APPENDIX ‘D’

PIPELINE ELECTROMAGNETIC INSPECTION REPORT

City of Winnipeg - AECOM

600 mm Charleswood-Assiniboia Feeder Main

Condition Assessment Report, Standard Analysis

PICA- Pipeline Inspection & Condition Analysis Corporation
(A Subsidiary of Russell NDT Holdings Ltd.)

24in Potable Water Chimera RFT ILI Tool

600mm CML Spiral Welded Steel Pipe

Assiniboine River Crossing – RFP 495-2018

Rouge Rd to Berkley St

Winnipeg, Manitoba

PICA Project: 8054

Inspection Date:	March 28, 2019
Report Submission:	August 26, 2019 (rev 1.1); June 1, 2019 (rev 1.0)
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Report Revision:	1.0

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City of Winnipeg:

600mm Charleswood-Assiniboia Feeder Main

Condition Assessment Report, Standard Analysis

Executive Summary

PICA, under contract with the City of Winnipeg (RFP 495-2018), inspected two 24in river crossing feeder mains for the City of Winnipeg using Remote Field Testing (RFT) Technology from March 26-28, 2019. The inspected lines are referred to as the Kildonan-Redwood Feeder Main and the Charleswood-Assiniboia Feeder Main. This report documents the inspection results for the 24in Charleswood-Assiniboia line, which crosses beneath the Assiniboine River and was inspected on March 28. The inspected portion spanned between excavations on the north and south sides of Assiniboine River (refer to the line map in Figure 4). This report documents PICA's findings.

A total of 111 localized wall loss indications were identified in the inspection data. Among these defects, two (2) defects measured <20% remaining wall (RW): a 19% RW indication in pipe 0100, and a 16% RW indication in pipe 0130. An additional 36 indications were measured as *deep* (20-39% RW), 62 were classified as *medium* (40-64% RW), and 11 were *shallow* (≥65% RW). Most (89) of the defect indications are located within a single stretch of the Feeder Main spanning from about 61m to 78m, corresponding to pipes 0100 and 0110 (PICA designation).

A listing of all logged anomalies together with detailed analysis information can be found in the companion document, "*PICA Inspection Results - 24in Charleswood-Assiniboia Feeder Main (rev1.1).xlsx*". Figure 1 and Figure 2 illustrate the axial and circumferential distribution of localized defect indications along the Charleswood-Assiniboia Feeder Main. Note that some data points partially overlap due to proximity. A condition assessment summary detailing the top three defect indications, as well as pipe average remaining wall values for each segment (greater than 2.11m in length) of the Feeder Main river crossing is provided in Figure 3.

Table 1. Overview of the RFT findings for the 600mm Charleswood-Assiniboia Feeder Main

Table 1: Feature Indication Summary	
Inspected Length	220.08m
Number of Pipe Segments: *(includes mitered elbows listed as single segments)*	28
Number of Analyzed Pipe Sections:	28
Thinnest circumferential pipe wall (Tcircmin) (RW %):	89% (in Pipe 0160)
Number of pipes without localized wall loss indications:	18
Number of pipes with localized wall loss indications:	10
• **Number of indications with >65% RW:**	11
• **Number of indications with 40-65% RW:**	62
• **Number of indications with <40% RW:**	36
• **Number of indications with <20% RW:**	2
Total number of wall loss indications reported:	111
Number of Fully Circumferential Indications Reported:	1
Number of Flange-Pair Connections:	27
Number of Open-Faced Flanges:	2
Number of Mitered Bends:	7

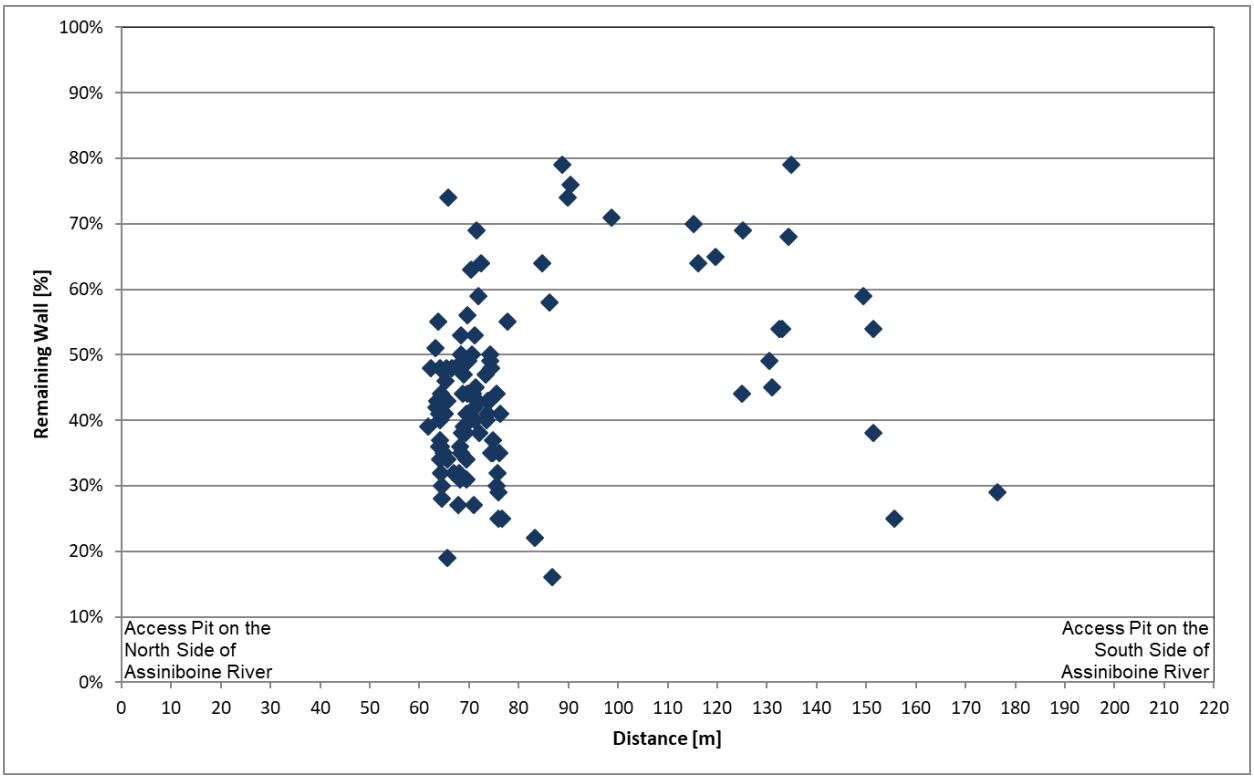

Figure 1. Axial distribution of defect indications and remaining wall (%) within the scanned length of the Charleswood-Assiniboia Feeder Main

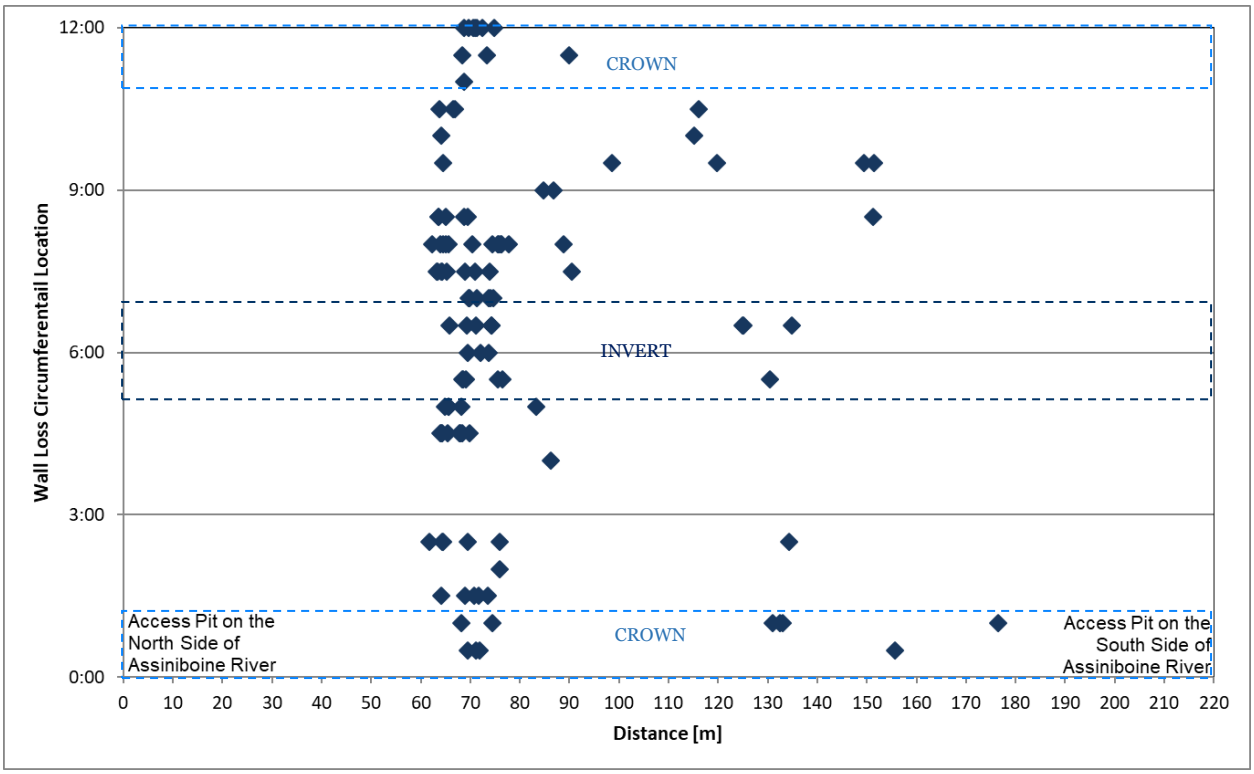

Figure 2. Circumferential distribution of pitting regions along the Charleswood-Assiniboia Feeder Main, described with clock positions referenced by looking from north to south

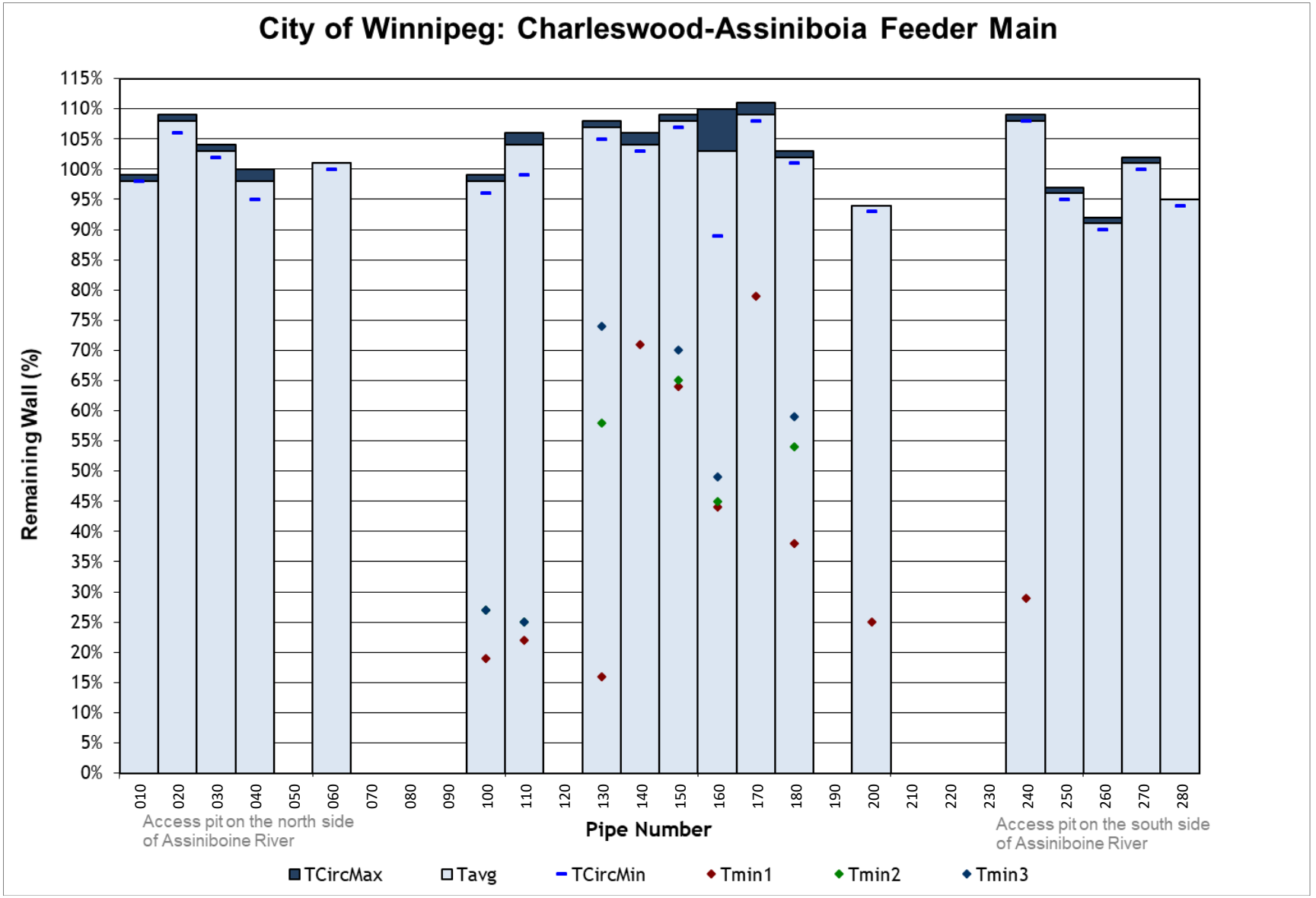

Figure 3. Condition assessment summary for the Charleswood-Assiniboia Feeder Main. Pipes less than 2.4 meters in length were not analyzed for pipe average remaining wall values.

Pipeline Inspection Background

The Charleswood-Assiniboia Feeder Main is a 600mm (24-inch) diameter steel main transporting potable water. A dual tethered Remote Field Technology (RFT) inspection of the feeder mains was conducted by PICA on March 28th, 2019. The section inspected by PICA crosses beneath the Assiniboine River, and extended between two excavations dug north and south of the river (in line with Rough Road and Berkley Street).

The excavations were made adjacent to existing chambers to gain access to the pipeline. Sections of pipe were cut and removed at each of the excavation locations. Figure 4 shows an overview of the inspected length of the Charleswood-Assiniboia Feeder Main crossing beneath the Assiniboine River, and approximate locations of the north and south excavations.

Table 2. Pipeline and RFT inspection information for the 600mm Charleswood-Assiniboia Feeder Main river crossing

Client:	City of Winnipeg	
Location:	Rouge Rd to Berkley St., Assiniboine River Crossing, Winnipeg, Manitoba	
Line Name/ Identifier:	Charleswood-Assiniboia Feeder Main	
Product:	Potable Water	
Pipe Diameter:	600 mm (24-inch)	
Material:	Steel, spiral welded	
NWT:	6.4 mm (0.250 in)	
Grade:		
Internal Liner:	CML (AWWA C205-62T); 0.25in WT (6.4mm) measured in field at excavations	
External Coating:	Coal-Tar Enamel (AWWA C203-57)	
Bends:	(Mitered) 43°, 30°, 6°, 7°	
Joint Type:	Flanges AWWA Class D	
Age:	55 yrs. (1964)	
RFT Inspection Access Locations:	Excavations north and south of the Assiniboine River	
	Elevation	**GPS Coordinates**
North Excavation:	233.0m	49°51'56.38"N, 97°18'2.00"W
South Excavation:	232.5m	49°51'51.74"N, 97°18'8.96"W
RFT Inspection Length:	220.08 m	
Reported Inspection Direction:	North to South	

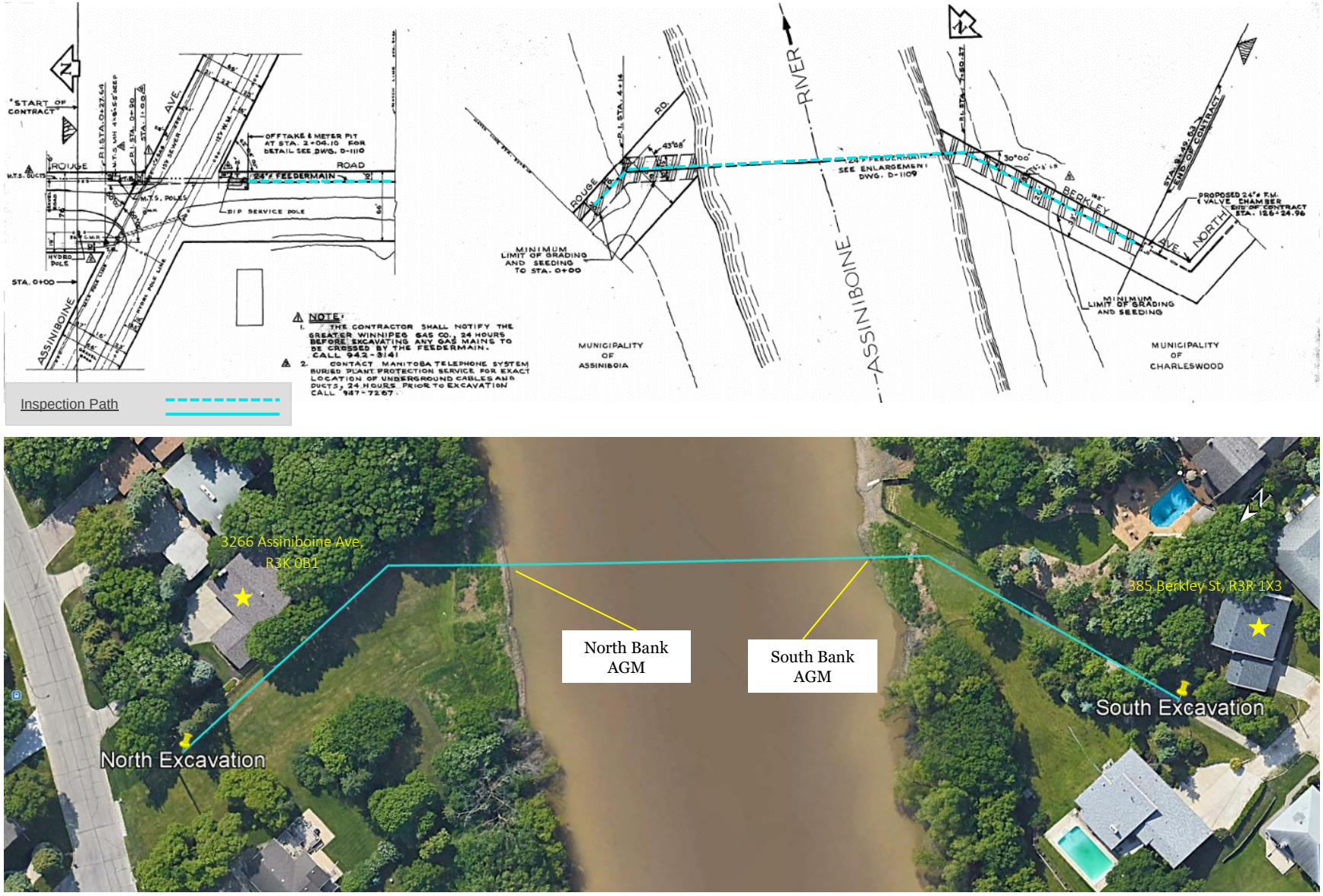

Figure 4. Path map overview of the 600 mm Charleswood-Assiniboia Feeder Main that crosses beneath the Assiniboine River.

Inspection Details

RFT Inspection Preparation

Prior to performing the RFT inspection, all available Critical Application Information (CAI) was reviewed including drawings and measurements of pipes and wall thicknesses provided by the client and subcontractor to ensure a successful inspection.

The pipeline section was isolated, and excavations were made at locations north and south of the river. Pipe sections were cut and removed to gain access to the pipeline. Cleaning pigs were pulled through the river crossing by J-Con to remove any loose scale in preparation for the In-Line Inspection (ILI).

Before PICA's mobilization, the pipeline was gauged by J-Con using PICA's custom gauge assembly to confirm the minimum bore and ensure the 24-inch Chimera RFT ILI tool could safely navigate the Charleswood-Assiniboia Feeder Main. Figure 5 shows the gauge tool after being pulled through the Feeder Main. Minor deflections were observed on the gauge fins, but no major bore restrictions were indicated that would prevent tool passage. A tagline was left in the pipe after the gauging activities were completed, for use during the RFT inspection mobilization.

The RFT Chimera tool assembly was sprayed with a 200mg/L free chlorine disinfection solution (Figure 6) before the tool was introduced into the Main.

Figure 5. PICA's custom gauge tool assembly shown after being pulled through the Charleswood-Assiniboia Feeder Main

Figure 6. Disinfecting the Chimera assembly using a 200 mg/L free chlorine solution

Winches were positioned at the South and North Excavations. The winchline at the South Excavation was connected to the tagline in the pipe. The tagline was pulled up on the north side of the river, pulling the south side winchline through the pipeline (Figure 7). Once the winchline from the South Excavation was pulled through the river crossing to the north access location, it was connected to the Chimera tool assembly.

Figure 7. Tagline being pulled up at north excavation to pull south side winchline through the Feeder Main.

RFT Inspection Procedure

The Chimera tool was lowered into the excavation at the north access location. The winchline odometer as well as the on-board odometer were both zeroed with the Chimera tool's odometer wheel flush with the pipe opening. For the first run, the Chimera tool's detectors were leading (facing south). Figure 8 shows the north access site with the Chimera RFT tool being lowered into the excavation and inserted into the Feeder Main.

Figure 8. North Excavation site, looking northeast

For the inspection of the Charleswood-Assiniboia Feeder Main, the Zero Reference Datum (ZRD) was set to the open flange face of the steel pipe at the North Excavation. The End Reference Datum (ERD) was established at the open flange face of the steel pipe at the South Excavation.

The Chimera tool was pulled from the North Excavation to the South Excavation at a velocity of 2.1 m/min, scanning at a frequency of 14 Hz. Figure 9 shows the excavation and winchline set-up at the south access location. Once the tool reached the excavation on the south side of the river, the tool was removed from the pipe to be turned around for a second inspection run.

During the process of extracting the tool and turning it around, the transmission on the southside winch slipped and the tool was dropped, causing minor tool damage and a short (2hr) delay in the return inspection.

Figure 9. South Excavation winchline set-up.

Following repairs, the Chimera tool was reinserted in the pipe with the detector module again leading (facing north-east). The return run was conducted at the same frequency and velocity as the first inspection run, with the tool traveling from the south excavation to the north excavation for retrieval. After the Chimera was received at the north access location, the collected RFT data was downloaded and reviewed for quality. The total length inspected was 220.08 meters.

PICA's custom Above Ground Monitors (AGMs) were used during the inline inspection as an additional source of positional information. These AGM units are programed to pick up the signal from the RFT ILI tool and were located on the edges of the riverbank so that the underwater portion of the river crossing could be identified during analysis and reporting. Figure 10 and Figure 11 show AGM units positioned on the north and south riverbanks of the Assiniboine River.

Figure 10. AGM unit positioned on the north bank of the Assiniboine river

Figure 11. AGM unit positioned on the south bank of the Assiniboine River

Analysis Results

Two data sets were collected during the inspection of the Charleswood-Assiniboia Feeder Main. One data set was collected as the Chimera tool traveled from the north excavation to the south. After arriving at the south excavation, the tool's orientation was flipped and a second data set was collected as the tool travelled from the south excavation back to the north for retrieval. Both data sets were analyzed, with defect indications correlated between the two inspections. This provides a high level of confidence in the location and sizing of the reported defect indications. All indications are reported with clock positions, referenced by facing south.

Location Reporting, Pipe Lengths & Features

Resource information collected and reviewed during the inspection project was used to supply the most accurate summary of positional information for each of the reported potential wall loss indications. This information included data collected by an Inertial Measurement Unit (IMU) which recorded the pitch, yaw and roll of the Chimera tool as it was pulled through the pipeline; AGM passage locations; and physical measurements of accessible piping. This information was compared with the client supplied drawings of the Feeder Main and was used for corroboration of reported construction feature and wall loss indications.

The 24-inch Chimera RFT ILI tool's on-board odometers, as well as winchline odometers were calibrated and zeroed prior to pulling the tool through the Charleswood-Assiniboia Feeder Main. The total inspected length recorded by the tool was 220.1 meters, with the ZRD set to the open flange face of the north end of the river crossing (identified as P6 in client records; PICA designation: pipe 0010), and the ERD set to the south open flange face at the south excavation (identified as P2 in client records; PICA designation: 0280). Distances stated in this report refer to the distance from the ZRD that was set at the north excavation.

The Charleswood-Assiniboia Feeder Main was constructed with pipe segments of various lengths joined with AWWA Class D Flange pairs. Most of the pipe segments were measured to be approximately 12m in length, corresponding to 40-foot pipe lengths specified in the construction records. Good correlation was observed between pipe lengths documented in client records and lengths measured by on-board odometers during the RFT inspection. A total of 28 pipe segments were identified during analysis of the RFT data. Due to the location of the excavation on the north shore, pipe segments identified in the client records as E7 (two-piece mitered bend) and P9 were not captured in the RFT inspected section.

AGM units were placed on the north and south banks of the Assiniboine river (GPS Coordinates). Recordings of the RFT tool passage correspond to 73.4 meters from the ZRD (AGM on the north riverbank), and 155.0 meters from the ZRD (AGM on the south riverbank).

Seven bends were identified in the RFT data during analysis. These bends correlate with the two horizontal and five vertical mitered bends documented in records provided by the client (Drawing No 7183 /64B.). A total of 27 flange pair connections were observed during analysis correlating to client provided drawings, as well as the open flange face located at the start of pipe 0010 and end of pipe 0280.

The flange connection between pipes 0240 and 0250 was noted to be leaking in 1965 (drawing number 7183/64B). Extra attention was given to this area near the flange connection during analysis to determine if any anomalous signal indications were recorded.

Pipe stress can be detected with RFT technology and correlated with locations of construction features such as anchor blocks. A fully circumferential indication of pipe stress was observed from 129.82m to 134.60m, within pipe 0160, corresponding to the location of an anchor block (listed as anchor block No. 3 in drawing D-1111, at Sta. 6+45). A list of all four anchor block locations is presented in Table 3. The Station Numbers in this Table are derived from client records.

Table 3. List of anchor block locations. Location information sourced from drawing D-1111 and 7183/64B.

Anchor Block No.	Pipe Number	Corresponding Station No.
1	0120, 0130	Sta. 5+05
2	0140	Sta. 5+70
3	0160	Sta. 6+45
4	0180	Sta. 7+15

General Wall Thickness

Pipe sections longer than 2.4m were analyzed to obtain the Pipe Average Remaining Wall (PARW) thickness calculated over the length of the inspected section. This value is reported as the "Tavg" RW in Table 4. The Chimera's sensor-exciter spacing (SES) is 2.11m, therefore pipe segments shorter than 2.4m were not analyzed for Tavg to ensure that the Chimera was not spanning between two or more separate pipes.

Due to manufacturing tolerances, fluctuations of ±15% in the individual PARW values are common. Variations outside the ±15% spread can be an indicator of a different nominal wall thickness or pipe type or point towards a problem like aggregate pitting or general wall loss. All pipes that were analyzed in the 600mm (24in) Charleswood-Assiniboia Feeder Main fall within the tolerance allowance.

Local Wall Thickness

Ten (10) pipes show evidence of pitting corrosion with a total of 111 localized pitting indications reported. Of these 111 indications, 11 indications measured to be "shallow" (≥65% RW), 62 indications measured to be "medium" (40-64% RW), and 36 indications measured "deep" (20-39% RW). In addition, two (2) defect measured below 20% RW: a 19% RW indication in pipe 0100, and a 16% RW indication in pipe 0130. Most (89) of the defect indications are located within a single stretch of the Feeder Main spanning from about 61m to 78m, corresponding to pipes 0100 and 0110 (PICA designation). Within these two pipe segments (0100 and 0110) significant corrosion patches were recorded along the invert. These corrosion patches range from4:30-8:30 o'clock and span between 68.0m-71.5m in pipe 0100, and between 73.5m-76.3m in pipe 0110. Only the larger localized indications that stand out from the surrounding corrosion were flagged during the analysis.

A colour map of the area with the smallest remaining wall indication recorded (16% RW in pipe 0130), located at 86.75m from the ZRD, is shown in Figure 12. Colour maps can highlight wall loss, wall gain, and material stresses within the pipe. Figure 13 to Figure 24 in Appendix 1 show additional colour maps of the data for all sections of pipe with reported wall loss indications, with defect indications annotated. Defect indications are highlighted in the figures with bounding boxes.

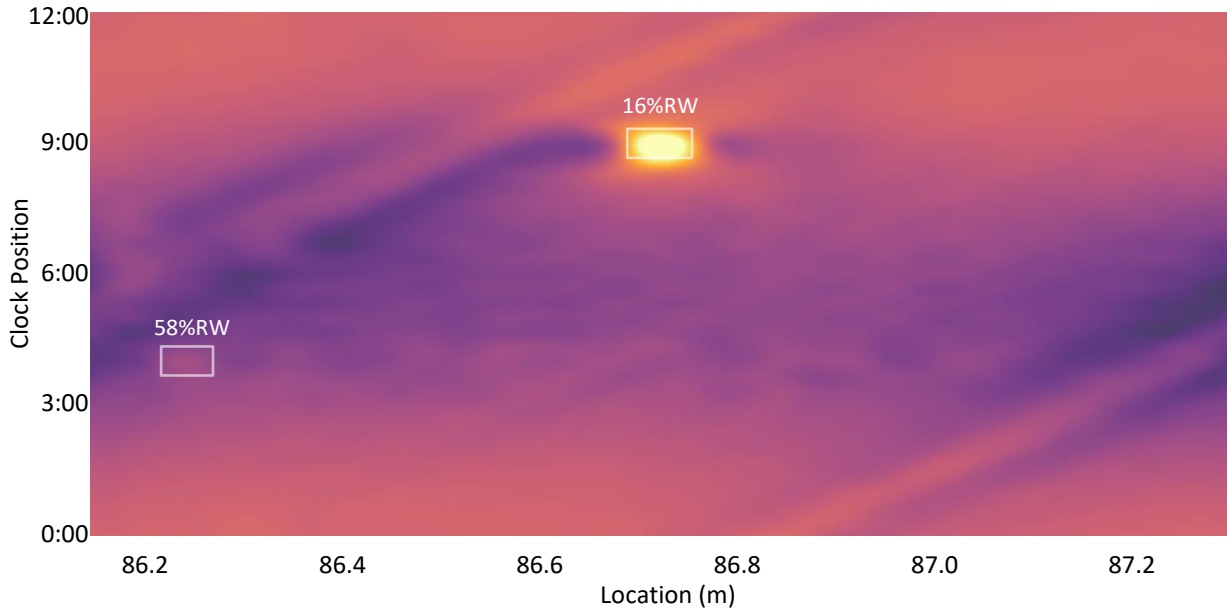

Figure 12. Colour map showing a close up of the 16% RW indication detected in pipe 0130, 86.75m from the ZRD on the north side of the river crossing

Table 4 details the three worst pitting indications per pipe (Tmin1, Tmin2 and Tmin3), as well as the average (Tavg), minimum circumferential (Tcircmin) and maximum circumferential (Tcircmax) remaining wall values for the inspected portion of the Charleswood-Assiniboia Feeder Main.

If AECOM and the City decide to perform verification and repair work on the onshore portions of the feeder main crossing (for example for pipe 0100), please let your PICA representative know. PICA can assist by providing dig sheets for the selected areas.

Data Quality

Prior to the inspection of the Charleswood-Assiniboia Feeder Main, the 24-inch Chimera RFT ILI tool was calibrated using a calibration pipe at PICA's shop. Details about the calibration can be found in Appendix 2.

Flange connections are difficult to assess. Flange pairs produce very large signals in the RFT data due to the amount of material present; these large flange signals can mask small wall loss indications at or adjacent to the connections. To mitigate the effects of the large RFT signal indications from flange pairs, the Chimera tool was pulled through the Main with the detectors leading for the first run and exciter leading for the second run. This maximizes the area of analyzable data collected on either side of these connections.

A significant number of pitting indications were observed near the invert of the pipeline within pipes 0100 and 0110 in both data sets. Several of these indications are reported with medium confidence due to proximity to spiral welds or travel noise in the RFT data. Defect indications detected within this area were compared between the two data sets to provide the highest accuracy possible during reporting. All defect indications reported are detailed in the Excel Workbook "*PICA Inspection Results - 24in Charleswood-Assiniboia Feeder Main (rev1.0)", Defects* spreadsheet. One of the detector pads (~4:30 clock position in the South-to-North run) was in contact with the pipe wall for most of the inspection – as a result the data from this pad is noisier than the data from other pads in that run. Rubbing of the detector pads against the pipe wall was also observed at the mitered bends, resulting in increased (travel) noise in the data at those locations. This rubbing noise as well as the RFT signal response to the bend (created by the changing alignment between exciter and detector at the bend locations) decreases the data quality at the bend locations.

Table 4. Summary of pipe tally and wall thickness readings for the Charleswood-Assiniboia Feeder Main

Pipe List and Wall Thickness Readings – 600 mm (24in) Charleswood-Assiniboia Feeder Main																
PICA Pipe #	Pipe Location			Tavg RW	Circumferential Wall Thickness		Local Wall Thickness									Comments
							Tmin1			Tmin2			Tmin3			
	Start (m)	End (m)	Length (m)		Tcircmax RW	Tcircmin RW	RW	Location (m)	Clock Position	RW	Location (m)	Clock Position	RW	Location (m)	Clock Position	
0010	0.0	11.5	11.5	98%	99%	98%										Located on north side of river
0020	11.5	23.6	12.1	108%	109%	106%										
0030	23.6	35.8	12.2	103%	104%	102%										
0040	35.8	48.0	12.2	98%	100%	95%										
0050	48.0	48.7	0.7													-11° pitch change recorded (2 PC 11° 39' elbow in drawing No.) 7183/64B)
0060	48.7	58.4	9.7	101%	101%	100%										
0070	58.4	59.6	1.2													50° horizontal bend RT (3 PC 43°08' horizontal elbow in drawing No. 7183/64B)
0080	59.6	60.6	1.0													
0090	60.6	61.3	0.7													8° pitch change recorded (2 PC 7°13' elbow in drawing No. 7183/64B)
0100	61.3	73.0	11.7	98%	99%	96%	19%	65.61	8:00	27%	67.81	4:30	27%	70.92	12:00	Numerous indications (see defect list for details)
0110	73.0	85.2	12.2	104%	106%	99%	22%	83.21	5:00	25%	75.86	2:30	25%	76.56	5:30	North side AGM is located on north river bank,

Pipe List and Wall Thickness Readings – 600 mm (24in) Charleswood-Assiniboia Feeder Main																
PICA Pipe #	Pipe Location			Tavg RW	Circumferential Wall Thickness		Local Wall Thickness									Comments
							Tmin1			Tmin2			Tmin3			
	Start (m)	End (m)	Length (m)		Tcircmax RW	Tcircmin RW	RW	Location (m)	Clock Position	RW	Location (m)	Clock Position	RW	Location (m)	Clock Position	
																73.37m in data (see photo on separate sheet). See defect list for defect details
0120	85.2	85.9	0.7													6.6° Pitch change recorded (2 PC elbow in drawing No. 7183/64B)
0130	85.9	98.0	12.2	107%	108%	105%	16%	86.75	9:00	58%	86.27	4:00	74%	89.85	11:30	Five defect indications reported, one with 16% RW (see defect list)
0140	98.0	110.2	12.2	104%	106%	103%	71%	98.61	9:30							One defect indication reported
0150	110.2	122.5	12.2	108%	109%	107%	64%	116.08	10:30	65%	119.71	9:30	70%	115.14	10:00	Three defect indications reported
0160	122.5	134.6	12.1	103%	110%	89%	44%	124.97	6:30	45%	131.00	1:00	49%	130.39	5:30	Seven defect indications reported, including a circumferential stress indication from 129.82m to 134.60m that correlates with a documented

Pipe List and Wall Thickness Readings – 600 mm (24in) Charleswood-Assiniboia Feeder Main																
PICA Pipe #	Pipe Location			Tavg RW	Circumferential Wall Thickness		Local Wall Thickness									Comments
							Tmin1			Tmin2			Tmin3			
	Start (m)	End (m)	Length (m)		Tcircmax RW	Tcircmin RW	RW	Location (m)	Clock Position	RW	Location (m)	Clock Position	RW	Location (m)	Clock Position	
																anchor block location
0170	134.6	146.8	12.2	109%	111%	108%	79%	134.79	6:30							One defect indication reported
0180	146.8	152.2	5.4	102%	103%	101%	38%	151.33	8:30	54%	151.49	9:30	59%	149.41	9:30	Three defect indications reported
0190	152.2	152.9	0.7													5.8° Pitch Change (2 PC 6°17' elbow in drawing No. 7183/64B)
0200	152.9	161.2	8.3	94%	94%	93%	25%	155.61	0:30							South side AGM is located @ 154.97m in data on south river bank (see photo on separate sheet). Contains 1 indication, estimated as 25% RW
0210	161.2	162.3	1.1													2.6° Pitch Change; horizontal bend RT (3 PC 30° horizontal elbow in drawing No. 7183/64B)
0220	162.3	164.3	2.0													

Pipe List and Wall Thickness Readings – 600 mm (24in) Charleswood-Assiniboia Feeder Main																
PICA Pipe #	Pipe Location			Tavg RW	Circumferential Wall Thickness		Local Wall Thickness									Comments
							Tmin1			Tmin2			Tmin3			
	Start (m)	End (m)	Length (m)		Tcircmax RW	Tcircmin RW	RW	Location (m)	Clock Position	RW	Location (m)	Clock Position	RW	Location (m)	Clock Position	
0230	164.3	165.0	0.7													(2 PC 1°28' elbow in drawing No. 7183/64B)
0240	165.0	177.1	12.1	108%	109%	108%	29%	176.47	1:00							Contains 1 indication, estimated as 25% RW
0250	177.1	189.3	12.2	96%	97%	95%										Start Joint flagged as leaking during install (1965) in drawing No. 7183/64B
0260	189.3	201.5	12.2	91%	92%	90%										
0270	201.5	213.6	12.1	101%	102%	100%										
0280	213.6	220.1	6.5	95%	95%	94%										Located on south side of river

Disclaimer – PICA Corporation

Scope of Services

The agreement of PICA Corp to perform services extends only to those services provided for in writing. Under no circumstances shall such services extend beyond the performance of the requested services. It is expressly understood that all descriptions, comments and expressions of opinion reflect the opinions or observations of PICA Corp based on information and assumptions supplied by the owner/operator and are not intended nor can they be construed as representations or warranties. PICA Corp is not assuming any responsibilities of the owner/operator and the owner/operator retains complete responsibility for the engineering, manufacture, repair and use decisions as a result of the data or other information provided by PICA Corp. Nothing contained in this Agreement shall create a contractual relationship with or cause of action in favor of a third party against either the Line Owner or PICA Corp. In no event shall PICA Corp's liability in respect of the services referred to herein exceed the amount paid for such services.

Standard of Care

In performing the services provided, PICA Corp uses the degree, care, and skill ordinarily exercised under similar circumstances by others performing such services in the same or similar locality. No other warranty, expressed or implied, is made or intended by PICA Corp.

Appendix 1: Colour Maps of Signal Indications

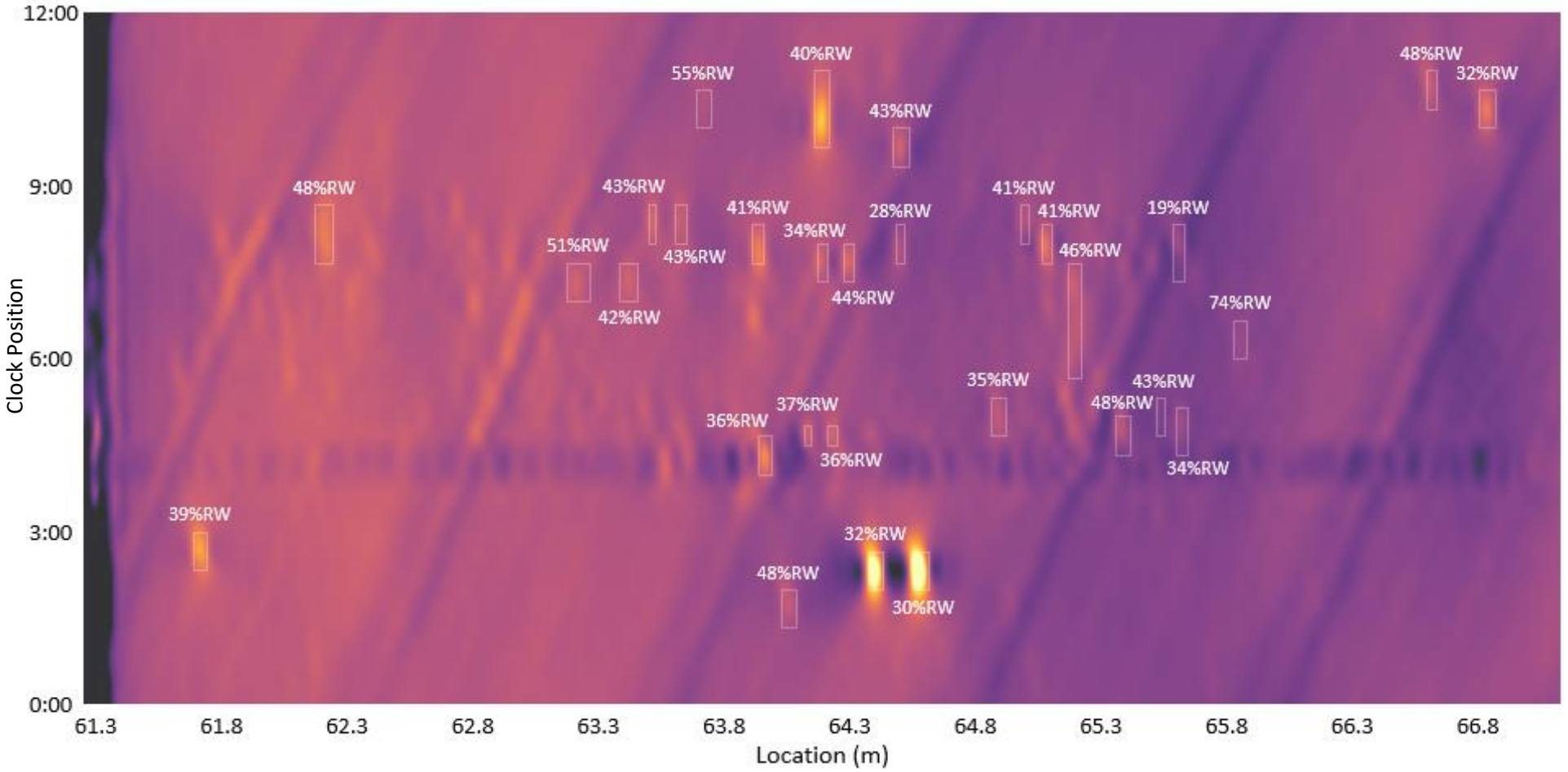

Figure 13. Colour map showing locations of defect indications reported within pipe number 0100 (Client pipe segment P10). A total of 66 indications have been reported in this pipe segment, continued in Figure 14. One deep defect (19% RW) was reported in this pipe segment, located 65.85m from the ZRD. Flange connection at beginning of pipe (61.29m) shown on left of colour map.

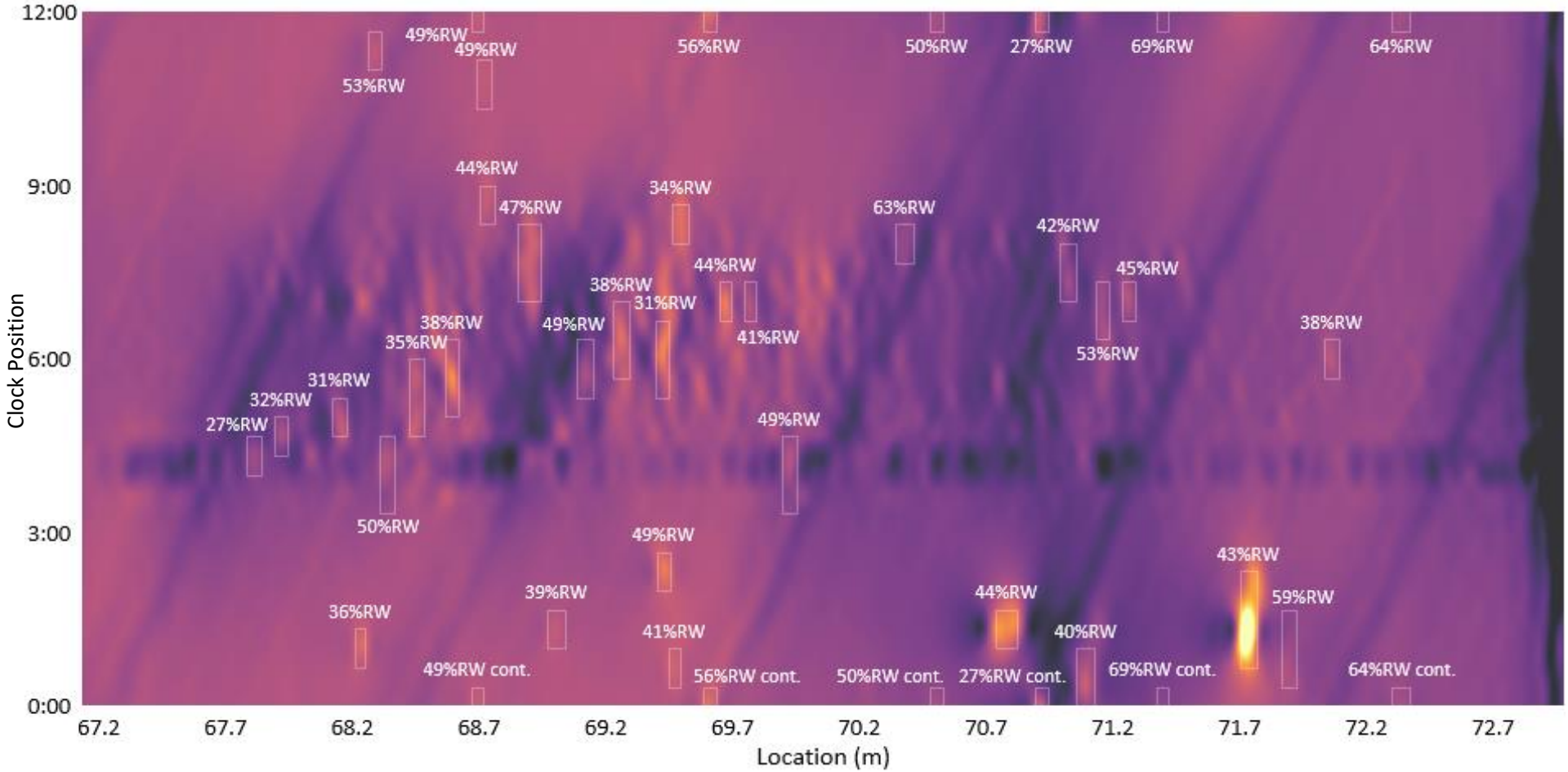

Figure 14. Continuation of pipe number 0100 colour map with defect indication locations shown. Flange connection at end of pipe (72.95m) shown on right of colour map.

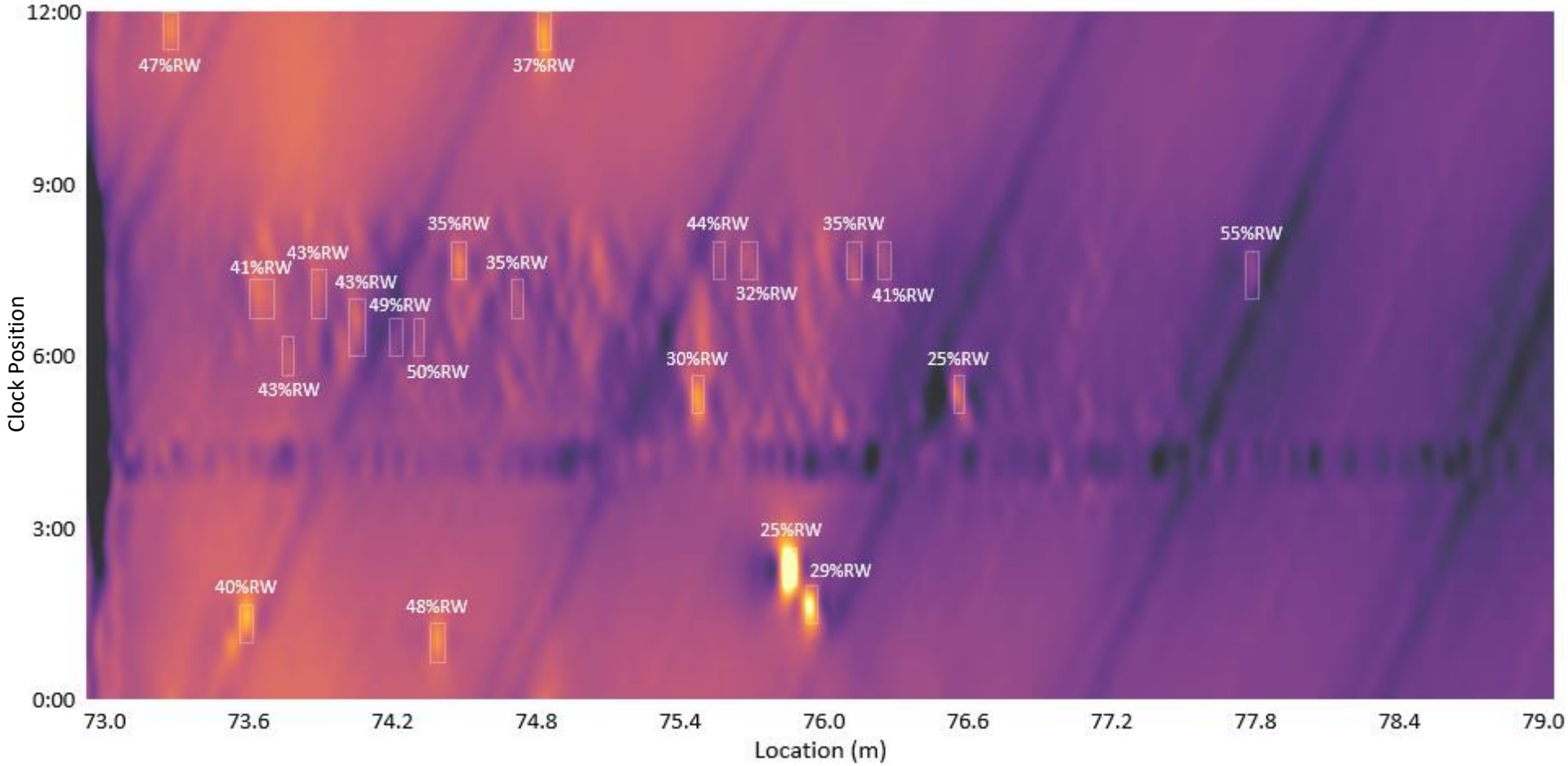

Figure 15. Pipe number 0110 colour map showing defect indication locations. A total of 23 indications have been reported in this pipe segment. Continued in Figure 16. Flange connection at start of pipe shown on left of colour map (72.95m).

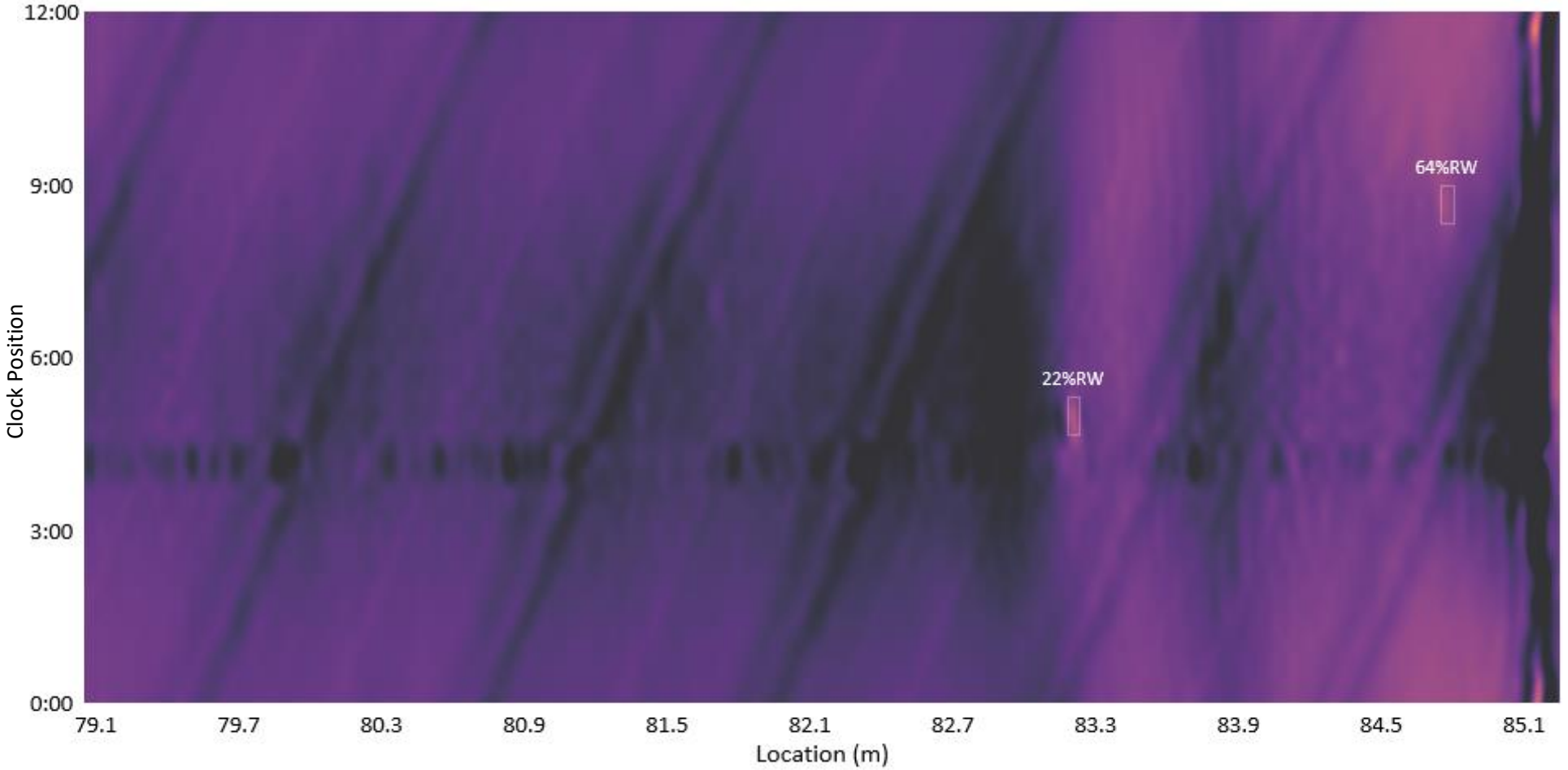

Figure 16. Continuation of pipe number 0110. Flange connection at end of pipe (85.15m) shown on right of colour map.

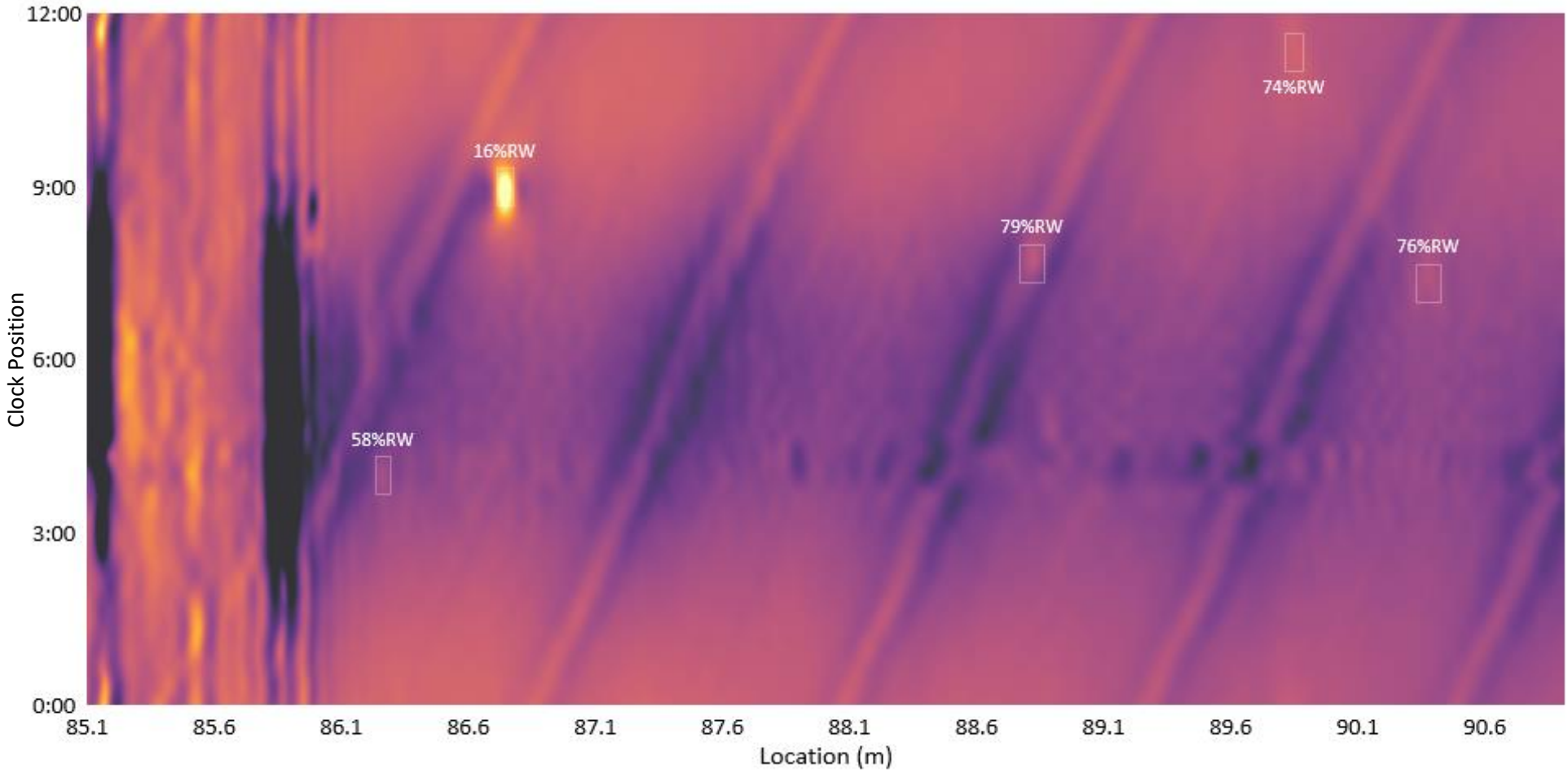

Figure 17. Pipe numbers 0120 (two piece mitered elbow extending from 85.15m to 85.86m) and 0130. A 6.6° pitch change was recorded at the elbow. Five defect indications were reported in pipe 0130, including a 16% RW indication at 86.75m from the ZRD.

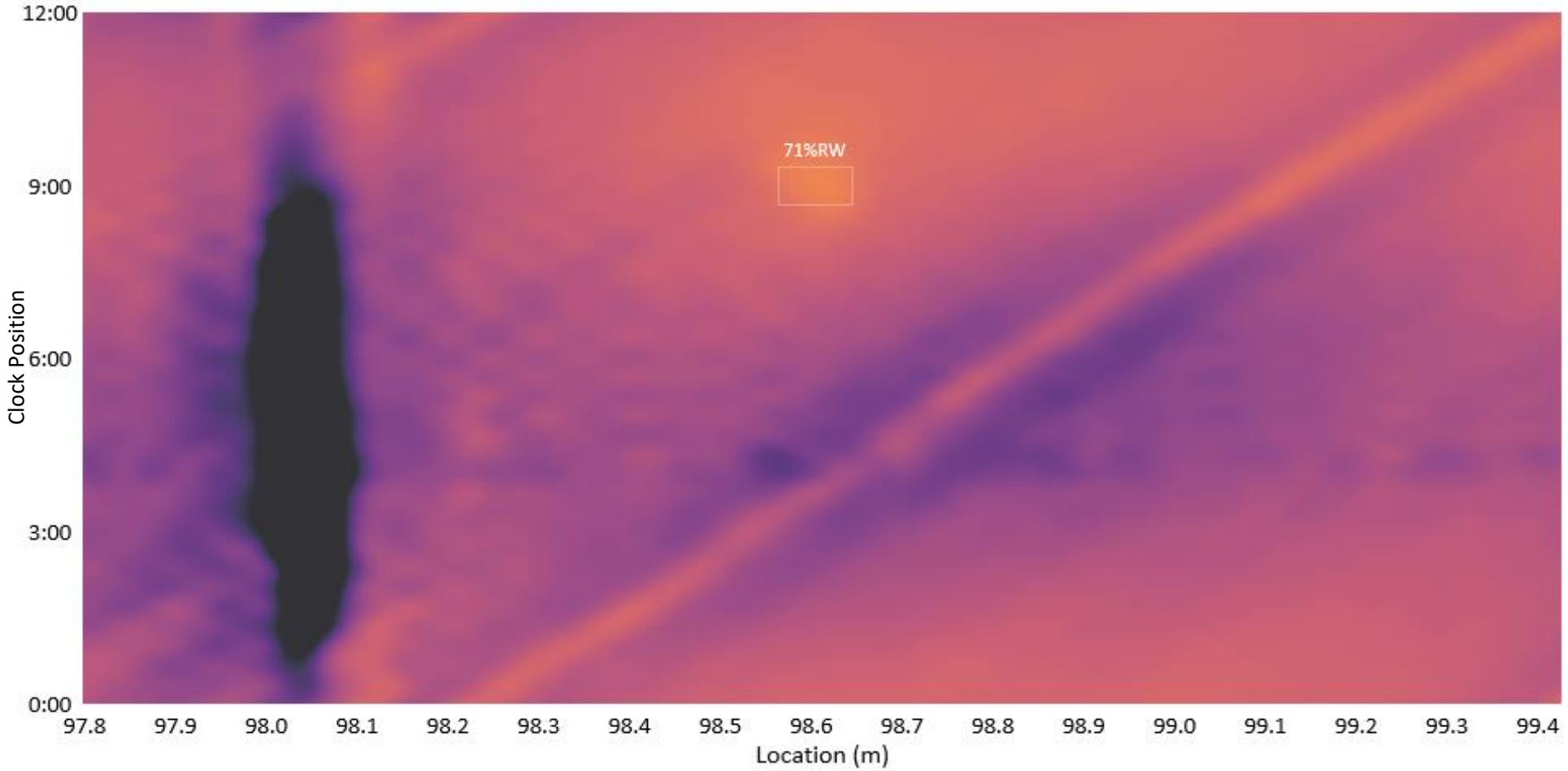

Figure 18. Pipe number 0140 colour map showing the single defect indication reported in this segment. A flange connection is visible beginning at 98.03m.

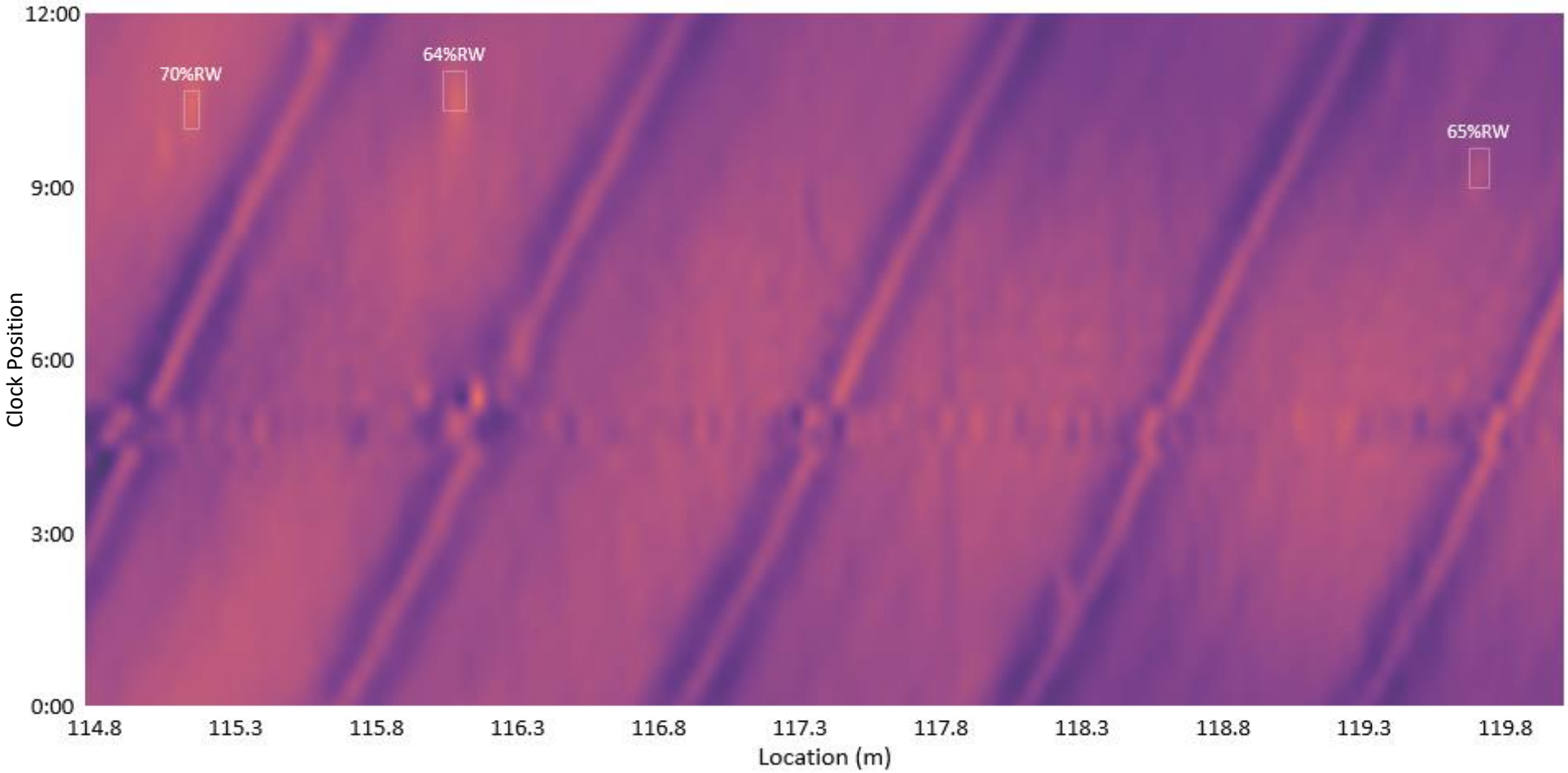

Figure 19. Pipe number 0150 colour map with three reported indications.

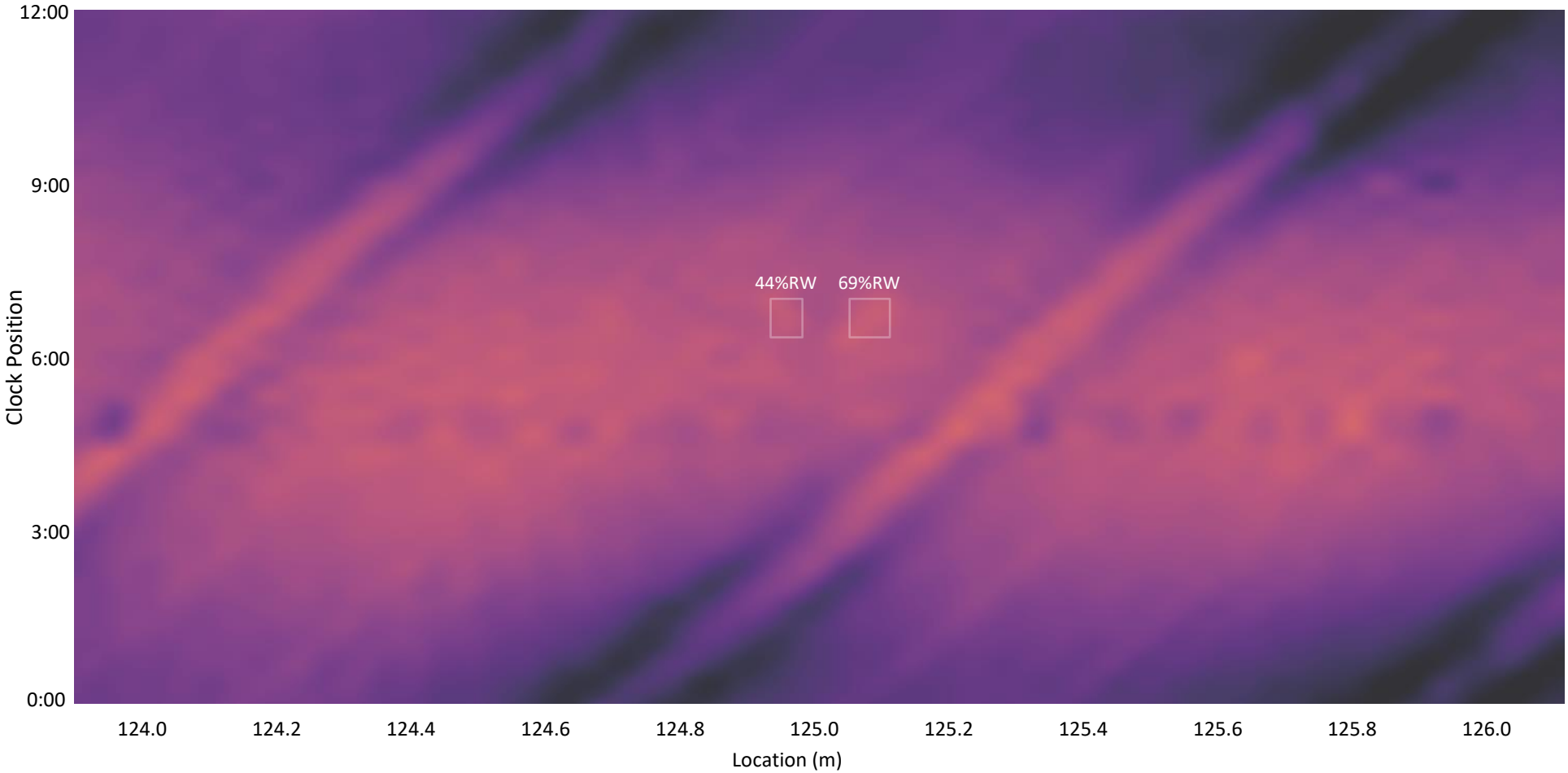

Figure 20. Pipe number 0160 showing locations of two of the seven defects reported within this pipe segment. Continued in Figure 21.

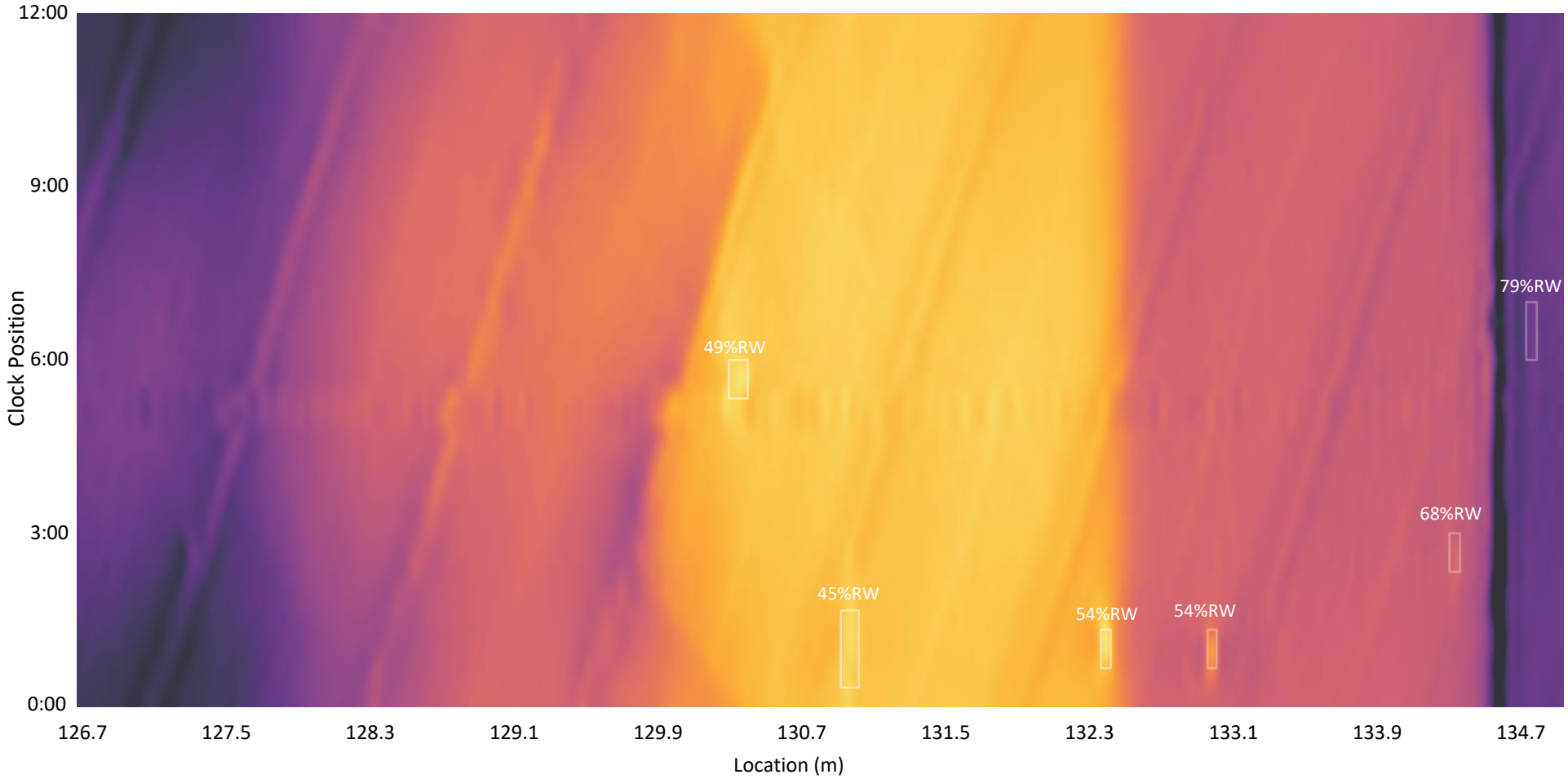

Figure 21. Colour map of pipe numbers 0160 and 0170. Seven defect indications were reported within pipe 0160, along with detected stress located from 129.82m to 134.60m corresponding to the location of an anchor block. The single reported indication within pipe number 0170 is shown past the flange connection at 134.6m.

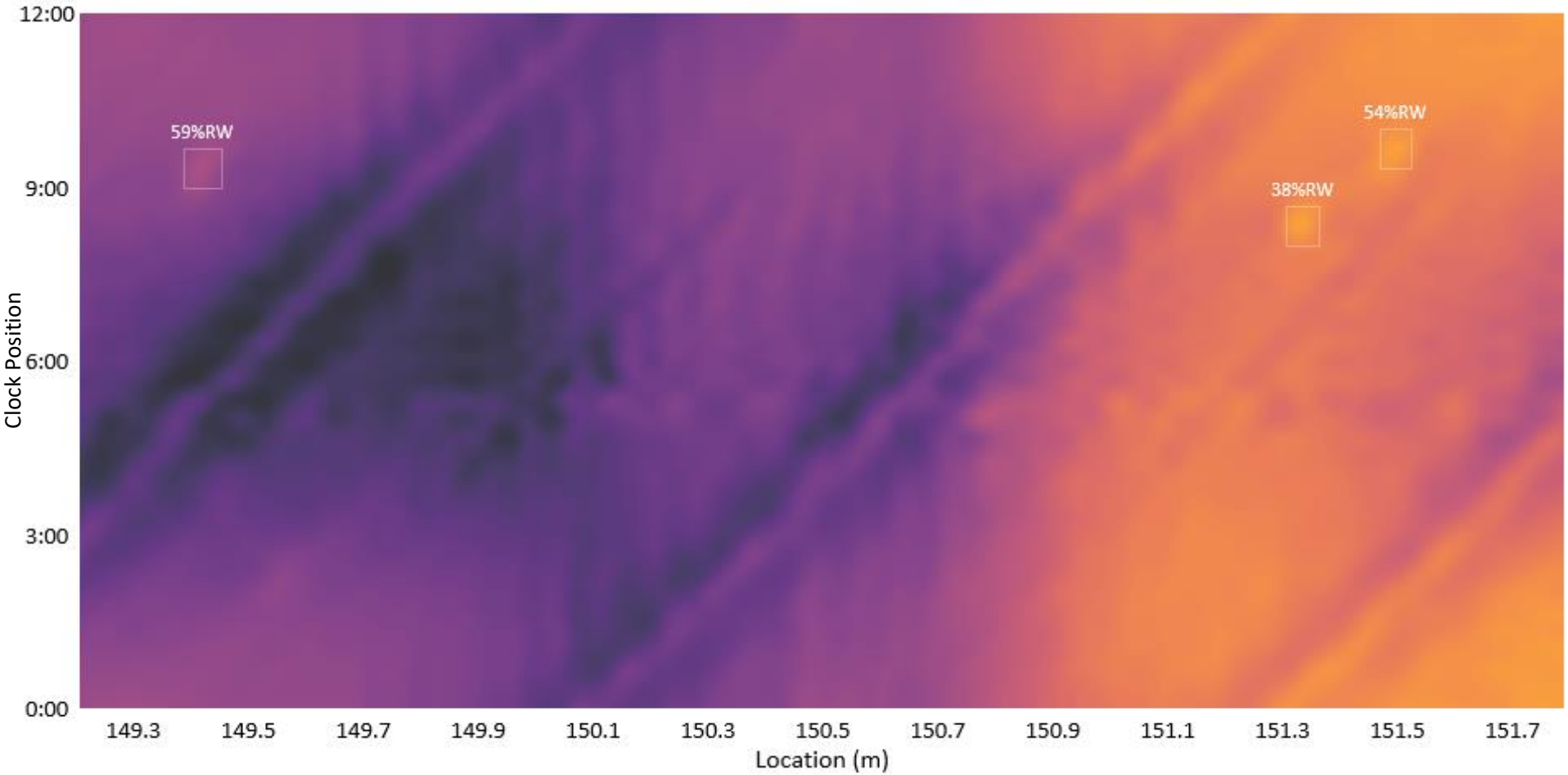

Figure 22. Pipe number 0180 showing the three indications reported within this pipe segment.

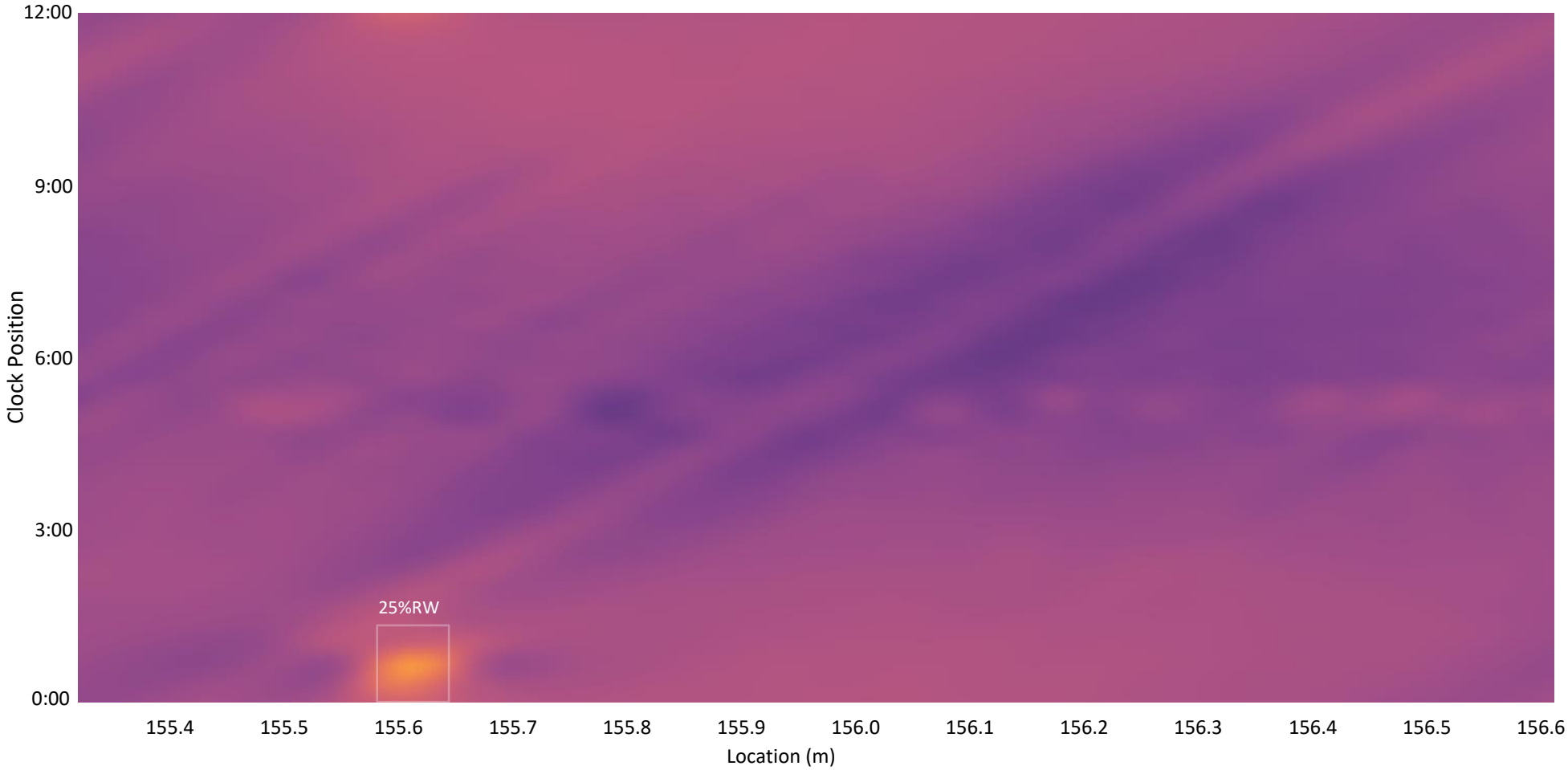

Figure 23. Pipe number 0200 colour map showing the single reported defect indication location within this pipe segment

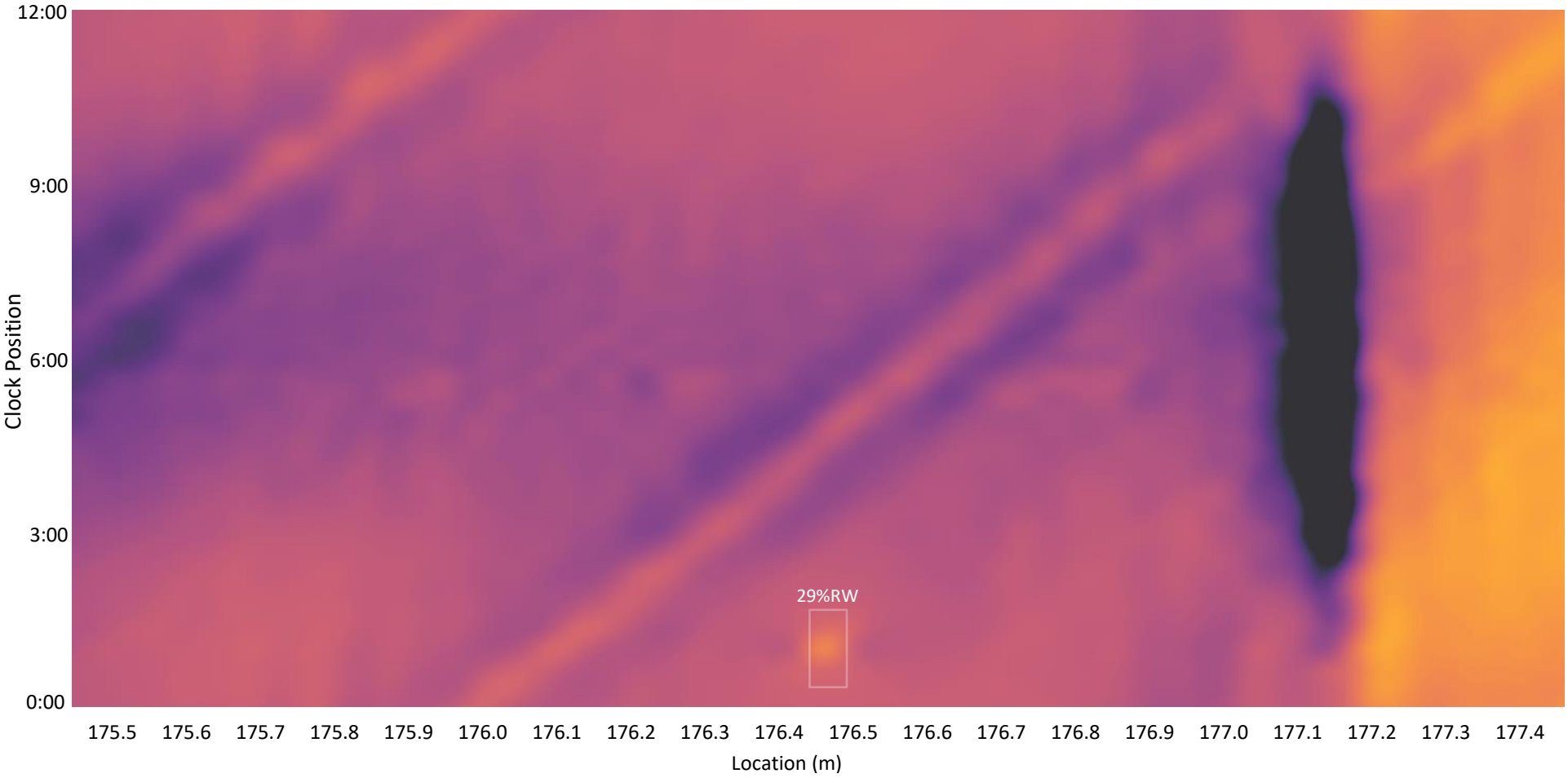

Figure 24. Pipe number 0240 colour map showing the single defect indication reported in this segment, along with a flange connection at 177.14m. This flange connection was noted to be leaking during installation on drawing 7183/64B in 1965. During analysis, special attention was given to this area near the flange connection, though no other wall loss indications were detected.

Appendix 2: RFT Tool Calibration

Prior to arriving on site, PICA performed a test run of the 24in Chimera tool in a 24in diameter, 9.5mm (0.375in) NWT, unlined spiral welded steel pipe to ensure that the tool was in proper working condition. The calibration pipe contained 5.1cm diameter circular flat bottom defects of varying wall loss percentages, and circular through holes (TH) of varying diameters. Machined defects were measured with an Ultrasonic Testing (UT) device to confirm final wall thicknesses. Table 5 provides an overview of the defects present in the calibration pipe.

Table 5. Defects machined into the 600mm diameter, 9.5mm (0.375in) NWT spiral welded steel calibration pipe

Defect Type	Remaining Wall:	Volume of Defect:
Circular Flat Bottom Defects 5.1 cm (2.0 in) diameter:	73%	5.2 cm^3 (0.3 in^3)
	53%	9.1 cm^3 (0.6 in^3)
	20%	15.4 cm^3 (0.9 in^3)
	Diameter of Defect:	**Volume of Defect:**
Circular Through Holes (0% RW):	1.3 cm (0.5in)	1.3 cm^3 (0.1 in^3)
	2.5 cm (1.0in)	4.7 cm^3 (0.3 in^3)
	5.1 cm (2.0in)	19.5 cm^3 (1.2 in^3)
	7.6 cm (3.0in)	43.2 cm^3 (2.7 in^3)
	10.2 cm (4.0in)	77.8 cm^3 (4.7 in^3)

Figure 25 show the circular flat bottom defects, and Figure 27 shows the circular through hole defects machined into the calibration pipe. All defects were visible in the RFT scan of the calibration pipe, including the 1.3cm (0.5in) diameter through hole and the 5.1cm x 73%RW flat bottom defect. Figure 26 shows the RFT scan of the calibration pipe. It is important to note that the results of the calibration may not be directly comparable to the 6.4 mm (0.250in) CML pipe used to construct the Charleswood-Assiniboia Feeder Main due to the differences in the grade and magnetic permeability of the steel pipe material.

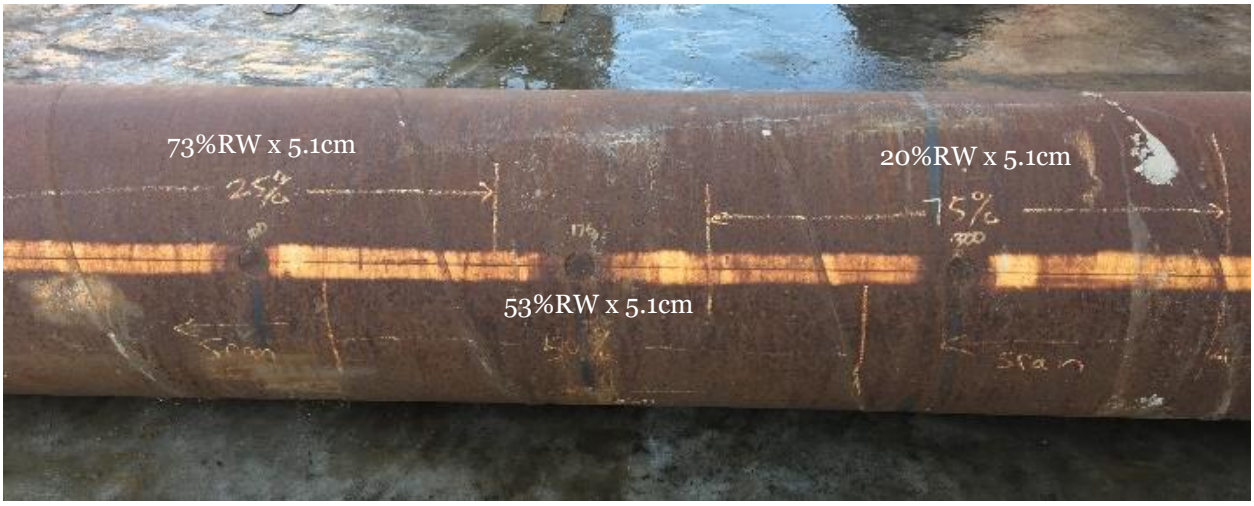

Figure 25. Calibration pipe with 73% RW, 53% RW, and 20% RW 5.1cm diameter flat bottom defects.

Figure 27. Through holes machined into the 24in calibration pipe. Defects measured 1.3 cm, 2.5 cm, 5.1 cm, 7.6 cm, and 10.2 cm (0.5in, 1.0in, 2.0in, 3.0in, and 4.0in) in diameter.

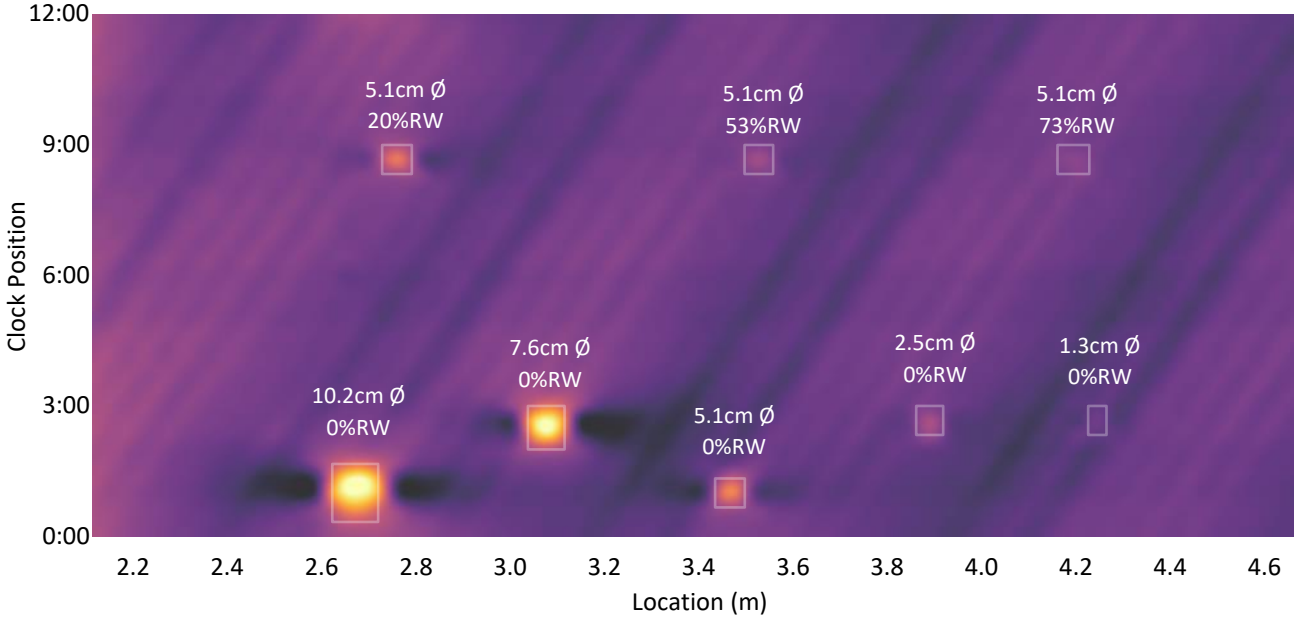

Figure 26. Colour map produced of scanned calibration pipe showing flat-bottom and through hole defects.

Appendix 3: Job Notes and Tool Log

Time (CST)	Operational Comments
Mar 26, 2019	
7:35	Inspection crew arrive on site at Kildonan-Redwood Feeder Main, West Chamber
7:40	First (mechanical Winch) skid steer off trailer
7:48	Laptop synced
8:20	Tool assembled
9:00	Odometer calibrated
9:14	Chimera tool powered up
9:32	Zeroed the wireline odometer with odometer wheel flush with pipe opening.
9:33	Tool scans at 7 Hz with detector leading as the tool begins its descent through the vertical piping
9:45:15	Tool reaches bottom of vertical piping, begin to pull tool back up
10:40	Doing rerun at 5hz with Exciter leading
11:12	Stopped recording
11:14	Restart tool at 5Hz for detector leading run
12:06	East side crew leaves with tool in preparation for inspection of horizontal section.
13:30	Wireline odometer zeroed when Exciter end plate is flush with white painted pipe opening at 13:30. Begin inspection with detector leading at 14 Hz. Start logging at 13:34.
15:13	AGM passage time (west side, AGM Q08874)
15:38	Tool arrived at 90 degrees elbow – start retrieve.
17:05	East side all packed up. Finished pulling tagline back into main from East to West.
17:20	Leave Site
Mar 27, 2019	
7:43	Arrival at Kildonan West side. Tail gate safety meeting.
8:02	Tool is brought to East Chamber
9:00	Tagline is pulled out on the East side, bringing up west winchline.
9:19	Chimera tool powered up. Begin inspection of horizontal portion of Feeder Main at 14Hz.
10:10	Tool passing AGM P40171 on East side of river.
11:21	Tool passing AGM Q08874 on West side of river.
11:49	Tool arrived at 90-degree elbow.
11:59	Tool passing AGM Q08874 on West side of river.
13:02	Data download complete.
13:14	Start up Chimera tool for last 10 Hz run.
13:31	Tool launch east to west at 10Hz.
14:12	Tool passes AGMs on West side of river.
14:41	Tool arrived at 90-degree elbow, start retrieve.
15:16	Tool arrives at East chamber.
16:45	Leave site.
Mar 28, 2019	
7:43	Arrive on site at Charleswood-Assiniboia, north excavation access.
10:25	Run Start north to south
11:02	Passage of AGM Q08874 on North side of river.
12:08	Tool arrives at south excavation
14:00	Winch slipped at South Chamber. Tool dropped and requiring repairs.
16:00	Zeroing wireline odometers with trailing conical pig 3 inch into the pipe.
16:08	Tool launch south to north.
16:38	Passage of AGM P40171 on South side of river.
17:21	Passage of AGM Q08874 on North side of river.
17:55	Tool arrives