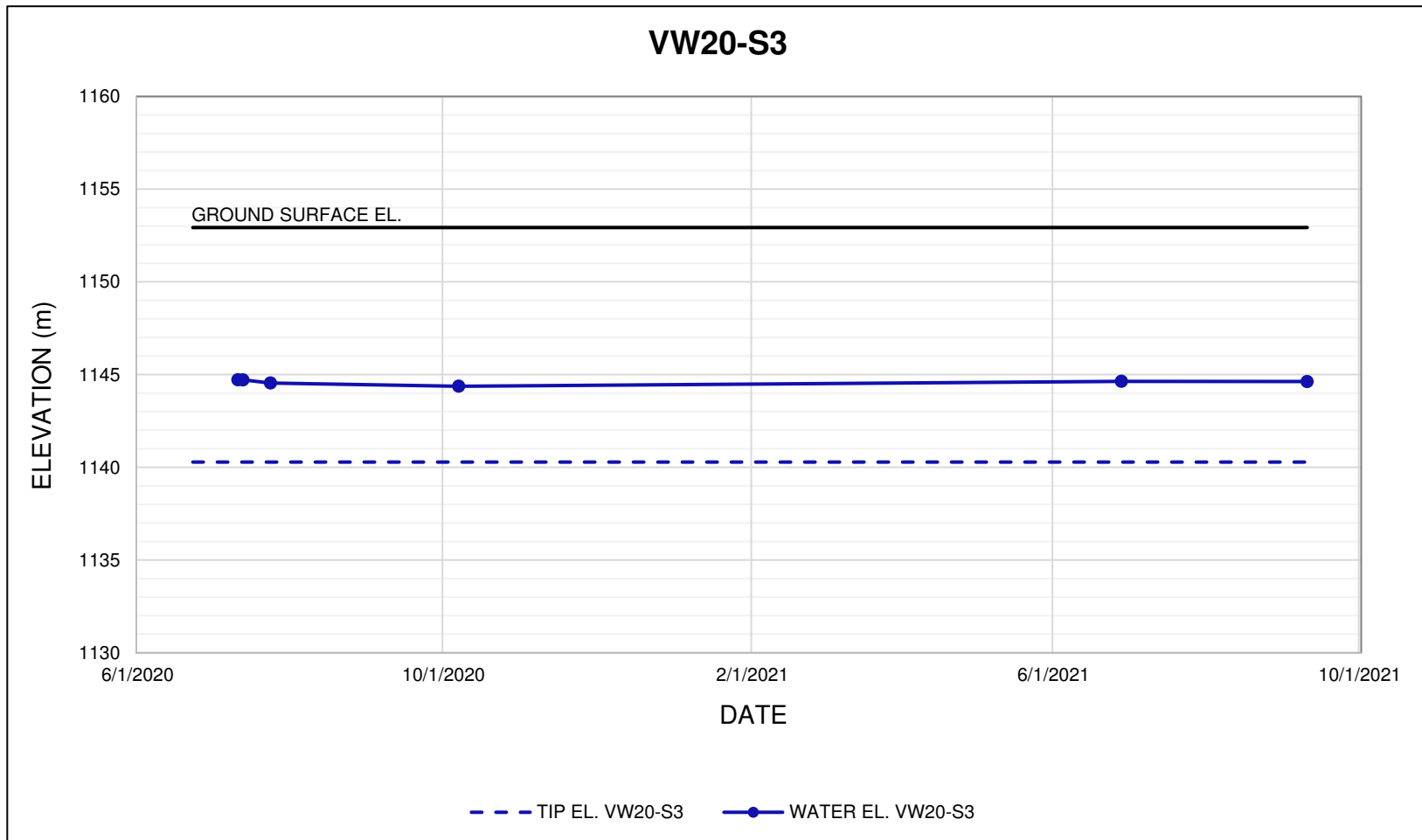
CLIENT 	PROJECT PEACE REGION (GRANDE PRAIRIE DISTRICT - SOUTH) GEOHAZARD RISK MANAGEMENT PROGRAM		
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	SCALE	PROJECT No. A05116A01	FIG No.



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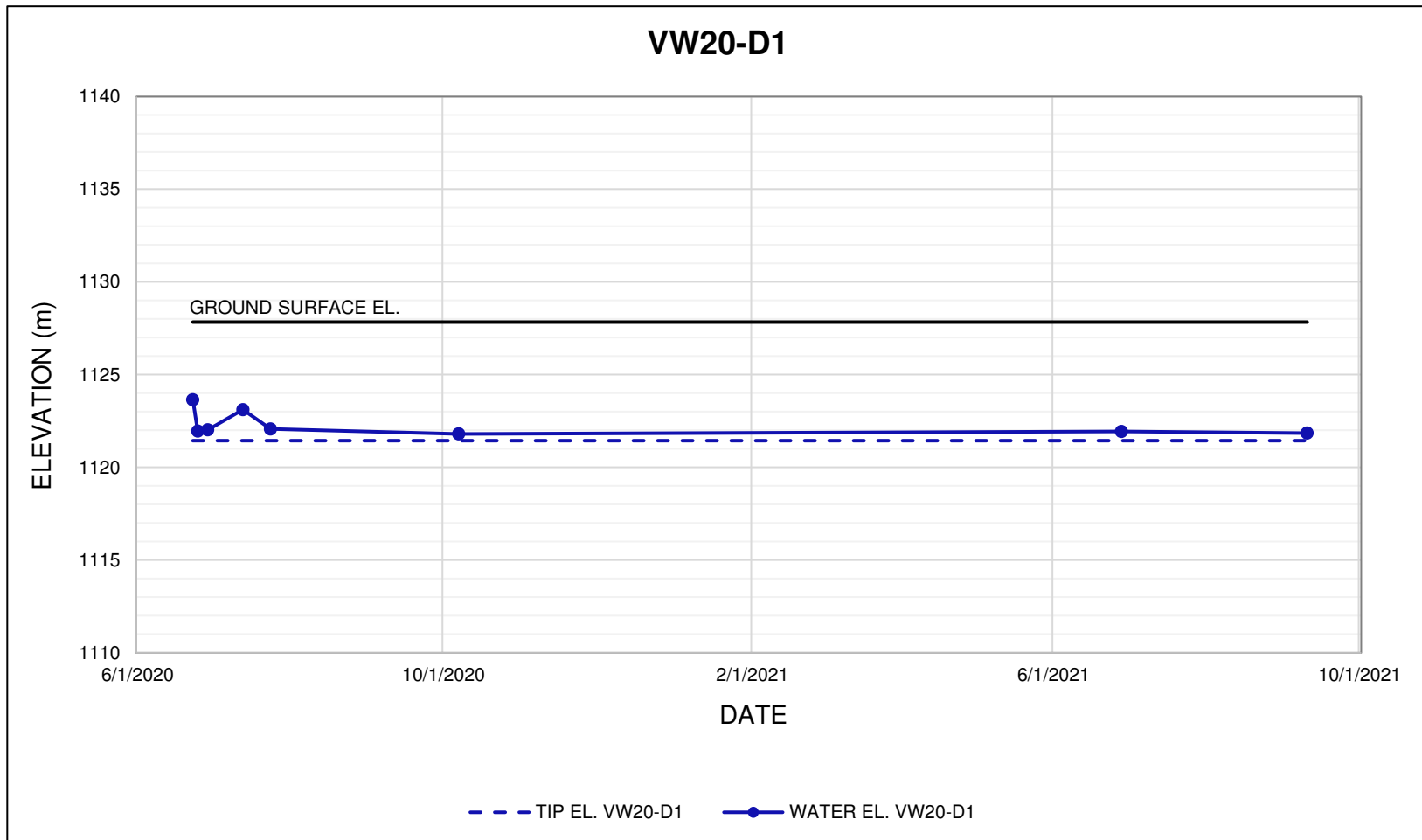
CLIENT 	PROJECT PEACE REGION (GRANDE PRAIRIE DISTRICT - SOUTH) GEOHAZARD RISK MANAGEMENT PROGRAM		
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	SCALE	PROJECT No. A05116A01	FIG No.



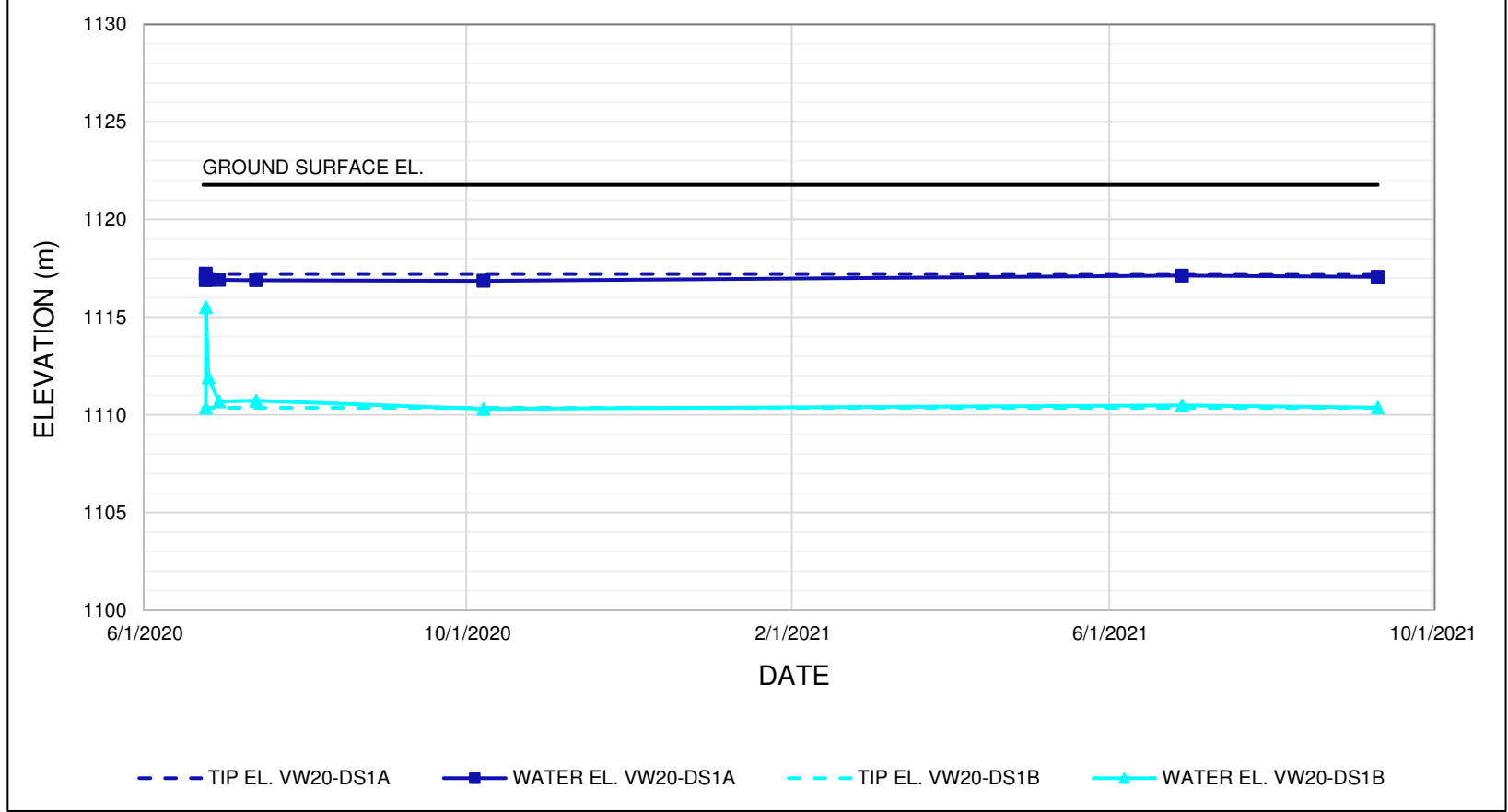
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	SCALE	PROJECT No.	FIG No.
		A05116A01	





### VW20-DS1A and VW20-DS1B

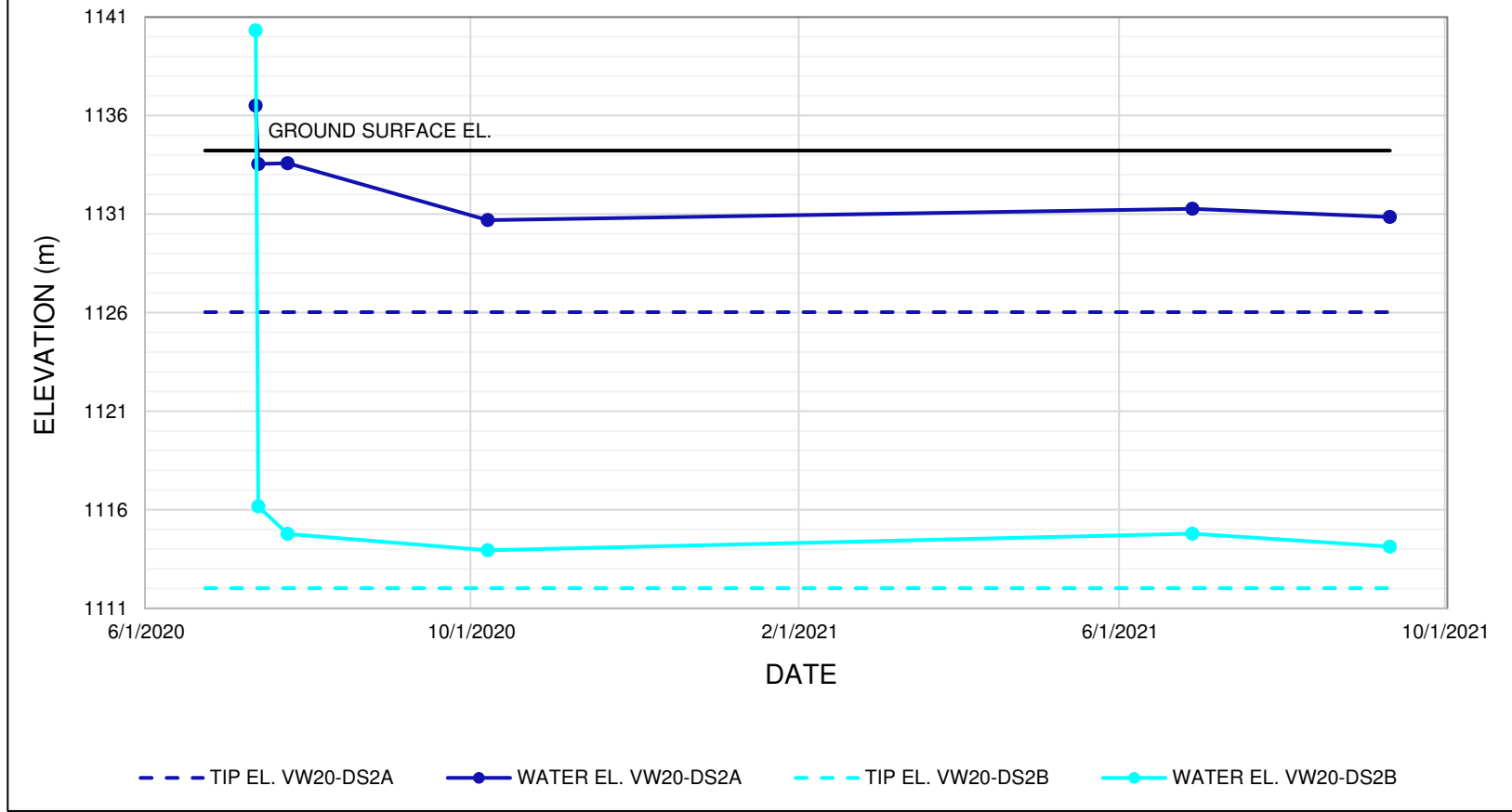


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	SCALE	PROJECT No.	FIG No.
		A05116A01	

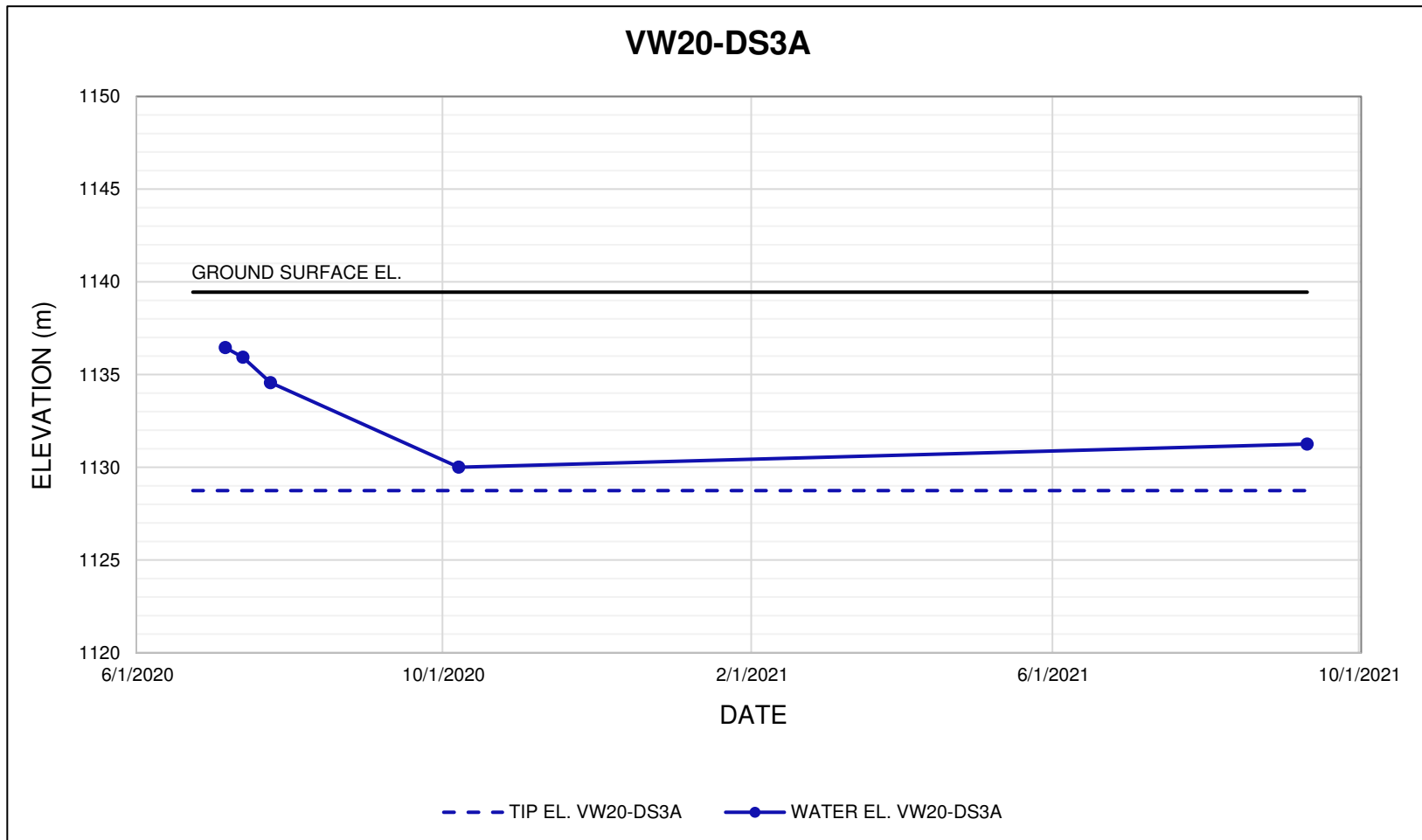
### VW20-DS2A and VW20-DS2B



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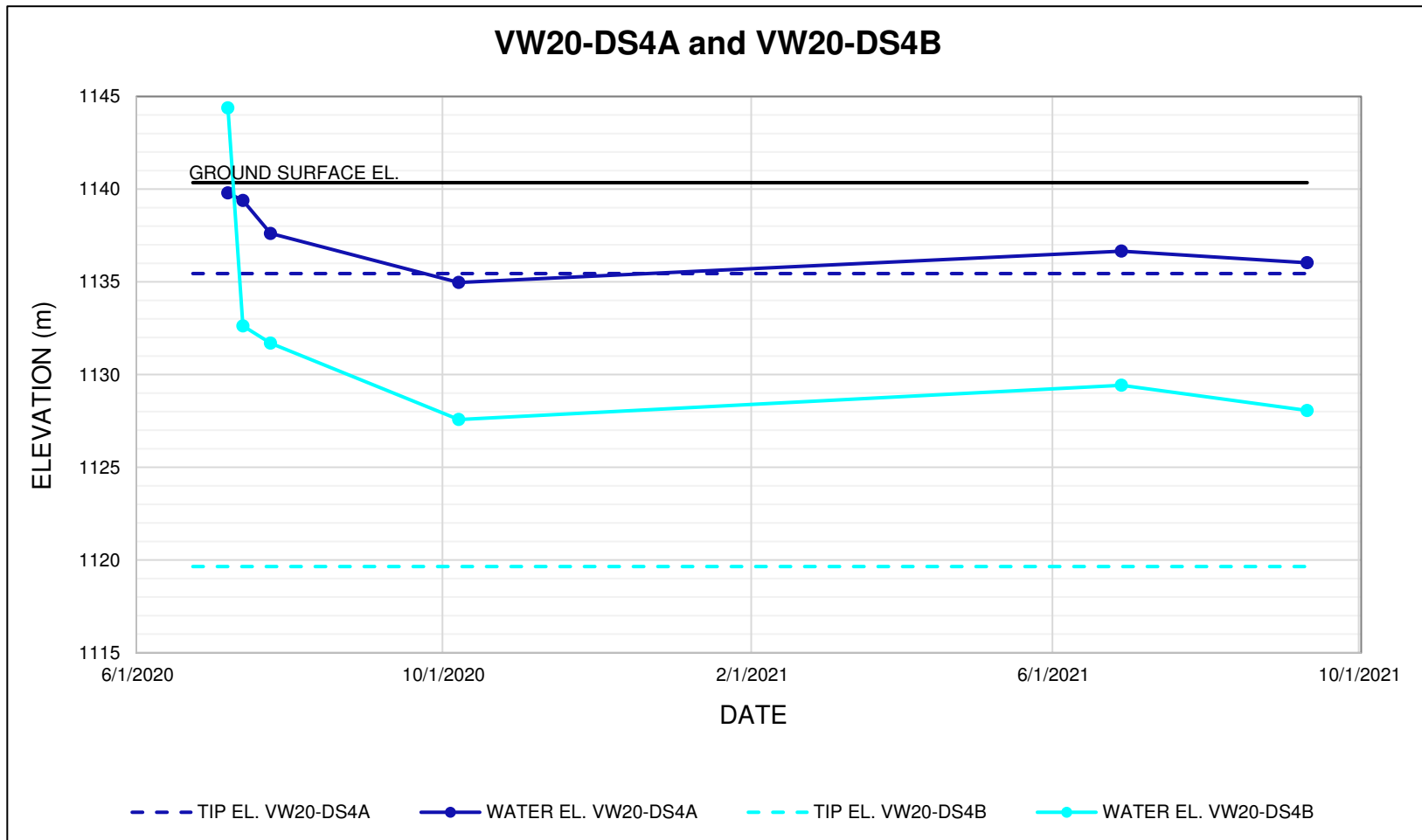
CLIENT 	PROJECT PEACE REGION (GRANDE PRAIRIE DISTRICT - SOUTH) GEOHAZARD RISK MANAGEMENT PROGRAM		
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	SCALE	PROJECT No.	FIG No.
		A05116A01	



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	SCALE	PROJECT No. A05116A01	FIG No.

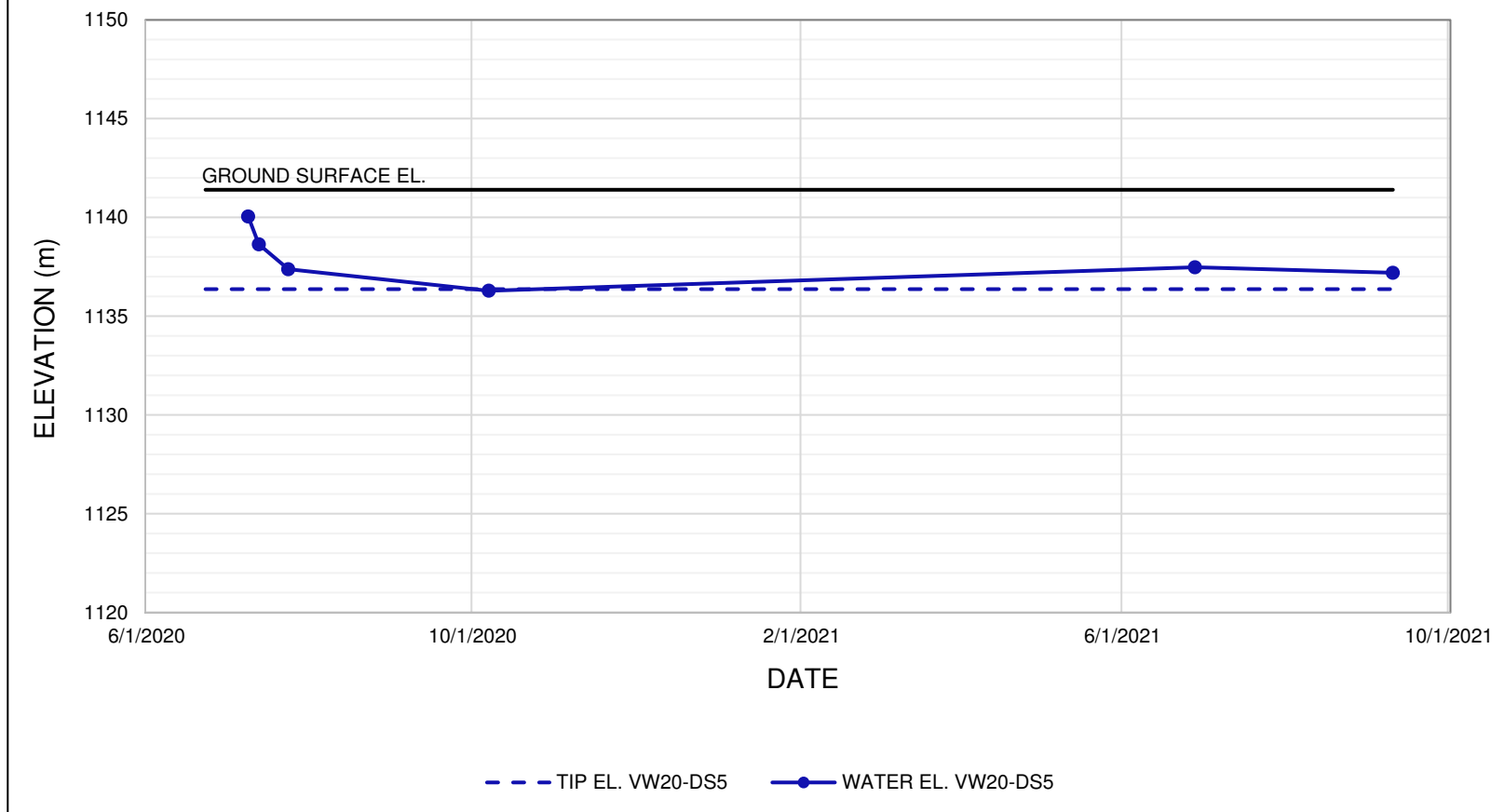


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SCALE	PROJECT No.	FIG No.
	A05116A01	

### VW20-DS5

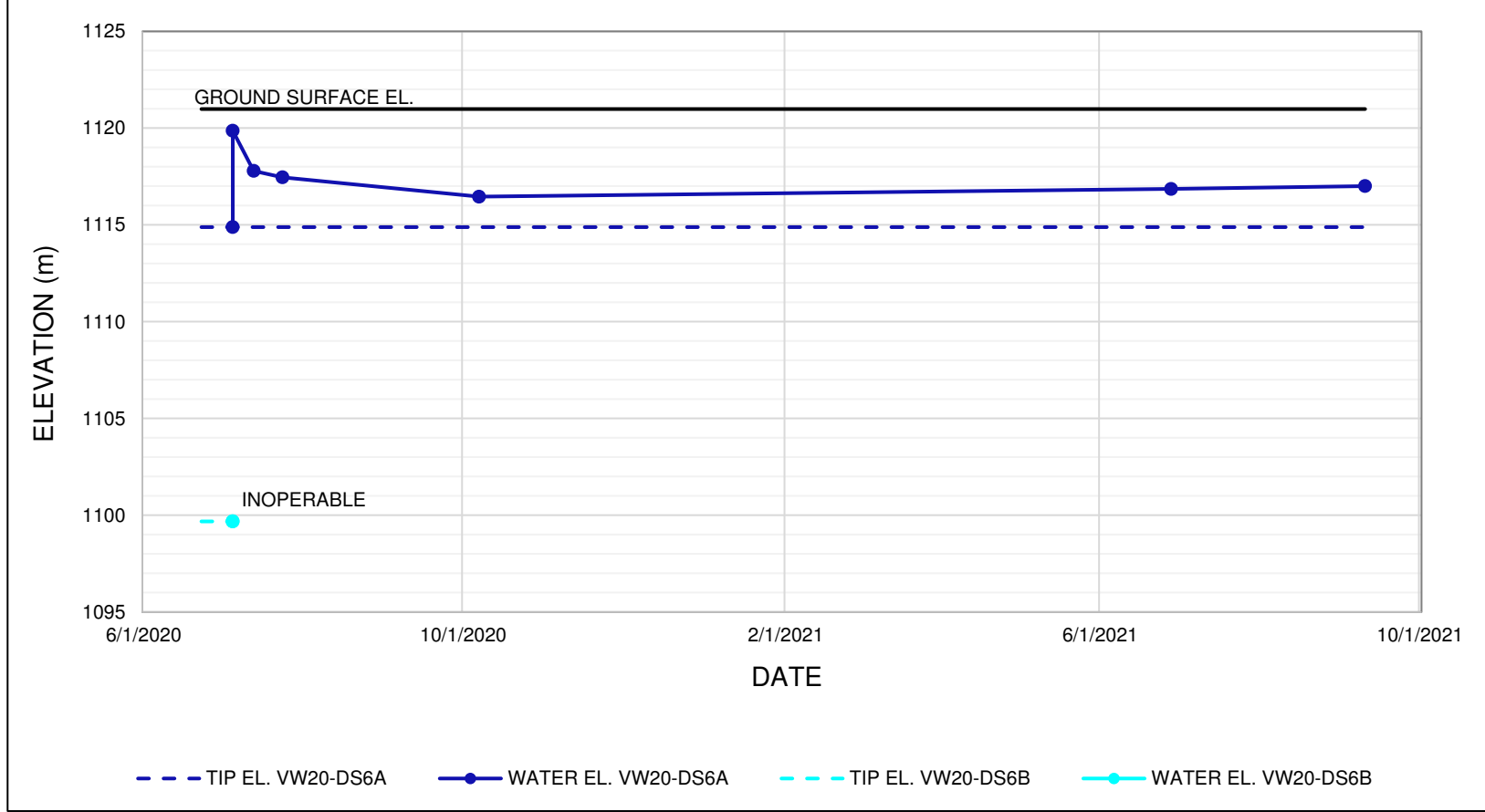


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CLIENT		PROJECT	
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SCALE	PROJECT No.	FIG No.	
	A05116A01		

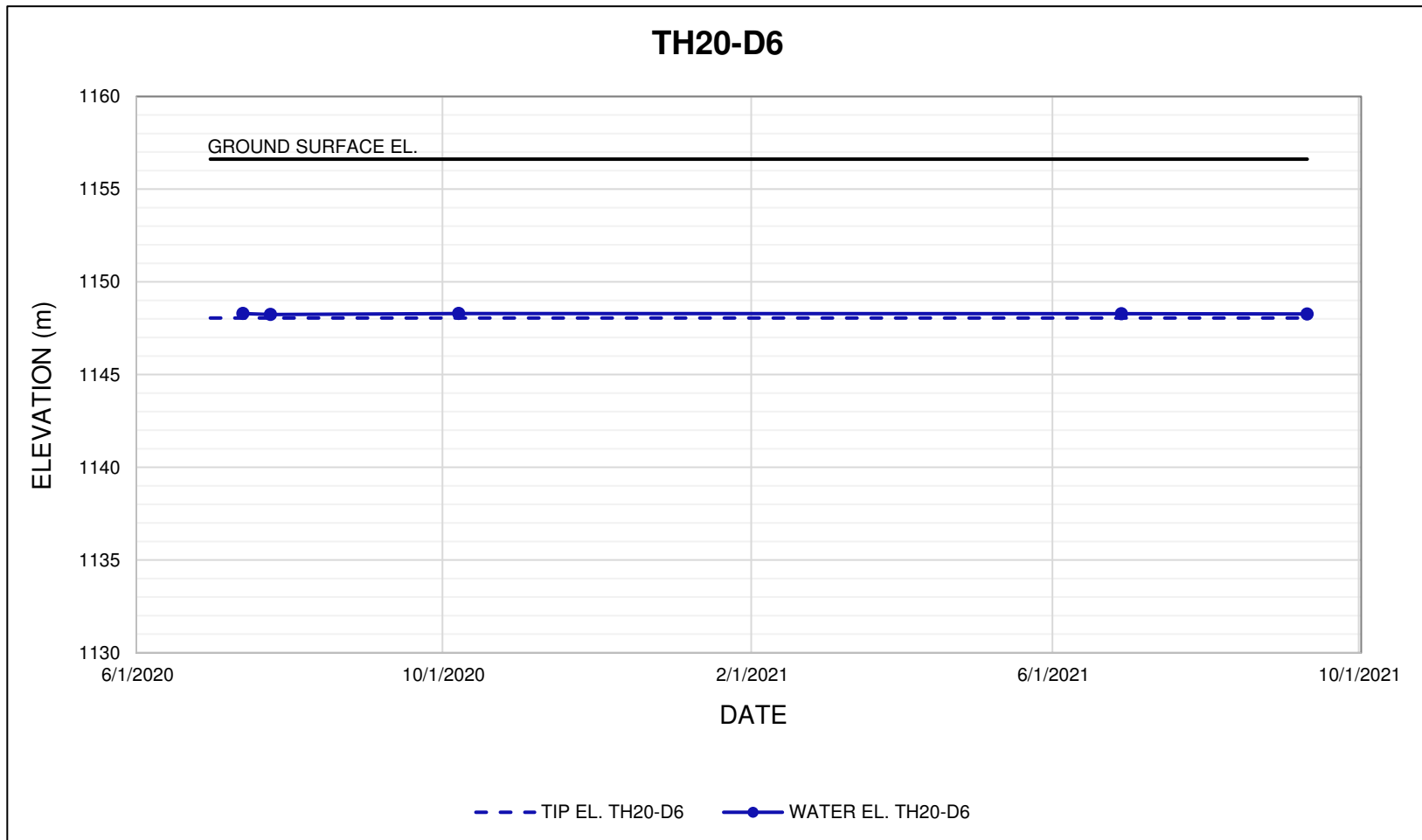
### VW20-DS6A AND VW20-DS6B



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SCALE	PROJECT No.    A05116A01    FIG No.