THURBER ENGINEERING LTD.

ALBERTA TRANSPORTATION
NORTH CENTRAL REGION – ATHABASCA AREA
INSTRUMENTATION MONITORING RESULTS

SPRING 2019

SECTION C

SITE NC014-1: HWY 661:02 FORT ASSINIBOINE

1. OBSERVATIONS

1.1 Field Program and Instrumentation Status

Two slope inclinometers (SI06-6 and SI06-11) and eleven standpipe piezometers (SP06-1 to SP06-5, SP06-9, SP06-10, SP06-13, SP6-14, SP06-18, SP06-19) were read at the Hwy 661:02 Fort Assiniboine site on June 18, 2019 by Mr. Niraj Regmi, G.I.T. and Mr. Kristoffer Conchada, T.T., both of Thurber Engineering Ltd. In addition, the four monitoring wells (MW18-1 to MW18-4) which were installed as part of a 2018 hydrogeological investigation were added to the instrumentation monitoring program (classified as standpipe piezometers in this report) and read during this monitoring event.

The SIs were read using a RST Digital Inclinometer probe with a 2 ft. wheelbase and a RST Pocket PC readout. Inclinometer reading depths were defined as per cable markings with respect to the top of the inclinometer casing. The standpipe piezometers were read using a DSGI dipmeter.

2. INTERPRETATION

2.1 General

SI plots for A and B directions are presented in Section D and are summarized below. Standpipe piezometer results are also provided in Section D.

2.2 Zones of Movement

No new zones of movement were observed in the SIs since the last set of readings recorded in the fall of 2018.

Historical zones of movement are summarized on Table NC014-1-1 at the end of this report. Table NC014-1-1 also provides a historical account of the total movement that has occurred at this site since the initialization of the slope inclinometers, the depth of movement and the maximum rate of movement.

2.3 Interpretation of Monitoring Results

Slope inclinometers SI06-6 and SI06-11 have recorded no discernible movements since initialization.

Standpipe piezometers SP06-1, SP06-2, SP06-3, SP06-4, SP06-5, SP06-9, SP06-10, SP16-13, SP06-18 and SP06-19 showed increases in groundwater level of 0.06 m, 0.11 m, 1.16 m, 0.10 m, 0.02 m, 0.05 m, 0.02 m, 0.04 m, 0.05 m and 0.06 m, respectively, since the fall of 2018 readings. The current groundwater level in SP06-2 is the highest ever recorded in the instrument. SP06-14 showed no change in groundwater level since the fall of 2018 readings.

Since they were last read in the fall of 2018, standpipe piezometers MW18-1, MW18-3 and MW18-4 showed increases in groundwater level of 0.09 m, 0.10 m and 0.25 m, respectively. MW18-2 showed a decrease in groundwater level of 0.04 m since it was last read in the fall of 2018.

The standpipe piezometer readings are summarized in Table NC014-1-2 below. The standpipe piezometer readings are also plotted on Figures NC014-1-1 and NC014-1-2 in Section D.

3. RECOMMENDATIONS

3.1 Future Work

The instruments should be read again in the fall of 2019.

3.2 Instrumentation Repairs

No instrument repairs are needed at this time.

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TABLE NC014-1-1
SPRING 2019 – HWY 661:02 FORT ASSINIBOINE
SLOPE INCLINOMETER INSTRUMENTATION READING SUMMARY

Date Monitored: June 18, 2019

INSTRUMENT #	DATE INITIALIZED	TOTAL CUMULATIVE RESULTANT MOVEMENT AND DEPTH OF MOVEMENT TO DATE (mm)	MAXIMUM RATE OF MOVEMENT (mm/yr)	CURRENT STATUS OF SI	DATE OF PREVIOUS READING	INCREMENTAL MOVEMENT SINCE PREVIOUS READING (mm)	CURRENT RATE OF MOVEMENT (mm/yr)	CHANGE IN RATE OF MOVEMENT SINCE PREVIOUS READING (mm/yr)
SI06-6	Mar. 31, 2006	No discernible movement	N/A	Operational	September 18, 2018	No discernible movement	N/A	N/A
SI06-11	Apr. 1, 2006	No discernible movement	N/A	Operational	September 18, 2018	No discernible movement	N/A	N/A
SI06-12	*Mar. 30, 2006*	*4.3 over 6.4 m depth to 6.8 m depth in 193º direction*	*1.5 mm/yr between September 2010 and May 2011*	*Blocked/ Destroyed*	*May 13, 2011*	*N/A*	*N/A*	*N/A*
SI06-15	*Mar. 28, 2006*	*No discernable movement*	*N/A*	*Blocked*	*May 22, 2007*	*N/A*	*N/A*	*N/A*
SI06-16	*Mar. 29, 2006*	*4.0 over 4.6 m depth to 8.2 m depth in 183º direction*	*2.6 mm/yr between May 2007 and May 2008*	*Sheared off at 7.8 m*	*Sept. 28, 2009*	*N/A*	*N/A*	*N/A*

Drawing 13357-NC014-1 in section D provides a sketch of the approximate location of the monitoring instrumentation for this site.

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TABLE NC014-1-2
SPRING 2019 – HWY 661:02 FORT ASSINIBOINE
STANDPIPE PIEZOMETER INSTRUMENTATION READING SUMMARY

Date Monitored: June 18, 2019

INSTRUMENT #	DATE INITIALIZED	TIP DEPTH (mBGS)	GROUND ELEV. (m)	CURRENT STATUS	MAXIMUM GROUNDWATER LEVEL (mBGS)	MEASURED GROUNDWATER LEVEL (mBGS)	PREVIOUS READING (mBGS)	CHANGE IN GROUNDWATER LEVEL SINCE PREVIOUS READING (m)
SP06-1	Apr. 2, 2006	9.13	N/A	Active	Sept. 12, 2016 (1.25)	1.66	1.72	0.06
SP06-2	Apr. 2, 2006	9.12	N/A	Active	June 18, 2019 (5.12)	5.12	5.23	0.11
SP06-3	Apr. 2, 2006	25.00	N/A	Active	May 27, 2015 (3.72)	5.04	6.20	1.16
SP06-4	Mar. 31, 2006	15.21	N/A	Active	Sept. 23, 2017 (8.57)	8.59	8.69	0.10
SP06-5	Mar. 31, 2006	25.00	N/A	Active	Apr. 2, 2006 (9.46)	14.25	14.27	0.02
SP06-9	Apr. 1, 2006	15.24	N/A	Active	Apr. 2, 2006 (4.46)	6.07	6.12	0.05
SP06-10	Apr. 2, 2006	25.00	N/A	Active	Sept. 23, 2017 (5.97)	6.65	6.67	0.02
SP06-13	Apr. 2, 2006	9.95	N/A	Active	Sept. 12, 2016 (6.95)	6.99	7.03	0.04
SP06-14	Mar. 28, 2006	9.16	N/A	Active	May 30, 2017 (6.61)	6.98	6.98	0.00

Drawing 13357-NC014-1 in section D provides a sketch of the approximate location of the monitoring instrumentation for this site.

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TABLE NC014-1-2 – CONTINUED…
SPRING 2019 – HWY 661:02 FORT ASSINIBOINE
STANDPIPE PIEZOMETER INSTRUMENTATION READING SUMMARY

Date Monitored: June 18, 2019

INSTRUMENT #	DATE INITIALIZED	TIP DEPTH (mBGS)	GROUND ELEV. (m)	CURRENT STATUS	MAXIMUM GROUNDWATER LEVEL (m)	MEASURED GROUNDWATER LEVEL (mBGS)	PREVIOUS READING (mBGS)	CHANGE IN GROUNDWATER LEVEL SINCE PREVIOUS READING (m)
SP06-17	*Apr. 2 2006*	*8.83*	*N/A*	*Destroyed*	*September 27, 2011 (6.12)*	*N/A*	*N/A*	*N/A*
SP06-18	Apr. 2, 2006	9.43	N/A	Active	Sept. 12, 2016 (1.85)	2.12	2.17	0.05
SP06-19	Apr. 2, 2006	7.95	N/A	Active	June 18, 2019 (6.71)	6.71	6.77	0.06
A11	*N/A*	*N/A*	*N/A*	*Destroyed*	*May 28, 2006 (6.70)*	*N/A*	*N/A*	*N/A*
MW18-1	June 2, 2018	9.10	634.97	Active	July 20, 2018 (7.30)	7.38	7.47	0.09
MW18-2	July 16, 2018	35.60	633.68	Active	Sept. 20, 2018 (25.70)	25.74	25.70	-0.04
MW18-3	June 2, 2018	13.60	656.84	Active	June 18, 2019 (5.98)	5.98	6.08	0.10
MW18-4	June 2, 2018	25.20	656.84	Active	June 18, 2019 (10.51)	10.51	10.76	0.25

Drawing 13357-NC014-1 in section D provides a sketch of the approximate location of the monitoring instrumentation for this site.

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ALBERTA TRANSPORTATION
NORTH CENTRAL REGION – ATHABASCA AREA
INSTRUMENTATION MONITORING RESULTS

SPRING 2019

SECTION D
DATA PRESENTATION

SITE NC014-1: HWY 661:02 FORT ASSINIBOINE

ALBERTA TRANSPORTATION
NORTH CENTRAL REGION - ATHABASCA AREA
INSTRUMENTATION MONITORING FIELD SUMMARY (NC014-1)
SPRING 2019

Location:	North of Fort Assiniboine (HWY 661:02 C1 1.690)	**Readout:**	DGSI Dipmeter
File Number:	13357	**Casing Diameter:**	2.75"
Probe:	RST SET 8R	**Temp:**	28
Cable:	RST SET 8R	**Read by:**	NKR/KPC

SLOPE INCLINOMETER (SI) READINGS

SI#	GPS Location (UTM 11)		Date	Stickup (m)	Depth from top of **casing** (ft)	Azimuth of A+ Groove degree	Current Bottom Depth Readings				Remarks
	Easting (m)	Northing (m)					A+	A-	B+	B-	
06-6	644703.11	6023511.82	18-Jun-19	0.82	83 to 5	203	555	-540	413	-404	*Read with 1 ft extension*
06-11	644849.96	6023532.50	18-Jun-19	0.55	81 to 3	190	375	-363	-663	671	*Read with 1 ft extension*

STANDPIPE PIEZOMETER (SP) READINGS

SP#	GPS Location (UTM 11)		Date	Stick-up (m)	Reading below top of casing (m)	Bottom Pipe Depth (below top of casing (m)
	Easting (m)	Northing (m)				
06-1	644588.96	6023693.84	18-Jun-19	1.05	2.71	9.13
06-2	644751.92	6023581.40	18-Jun-19	0.95	6.07	9.12
06-3	644752.96	6023581.43	18-Jun-19	0.78	5.82	25.00
06-4	644703.11	6023511.82	18-Jun-19	0.78	9.37	15.21
06-5	644703.11	6023511.82	18-Jun-19	0.93	15.18	25.00
06-9	644812.00	6023448.00	18-Jun-19	0.72	6.79	15.24
06-10	644849.96	6023532.50	18-Jun-19	0.80	7.45	25.00
06-13	644686.08	6023480.33	18-Jun-19	0.90	7.89	9.95
06-14	644741.20	6023451.11	18-Jun-19	0.97	7.95	9.16
06-18	644845.00	6023335.00	18-Jun-19	1.45	3.57	9.43
06-19	644936.00	6023245.00	18-Jun-19	0.99	7.70	7.95
MW18-1	644771.18	6023436.42	18-Jun-19	0.83	8.21	9.10
MW18-2	644782.87	6023425.99	18-Jun-19	0.80	26.54	35.60
MW18-3	644853.47	6023534.67	18-Jun-19	0.72	6.70	14.97
MW18-4	644851.48	6023535.58	18-Jun-19	0.87	11.38	25.20

INSPECTOR REPORT

Call Alan O'Brien at 780-349-1470 to read MW18-3 and MW18-4. They are next to SP06-9 and SP06-10.

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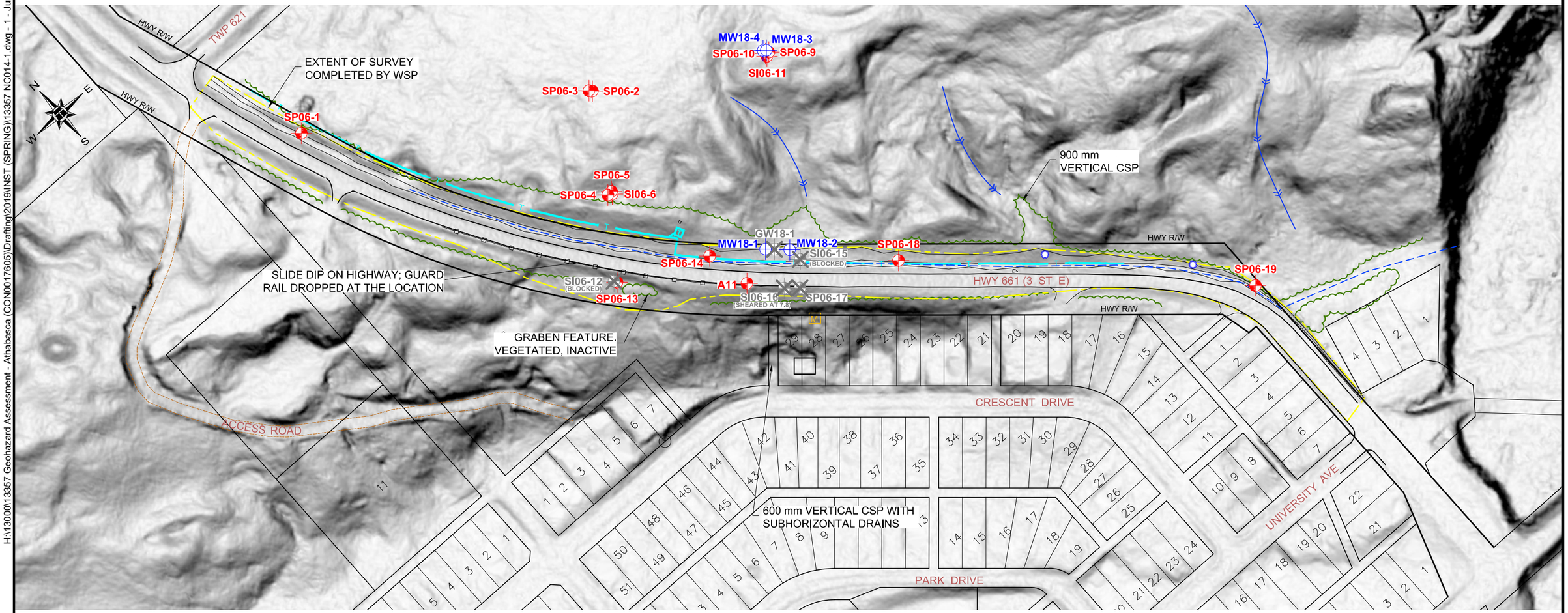

LEGEND

- MONITORING WELL LOCATION
- GRAVITY WELL LOCATION
- APPROXIMATE INSTRUMENT LOCATION
- (SP) STANDPIPE PIEZOMETER
- (SI) SLOPE INCLINOMETER
- DAMAGED / SHEARED OFF INSTRUMENT
- VERTICAL CSP FILLED WITH COBBLES
- TREELINE
- METAL BOX (POSSIBLY WITH SUBHORIZONTAL DRAINS)
- TELUS LINE
- GUARD RAIL
- GULLY

NOTES:

1. SURVEY CONDUCTED ON JUNE 13, 2017 BY WSP
2. LIDAR, AS RECENT AS 2015, USED TO AUGMENT WSP SURVEY

0 25 50 75 100 125 150m

SCALE 1:2500

Alberta

NORTH CENTER REGION - ATHABASCA AREA

NC014-1: FORT ASSINIBOINE
SITE PLAN SHOWING INSTRUMENT LOCATIONS

DWG No. 13357-NC014-1

DRAWN BY	ML
DESIGNED BY	BWN
APPROVED BY	TSA
SCALE	1:2500
DATE	JUNE 2019
FILE No.	13357

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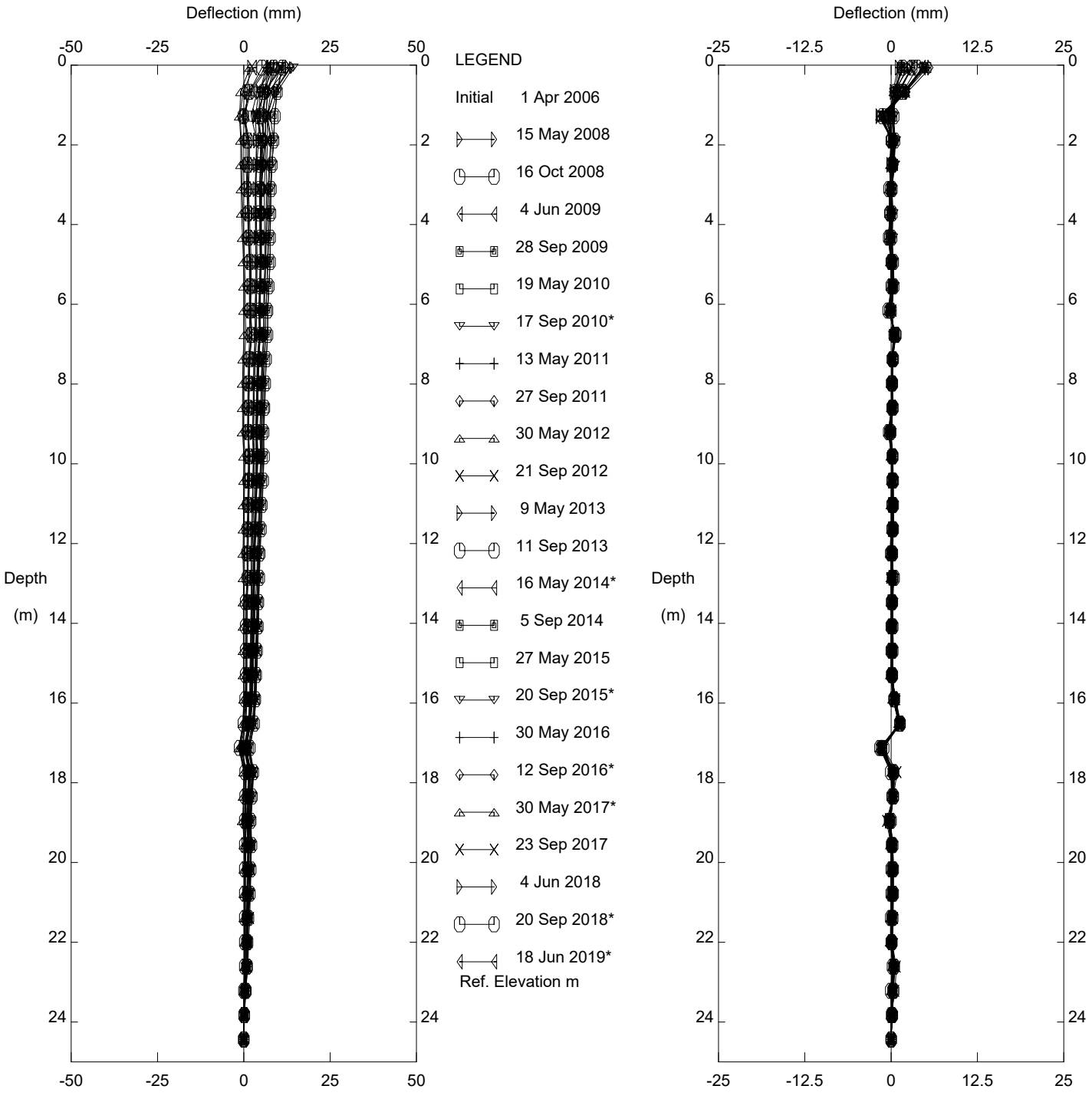
Thurber Engineering Ltd



Cumulative Deflection

Direction A

Incremental Deflection

Direction A

Hwy 661:02 Ft Assiniboine, Inclinometer SI06-11

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

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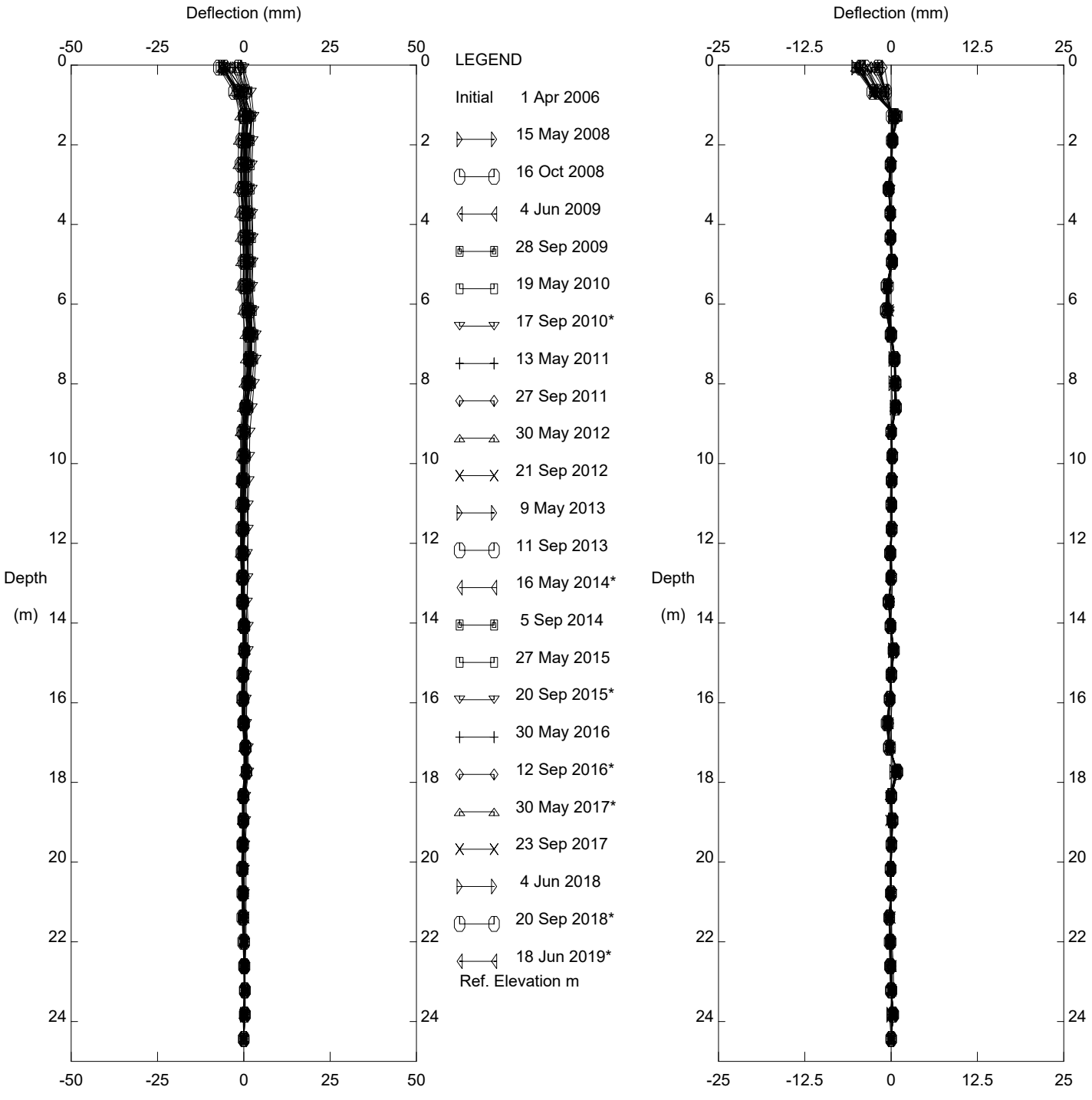

Cumulative Deflection

Direction B

Incremental Deflection

Direction B

Hwy 661:02 Ft Assiniboine, Inclinometer SI06-11

Alberta Transportation

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

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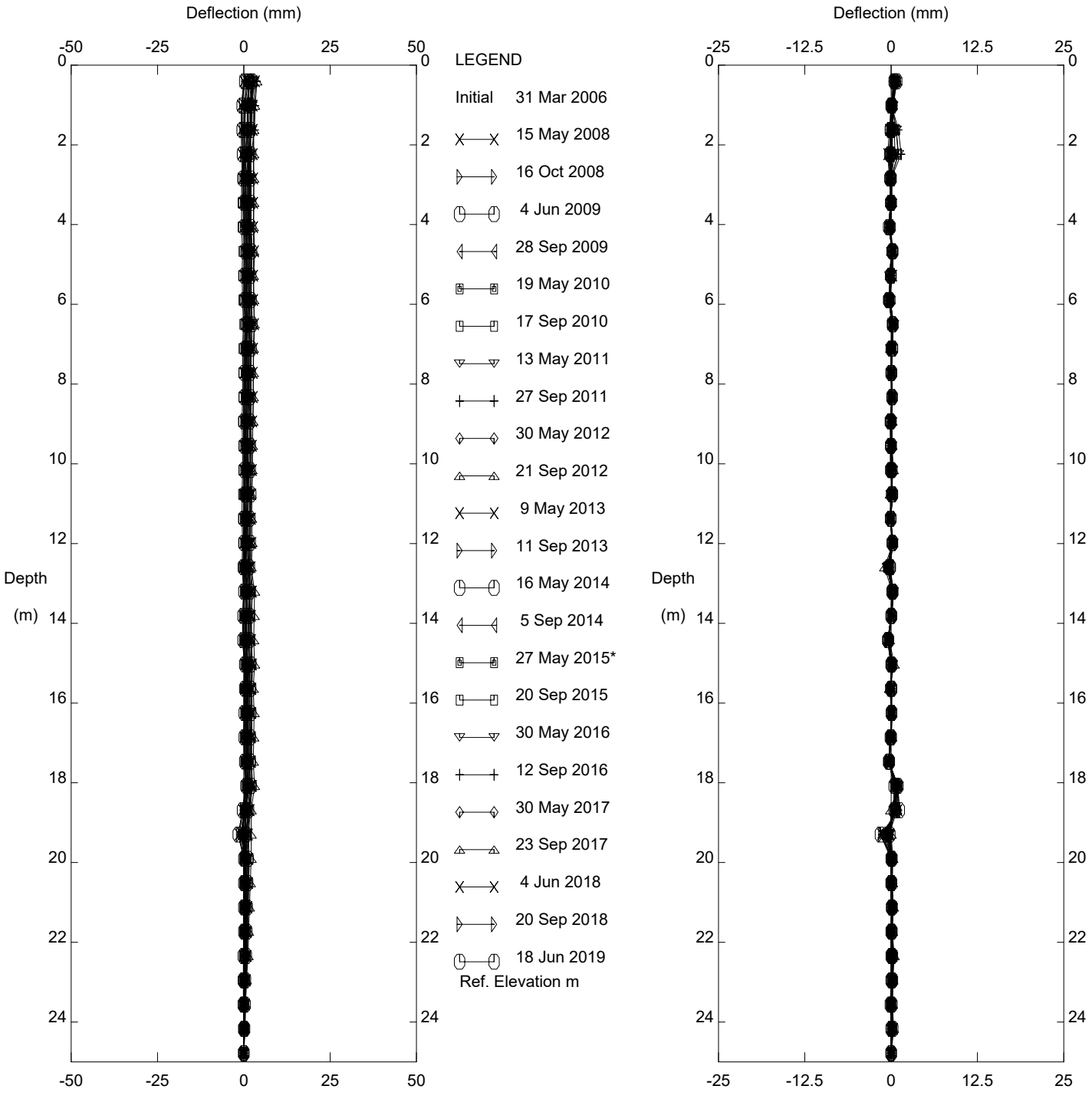
Thurber Engineering Ltd



Cumulative Deflection

Direction A

Incremental Deflection

Direction A

Hwy 661:02 Ft Assiniboine, Inclinometer SI06-6

Alberta Transportation

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

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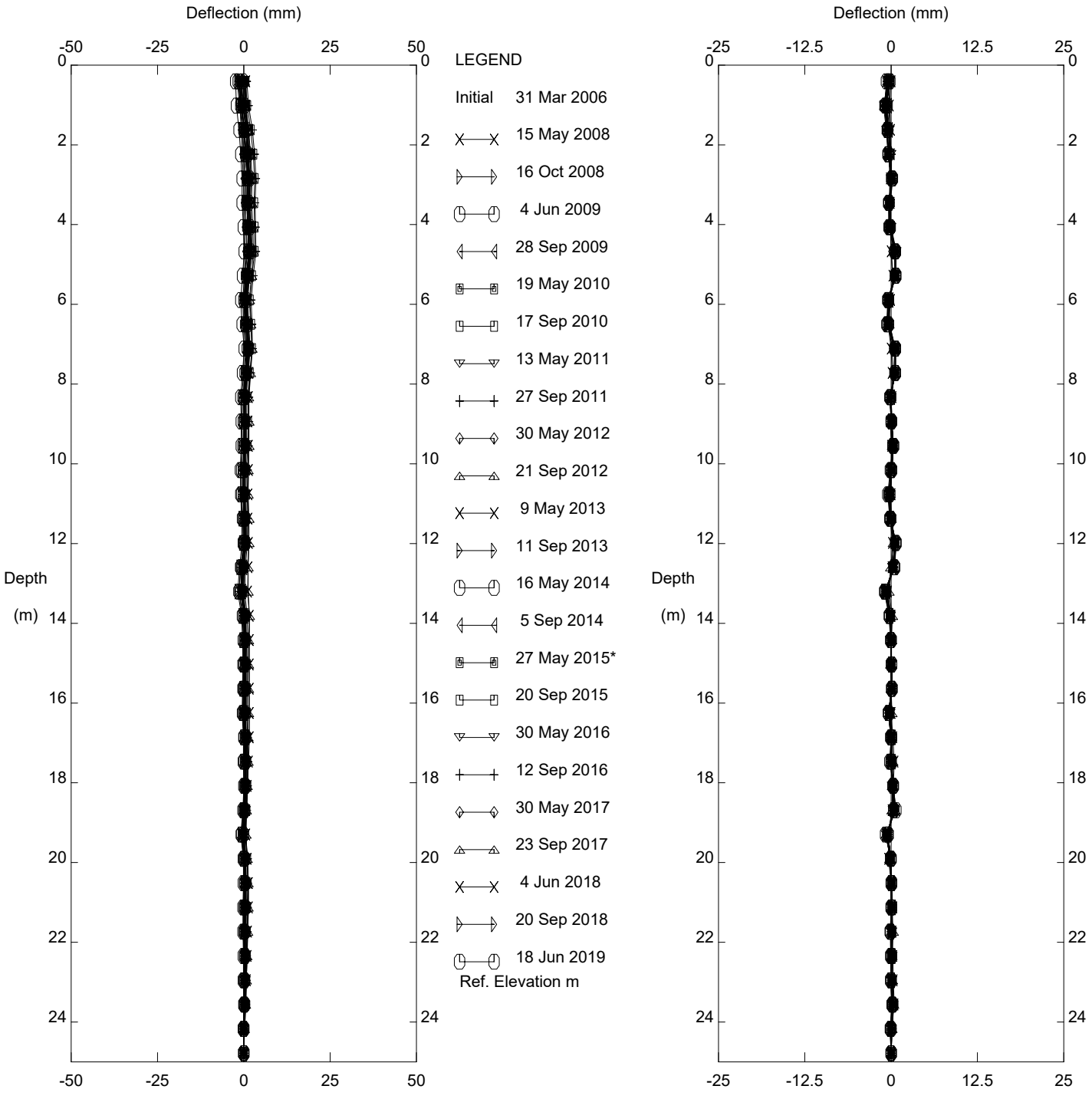
Thurber Engineering Ltd



Cumulative Deflection

Direction B

Incremental Deflection

Direction B

Hwy 661:02 Ft Assiniboine, Inclinometer SI06-6

Alberta Transportation

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

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FIGURE NC014-1-1
STANDPIPE PIEZOMETER DATA FOR HWY 661:02 FORT ASSINIBOINE

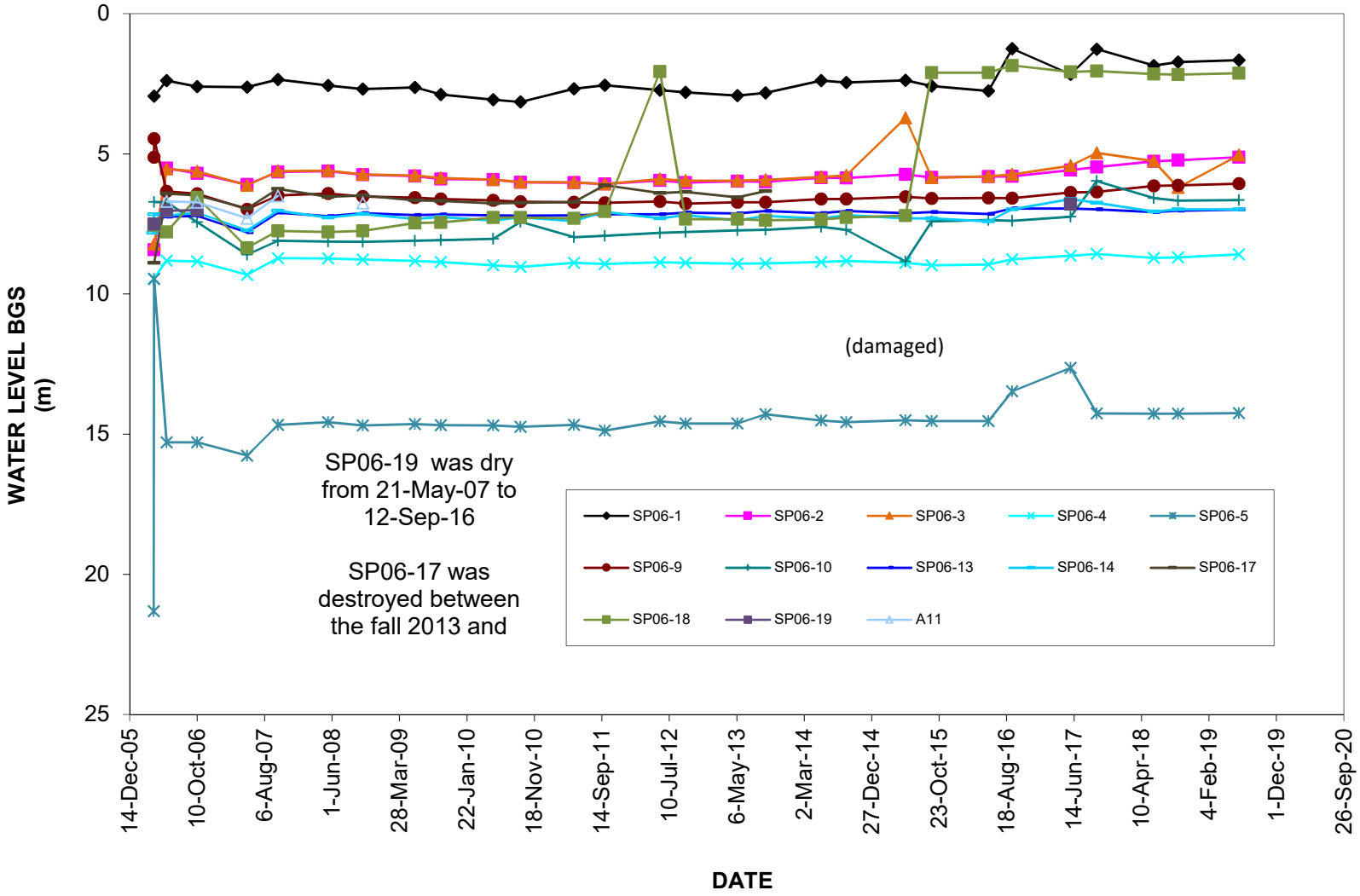

FIGURE NC014-1-2
STANDPIPE PIEZOMETER DATA FOR HWY 661:02 FORT ASSINIBOINE
(2018 MONITORING WELLS)