LEPELLE NORTHERN WATER

CONDITION ASSESMENT ON 9.5KM PIPELINE AT PHALABORWA WTW.

COASTTECH PROJECTS (PTY) LTD.

15 March 2024

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Executive Summary

Coasttech Projects (Pty) Ltd, was appointed by Lepelle Northern Water, to undertake a Condition Assessment for a pipeline that transports portable water from the Phalaborwa Water Treatment Works to the Phalaborwa Mining Company (PMC).

The scope of works comprised of in-line inspections (ILI) as well as the External Corrosion Direct Assessment (ECDA) Surveys. The In-line inspection technique that was employed was the CCTV Inspection, there was provision for leak detection survey also, but due to the pipeline being decommissioned and drained, only the CCTV survey could be performed. The ECDA was fully explored in accordance with the NACE SP0502 guidelines and in the following order:

Direct Current Voltage Gradient Survey, locating coating defects anomalies, locations and potential gradient measure.

The external corrosion protection system of the buried pipelines consists of an external pipe coating system and theft/vandalism bonded Cathodic Protection. In general, the external pipeline coating system consists of sections with the bitumen and replacement sections.

The DCVG survey data was collected electronically capturing pertinent pipeline and right of way features which were location, time and date stamped with respect to the WGS 84, GPS co-ordinate system.

This systematic approach to the survey techniques enabled the successful correlation and analysis of the DCVG data to show sections where areas of coating defects and gradient potentials were located, classifying coating defects and areas for immediate, scheduled or monitored action to be taken. Test stations and right of way areas requiring attention, are referenced and summarised herein.

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1 Background & Introduction

Coasttech Projects (Pty) Ltd, was appointed by Lepelle Northern Water, to undertake a condition assessment of a 560mm diameter pipeline, spanning over 9,5 kilometres from the Phalaborwa Water Treatment Works transporting portable water to the water utility's clients within the Phalaborwa area. The pipeline had been decommissioned due to frequent bursts that had been experienced over a period of time which was seen as a course for concern. With the pipeline being decommissioned, the scheme finds itself operating in a risky manner as it is operating without any redundancy. A failure that can occur on the current operating pipe system can easily translate to a total downtime, without any backup plan. It was then seen as of utmost importance to undertake this condition assessment that can help shed light into the possible causes of the bursts and to get the overall structural integrity of the pipeline.

1.1 Objectives

The paramount objective of the condition assessment was to determine the possible causes of the bursts as well as to assess the structural integrity of the pipeline in order to provide reliable data that can assist in the formulation of future repair strategies.

1.2 Scope Of Works - Condition Assessment Surveys

The scope of work for the pipeline condition assessments surveys entailed the following;

- Leak Detection Testing
- CCTV Inspection
- Coating Defect Survey
- Corrosion Assessment on Valve Chambers
- Soil Resistivity Survey (Soil Corrosivity Survey)
- Pipe to Soil Potential and Visual Assessment on Cathodic Protection (CP) Structures.
- Stray Current Analysis (Electromagnetic Current Attenuation Survey)
- Metal Loss/ Wall Thickness Testing

The pipeline details are listed below:

Pipe Diameter	: 560mm
Pipe Thickness	: 6mm
Pipe Length	: 9,5 Km
Coating	: Bituminous Pipe Coating System
Pipe Age	: 50+ Years

2 Abbreviations

Table 1: Abbreviations

Abbreviation	Description
AC	Alternating Current
API	American Petroleum Institute
CCTV	Closed Circuit Television
CH	Valve Chamber
CP	Cathodic Protection
CSE	Copper Sulphate Electrode
CT	CP Structures
DC	Direct Current
DCVG	Direct Current Voltage Gradient Survey
ECDA	External Corrosion Direct Assessment
HT	High Tension
HV	High Voltage
IF	Insulating Flange
IJ	Insulation Joint
KP	Kilometer Point
MP	Mark post
NACE	National Association of Corrosion Engineers
PCM	Pipeline Current Mapping
PSP	Pipe to Soil Potential
RC	Road Crossing
RV	River
RL	Railway line
ST	Stream
SVT	Servitude
TP	Test Post
TRU	Transformer Rectifier Unit
ROW	Right of Way (Servitude)

3 Reference Documentation

The condition assessment was carried out in accordance with international standards and cited references below:

- NACE SP 0169 – Control of External Corrosion on Underground or Submerged Metallic Piping Systems.
- NACE RP 0177- 95 Mitigation of alternating current and lightning effects on Metallic Structures and corrosion control systems.
- NACE SP 0200 – Steel Cased Pipeline Practices.
- NACE standard (TM0102-2002)- Current Drain Test
- NACE TM 0497 – Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping Systems
- NACE RP 0502 – Pipeline External Corrosion Direct Assessment Methodology.
- BSI – Standard BS 7361, Part 1, “Cathodic Protection: Code of Practice for Land and Marine Applications”.
- ASME B31.3/B31G

4 Condition Assessment Methodologies as per the SOW

Coasttech Projects (Pty) Ltd. commissioned a condition assessment methodology by segmenting the scope of works into two parts , one that assesses the inside of the pipeline, and the other that concentrates on the external part of the pipeline and also looks at the environment surrounding the pipeline. The two groups are identified as Part 1 : In-line inspection (ILI) and part 2 : External Corrosion Direct Assessment (ECDA).

4.1 Part 1 : In-Line Inspection (ILI)

In-Line Inspection (ILI) is achieved by performing a non-intrusive leak detection and CCTV inspection to detect and confirm the presence of leaks and determine the lining condition of the steel pipeline. Due to the pipeline being decommissioned, it proved to be impossible to carry out the leak detection testing as the method requires water to be flowing in the pipe, The only in-line inspection method that was successfully performed was the CCTV inspection.

The CCTV inspection was performed in the following steps,

- Pre-Assessment
  - Collection of chainages information.
  - identifying access and exit points for the robotic crawler(Valves).
- Insertion & Monitoring
  - Launching of the robotic crawler from the access point.
  - Controlling of camera levels, angles and speed of robotic crawler.
- Footage Analysis & Reporting
  - Using the pictures and footage , collecting and collation of date with reference to locations of the pipeline.

4.2 Part 2: External Corrosion Direct Assessment (ECDA)

External Corrosion Direct Assessment (ECDA) is a structured process that is intended at improving safety by assessing and reducing the impact of external corrosion on pipeline integrity, by identifying and addressing corrosion activity and repairing corrosion defects and remediating the cause. ECDA proactively seeks to prevent corrosion defects from growing to a size that is large enough to impact structural integrity. The ECDA techniques that were employed in this project were the coating defect survey, corrosion assessment on valve chambers, soil resistivity survey, visual assessment on cp structures, pipe to soil potential survey, stray current analysis and metal loss/ wall thickness testing.

The ECDA process contains four (4) Stages that we followed;

- Pre-Assessment
  - Collection of historic and current data
- Indirect Inspection
  - Covers the above-ground inspections to identify and define severity of coating faults, areas where corrosion activity has occurred or may be occurring, and other anomalies.
- Direct Examination
  - Analysis of the indirect inspection data to select sites for excavations and pipe surface evaluation.
  - The data from direct examination are combined with prior data to identify and assess the impact of external corrosion on the pipeline.
  - Evaluation of pipeline coating performance .
  - Corrosion defects repairs.
  - Mitigation of corrosion protection faults.
- Post Assessment
  - Analysis of data collected from the precious three (3) steps, to assess the effectiveness of the ECDA process and determine re-assessments intervals.

5 Part 1 : In-Line Inspection (ILI) Evaluation Summary

The CCTV survey was commissioned and a survey report is appended to this progress report and labelled as follows:

- Inspection Report (CCTV)
- Chainage Corrosion Pictures
- CCTV Videos

From the CCTV survey report, it is evident from the pictures and videos that most parts of the lining system have underwent blistering, cracking, peeling, rust spotting and rust staining. The major contributing factor to the lining defects is ageing of the pipeline.

6 Part 2: External Corrosion Direct Assessment (ECDA) Evaluation Summary

6.1 ECDA Survey System Setup

The Lepelle Northern Water Phalaborwa water treatment works pipelines are protected using impressed current CP systems (ICCP), unfortunately most of them were found to be vandalized, through critical bonds to other pipelines with applied CP. The surveys were conducted in the direction of product flow.

A temporary CP system was set up and interrupted using GPS synchronised current interrupters. Potential measurements carried out at the pipe end points conferred that the temporary CP systems could be interrupted with an increased output due to the high attenuation noted.

6.2 Direct Current Voltage Gradient (DCVG) Survey

The DCVG survey was carried out according to the test station run summary as presented in Appendix 2. The coating defects were located, flagged and the potential gradients and the data was collected electronically along with pertinent pipeline and Right of Way (ROW) features along each test run. The datalogger has a built in GPS antenna that enables GPS positioning and data to be collected which is based on the WGS 84 longitude and latitude system with each data point collected. This enables a permanent location stamp of the feature to be captured that enables future location and traceability (Accuracy is within 2 – 3 metres). When viewing the data on Google Earth, spatial errors can be up to 5 metres.

The weather during the DCVG / ACVG survey was very hot, with not good rainfall before the DCVG survey in the first quarter of 2044 and during the survey. Reference cell contact to earth resistance was good throughout the surveys, with additional watering. The right of ways consists of green grass areas of which the green grass areas retain surface moisture.

6.3 Direct Inspections

Analyses of indirect inspection data was performed to select sites for excavations and pipe surface evaluations. The data from the direct examinations are combined with prior data to assess the impact of external corrosion on the pipeline. Additional data including the evaluation of pipeline coating performance, corrosion defect repairs, and mitigation of corrosion protection faults are included in this step. As this is the first known ECDA assessment of the pipeline, additional data collection and direct examinations were completed to understand the pipeline integrity with respect to external soil side corrosion and other associated risks.

The direct inspections carried out were according to the indirect inspection summary report i.e., classified as immediate and/or scheduled. These areas were excavated and the comprehensive detail collected is dependent on a selected list of tests performed, on the as-found direct findings of which some of are listed below:

- Physical and visual assessment and record,
- Location, area, category and surrounding geography,
- As-found status and condition noting the type of soils, other utilities, CP and coating status, damage etc.,
- Coating condition, type, damage,
- CP status, direct measurements, calcareous deposits,
- Corrosion classification and metal loss and measure ,
- 3rd party mechanical damage, as-built, coating damage, metal loss etc.,
- Damage review and classification
- Non-Destructive Testing (NDT) where required included, pipe wall thickness and phased array.

7 ECDA Classification of Findings

7.1 Pre-Assessment (ECDA Region Identifications)

The pipeline is situated in a highly congested area, classified as a Class 3 zone, where stray current interference and presence of other utilities lines are present. From the data and pipeline records received to date, the pipeline is defined into 1 section:

- Section from the Phalaborwa WTW to the Phalaborwa Mining Company.

The section is classified into the same ECDA region for the indirect examination phase where predominantly the DCVG was used to identify coating anomalies.

Over the lengthy time history of the pipeline, some sections have been replaced and repaired. A leak along the section was also reported and attributed to external corrosion. There are no leak registry archives, however the records indicate that leaks had been repaired with emergency mechanical clamps. These repairs are classified as temporary repairs and this section of piping with the temporary clamp repairs will need to be replaced.

7.2 Pipe To Soil Potentials and ACVG Findings

Pipe to soil potentials measured were recorded and collected as negative potentials when compared to saturated copper sulphate reference electrode, and the value thereof is used as the corrosion criteria/predictor.

NACE RP0169-2002, stipulates the following protection criteria, which is the minimum criteria:

(-850 rule) Potentials more negative than -850 millivolts would indicate adequate levels of CP protection to mitigate soil side corrosion in soils with no MIC.

As per NACE SP0502 guidelines, the analysis and classification of pipe to soil potential data, is the process of estimating the possibility of corrosion activity throughout the given year.

7.3 DCVG Coating Defect Classification

DCVG defect severity sizing is referenced as per NACE SP0502 and shown in Table 2, there are small, medium and large coating defects. Using the standard interpolation calculation, the percentage calculation estimates for the coating size are calculated. The sizing estimation is indicative and it should be noted here that the pipe depth, soil resistivity and any surface deposits on the metal surface at the coating defect will affect this calculation. Field verification findings are necessary to correlate and quantify these findings.

Table 2: Summary of DCVG classifications and findings

No.	% IR Severity	Classification	Verification
1	0-15%	Small	To be confirmed
2	16-35%	Medium	To be confirmed
3	>36%	Large	To be confirmed

7.4 Soil Resistivity Survey and Profile

A soil resistivity survey was carried out along the pipeline ROW at regular spaced intervals, to determine the degree of corrosivity of the soil. The technique used was the Wenner-4-pin method, as per specification ASTM G57. The relationship between resistivity and corrosivity as a guideline is given in Table 3 below.

Table 3: Relationship between resistivity and corrosivity

Resistivity (Ω.m)	Corrosivity
<10	Extremely Corrosive
10 to 50	Very Corrosive
51 to 100	Mildly Corrosive
> 100	Non-Corrosive

7.5 Direct Inspection Findings

For initial ECDA studies, a minimum of two direct examinations shall be performed. In the case where indications have been identified and classified, the following rulings apply for Direct Examinations, as summarized in Table 4:

Table 4: Summary of classifications and Direct Inspection Requirements

Classification	Descriptive
Minor / To be Monitored	Not required if a scheduled/immediate area is examined. A minimum of 2 areas are to be examined if ECDA is applied for the first time.
Moderate / Scheduled	One area to be examined, pending on findings of pipeline operator can be More or Less conservative & inspect another area
Severe / Immediate	Requires direct examination

A total of two sites were exposed for direct inspection and analysis. The findings of the direct inspection which include the detailed list of findings and visual records and magnitudes of metal loss are contained in Appendix 3.

8 Summary Of ECDA Indirect Survey Findings

8.1 Soil Resistivity Survey

The average soil resistivities at the depths specified, indicate that most of the pipeline route is in the non-corrosive area, however there are areas that gave extremely corrosive results. As few as they are, they can still contribute to a great deal of corrosion activity if other corrosion conditions are present, hence it would be advisable to consider soils as corrosive for the design purposes.

8.2 Summary Of DCVG Findings

Table 5 below, summarizes the DCVG findings. This includes the total number of defects, the cumulative distance surveyed and the defect severity and category ranking of the number of defects.

Table 5: Summary of the DCVG results

Pipeline Section	Distance Surveyed (Km)	Total No. Defects	Defects Small	Defects Medium	Defects > Large
Entire 9Km Pipeline	9	115	65	40	10

Table 6 present a summary of the severe/immediate and scheduled/moderate areas of concern, when looking at the results of indirect survey technique and taking into consideration the classifications and capabilities of the survey technique.

Table 6: Summary of the DCVG Severe/Immediate and Scheduled areas of Concern

Pipeline Section	Reference TS	Run	Classification	Comment
Entire 9km Pipeline	D	2	Monitored	2 coating defects located.

8.3 ROW and Test Station Findings

There are vandalized test stations situated along the pipeline route. The test stations are classified as critical bond, bonding and/or monitoring test stations. Start and end potential readings were taken at the valves at the WTW and Chambers, concluding a 9000m survey. The detailed test station report is contained in Appendix 1.Other valve chambers were opened and visually inspected, most contained water surrounding the pipeline. External corrosion was visible in areas where the pipe was in-direct contact with the water, inside the valve chamber.

FIGURE 1 : WATER FLOODED VALVE CHAMBER.

FIGURE 2 : CP TEST POST

8.4 DCVG Results

The survey results and findings are presented in two test runs, starting at the Phalaborwa WTW and finishing at the Chamber. Most coating defects were located at the pipeline welding seams. The sizing classification indicates there are defects that require attention and the classification is given as immediate or scheduled either due to large gradients and/or sudden changes in the gradient potentials.

In general, the findings conclude that the external coating on the pipeline varies, some areas are showing good coating and other areas are showing bad coating. The defect distribution and relative severity is shown in Appendix 2, which shows a clustered distribution along certain sections along its route.

8.5 NDT Results

NDT tests measured a pipe wall thickness of 4.17mm to 6mm at Scan Excavation 1A and pipe wall thickness at Scan Excavation 1B indicating no wall loss noted as thickness ranges from 5.5mm.

The detailed findings of the NDT tests performed are contained in Appendix 3.

8.6 Direct Inspection Results

Potential measurements showed an On potential of -0.402V. Examination of the pipe surface showed a blast profiled pipe surface, with no areas of external metal loss or areas of mechanical damage, noted.

The external pipe coating in the second excavation was repaired and the surrounding area was backfilled and re-instated, in accordance with Lepelle Northern Water pipeline requirements and specifications, upon completion of the direct inspection tests.

8.7 Excavation 01

The surrounding soil consist of no sand padding or backfill around the pipe, red soil covers the pipe to grade level. The average grade cover to pipe top dead center measured 1.6m.The external coating is a bitumen wrap. Closer inspection of the pipe coating indicated a coating tear at the 04 o'clock position possibly attributed to 3rd party mechanical damage caused by sling/strap damage during handling of the pipeline during construction. Careful exposure of the pipe surface showed a thick build-up of calcareous deposits, the removal hereof showed a corrosion pit feature that showed the presence of magnetite.

8.8 Excavation 02

The surrounding soils consist of no sand padding or backfill around the pipe, red soil covers the pipe to grade level. The average grade cover to pipe top dead centre measured 1.6 m. Closer inspection of the pipe coating found two coating anomalies on the pipe bend, possibly attributed due to the tight bend radius.

No visible metal loss was found on removal of the coating. NDT tests measured a pipe wall thickness of 5.5mm along this section and were reported as acceptable.

9 Conclusion

9.1 In-Line Inspection (ILI) CCTV Survey Conclusion

The following findings were obtained from the CCTV in-line inspection;

- Sections of the pipe lining have undergone blistering , cracking and peeling.
- Rust spotting and rust staining was observed.
- The internal lining system is deteriorating due to the pipeline age.

9.2 External Corrosion Direct Assessment (ECDA) Survey Conclusion

The results found from employing the ECDA techniques gave the following findings:

- The health or integrity of the pipeline is of paramount importance, owing to its geographic area that is built up and sharing its servitude with other pipelines from Lepelle Northern Water and those of other third parties.
- The pipeline was found to be crossing high voltage power line servitudes , which is a course for concern when it comes to stray currents jumping into the pipeline , it is highly likely that when those currents leave the pipeline , that is where corrosion is likely to occur.
- The corrosivity of the soil in the area was found to be mostly non-corrosive with an exception of a few areas which gave a negative spike and reported corrosivity. The few corrosive areas are capable of causing a great deal of destruction when other negative factors are present on those areas.
- The presence of corrosion pits indicates the active metal loss took place early in the pipeline's life as the coating damage suggests 3rd party mechanical handling (slings/strap) damage.
- The cathodic protection system was installed and commissioned, but due to theft and vandalism , the pipeline has not been protected for years.
- The wall thickness results suggested that the pipe has not experienced substantial metal loss, but the issues were found to be on the previously repaired areas and areas where temporary clamps are installed.
- The wall thickness loss was experienced mainly on pipe joints, and that is where corrosion is more likely to attack, with the historic data showing that more bursts and leaks have been reported to have been found mostly on the pipe joints.

9.3 Overall Conclusion

After combining both in-line inspection and ECDA techniques, it is possible to conclude that the majority of pipeline failures can be traced back to repair methodologies in which the external coating was not restored or reinstated where it had been removed to carry out repairs, or in areas where temporary clamps were introduced. The pipeline is left bare and prone to external corrosion. The inside pipe lining was discovered to have deteriorated over time due to the age of the pipeline, but no conclusive evidence was found to show that the loss of internal lining led to bursts or structural failure of the pipe. The results of the wall thickness test, which indicated that the pipe has not lost thickness because it is still above 5mm for the majority of the pipeline from the 6mm thickness when it was laid, provide weight to this conclusion. The pipe joints were discovered to have lost the greatest amount of wall thickness, and the external coating was not in the best of shape.

10 Recommendations

The areas that require attention are summarised as follows:

- Repairs and upkeep of the cathodic protection system, to protect the pipeline from external corrosion.
- Cathodic protection, AC mitigation assessments and designs are recommended to protect the pipe from the 3rd party infrastructure such as Eskom HV lines that traverses the pipeline servitude.
- The corrosion of pipe sections within valve chambers can be reduced by an above-ground coating application, especially in areas where chambers experience a lot of water ingress.
- Exposure of all pipe joints, to asses and remedy where the welding and coating are found to be compromised, in order to prevent more bursts from occurring since the historical data shows that most bursts were located on pipe joints.
- A leak detection testing is still recommended after all the known defects have been addressed, when the pipe has been recommissioned to further ensure that all compromised areas are repaired.
- The pipeline's inner lining repairs are not a priority at this time because the lining failure cannot be traced back to the frequent pipe bursts or have a detrimental impact on the pipeline's structural integrity. The inner coating/lining repair methods were investigated, and it was discovered that because the pipe diameter was too smaller for humans to perform tasks safely within the pipe, other trenchless technologies were discovered and are appended to this report for informational purposes.

11 Appendices

11.1 Appendix 1 : CP Assets and Valve Chambers

LEPELLE WATER / Coasttech Projects (Pty) Ltd. Conditional Assessment	Visual Inspection Record **AREA**: WTW PHALABORWA TO PMC **WTW Connection to PMC Pipeline**	

Project Number :	Client : LEPELLE	Consultant : Coasttech Projects (Pty) Ltd

Item	Description	Comments
1	Railway Line	NO AC Raiway Line crosses pipeline.
2	HVAC Powerline	HVAC Power lines, parallel to pipeline.
3	Foreign Pipeline	Lepelle Water pipelines running parallel..
4	Test Post (Big Headed)	Vandalised Big Headed Type present,with nothing inside, no access to TP
5	Test Post (Monitoring)	No Monitoring Type Test Posts visible.
6	CP Bunker	No bunker present.
7	TRU plus Enclosure Type	No Durasafe TRU enclosure, no TRU or cables present.
8	NDU/FDU plus Enclosure Type	None observed.
9	ACM Bunker / SSDCD Device	None observed.
10	ACM Equipotential Gradient Mat	None observed.
11	Pipe Diameter	Approximately 9000m, pipe diameters 560mm.
12	Pipeline Coating	To be confirmed - Bitumen
13	Valve Chamber / Type	Concrete chambers, concrete lids, some vandalised.
14	Reservoir	None observed.
16	Leaks	leaks observed.

Photo Gallery

LEPELLE WATER / Coasttech Projects (Pty) Ltd. Conditional Assessment	Visual Inspection Record **AREA**: WTW PHALABORWA to PMC **WTW Connection to PMC Pipeline**	
Project Number :	Client : Lepelle Water	Consultant : Coasttech Projects (Pty) Ltd

PHOTO GALLERY

11.2 Appendix 2 : ECDA Surveys CP Results

LATITUDE	LONGITUDE	COMMENT	CHAINAGE	OLRE	SIGNAL START	SIGNAL END	%IR
DCVG LEPELLE WATER WTW 560mm PIPELINE							
		CHAMBER	0	700	3215	2743	
		D1	24	500			22
		D2	72	347			16
		D4	90	777			11
		D5, CHAMBER	247.5	298			25
		MP	500				
		D6	569.8	666			
		D7	682.3	877			22
		D8 MP	776.6	185			29
		D9	803.2	309			6
		D10, SV3	847	412			10
		D11	0.1	327			13
		D12	946	248			11
		D13	1136	523			9
		D14	1178.5	266			18
		D15	1223	525			9
		D16	1267.2	678			19
		D17	1304	349			24
		D18	1385.2	445			13
		D19	1401.5	325			16
		CHAMBER, TEST POST	1520		1427	1610	
		D20	1592	554			37
		D21	1622.4	39			3
		D22	1655.3	239			16
		D23	1712.2	109			7
		D24	1729.6	99			7
		D25	1751.8	445			30
		D26	1777.9	284			19
		D27	1899.5	423			28
		D28	2019	302			20
		D29	2210.7	266			18
		D30	2228.4	169			11
		D31	2271.7	1101			73
		D32	2993.6	674			44
		D33	329	346			24
		D34	3531.5	877			56
		D35	3681.7	1173			75
		D36	3772.4	1400			89
		D37	3792.8	1082			69
		D38	3823.2	299			19
		D39	3478.5	446			29
		D40	3485.8	278			18
		D41	3594.9	427			27
		D42	3703.4	882			56
		CHAMBER	3994				
		D43	4000	266			17
		D44 SV	4123.5	385			24
		D45	4229.5	226			14
		D46	4277.6	229			14
		D47	4298.2	339			21
		D48	4303.5	189			12
		D49	4325.5	279			18
		D50	4351.5	378			24
		D51 SV	4376.5	328			21
		D52	4397.9	340			21
		D53	4436.6	326			20
		D54	4455.6	230			14
		D55	4476.7	195			12
		D56	4495.3	330			21
		D57	4513.2	386			24
		D58	4524.7	435			27
		D59	4548.7	314			20
		D60	4560.3	117			7
		D61	4572.7	148			9
		D62	4584.7	190			12
		CHAMBER	4786.9		3993	1926	
		D63	4793.6	387			18
		D64	4821.2	298			14

		D65	4843.4	87			4
		D66	4960.4	56			3
		D67	4991.9	128			6
		D68	5023.1	272			13
		D69	5059.4	78			4
		D70	5109.8	166			8
		D71	5224.2	150			7
		D72	5237.6	211			11
		D73	5346.7	268			14
		D74	5374.9	275			14
		D75	5395.1	127			7
		D76	5399	79			4
		D77	5400.7	132			7
		D78	5407.2	237			12
		D79	5412.4	300			16
		CHAMBER AV	5419		3282	2822	
		D80	5517.4	497			17
		D81	5545.6	219			7
		D82	5588.7	27			1
		D83	6104.7	24			1
		D84	6136.2	98			3
		D85	6163.7	88			3
		D86	6174.8	202			7
		D87	6193.7	106			4
		D88	6205.8	45			2
		D89	6216.7	53			2
		D90	6236.5	68			2
		D91	6277.2	394			14
		D92	6290.3	230			8
		D93	6303.1	331			11
		D94	6371.1	356			12
		D95	6454.2	486			17
		D96	6566.2	166			6
		D97	6687.2	34			1
		D98	6995	1800			63
		PIPE EXPOSED	7000				0
		CENTRE STREAM	7333				
		D99	7350.1	204			7
		D100	7369.4	343			12
		D101	7372.6	129			5
		VANDALIZED TEST POST	7416		4977	1570	
		D102	7510.1	67			2
		D103	7644.8	233			7
		D104	7761.1	344			10
		D105	7873.9	358			11
		D106 SV	7889.2	277			8
		D107	7916.8	138			4
		D108	7928.1	98			3
		VANDALIZED TP	7937		2668	2300	
		D109	8193.2	322			14
		D110	8227.7	182			8
		D111	8551.4	85			4
		D112	8669	765			33
		D113	8776.1	58			3
		D114	8882.2	336			15
		D115 SV	8942	583			25
		CHAMBER	9000		1298	250	

Survey date:	Phalaborwa	Measured from WTW of Chamber On Lepelle	Bulk	Bulk Soil Resistivity Ohm-m 1.6m Depth	
DD.dddddd	DD.dddddd		Resistance Ohm 1.6m Pin Spacing		
H_Latitude	H_Longitude	Distance(m)	Res	Res	Comments
-24.065067	31.1415	0	24	241.37	Survey Start
-24.064205	31.141237	100	12	120.69	
-24.063347	31.140995	200	32	321.83	
-24.062515	31.14077	300	29	291.66	
-24.061663	31.140502	400	24	241.37	
-24.06085	31.140247	500	21	211.20	
-24.059987	31.139993	600	18	181.03	
-24.059153	31.139752	700	31	311.77	
-24.058312	31.139502	800	17	170.97	
-24.057495	31.139252	900	13	130.74	
-24.056647	31.139035	1000	37	372.11	
-24.055773	31.138773	1100	21	211.20	
-24.054945	31.13849	1200	36	362.06	
-24.054945	31.13849	1300	19	191.09	
-24.0533	31.13797	1400	20	201.14	
-24.05244	31.137743	1500	27	271.54	
-24.0516	31.13749	1600	22	221.26	
-24.050782	31.137428	1700	26	261.49	
-24.049935	31.136903	1800	30	301.71	
-24.049003	31.136787	1900	109	1096.23	
-24.048283	31.136587	2000	36	362.06	
-24.047435	31.136227	2100	51	512.91	
-24.046617	31.135983	2200	30	301.71	
-24.045787	31.135783	2300	11	110.63	
-24.04508	31.135508	2400	36	362.06	
-24.044098	31.13527	2500	64	643.66	
-24.043402	31.135045	2600	27	271.54	
-24.042432	31.134772	2700	24	241.37	
-24.041593	31.134467	2800	27	271.54	
-24.040752	31.134243	2900	27	271.54	
-24.03984	31.134088	3000	6	60.34	
-24.038978	31.133798	3100	15	150.86	
		3200			River Start
		3300			River End
-24.03641	31.133037	3400	18	181.03	

-24.035572	31.132743	3500	16	160.91	
-24.034728	31.132503	3600	75	754.29	
-24.033895	31.132275	3700	35	352.00	
-24.033038	31.132025	3800	21	211.20	
-24.032135	31.13173	3900	44	442.51	
-24.031302	31.131495	4000	43	432.46	
-24.030433	31.13123	4100	45	452.57	
-24.029548	31.130978	4200	44	442.51	
-24.028733	31.130705	4300	70	704.00	
-24.027853	31.130495	4400	28	281.60	
-24.027087	31.130347	4500	102	291.66	3 HV Eskom Powerlines running parallel with the pipelines
-24.026628	31.131182	4600	31	311.77	
-24.026052	31.131838	4700	30	301.71	
-24.025515	31.132603	4800	30	301.71	
-24.024988	31.133348	4900	29	291.66	
-24.024462	31.134128	5000	32	321.83	
-24.023945	31.134942	5100	14	140.80	
-24.02347	31.135547	5200	23	231.31	
-24.02288	31.136407	5300	28	281.60	
-24.022375	31.137203	5400	27	271.54	
-24.021893	31.13788	5500	25	251.43	
-24.021247	31.138863	5600	32	321.83	
-24.020823	31.139488	5700	48	482.74	
-24.020243	31.140172	5800	24	241.37	
-24.01948	31.140575	5900	33	331.89	
-24.018738	31.14114	6000	3	30.17	
-24.018095	31.141708	6100	57	573.26	
-24.017373	31.142138	6200	189	1900.80	
-24.016538	31.142598	6300	130	1307.43	
-24.015743	31.142972	6400	140	1408.00	
-24.015093	31.14326	6500	42	422.40	
4.014097	31.14377	6600	41	412.34	
-24.013423	31.144098	6700	33	331.89	
-24.012575	31.144442	6800	43	432.46	
-24.011815	31.14485	6900	44	442.51	
-24.011003	31.145227	7000	43	432.46	
-24.010203	31.145447	7100	4	40.23	
-24.009393	31.145733	7200	32	321.83	
-24.008468	31.145913	7300	1.3	13.07	
-24.007598,	31.146218	7400	10	100.57	
-24.006895	31.146403	7500	21	211.20	

-24.00599	31.146655	7600	29	291.66	
-24.00506	31.146918	7700	13	130.74	
-24.00421	31.147237	7800	18	181.03	
-24.003345	31.147505	7900	4.2	42.24	
		8000	1.2	12.07	
		8100	6	60.34	
-24.000818	31.148307	8200	21	211.20	
-23.99998	31.14826	8300	5	50.29	
-23.999237	31.147772	8400	0.9	9.05	Proposed GB
-23.998462	31.147412	8500	16	160.91	
-23.997628	31.147107	8600	39	392.23	
-23.996872	31.146598	8700	161	1619.20	
-23.996035	31.146193	8800	54	543.09	
-23.99545	31.145788	8900	51	512.91	
-23.994467	31.145272	9000	9	90.51	Survey End

11.3 Appendix 3 : Metal Loss Assessment Results

NJM Heat Treatment & NDE Services (PTY) Ltd	**Phased Array Ultrasonic Examination Report**	**Report No.:**	SEC2-PAUT-0135
		Job No.:	Not Applicable
		Equipent No.:	Water Pipe
		Page No.:	1 of 9

Data Collector	**Name:**	WR Venter	**Data Analyzer**	**Name:**	WR Venter	**Reviewer**	**Name:**	GP le Roux	**Client**	**Name:**	
	Qualification:	PCN LII		**Qualification:**	PCN LII		**Qualification:**	SNT TC 1A LII		**Qualification:**	
	Signature:			**Signature:**			**Signature:**			**Signature:**	
	Date:	2024/03/06		**Date:**	2024/03/06		**Date:**	2024/03/06		**Date:**	

Phased Array Ultrasonic Examination Report

Report No.:	SEC2-PAUT-0135
Job No.:	Not Applicable
Equipent No.:	Water Pipe
Page No.:	2 of 9

CONTRACT DETAIL

Date of Test:	05 March 2024	**Material:**	Carbon Steel	**Spec. Criteria:**	ASME V Art 4 2021
Client:	Lepelle NW	**Surface Condition:**	As Cleaned	**Acc. Criteria:**	Record & Report
Location:	PMC	**Weld Process:**	Not Applicable	**Work Procedure:**	WP 023 Rev 0
Description:	See Remarks	**Diameter/Thickness:**	560NB	**Work Instruction:**	See Scan Plan
Drawing / QCP No.:	Not Applicable	**PWHT:**	Before - After - N/A X	**Calibration Sheet:**	WR-06-03-2024_PAUT

EQUIPMENT DETAIL

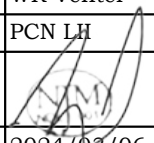
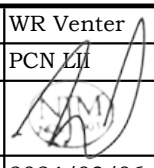
Equipment Type:	Omniscan X3	**Wedge Specification:**	REX 1	**Coll. Hardware :**	MXU - 5.14,1
Equipment I.D.:	85421	**Wedge I.D.:**	REX 1	**Cal. Block(s) :**	IIW V1
Probe Specification:	7.5DL32 32X5--REX1	**Scanner Type:**	Scanbuddy	**Reference Block:**	-
Probe I.D.:	V0612	**Scanner I.D.:**	NJM 1	**Cal. Block Temp.:**	-
Temp. Meter Type:	-	**Temp. Meter Ser. No.:**	-	**Material Temp.:**	-

CALIBRATION DETAIL

TCG/DAC	X	**AVG**		**SDH**	2,5mm	**FBH**		**NOTCH**		**% FSH**	

Setup Information	**Scan Type**	**1st Element**	**Element Quantity**	**Last Element**	**Wave Type**	**Ref. dB**	**Scan dB**
GRP 1	Linear	1	32	32	SW	14,8	6
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-

Limitations:	Restricted Access due to close proximity of pipe. On Excavation 1 (Start) Clampand patch restricted access. See P4
Remarks:	PAUT Corrosion mapping was done on 2 excavated areas
Results:	See page 4 to 9.

Data Collector	**Name:**	WR Venter	**Data Analyzer**	**Name:**	WR Venter	**Reviewer**	**Name:**	GP le Roux	**Client**	**Name:**	
	Qualification:	PCN LII		**Qualification:**	PCN LII		**Qualification:**	SNT TC 1A LII		**Qualification:**	
	Signature:			**Signature:**			**Signature:**			**Signature:**	
	Date:	2024/03/06		**Date:**	2024/03/06		**Date:**	2024/03/06		**Date:**	

Phased Array Ultrasonic Examination Report

Report No.:	SEC2-PAUT-0135
Job No.:	Not Applicable
Equipent No.:	Water Pipe
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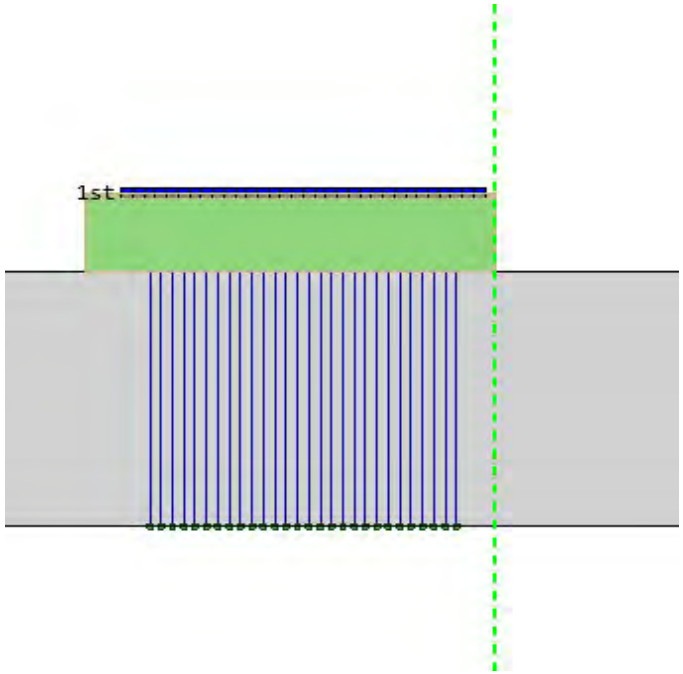
Scan Plan



Data Collector	**Name:**	WR Venter	**Data Analyzer**	**Name:**	WR Venter	**Reviewer**	**Name:**	GP le Roux	**Client**	**Name:**	
	Qualification:	PCN LII		**Qualification:**	PCN LII		**Qualification:**	SNT TC 1A LII		**Qualification:**	
	Signature:			**Signature:**			**Signature:**			**Signature:**	
	Date:	2024/03/06		**Date:**	2024/03/06		**Date:**	2024/03/06		**Date:**	

Phased Array Ultrasonic Examination Report

Report No.:	SEC2-PAUT-0135
Job No.:	Not Applicable
Equipent No.:	Water Pipe
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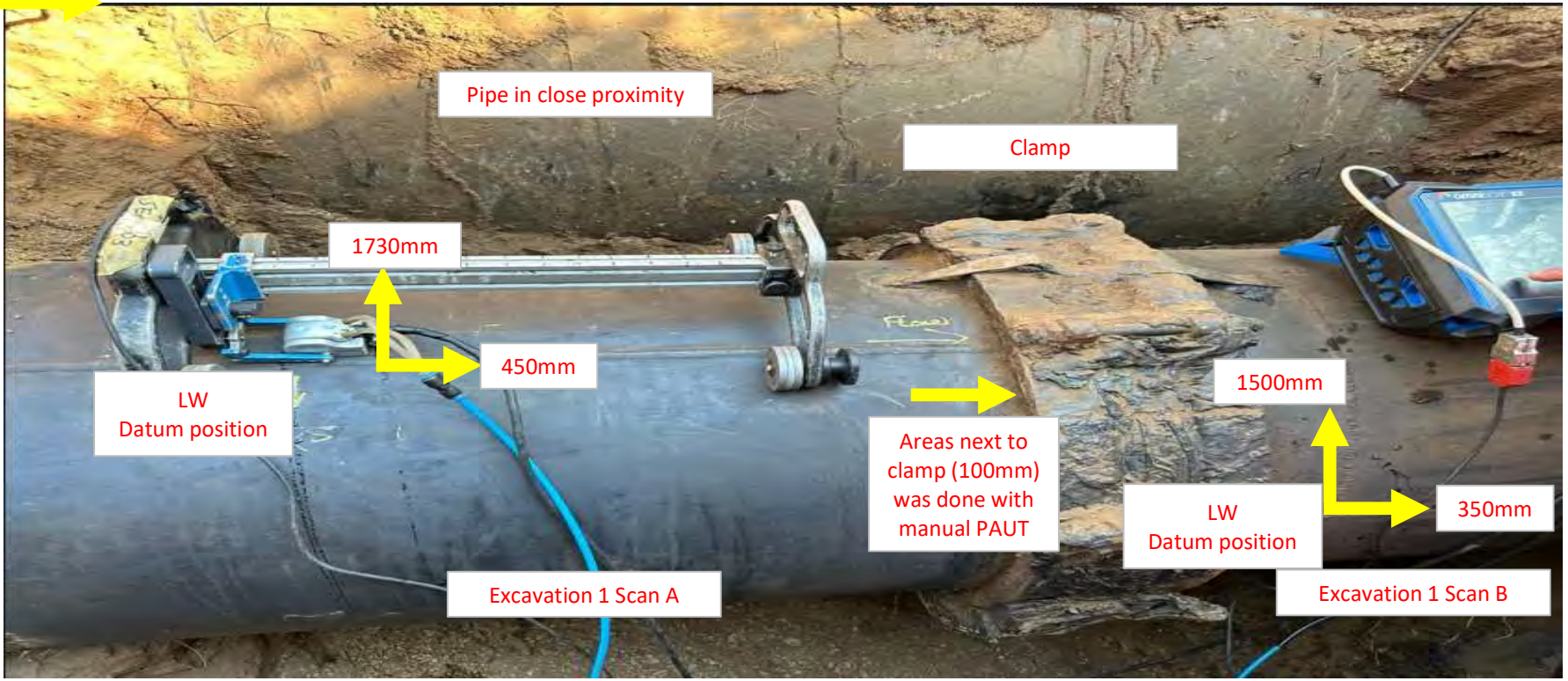
Excavation 1 (Start)



Data Collector	**Name:**	WR Venter	**Data Analyzer**	**Name:**	WR Venter	**Reviewer**	**Name:**	GP le Roux	**Client**	**Name:**	
	Qualification:	PCN LII		**Qualification:**	PCN LII		**Qualification:**	SNT TC 1A LII		**Qualification:**	
	Signature:			**Signature:**			**Signature:**			**Signature:**	
	Date:	2024/03/06		**Date:**	2024/03/06		**Date:**	2024/03/06		**Date:**	

Phased Array Ultrasonic Examination Report

Report No.:	SEC2-PAUT-0135
Job No.:	Not Applicable
Equipent No.:	Water Pipe
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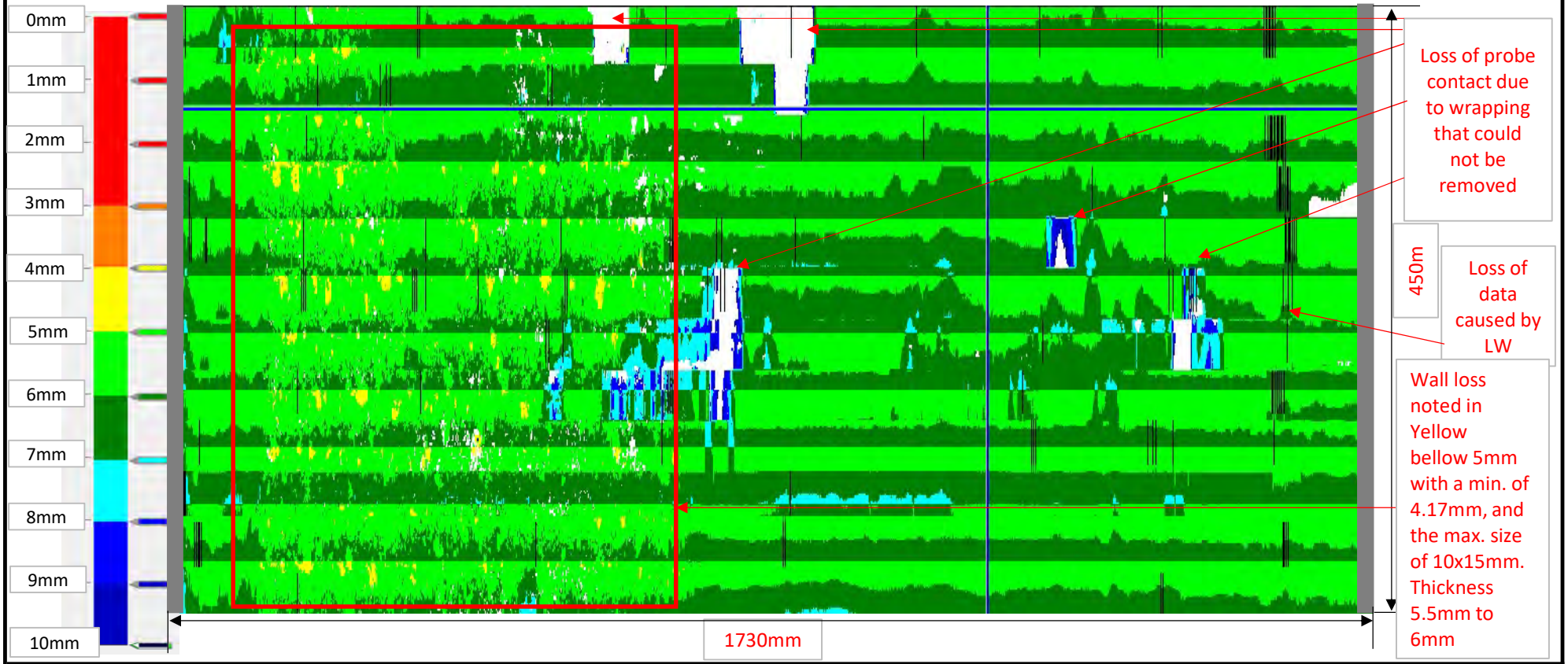
Scan Excavation 1A

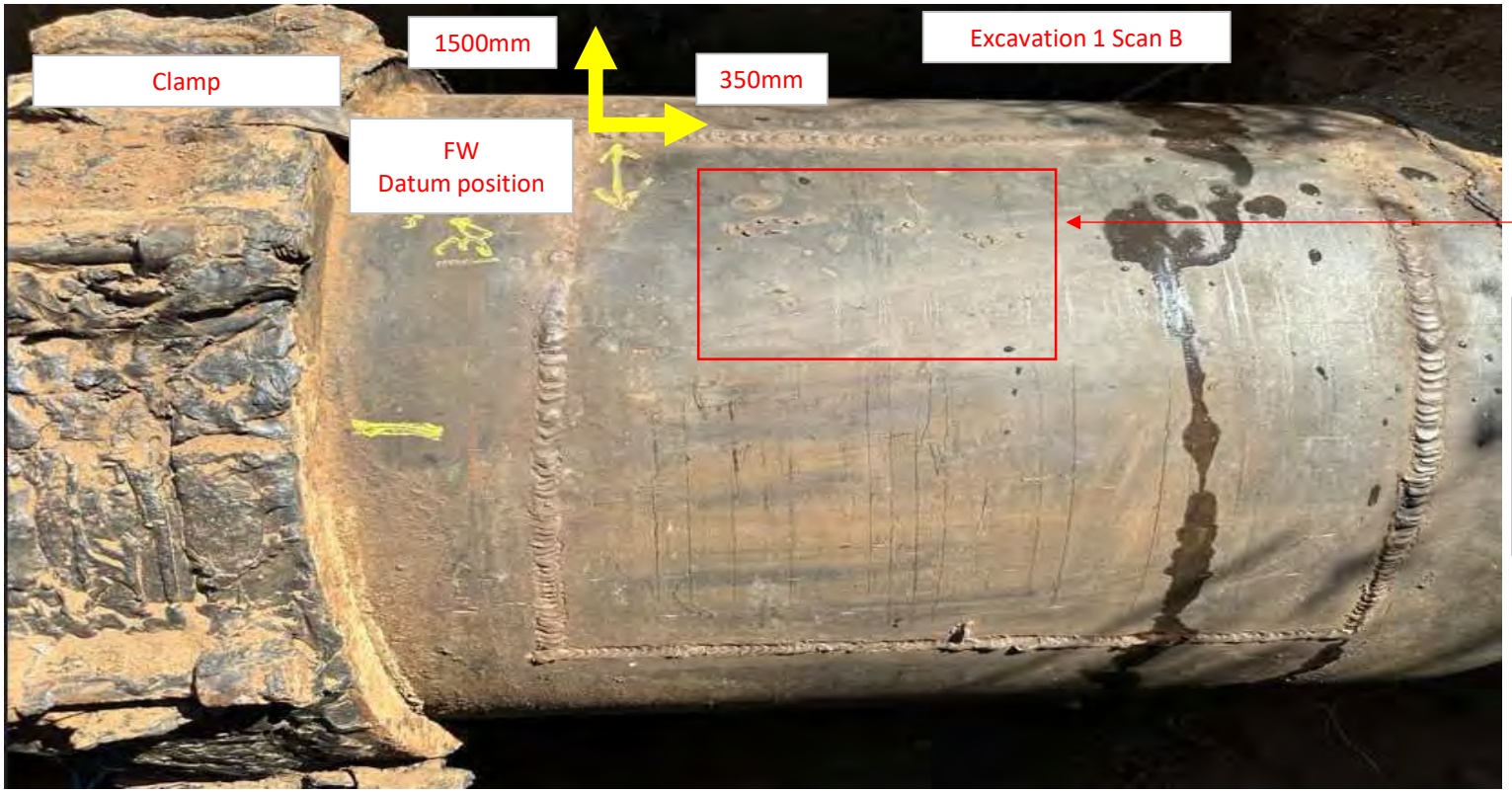


Data Collector	**Name:**	WR Venter	**Data Analyzer**	**Name:**	WR Venter	**Reviewer**	**Name:**	GP le Roux	**Client**	**Name:**	
	Qualification:	PCN LII		**Qualification:**	PCN LII		**Qualification:**	SNT TC 1A LII		**Qualification:**	
	Signature:			**Signature:**			**Signature:**			**Signature:**	
	Date:	2024/03/06		**Date:**	2024/03/06		**Date:**	2024/03/06		**Date:**	

Phased Array Ultrasonic Examination Report

Report No.:	SEC2-PAUT-0135
Job No.:	Not Applicable
Equipent No.:	Water Pipe
Page No.:	6 of 9

Excavation 1 (Start)



Data Collector	**Name:**	WR Venter	**Data Analyzer**	**Name:**	WR Venter	**Reviewer**	**Name:**	GP le Roux	**Client**	**Name:**	
	Qualification:	PCN LII		**Qualification:**	PCN LII		**Qualification:**	SNT TC 1A LII		**Qualification:**	
	Signature:			**Signature:**			**Signature:**			**Signature:**	
	Date:	2024/03/06		**Date:**	2024/03/06		**Date:**	2024/03/06		**Date:**	

Phased Array Ultrasonic Examination Report

Report No.:	SEC2-PAUT-0135
Job No.:	Not Applicable
Equipent No.:	Water Pipe
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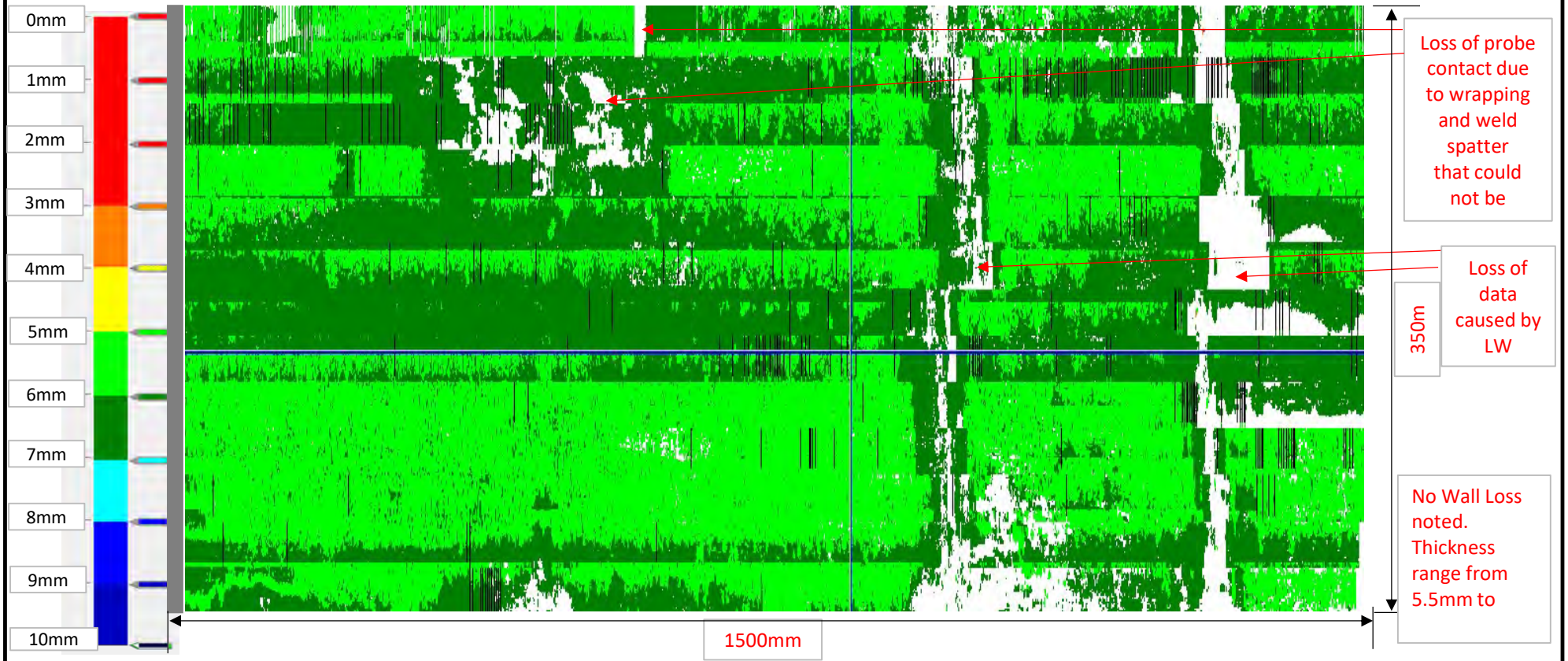
Scan Excavation 1B



Data Collector	**Name:**	WR Venter	**Data Analyzer**	**Name:**	WR Venter	**Reviewer**	**Name:**	GP le Roux	**Client**	**Name:**	
	Qualification:	PCN LII		**Qualification:**	PCN LII		**Qualification:**	SNT TC 1A LII		**Qualification:**	
	Signature:			**Signature:**			**Signature:**			**Signature:**	
	Date:	2024/03/06		**Date:**	2024/03/06		**Date:**	2024/03/06		**Date:**	

Phased Array Ultrasonic Examination Report

Report No.:	SEC2-PAUT-0135
Job No.:	Not Applicable
Equipent No.:	Water Pipe
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Excavation 2 (End)

Data Collector	**Name:**	WR Venter	**Data Analyzer**	**Name:**	WR Venter	**Reviewer**	**Name:**	GP le Roux	**Client**	**Name:**	
	Qualification:	PCN LII		**Qualification:**	PCN LII		**Qualification:**	SNT TC 1A LII		**Qualification:**	
	Signature:			**Signature:**			**Signature:**			**Signature:**	
	Date:	2024/03/06		**Date:**	2024/03/06		**Date:**	2024/03/06		**Date:**	

Phased Array Ultrasonic Examination Report

Report No.:	SEC2-PAUT-0135
Job No.:	Not Applicable
Equipent No.:	Water Pipe
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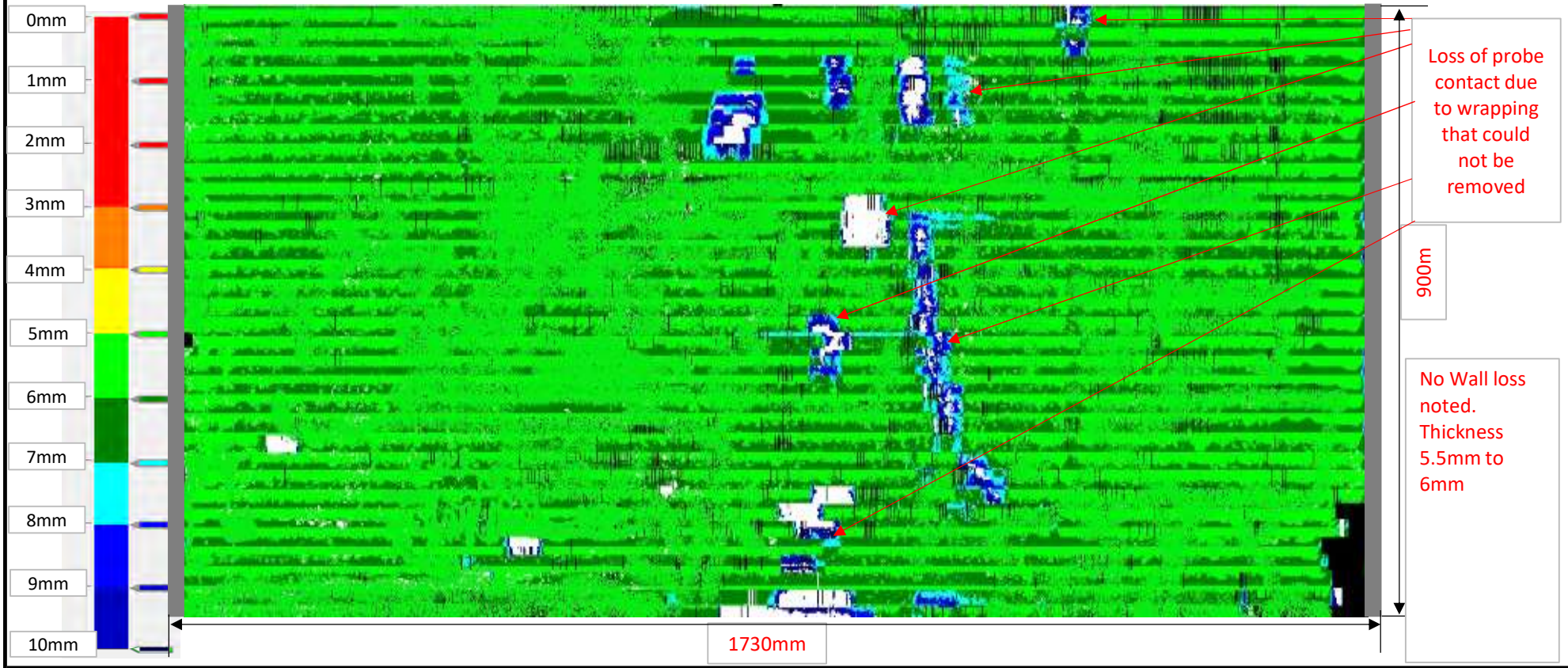
Scan Excavation 2



Data Collector	**Name:**	WR Venter	**Data Analyzer**	**Name:**	WR Venter	**Reviewer**	**Name:**	GP le Roux	**Client**	**Name:**	
	Qualification:	PCN LII		**Qualification:**	PCN LII		**Qualification:**	SNT TC 1A LII		**Qualification:**	
	Signature:			**Signature:**			**Signature:**			**Signature:**	
	Date:	2024/03/06		**Date:**	2024/03/06		**Date:**	2024/03/06		**Date:**	

11.4 Appendix 4 : CCTV Survey Results

Inspection Report CCTV

Survey reference – Condition Assesment on 9,5KM Pipeline at Phalaborwa WTW

Date – 290823

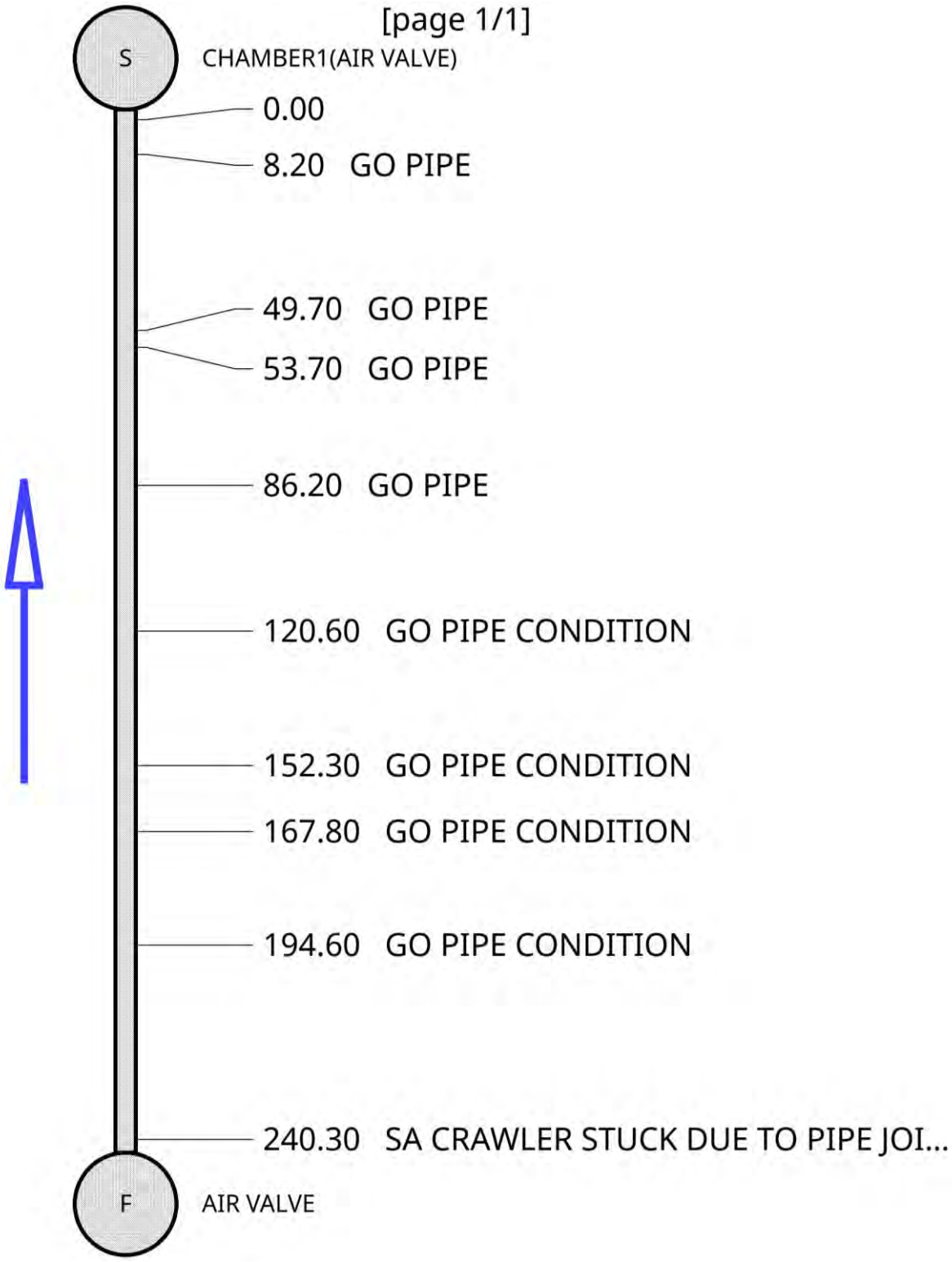
Contents

Drain / Sewer Survey

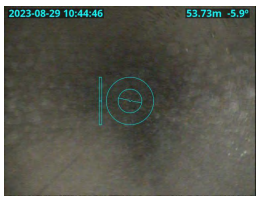
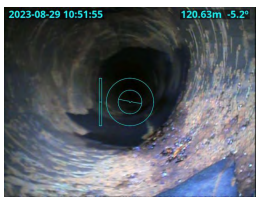
1.1 Survey Header

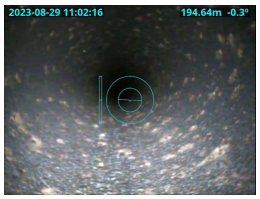
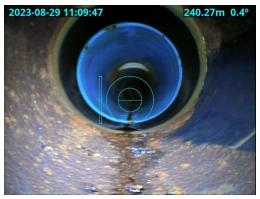
1.1.1	**Surveyed by (Operator)**	AKANI/DARREN
1.1.2	**Contract no.**	
1.1.3	**Job no.**	
1.1.4	**Catchment (Drainage area)**	
1.1.5	**Division**	LEPELLE NORTHERN WATER
1.1.6	**District**	MOPANE
1.1.7	**Pipeline length ref**	9500
1.1.8	**Date**	290823
1.1.9	**Time**	10:25
1.1.10	**Location**	PHALABORWA
1.1.11	**Start manhole no.**	CHAMBER1(AIR VALVE)
1.1.12	**Start depth**	
1.1.13	**Start cover level**	
1.1.14	**Start invert level**	2.64
1.1.15	**Finish manhole no.**	AIR VALVE
1.1.16	**Finish depth**	
1.1.17	**Finish cover level**	
1.1.18	**Finish invert level**	2.74
1.1.19	**Use of Drain**	(Z) Not Known
1.1.20	**Direction**	(U) Survey upstream (camera pointing against flow)
1.1.21	**Size 1 (diameter/height)**	560mm
1.1.22	**Size 2 (width)**	
1.1.23	**Shape**	(C) Circular
1.1.24	**Material**	(ST) Steel
1.1.25	**Lining**	
1.1.26	**Pipe length**	150m
1.1.27	**Total length**	9500m
1.1.28	**Year laid**	N/A
1.1.29	**Video cassette number**	
1.1.30	**Comments: General**	
1.1.31	**Purpose**	(Z) Not Known
1.1.32	**Sewer category**	(Z) Not Known
1.1.33	**Pre-cleaning**	(N) No
1.1.34	**Weather**	
1.1.35	**Location code**	
1.1.36	**Further location details**	

1.2 Diagram


[page 1/1]
S
CHAMBER1(AIR VALVE)
0.00
8.20 GO PIPE
49.70 GO PIPE
53.70 GO PIPE
86.20 GO PIPE
120.60 GO PIPE CONDITION
152.30 GO PIPE CONDITION
167.80 GO PIPE CONDITION
194.60 GO PIPE CONDITION
240.30 SA CRAWLER STUCK DUE TO PIPE JOI...
F
AIR VALVE

1.3 Observations

Distance Cont. Defect Clock (At – To)	Condition code and attributes	Photo Ref
Joint	Remarks	Video Ref
8.2	(GO) General observation at this point	./2023-08-29-10-25-26/2023-08-29-10-25-26_2023_08_29-10_40_42_122.jpg 
	PIPE	0:00:46
49.7	(GO) General observation at this point	./2023-08-29-10-25-26/2023-08-29-10-25-26_2023_08_29-10_44_00_498.jpg 
	PIPE	0:03:51
53.7	(GO) General observation at this point	./2023-08-29-10-25-26/2023-08-29-10-25-26_2023_08_29-10_44_46_545.jpg 
	PIPE	0:04:21
86.2	(GO) General observation at this point	./2023-08-29-10-25-26/2023-08-29-10-25-26_2023_08_29-10_49_10_302.jpg 
	PIPE	0:06:58
120.6	(GO) General observation at this point	./2023-08-29-10-25-26/2023-08-29-10-25-26_2023_08_29-10_51_55_415.jpg 
	PIPE CONDITION	0:09:34

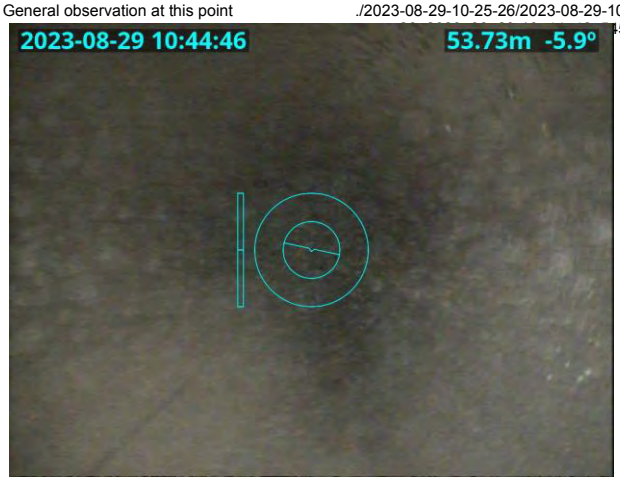
Distance Cont. Defect Clock (At – To)	Condition code and attributes	Photo Ref
Joint	Remarks	Video Ref
152.3	(GO) General observation at this point	./2023-08-29-10-25-26/2023-08-29-10-25-26_2023_08_29-10_55_18_712.jpg 
	PIPE CONDITION	0:12:43
167.8	(GO) General observation at this point	./2023-08-29-10-25-26/2023-08-29-10-25-26_2023_08_29-10_58_45_408.jpg 
	PIPE CONDITION	0:14:41
194.6	(GO) General observation at this point	./2023-08-29-10-25-26/2023-08-29-10-25-26_2023_08_29-11_02_16_911.jpg 
	PIPE CONDITION	0:17:57
240.3	(SA) Survey abandoned	./2023-08-29-10-25-26/2023-08-29-10-25-26_2023_08_29-11_09_47_473.jpg 
	CRAWLER STUCK DUE TO PIPE JOINT	0:25:15

1.4 Photographs

(GO) General observation at this point ./2023-08-29-10-25-26/2023-08-29-10-25-22.jpg

(GO) General observation at this point ./2023-08-29-10-25-26/2023-08-29-10-25-498.jpg

(GO) General observation at this point ./2023-08-29-10-25-26/2023-08-29-10-25-45.jpg



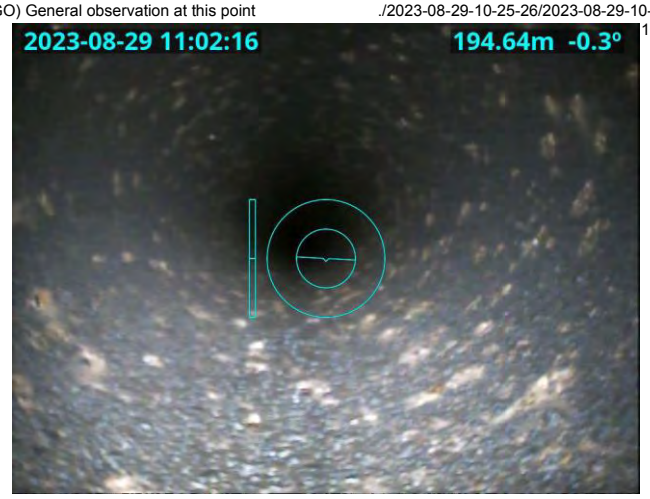
(GO) General observation at this point ./2023-08-29-10-25-26/2023-08-29-10-25-802.jpg

(GO) General observation at this point ./2023-08-29-10-25-26/2023-08-29-10-25-5.jpg

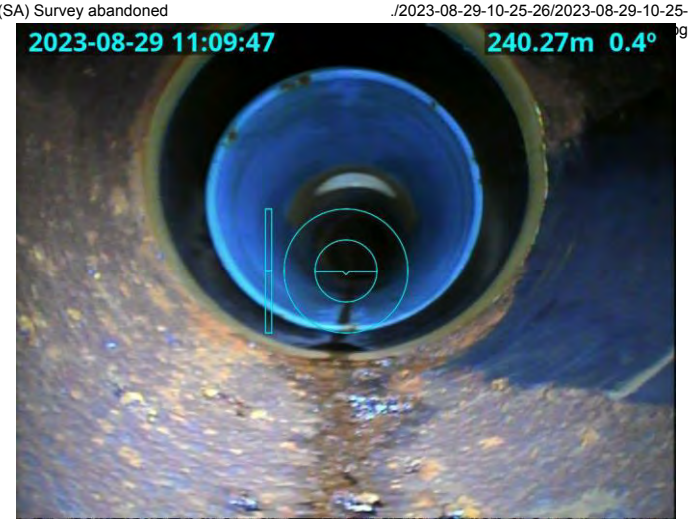
(GO) General observation at this point ./2023-08-29-10-25-26/2023-08-29-10-25-12.jpg

(GO) General observation at this point ./2023-08-29-10-25-26/2023-08-29-10-25-.jpg

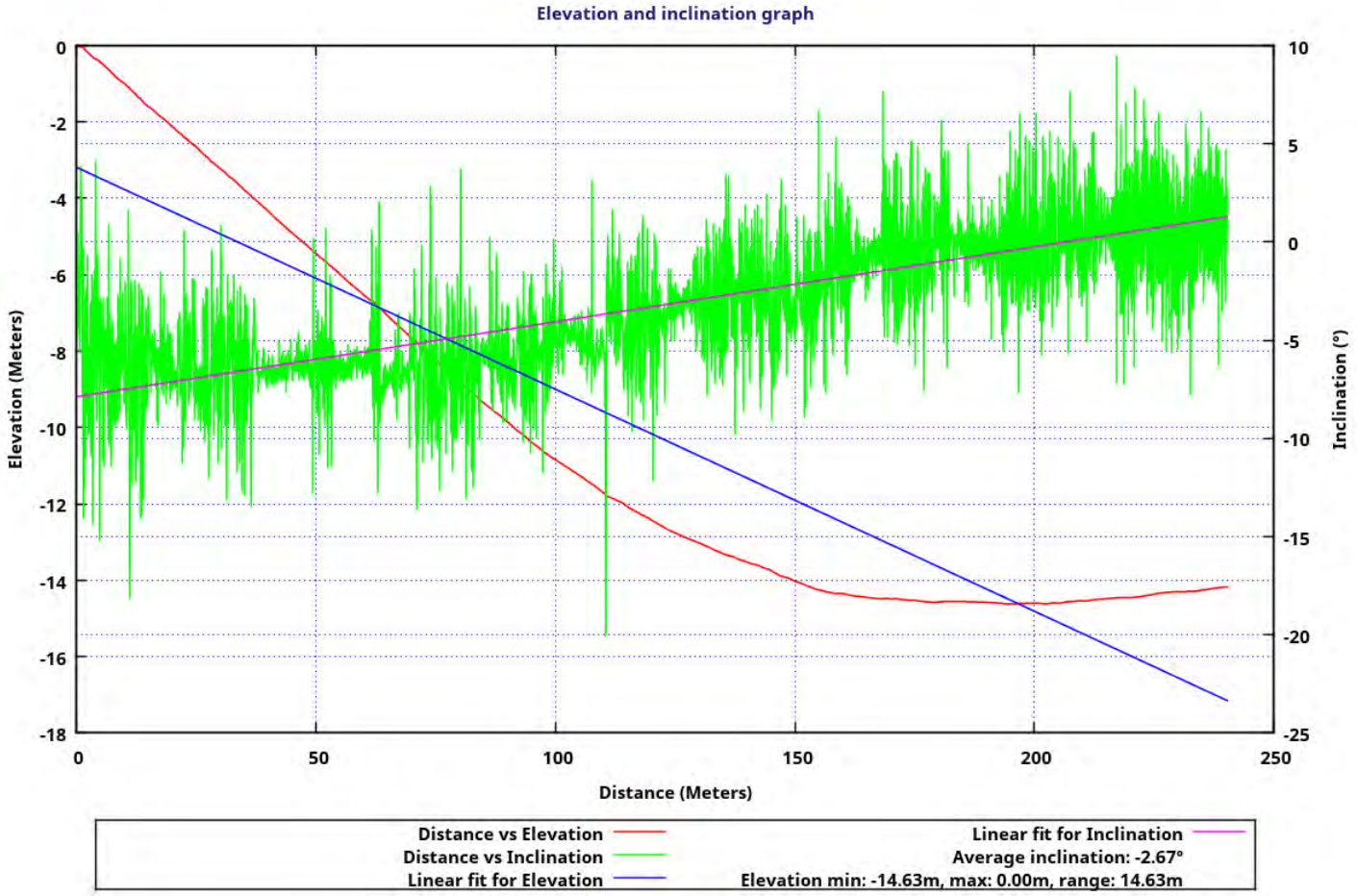
(GO) General observation at this point ./2023-08-29-10-25-26/2023-08-29-10-25-1.jpg



(SA) Survey abandoned ./2023-08-29-10-25-26/2023-08-29-10-25-pg



1.5 Inclination Graph

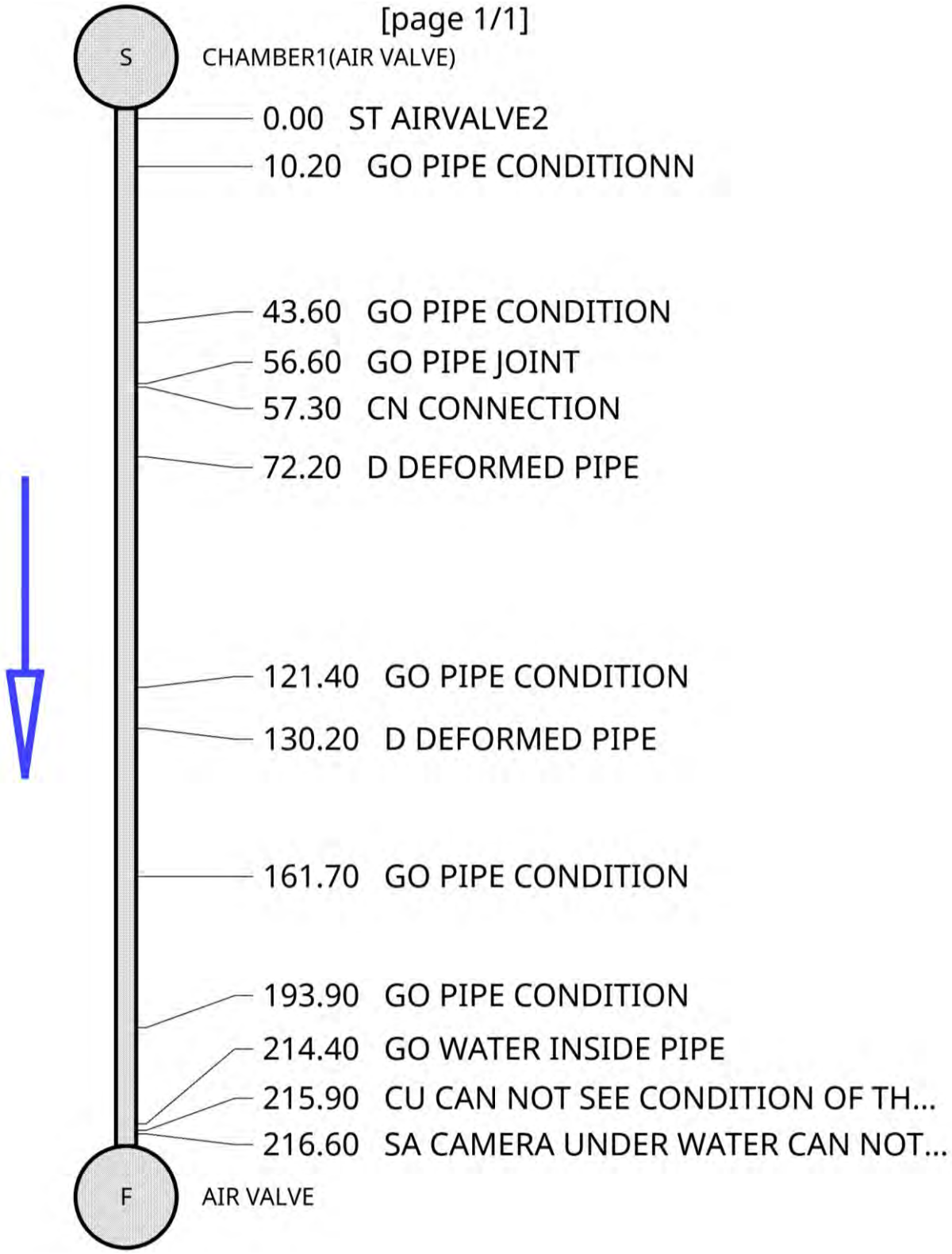


2 Drain / Sewer Survey

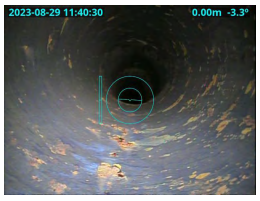
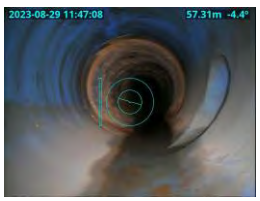
2.1 Survey Header

2.1.1	**Surveyed by (Operator)**	AKANI/DARREN
2.1.2	**Contract no.**	
2.1.3	**Job no.**	
2.1.4	**Catchment (Drainage area)**	
2.1.5	**Division**	LEPELLE NORTHERN WATER
2.1.6	**District**	MOPANE
2.1.7	**Pipeline length ref**	9500
2.1.8	**Date**	290823
2.1.9	**Time**	11:35
2.1.10	**Location**	PHALABORWA
2.1.11	**Start manhole no.**	CHAMBER1(AIR VALVE)
2.1.12	**Start depth**	
2.1.13	**Start cover level**	
2.1.14	**Start invert level**	2.64
2.1.15	**Finish manhole no.**	AIR VALVE
2.1.16	**Finish depth**	
2.1.17	**Finish cover level**	
2.1.18	**Finish invert level**	2.84
2.1.19	**Use of Drain**	(Z) Not Known
2.1.20	**Direction**	(D) Survey downstream (camera pointing with flow)
2.1.21	**Size 1 (diameter/height)**	560mm
2.1.22	**Size 2 (width)**	
2.1.23	**Shape**	(C) Circular
2.1.24	**Material**	(ST) Steel
2.1.25	**Lining**	
2.1.26	**Pipe length**	150m
2.1.27	**Total length**	9500m
2.1.28	**Year laid**	N/A
2.1.29	**Video cassette number**	
2.1.30	**Comments: General**	
2.1.31	**Purpose**	(Z) Not Known
2.1.32	**Sewer category**	(Z) Not Known
2.1.33	**Pre-cleaning**	(N) No
2.1.34	**Weather**	
2.1.35	**Location code**	
2.1.36	**Further location details**	

2.2 Diagram


[page 1/1]
S
CHAMBER1(AIR VALVE)
0.00 ST AIRVALVE2
10.20 GO PIPE CONDITIONN
43.60 GO PIPE CONDITION
56.60 GO PIPE JOINT
57.30 CN CONNECTION
72.20 D DEFORMED PIPE
121.40 GO PIPE CONDITION
130.20 D DEFORMED PIPE
161.70 GO PIPE CONDITION
193.90 GO PIPE CONDITION
214.40 GO WATER INSIDE PIPE
215.90 CU CAN NOT SEE CONDITION OF TH...
216.60 SA CAMERA UNDER WATER CAN NOT...
F
AIR VALVE

2.3 Observations

Distance Cont. Defect Clock (At – To)	Condition code and attributes	Photo Ref
Joint	Remarks	Video Ref
0.0	(ST) Start of survey	./2023-08-29-11-35-09/2023-08-29-11-35-09_2023_08_29-11_40_30_698.jpg 
	AIRVALVE2	0:00:03
10.2	(GO) General observation at this point	./2023-08-29-11-35-09/2023-08-29-11-35-09_2023_08_29-11_41_42_740.jpg 
	PIPE CONDITIONN	0:00:54
43.6	(GO) General observation at this point	./2023-08-29-11-35-09/2023-08-29-11-35-09_2023_08_29-11_44_08_845.jpg 
	PIPE CONDITION	0:03:03
56.6	(GO) General observation at this point	./2023-08-29-11-35-09/2023-08-29-11-35-09_2023_08_29-11_45_35_483.jpg 
	PIPE JOINT	0:04:07
57.3 02	(CN) Connection at ... o'clock, diameter ...mm Clock At/From: 02 Diameter/Dimension: N/A	./2023-08-29-11-35-09/2023-08-29-11-35-09_2023_08_29-11_47_08_925.jpg 
	CONNECTION	0:04:36

Distance Cont. Defect Clock (At – To)	Condition code and attributes	Photo Ref
Joint	Remarks	Video Ref
72.2	(D) Deformed sewer ...% Percentage: 5%	./2023-08-29-11-35-09/2023-08-29-11-35-09_2023_08_29-11_48_55_066.jpg 
	DEFORMED PIPE	0:05:57
121.4	(GO) General observation at this point	./2023-08-29-11-35-09/2023-08-29-11-35-09_2023_08_29-11_53_05_922.jpg 
	PIPE CONDITION	0:09:37
130.2	(D) Deformed sewer ...% Percentage: 5%	./2023-08-29-11-35-09/2023-08-29-11-35-09_2023_08_29-11_54_33_902.jpg 
	DEFORMED PIPE	0:10:38
161.7	(GO) General observation at this point	./2023-08-29-11-35-09/2023-08-29-11-35-09_2023_08_29-11_57_34_054.jpg 
	PIPE CONDITION	0:13:1
193.9	(GO) General observation at this point	./202 5- 09_2023_08_29-12_00_49_303.jpg 
	PIPE CONDITION	0:16:17

Distance Cont. Defect Clock (At – To)	Condition code and attributes	Photo Ref
Joint	Remarks	Video Ref
214.4	(GO) General observation at this point	./2023-08-29-11-35-09/2023-08-29-11-35-09_2023_08_29-12_03_22_997.jpg 
	WATER INSIDE PIPE	0:18:33
215.9	(CU) Camera under water	./2023-08-29-11-35-09/2023-08-29-11-35-09_2023_08_29-12_04_27_741.jpg 
	CAN NOT SEE CONDITION OF THE PIPE	0:18:59
216.6	(SA) Survey abandoned	./2023-08-29-11-35-09/2023-08-29-11-35-09_2023_08_29-12_05_17_312.jpg 
	CAMERA UNDER WATER CAN NOT SEE CONDITION OF THE PIPE	0:19:17

2.4 Photographs

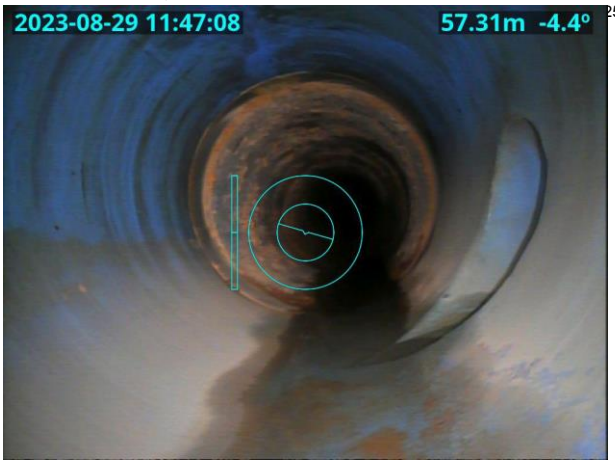
(ST) Start of survey ./2023-08-29-11-35-09/2023-08-29-11-35-98.jpg

(GO) General observation at this point ./2023-08-29-11-35-09/2023-08-29-11-35-40.jpg

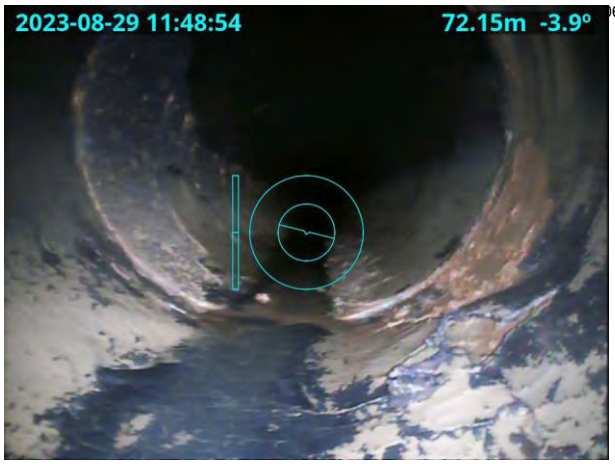
(GO) General observation at this point ./2023-08-29-11-35-09/2023-08-29-11-35-45.jpg

(GO) General observation at this point ./2023-08-29-11-35-09/2023-08-29-11-35-83.jpg

(CN) Connection at ... o'clock, diameter ...mm ./2023-08-29-11-35-09/2023-08-29-11-35-25.jpg

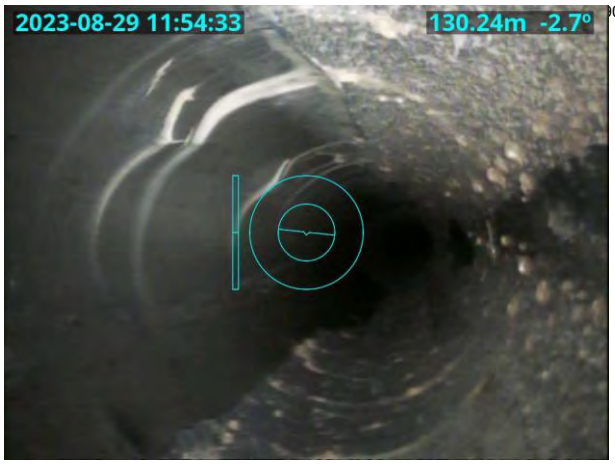


(D) Deformed sewer ...% ./2023-08-29-11-35-09/2023-08-29-11-35-66.jpg



(GO) General observation at this point ./2023-08-29-11-35-09/2023-08-29-11-35-22.jpg

(D) Deformed sewer ...% ./2023-08-29-11-35-09/2023-08-29-11-35-02.jpg

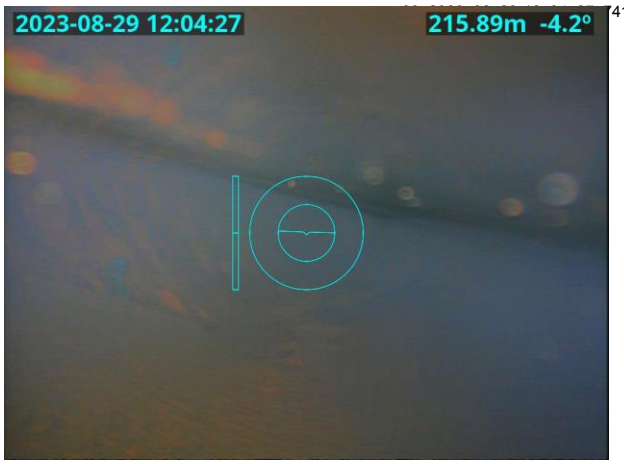


(GO) General observation at this point ./2023-08-29-11-35-09/2023-08-29-11-35-54.jpg

(GO) General observation at this point ./2023-08-29-11-35-09/2023-08-29-11-35-03.jpg

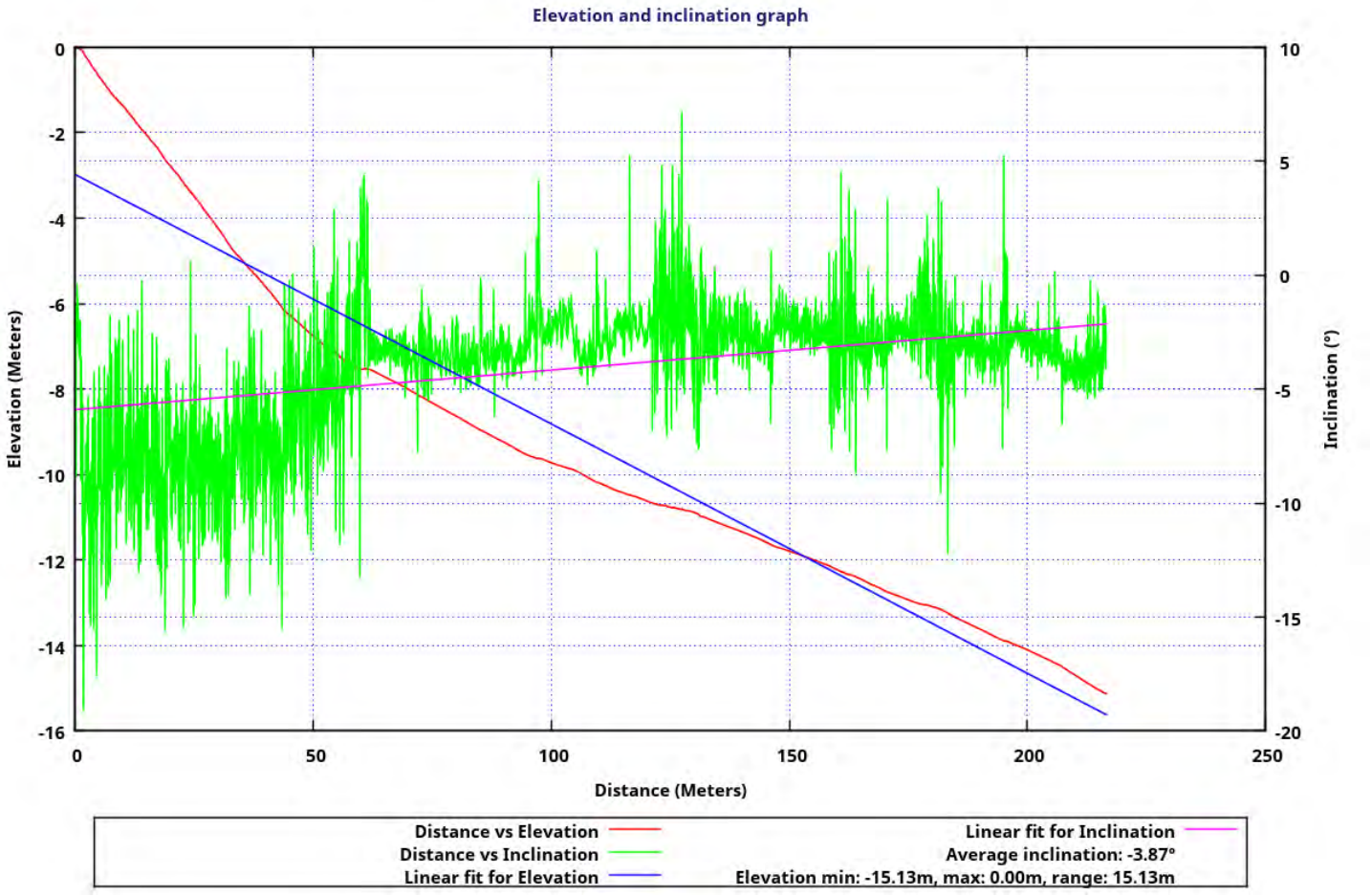
(GO) General observation at this point ./2023-08-29-11-35-09/2023-08-29-11-35-97.jpg

(CU) Camera under water ./2023-08-29-11-35-09/2023-08-29-11-35-41.jpg



(SA) Survey abandoned ./2023-08-29-11-35-09/2023-08-29-11-35-12.jpg

2.5 Inclination graph

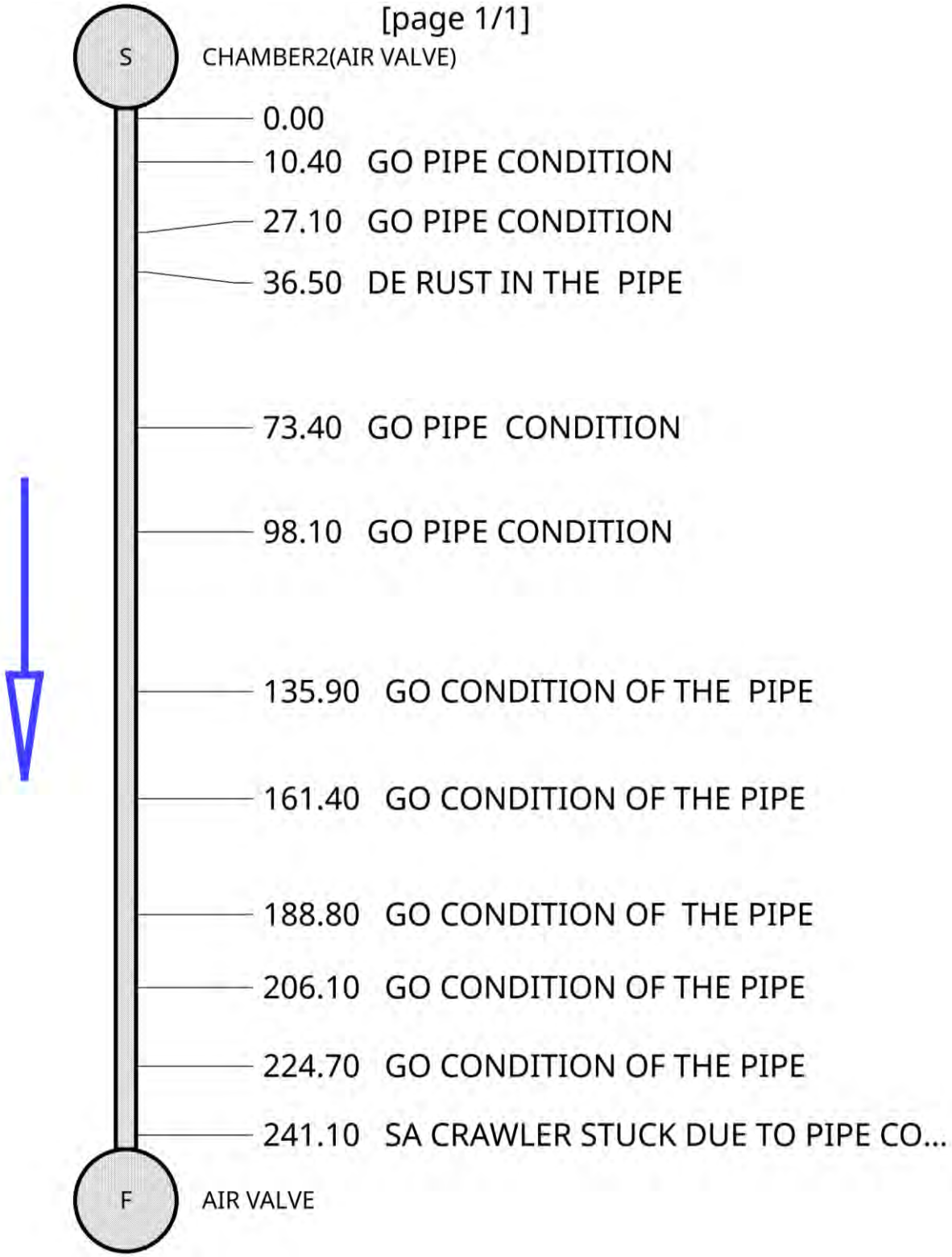


3 Drain / Sewer Survey

3.1 Survey Header

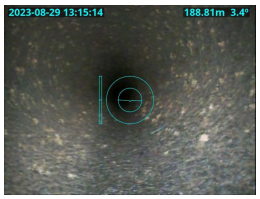
3.1.1	**Surveyed by (Operator)**	AKANI/DARREN
3.1.2	**Contract no.**	1
3.1.3	**Job no.**	
3.1.4	**Catchment (Drainage area)**	
3.1.5	**Division**	LEPELLE NORTHERN WATER
3.1.6	**District**	MOPANE
3.1.7	**Pipeline length ref**	9500
3.1.8	**Date**	290823
3.1.9	**Time**	12:55
3.1.10	**Location**	PHALABORWA
3.1.11	**Start manhole no.**	CHAMBER2(AIR VALVE)
3.1.12	**Start depth**	
3.1.13	**Start cover level**	
3.1.14	**Start invert level**	2.72
3.1.15	**Finish manhole no.**	AIR VALVE
3.1.16	**Finish depth**	
3.1.17	**Finish cover level**	
3.1.18	**Finish invert level**	2.8
3.1.19	**Use of Drain**	(Z) Not Known
3.1.20	**Direction**	(D) Survey downstream (camera pointing with flow)
3.1.21	**Size 1 (diameter/height)**	560mm
3.1.22	**Size 2 (width)**	
3.1.23	**Shape**	(C) Circular
3.1.24	**Material**	(ST) Steel
3.1.25	**Lining**	
3.1.26	**Pipe length**	N/Am
3.1.27	**Total length**	9500m
3.1.28	**Year laid**	N/A
3.1.29	**Video cassette number**	
3.1.30	**Comments: General**	
3.1.31	**Purpose**	(Z) Not Known
3.1.32	**Sewer category**	(Z) Not Known
3.1.33	**Pre-cleaning**	(N) No
3.1.34	**Weather**	
3.1.35	**Location code**	
3.1.36	**Further location details**	

3.2 Diagram


[page 1/1]
S
CHAMBER2(AIR VALVE)
0.00
10.40 GO PIPE CONDITION
27.10 GO PIPE CONDITION
36.50 DE RUST IN THE PIPE
73.40 GO PIPE CONDITION
98.10 GO PIPE CONDITION
135.90 GO CONDITION OF THE PIPE
161.40 GO CONDITION OF THE PIPE
188.80 GO CONDITION OF THE PIPE
206.10 GO CONDITION OF THE PIPE
224.70 GO CONDITION OF THE PIPE
241.10 SA CRAWLER STUCK DUE TO PIPE CO...
F
AIR VALVE

3.3 Observations

Distance Cont. Defect Clock (At – To)	Condition code and attributes	Photo Ref
Joint	Remarks	Video Ref
10.4	(GO) General observation at this point	./2023-08-29-12-55-16/2023-08-29-12-55-16_2023_08_29-12_58_12_421.jpg 
	PIPE CONDITION	0:01:00
27.1	(GO) General observation at this point	./2023-08-29-12-55-16/2023-08-29-12-55-16_2023_08_29-12_59_33_741.jpg 
	PIPE CONDITION	0:02:05
36.5	(DE) Debris ...% cross-sectional area loss Percentage: 3%	./2023-08-29-12-55-16/2023-08-29-12-55-16_2023_08_29-13_00_33_338.jpg 
	RUST IN THE PIPE	0:02:52
73.4	(GO) General observation at this point	./2023-08-29-12-55-16/2023-08-29-12-55-16_2023_08_29-13_03_57_446.jpg 
	PIPE CONDITION	0:05:31
98.1	(GO) General observation at this point	./2023-08-29-12-55-16/2023-08-29-12-55-16_2023_08_29-13_06_02_382.jpg 
	PIPE CONDITION	0:07:20

Distance Cont. Defect Clock (At – To) Joint	Condition code and attributes Remarks	Photo Ref Video Ref
135.9	(GO) General observation at this point	./2023-08-29-12-55-16/2023-08-29-12-55-16_2023_08_29-13_09_14_425.jpg 
	CONDITION OF THE PIPE	0:10:15
161.4	(GO) General observation at this point	./2023-08-29-12-55-16/2023-08-29-12-55-16_2023_08_29-13_11_59_550.jpg 
	CONDITION OF THE PIPE	0:12:39
188.8	(GO) General observation at this point	./2023-08-29-12-55-16/2023-08-29-12-55-16_2023_08_29-13_15_14_802.jpg 
	CONDITION OF THE PIPE	0:15:34
206.1	(GO) General observation at this point	./2023-08-29-12-55-16/2023-08-29-12-55-16_2023_08_29-13_17_38_253.jpg 
	CONDITION OF THE PIPE	0:17:33
224.7	(GO) General observation at this point	./2023-08-29-12-55-16/2023-08-29-12-55-16_2023_08_29-13_21_15_007.jpg 
	CONDITION OF THE PIPE	0:20:49

Distance	Condition code and attributes	Photo Ref
Cont. Defect		
Clock (At – To)		
Joint	Remarks	Video Ref
241.1	(SA) Survey abandoned	./2023-08-29-12-55-16/2023-08-29-12-55-16_2023_08_29-13_25_01_923.jpg 
	CRAWLER STUCK DUE TO PIPE CONDITION	0:24:16

3.4 Photographs

(GO) General observation at this point ./2023-08-29-12-55-16/2023-08-29-12-55-21.jpg

(GO) General observation at this point ./2023-08-29-12-55-16/2023-08-29-12-55-41.jpg

(DE) Debris ...% cross-sectional area loss ./2023-08-29-12-55-16/2023-08-29-12-55-38.jpg

(GO) General observation at this point ./2023-08-29-12-55-16/2023-08-29-12-55-46.jpg

(GO) General observation at this point ./2023-08-29-12-55-16/2023-08-29-12-55-32.jpg

(GO) General observation at this point ./2023-08-29-12-55-16/2023-08-29-12-55-25.jpg

(GO) General observation at this point ./2023-08-29-12-55-16/2023-08-29-12-55-50.jpg

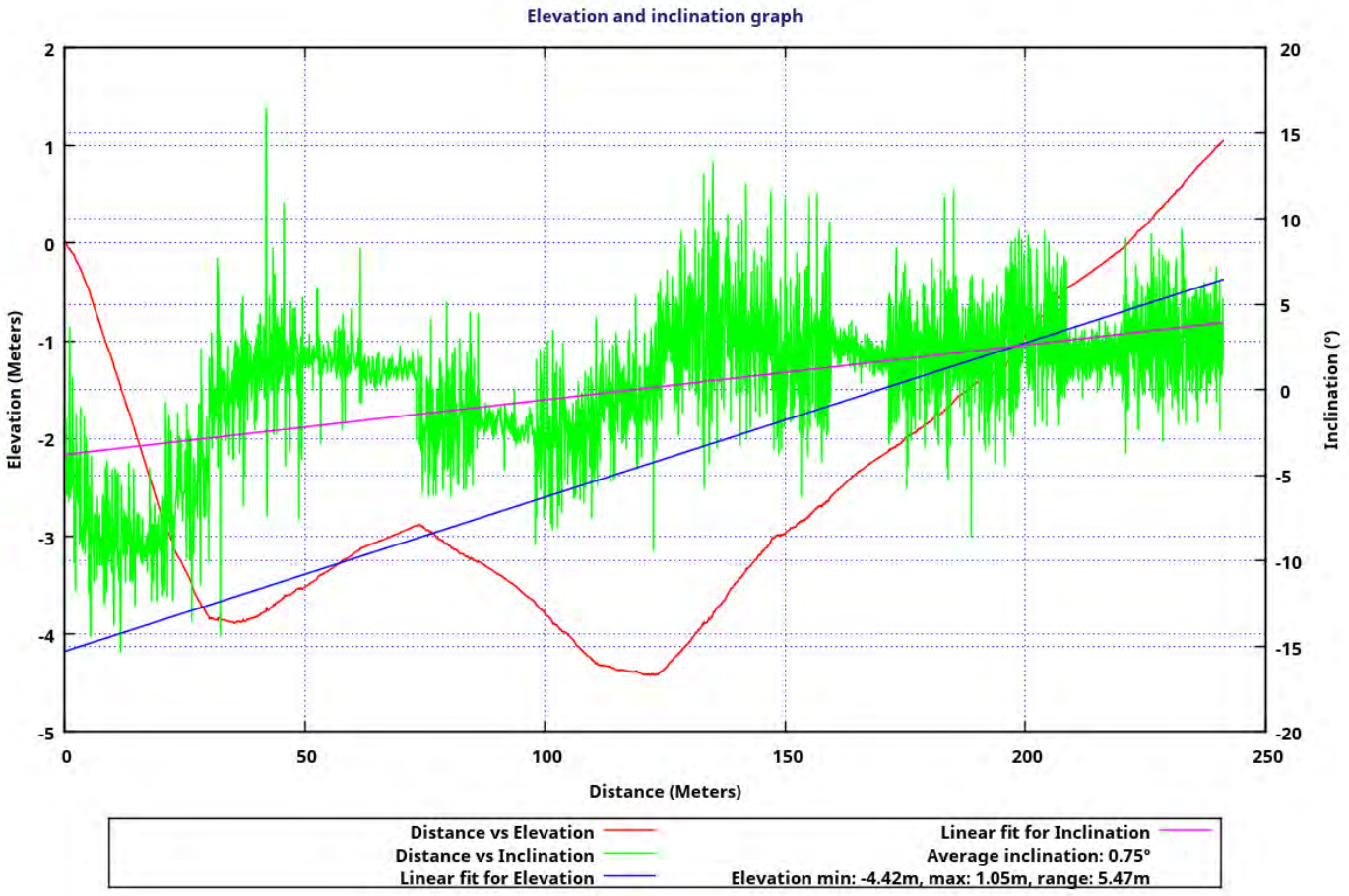
(GO) General observation at this point ./2023-08-29-12-55-16/2023-08-29-12-55-02.jpg

(GO) General observation at this point ./2023-08-29-12-55-16/2023-08-29-12-55-53.jpg

(GO) General observation at this point ./2023-08-29-12-55-16/2023-08-29-12-55-07.jpg

(SA) Survey abandoned ./2023-08-29-12-55-16/2023-08-29-12-55-23.jpg

3.5 Inclination graph

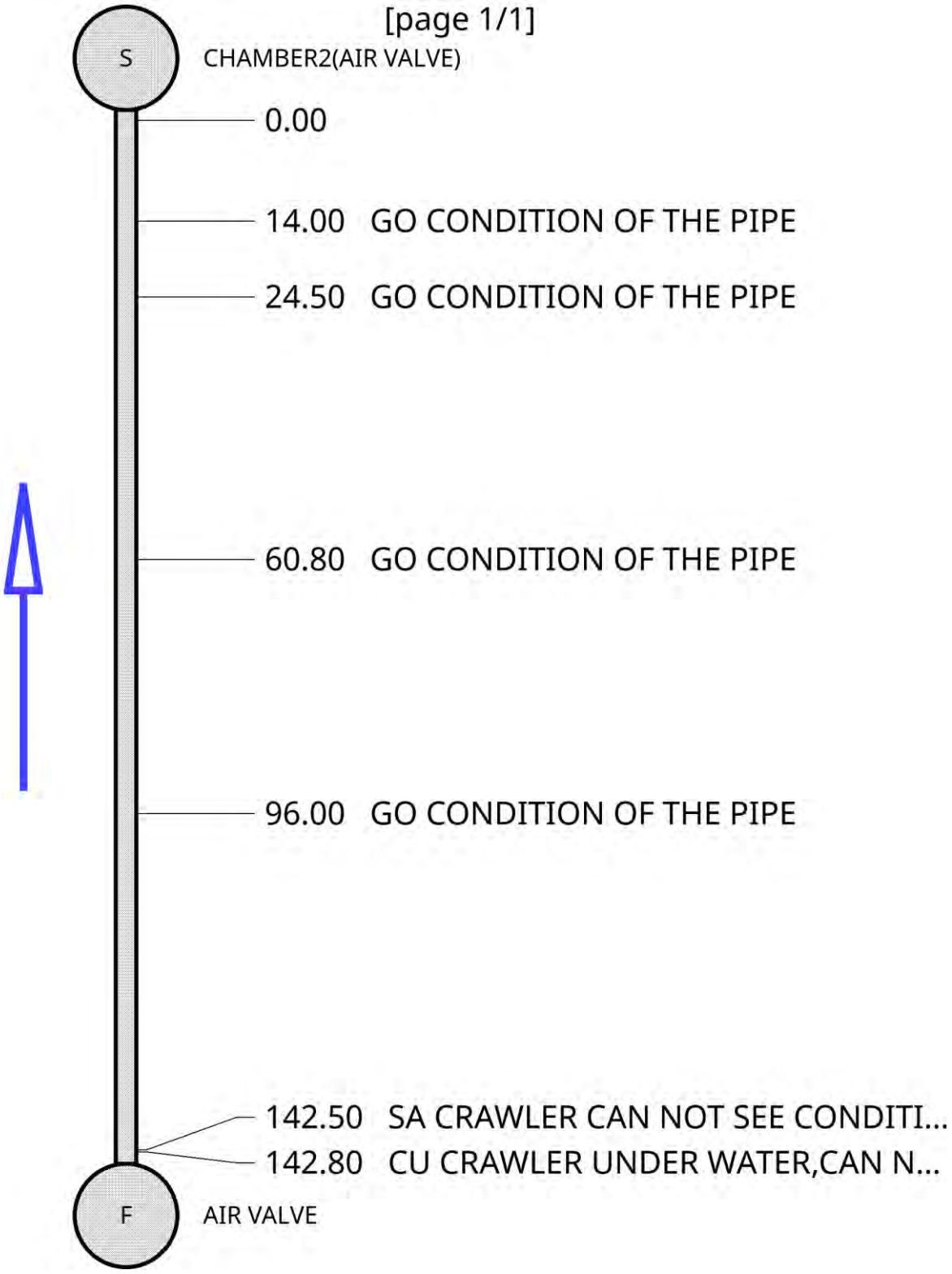


4 Drain / Sewer Survey

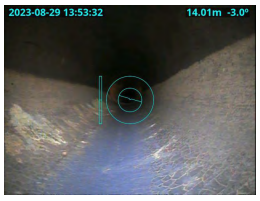
4.1 Survey Header

4.1.1	**Surveyed by (Operator)**	AKANI/DARREN
4.1.2	**Contract no.**	1
4.1.3	**Job no.**	
4.1.4	**Catchment (Drainage area)**	
4.1.5	**Division**	LEPELLE NORTHERN WATER
4.1.6	**District**	MOPANE
4.1.7	**Pipeline length ref**	9500
4.1.8	**Date**	290823
4.1.9	**Time**	13:49
4.1.10	**Location**	PHALABORWA
4.1.11	**Start manhole no.**	CHAMBER2(AIR VALVE)
4.1.12	**Start depth**	
4.1.13	**Start cover level**	
4.1.14	**Start invert level**	2.72
4.1.15	**Finish manhole no.**	AIR VALVE
4.1.16	**Finish depth**	
4.1.17	**Finish cover level**	
4.1.18	**Finish invert level**	2.83
4.1.19	**Use of Drain**	(Z) Not Known
4.1.20	**Direction**	(U) Survey upstream (camera pointing against flow)
4.1.21	**Size 1 (diameter/height)**	560mm
4.1.22	**Size 2 (width)**	
4.1.23	**Shape**	(C) Circular
4.1.24	**Material**	(ST) Steel
4.1.25	**Lining**	
4.1.26	**Pipe length**	N/Am
4.1.27	**Total length**	9500m
4.1.28	**Year laid**	N/A
4.1.29	**Video cassette number**	
4.1.30	**Comments: General**	
4.1.31	**Purpose**	(Z) Not Known
4.1.32	**Sewer category**	(Z) Not Known
4.1.33	**Pre-cleaning**	(N) No
4.1.34	**Weather**	
4.1.35	**Location code**	
4.1.36	**Further location details**	

4.2 Diagram


[page 1/1]
S
CHAMBER2(AIR VALVE)
0.00
14.00 GO CONDITION OF THE PIPE
24.50 GO CONDITION OF THE PIPE
60.80 GO CONDITION OF THE PIPE
96.00 GO CONDITION OF THE PIPE
142.50 SA CRAWLER CAN NOT SEE CONDITI...
142.80 CU CRAWLER UNDER WATER,CAN N...
F
AIR VALVE

4.3 Observations

Distance Cont. Defect Clock (At – To)	Condition code and attributes	Photo Ref
Joint	Remarks	Video Ref
14.0	(GO) General observation at this point	./2023-08-29-13-49-14/2023-08-29-13-49-14_2023_08_29-13_53_32_529.jpg 
	CONDITION OF THE PIPE	0:01:02
24.5	(GO) General observation at this point	./2023-08-29-13-49-14/2023-08-29-13-49-14_2023_08_29-13_54_40_604.jpg 
	CONDITION OF THE PIPE	0:01:44
60.8	(GO) General observation at this point	./2023-08-29-13-49-14/2023-08-29-13-49-14_2023_08_29-13_57_29_062.jpg 
	CONDITION OF THE PIPE	0:04:09
96.0	(GO) General observation at this point	./2023-08-29-13-49-14/2023-08-29-13-49-14_2023_08_29-14_00_17_400.jpg 
	CONDITION OF THE PIPE	0:06:32
142.5	(SA) Survey abandoned	./2023-08-29-13-49-14/2023-08-29-13-49-14_2023_08_29-14_05_29_749.jpg 
	CRAWLER CAN NOT SEE CONDITION OF THE PIPE,PIPE FILLED WITH WATER.	0:10:21

Distance Cont. Defect Clock (At – To)	Condition code and attributes	Photo Ref
Joint	Remarks	Video Ref
142.8	(CU) Camera under water	./2023-08-29-13-49-14/2023-08-29-13-49-14_2023_08_29-14_03_59_422.jpg 
	CRAWLER UNDER WATER,CAN NOT SEE CONDITION OF THE PIPE	0:09:52

4.4 Photographs

(GO) General observation at this point ./2023-08-29-13-49-14/2023-08-29-13-49-29.jpg

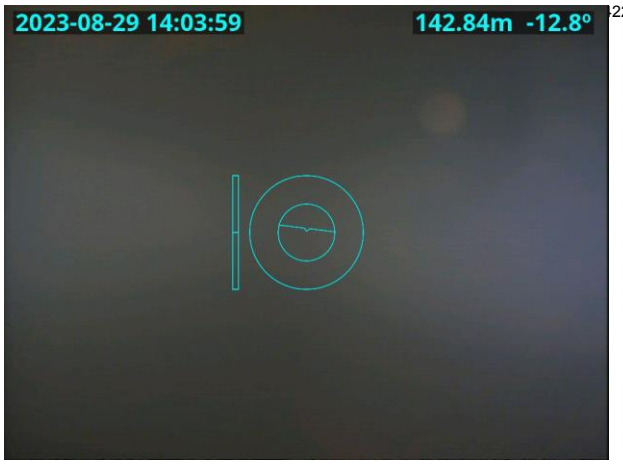
(GO) General observation at this point ./2023-08-29-13-49-14/2023-08-29-13-49-504.jpg

(GO) General observation at this point ./2023-08-29-13-49-14/2023-08-29-13-49-52.jpg

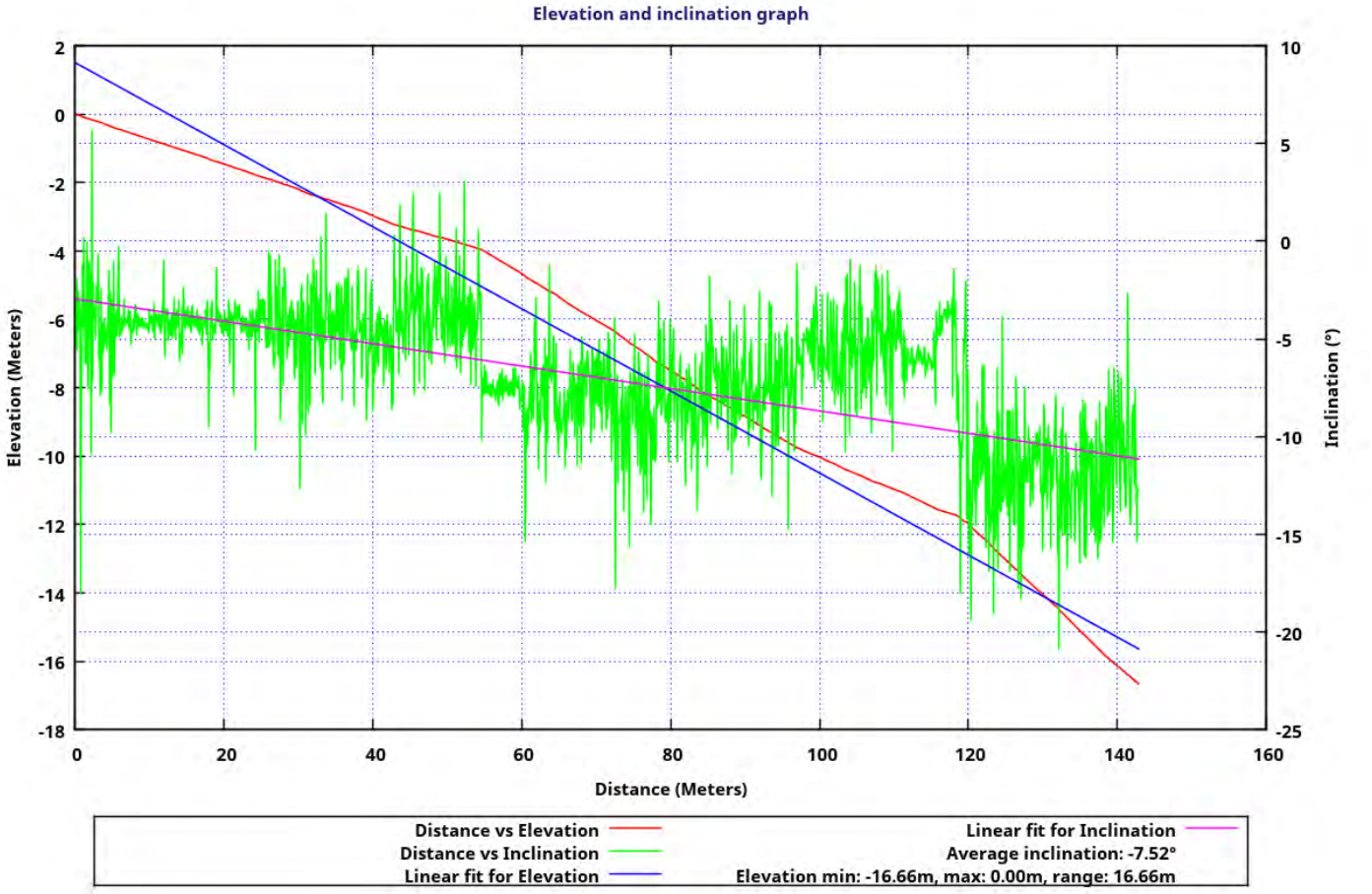
(GO) General observation at this point ./2023-08-29-13-49-14/2023-08-29-13-49-400.jpg

(SA) Survey abandoned ./2023-08-29-13-49-14/2023-08-29-13-49-49.jpg

(CU) Camera under water ./2023-08-29-13-49-14/2023-08-29-13-49-22.jpg



4.5 Inclination graph

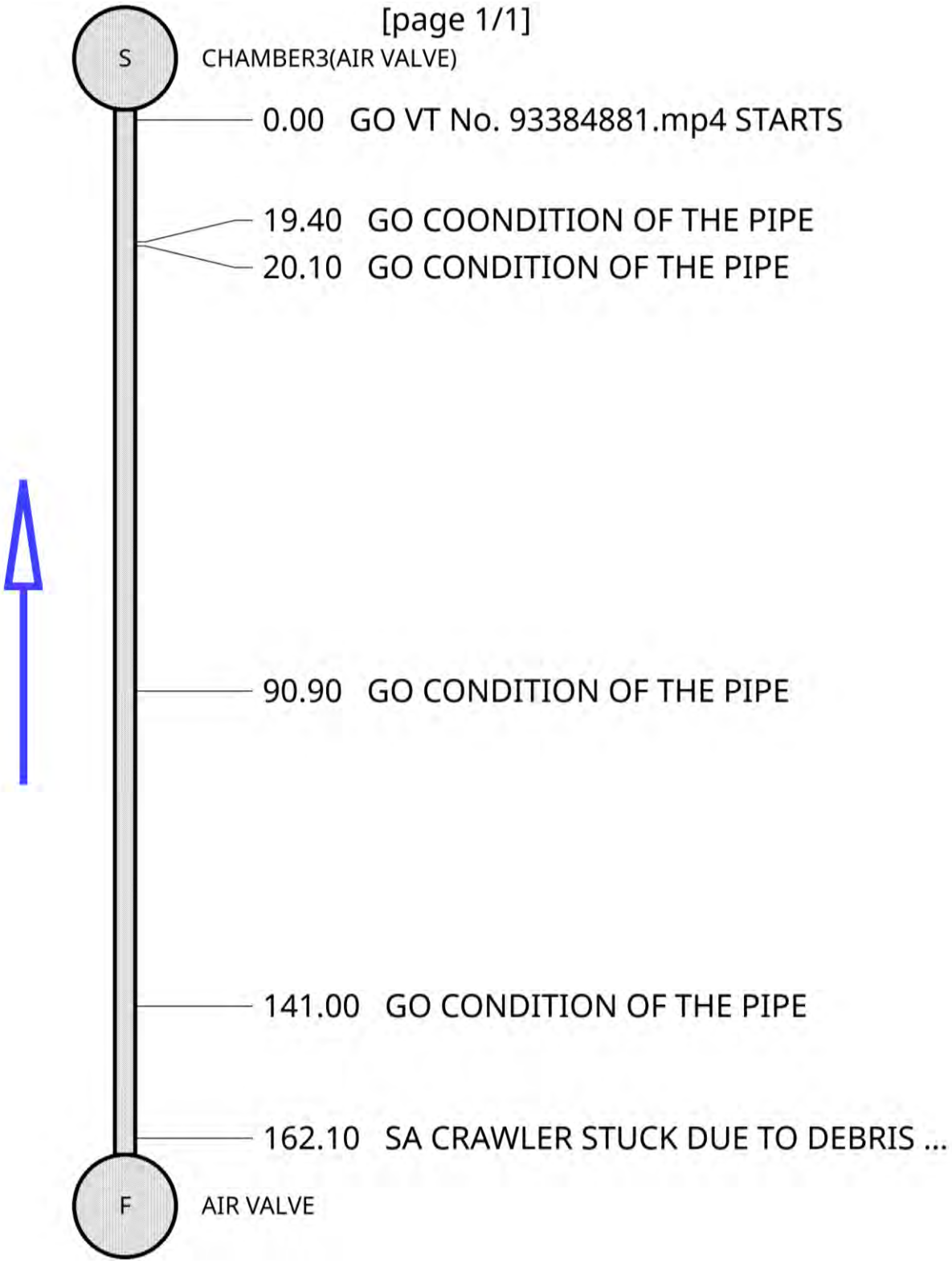


5 Drain / Sewer Survey

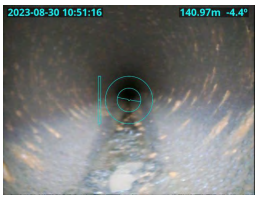
5.1 Survey Header

5.1.1	**Surveyed by (Operator)**	AKANI/DARREN
5.1.2	**Contract no.**	1
5.1.3	**Job no.**	
5.1.4	**Catchment (Drainage area)**	
5.1.5	**Division**	LEPELLE NORTHERN WATER
5.1.6	**District**	MOPANE
5.1.7	**Pipeline length ref**	9500
5.1.8	**Date**	300823
5.1.9	**Time**	09:50
5.1.10	**Location**	PHALABORWA
5.1.11	**Start manhole no.**	CHAMBER3(AIR VALVE)
5.1.12	**Start depth**	
5.1.13	**Start cover level**	
5.1.14	**Start invert level**	2.61
5.1.15	**Finish manhole no.**	AIR VALVE
5.1.16	**Finish depth**	
5.1.17	**Finish cover level**	
5.1.18	**Finish invert level**	2.72
5.1.19	**Use of Drain**	(Z) Not Known
5.1.20	**Direction**	(U) Survey upstream (camera pointing against flow)
5.1.21	**Size 1 (diameter/height)**	560mm
5.1.22	**Size 2 (width)**	
5.1.23	**Shape**	(C) Circular
5.1.24	**Material**	(ST) Steel
5.1.25	**Lining**	
5.1.26	**Pipe length**	N/Am
5.1.27	**Total length**	9500m
5.1.28	**Year laid**	N/A
5.1.29	**Video cassette number**	
5.1.30	**Comments: General**	
5.1.31	**Purpose**	(Z) Not Known
5.1.32	**Sewer category**	(Z) Not Known
5.1.33	**Pre-cleaning**	(N) No
5.1.34	**Weather**	
5.1.35	**Location code**	
5.1.36	**Further location details**	

5.2 Diagram


[page 1/1]
S
CHAMBER3(AIR VALVE)
0.00 GO VT No. 93384881.mp4 STARTS
19.40 GO COONDITION OF THE PIPE
20.10 GO CONDITION OF THE PIPE
90.90 GO CONDITION OF THE PIPE
141.00 GO CONDITION OF THE PIPE
162.10 SA CRAWLER STUCK DUE TO DEBRIS ...
F
AIR VALVE

5.3 Observations

Distance Cont. Defect Clock (At – To)	Condition code and attributes	Photo Ref
Joint	Remarks	Video Ref
0.0	(GO) General observation at this point	
	VT No. 93384881.mp4 STARTS	0:00:02
19.4	(GO) General observation at this point	./2023-08-30-09-50-33/2023-08-30-09-50-33_2023_08_30-10_00_18_470.jpg 
	COONDITION OF THE PIPE	0:01:23
20.1	(GO) General observation at this point	./2023-08-30-09-50-33/2023-08-30-09-50-33_2023_08_30-10_42_45_060.jpg 
	CONDITION OF THE PIPE	0:01:23
90.9	(GO) General observation at this point	./2023-08-30-09-50-33/2023-08-30-09-50-33_2023_08_30-10_47_33_662.jpg 
	CONDITION OF THE PIPE	0:05:55
141.0	(GO) General observation at this point	./2023-08-30-09-50-33/2023-08-30-09-50-33_2023_08_30-10_51_16_927.jpg 
	CONDITION OF THE PIPE	0:09:22

Distance Cont. Defect Clock (At – To)	Condition code and attributes	Photo Ref
Joint	Remarks	Video Ref
162.1	(SA) Survey abandoned	./2023-08-30-09-50-33/2023-08-30-09-50-33_2023_08_30-10_54_45_655.jpg 
	CRAWLER STUCK DUE TO DEBRIS IN THE PIPE	0:12:30

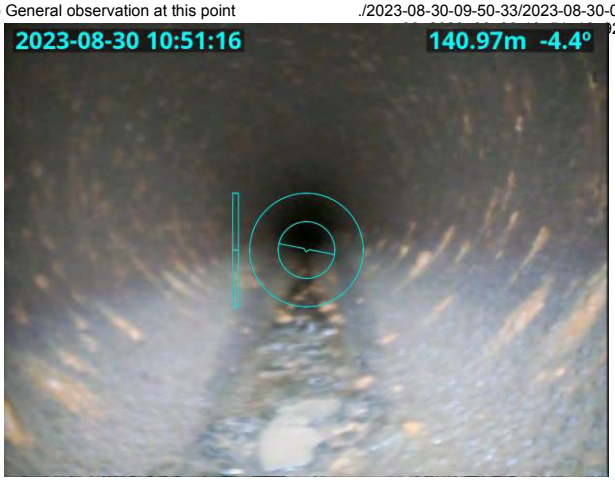
5.4 Photographs

(GO) General observation at this point ./2023-08-30-09-50-33/2023-08-30-09-50-70.jpg

(GO) General observation at this point ./2023-08-30-09-50-33/2023-08-30-09-50-060.jpg

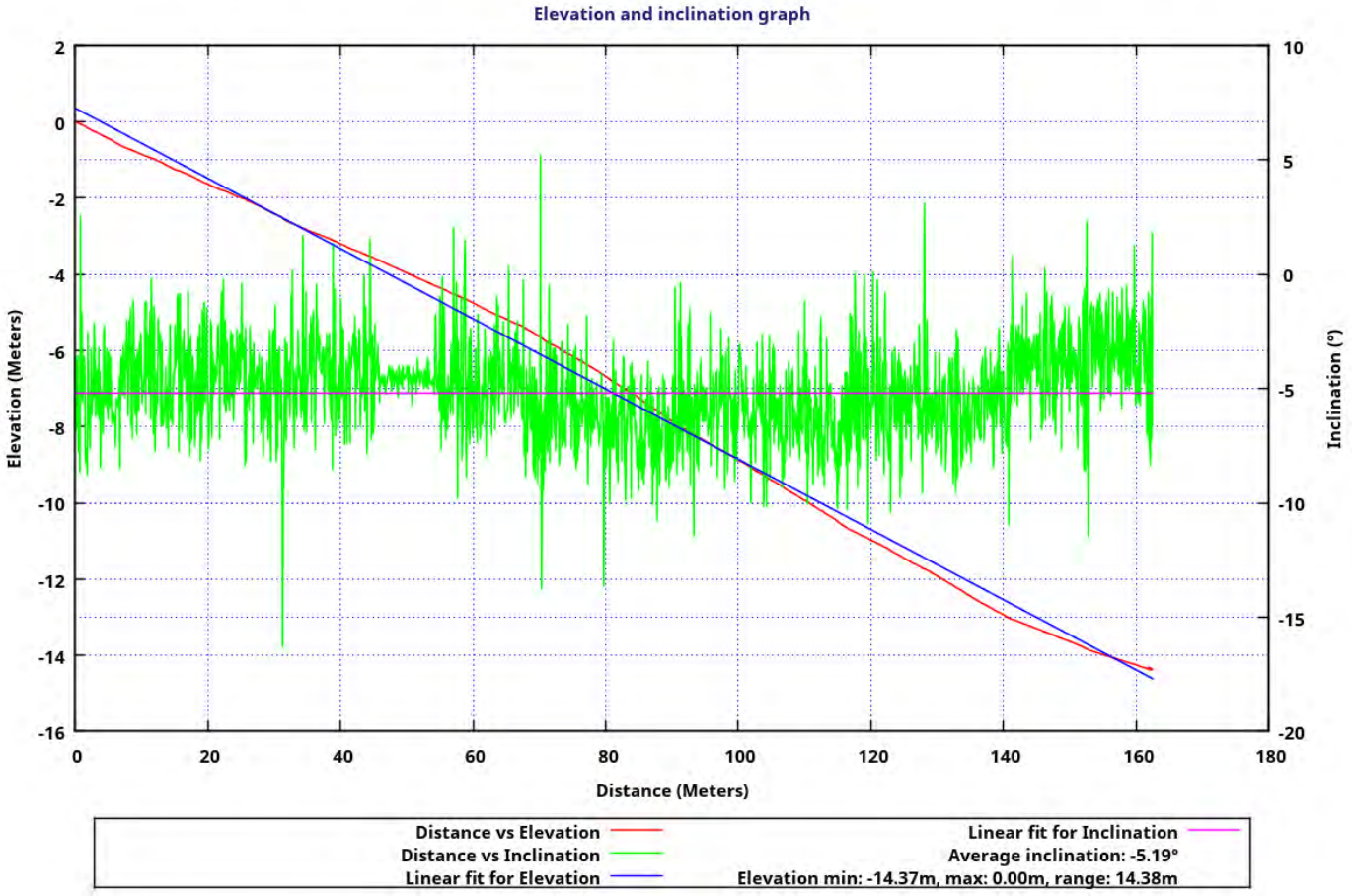
(GO) General observation at this point ./2023-08-30-09-50-33/2023-08-30-09-50-32.jpg

(GO) General observation at this point ./2023-08-30-09-50-33/2023-08-30-09-50-027.jpg



(SA) Survey abandoned ./2023-08-30-09-50-33/2023-08-30-09-50-55.jpg

5.5 Inclination Graph

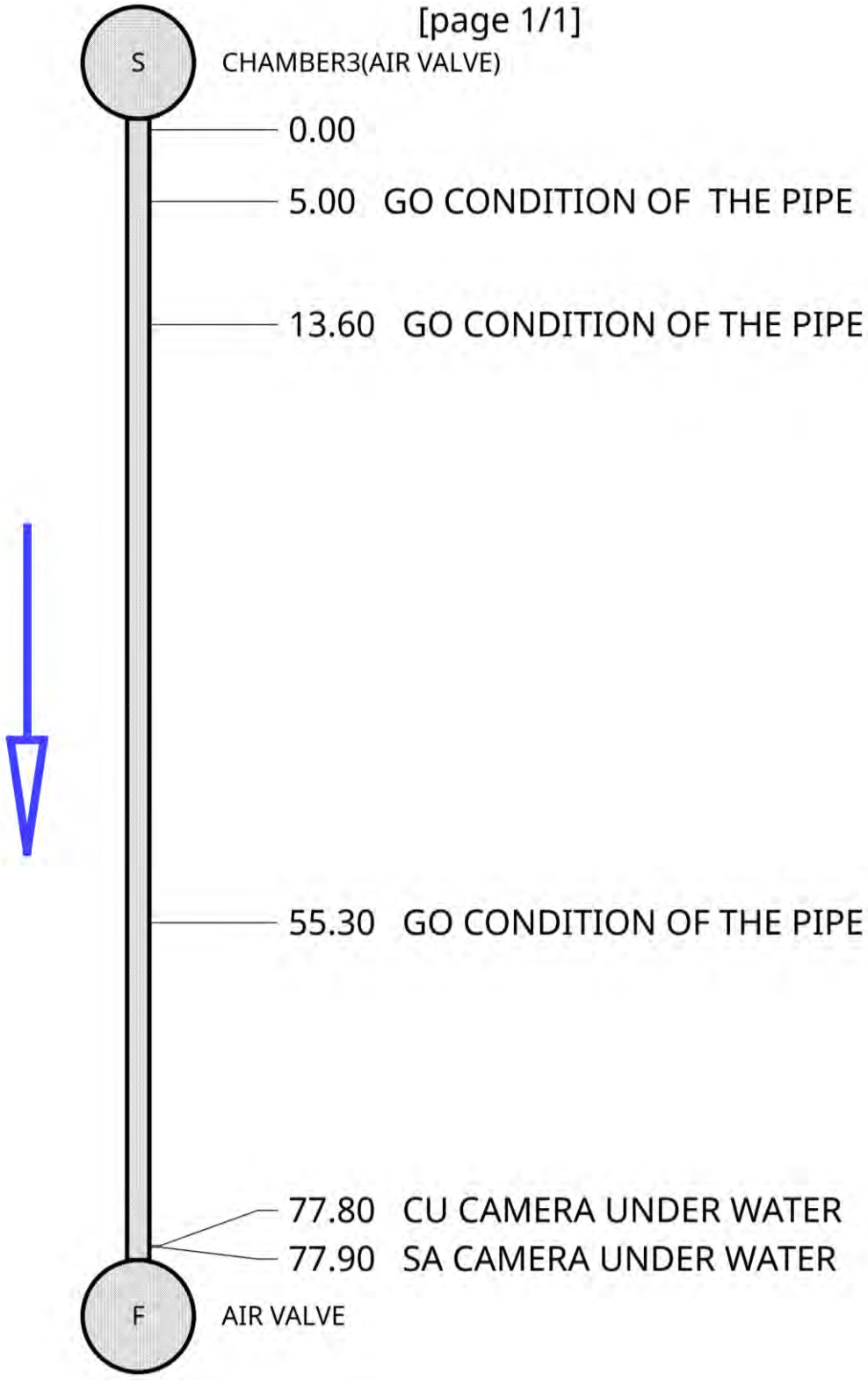


6 Drain / Sewer Survey

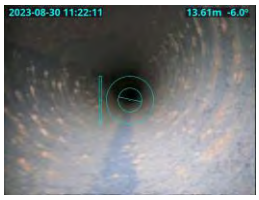
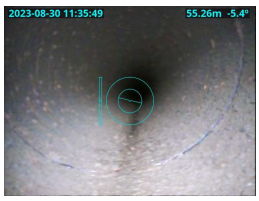
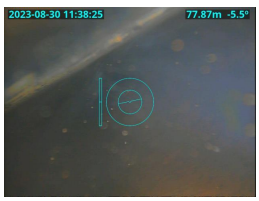
6.1 Survey Header

6.1.1	**Surveyed by (Operator)**	AKANI/DARREN
6.1.2	**Contract no.**	1
6.1.3	**Job no.**	
6.1.4	**Catchment (Drainage area)**	
6.1.5	**Division**	LEPELLE NORTHERN WATER
6.1.6	**District**	MOPANE
6.1.7	**Pipeline length ref**	9500
6.1.8	**Date**	300823
6.1.9	**Time**	11:15
6.1.10	**Location**	PHALABORWA
6.1.11	**Start manhole no.**	CHAMBER3(AIR VALVE)
6.1.12	**Start depth**	
6.1.13	**Start cover level**	
6.1.14	**Start invert level**	2.61
6.1.15	**Finish manhole no.**	AIR VALVE
6.1.16	**Finish depth**	
6.1.17	**Finish cover level**	
6.1.18	**Finish invert level**	2.86
6.1.19	**Use of Drain**	(Z) Not Known
6.1.20	**Direction**	(D) Survey downstream (camera pointing with flow)
6.1.21	**Size 1 (diameter/height)**	560mm
6.1.22	**Size 2 (width)**	
6.1.23	**Shape**	(C) Circular
6.1.24	**Material**	(ST) Steel
6.1.25	**Lining**	
6.1.26	**Pipe length**	N/Am
6.1.27	**Total length**	9500m
6.1.28	**Year laid**	N/A
6.1.29	**Video cassette number**	
6.1.30	**Comments: General**	
6.1.31	**Purpose**	(Z) Not Known
6.1.32	**Sewer category**	(Z) Not Known
6.1.33	**Pre-cleaning**	(N) No
6.1.34	**Weather**	
6.1.35	**Location code**	
6.1.36	**Further location details**	

6.2 Diagram


[page 1/1]
S
CHAMBER3(AIR VALVE)
0.00
5.00 GO CONDITION OF THE PIPE
13.60 GO CONDITION OF THE PIPE
55.30 GO CONDITION OF THE PIPE
77.80 CU CAMERA UNDER WATER
77.90 SA CAMERA UNDER WATER
F
AIR VALVE

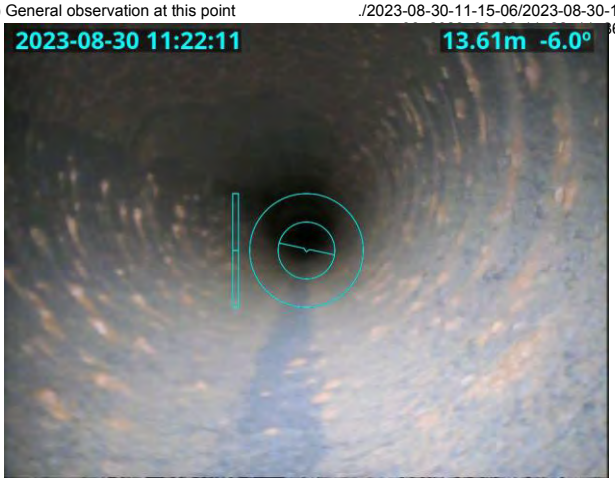
6.3 Observations

Distance Cont. Defect Clock (At – To)	Condition code and attributes	Photo Ref
Joint	Remarks	Video Ref
5.0	(GO) General observation at this point	./2023-08-30-11-15-06/2023-08-30-11-15-06_2023_08_30-11_18_41_695.jpg 
	CONDITION OF THE PIPE	0:00:32
13.6	(GO) General observation at this point	./2023-08-30-11-15-06/2023-08-30-11-15-06_2023_08_30-11_22_11_866.jpg 
	CONDITION OF THE PIPE	0:01:52
55.3	(GO) General observation at this point	./2023-08-30-11-15-06/2023-08-30-11-15-06_2023_08_30-11_35_49_679.jpg 
	CONDITION OF THE PIPE	0:05:09
77.8	(CU) Camera under water	./2023-08-30-11-15-06/2023-08-30-11-15-06_2023_08_30-11_37_50_069.jpg 
	CAMERA UNDER WATER	0:06:46
77.9	(SA) Survey abandoned	./2023-08-30-11-15-06/2023-08-30-11-15-06_2023_08_30-11_38_25_436.jpg 
	CAMERA UNDER WATER	0:06:59

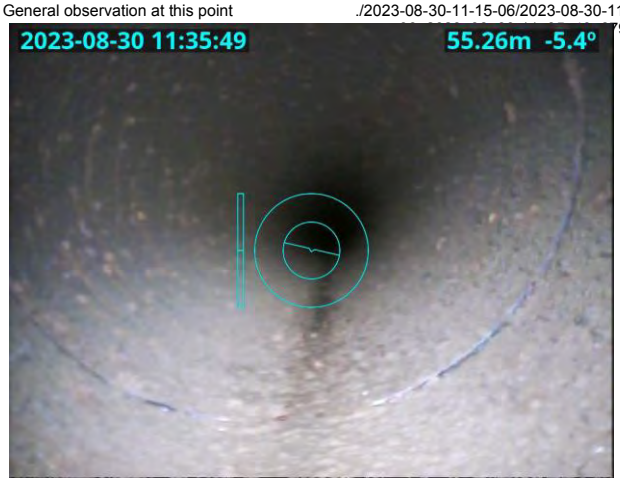
6.4 Photographs

(GO) General observation at this point ./2023-08-30-11-15-06/2023-08-30-11-15-95.jpg

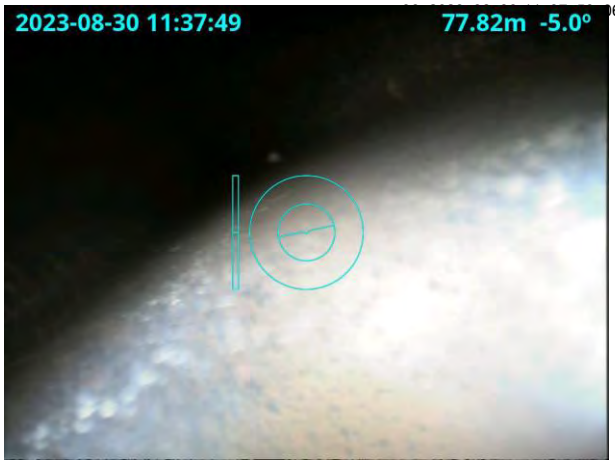
(GO) General observation at this point ./2023-08-30-11-15-06/2023-08-30-11-15-366.jpg



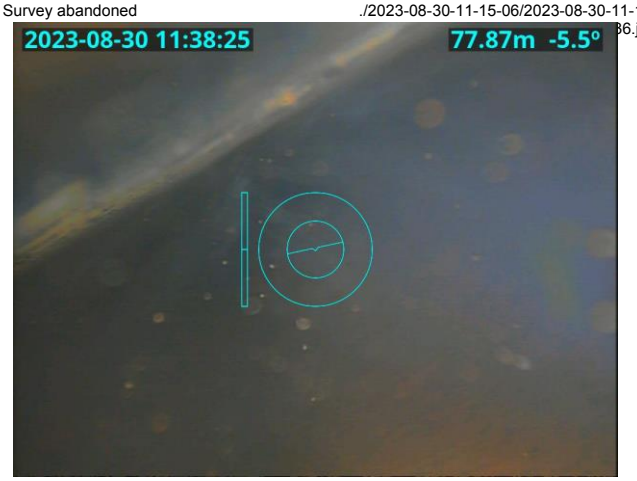
(GO) General observation at this point ./2023-08-30-11-15-06/2023-08-30-11-15-779.jpg



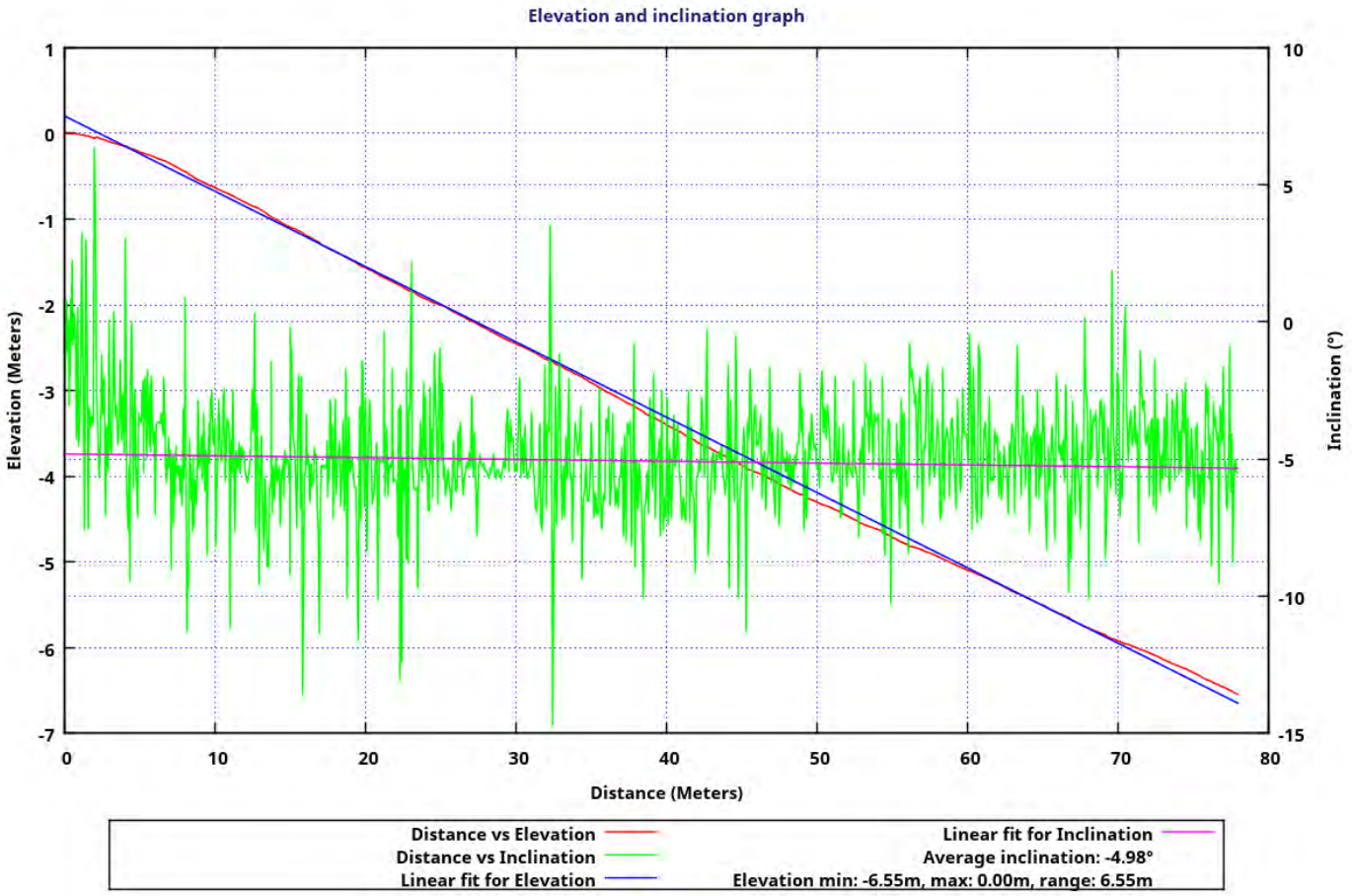
(CU) Camera under water ./2023-08-30-11-15-06/2023-08-30-11-15-1069.jpg



(SA) Survey abandoned ./2023-08-30-11-15-06/2023-08-30-11-15-1436.jpg



6.5 Inclination graph



11.5 Appendix 5 : Trenchless Pipeline Relining Technology

ASOE

Manufactured under ISO 9001:2015 Quality Management Systems accreditation

Pipe-in Liner™

Trenchless Rehabilitation on Pressure Pipes

Asoe, provider of trenchless pipe rehabilitation solutions

Asoe Hose Manufacturing, Inc. develops different types of trenchless pipe rehabilitation solutions to pressure pipes. Pipe-in Liner is the easiest to install.

Pipe-in Liner is a Fabric Reinforced Flexible Plastic Hose (FRFPH). The basic installation procedure is as follows:

1. Fold firstly Pipe-in Liner into U-shape
2. Pull the liner into the host pipes
3. Expand the liner in the host pipes

Then the Pipe-in liner will work as a leakage-free liner inside the host pipes.

Pipe-in Liners are classified into four different series: Pipe-in Liner W Series, Pipe-in Liner O Series, Pipe-in Liner G series, and Pipe-in Liner H series. Pipe-in Liner W series are used to rehabilitate pressure pipelines, including water main pipes and force mains at normal temperature. Pipe-in Liner O series are used to rehabilitate oil pipes both onshore and offshore. Pipe-in Liner G series are used to rehabilitate gas pipes both onshore and offshore. Pipe-in liner H series are used to rehabilitate pipes in municipal heat system. Pipe-in liner H series can resist a temperature up to 95° C (203° F); furthermore, Asoe is the first company in the world to develop this type of solution to rehabilitate hot water pipes.

Besides liners, Asoe also supplies complete solutions and accessory equipment, including couplings to connect Pipe-in Liner with host pipes, equipment to install couplings, and technical consulting etc.

Pipe-in Liner solution is a structurally independent rehabilitation technology. There is no connection between the host pipe and the liner; the liner works independently from the host pipe. The liner is rigid and maintains the round shape inside the host pipes when there is a vacuum inside the host pipe or when there is temporary external pressure on the host pipe.

Pipe-in Liner is flexible and can easily rehabilitate bent pipes of less than 45° to 90° with a 5D radius.

Also, Pipe-in Liner Technology only requires coarse pipe cleaning.

Corrosion-resistant

Quick Installation

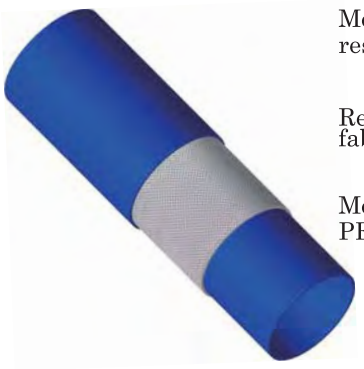
Holds High Pressure Internally

Pipe-in Liner™ for trenchless pipe rehabilitation

Application of Pipe-in Liners

Pipe-in Liners are fabric reinforced flexible plastic pipes (FRFPP) used for trenchlessly rehabilitating four different types of pressure pipes:
Pipe-in Liner W Series (rehabilitating water main pipes and other water pipes with inside pressure);
Pipe-in Liner O Series (rehabilitating oil pipes);
Pipe-in Liner G Series (rehabilitating gas pipes);
Pipe-in Liner H Series (rehabilitating hot water pipes).

Technical Specification of Pipe-in Liners

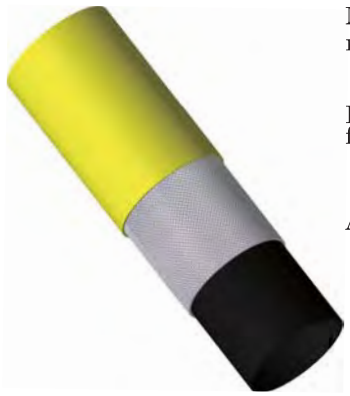


Pipe-in Liner W Series

Nominal ID of host pipes: 50mm (2 inches)— 800mm (32 inches)
Maximum length of each installation: up to 4000m (13,000ft)
Maximum operating pressure: 1.0 - 4.0 Mpa (150psi-600psi)
Maximum bursting pressure: 3.0-12.0 Mpa (450psi-1800psi)
Installation mode: Pull in U-shape Liners
Raw materials: high tenacity fabric reinforcement layer, abrasion-resistant PE cover, PE tube (NSF61 certified, Potable Water Safety approved by NHFPC of China)
Abrasion resistance (DIN53516) : 10.5 mm^3
Temperature of media: -40°C to 70°C (-40°F to 158°F)
Wall thickness: 6mm-8mm (0.236-0.315 inch)
Trenchless solution type: Semi-structural pipe rehabilitation
Pulling speed: up to 400m/h
Service life duration: 50 years

Pipe-in Liner O Series

Nominal ID of host pipes: 50mm (2 inches)— 800mm (32 inches)
Maximum length of each installation: up to 4000m (13,000ft)
Maximum operating pressure: 1.0 - 4.0 Mpa (150psi-600psi)
Maximum bursting pressure: 3.0-12.0 Mpa (450psi-1800psi)
Installation mode: Pull in U-shape Liners
Raw Materials: high tenacity fabric reinforcement layer, abrasion resistant PE cover, oil-resistant PU tube or oil and heat-resistant PVDF tube (PVDF is expensive relatively)
Abrasion resistance (DIN53516) : 10.5 mm^3
Temperature of media: -40°C to 70°C(-40°F to 158°F)
Wall thickness: 6mm-8mm (0.236-0.315 inch)
Trenchless solution type: Semi-structural pipe rehabilitation
Pulling speed: up to 400m/h
Service life duration: 40 years



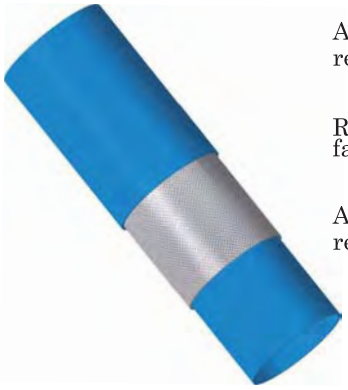
Modified abrasion-resistant PE layer

Reinforcement fabric layer

Airtight PU layer

Pipe-in Liner G Series

Nominal ID of host pipes: 50mm (2 inches)— 800mm (32 inches)
Maximum length of each installation: up to 4000m (13,000ft)
Maximum operating pressure: 1.0 - 4.0 Mpa (150psi-600psi)
Maximum bursting pressure: 3.0-12.0 Mpa
Installation mode: Pull in U-shape Liners
Raw Materials: high tenacity fabric reinforcement layer, abrasion resistant PE cover, airtight PU tube
Abrasion resistance (DIN53516) : 10.5 mm^3
Temperature of media: -40°C to 70°C (-40°F to 158°F)
Wall thickness: 6mm-8mm (0.236-0.315 inch)
Trenchless solution type: Semi-structural pipe rehabilitation
Pulling speed: up to 400m/h
Service life duration: 40 years



Abrasion and heat resistant PUX layer

Reinforcement fabric layer

Abrasion and heat resistant PUX layer

Pipe-in Liner H Series

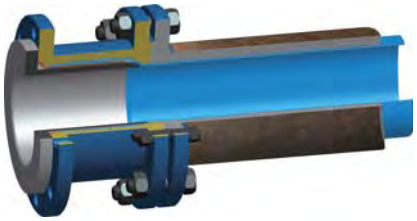
Nominal ID of host pipes: 50mm (2 inches)— 800mm (32 inches)
Maximum length of each installation: up to 4000m (13,000ft)
Maximum operating pressure: 1.0 - 4.0 Mpa (150psi-600psi)
Maximum bursting pressure: 3.0-12.0 Mpa (450psi-1800psi)
Installation mode: Pull in U-shape Liners
Raw Materials: high tenacity fabric reinforcement layer, heat-resistant PUX cover, heat-resistant PUX tube
Abrasion resistance (DIN53516) : 10.5 mm^3
Temperature of media: -40°C to 95°C (-40°F to 203°F)
Wall thickness: 6mm-8mm (0.236-0.315 inch)
Trenchless solution type: Semi-structural pipe rehabilitation
Pulling speed: up to 400m/h
Service life duration: 40 years

Information on host pipes needed for choosing correct liners:

In order to purchase correct liners to rehabilitate host pipes, the following information is required:
1. Normal operating pressure and temperature;
2. Media transferred inside the host pipes, such as water, oil, gas, hot water, chemicals etc.
3. Materials and actual ID of host pipes, number of bends, degrees of bends, etc.
4. The length of each section of host pipes which are supposed to be rehabilitated.

Pipe-in Liners withstand the inside pressure, but Pipe-in Liners cannot resist the external load. However, the host pipes must be able to bear the external load. If the host pipes collapse, Pipe-in Liner solution is not recommended.

PILC Couplings



PILC couplings for trenchless pipe rehabilitation

PILC couplings contain three parts: outer flange tube, expansion ferrule, inner pushing tube.

Outer flange tube is made of carbon steel coated with epoxy powder coating and is to fix PILC couplings onto host pipes.

Expansion ferrule is made of carbon steel and is to prevent the lining from slipping and abrasion.

Inner pushing tube is made of carbon steel or stainless steel according to media transferred. It is to fasten the liners onto the flange tube.

Size of couplings: DN50- DN800 (2-32 inches).

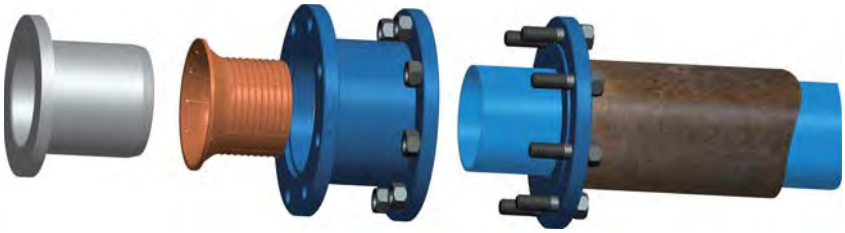
Features

Reliable design ensures the liner to be locked tightly onto PILC couplings with no leaking.

No loss in water flow because the inside diameter of inner pushing tubes are the same as that of liners.

No friction loss at the connecting point of liners and inner pushing tube.

Easy to install. Hydraulic equipment is needed to install couplings.



Expansion ferrule Accessory flange Pipe-in Liner

Inner pushing tube Outer flange tube Host Pipe

Other suggestions on PILC installation

Flanges are recommended to be used to connect the host pipes with PILC couplings although it is possible to weld the PILC directly onto host pipe.

Flanges are recommended to be used between PILC couplings and transition tubes.

Flanges are recommended to be used between host pipes and transition tubes, although it is possible to weld the PILC directly onto host pipe.

PILC installation services

Hydraulic installation equipment can be purchased or leased from Asoe. Contractual engineers are suggested to get some training by Asoe. Asoe's installtation engineers can be hired to help contractors to install PILC couplings.

Installation

- Choose section of host pipes to be rehabilitated
- Install by-pass hoses in order to keep transferring flow during rehabilitating
- Dig construction pits at two ends
- Inspect pipes with a mobile TV camera and analysis of video recordings
- Mechanical coarse cleaning of host pipes with scraper pigs
- Clean host pipes by water jetting
- Position Pipe-in Liners at the start pit and the pulling winch at destination pit
- The pulling head shall be installed onto the liner.
- Hose guides shall be installed.
- Fold Pipe-in Liner into U-shape and bind the liner with scotch tape.
- The liner shall be pulled into the host pipes.
- PILC couplings shall be installed onto the host pipes.
- Hydrostatic pressure test shall be completed.
- Transition pipes shall be installed.
- Then transferring fluid will be recovered.
- Finally, remove the by-pass and close the pit.

Technical Advantages

It is a perfect solution for the pipeline rehabilitation projects, which involve host pipes that can't be repaired by the traditional remove-and-replace method.

Free of maintenance after the liner rehabilitation.

This pipe in liner method can be applied to the bended pipes of less than 45° bend to 90° with a 5D radius.

The Pipe In Liner can resist internal pressure independently.

The requirements of host pipes for working zones and conditions are low.

Low effects on the surrounding environment during liner installation.

No chemical epoxy resin applied and no air pollution emission.

The pipe in liner is a quick installation.

The pipe in liner can be applied to a long-distance installation from one access point.

Rehabilitation Applications

1. Water Mains and Force Mains
2. Onshore and Offshore Oil or Gas Pipelines
3. Chemical Pipelines
4. Water Heating System Pipelines

Reference of Projects


1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1. Gas pipeline rehabilitation in Mianyang, Sichuan, China.

Pipe-in Liner G series were installed in the gas pipelines with the ID 200mm. Totally two sections of gas pipes were rehabilitated with the total length 450 meters.

2. Water drainage pipelines rehabilitation in a water plant in Zhuhai, Guangdong, China.

Pipe-in Liner W series were installed in the water drainage pipelines with the ID 300mm. As many as three sections of water drainage pipes were rehabilitated with the total length 120 meters.

3.Gas pipeline rehabilitation in Fushun, Liaoning, China.

Pipe-in Liner G series were installed in the gas pipe with the ID 400mm. Two sections of gas pipes were rehabilitated with the total length 280 meters.

4. Water main pipes rehabilitation in Xiamen, Fujian, China.

As many as four sections of DN500 water pipes were rehabilitated by Pipe-in Liner W Series with the total length 600 meters.

5. Oil pipeline rehabilitation in Venezuela.

Pipe-in Liner O series were installed in the oil pipes with the ID 100mm. One section of oil pipes was rehabilitated with the total length 660m.

6. Water pipelines rehabilitating in Rostov, a nuclear plant in Russia.

Pipe-in Liner W series were installed in the water pipelines with the ID 300mm. As many as ten sections of water pipes were rehabilitated with the total length 600m.

7. One project of DN700 water pipes rehabilitation in China is undergoing.


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