

Corrosion ILI Program Summary Document

Line 5 WNO-WMA BHGE MFL3 2019

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1.0 Purpose

This document will provide a summary of all aspects associated with the corrosion management program. Contents of this summary may include but it is not limited to:

- Summary of priority notification features
- Summary of the results of Lakehead system integrity remediation process

It is important to consider that this document is a working file that tracks learnings and/or status of the corrosion program. Therefore, all changes to the selection process should be included in the corresponding sections and a clear summary of the learnings and resultant actions should be documented within this document.

2.0 Scope

This record applies to the ILI reports indicated on the front page of this document. This document will reference Pipeline Integrity (PI) procedures and work instructions as part of the Fitness for Service (FfS) process defined further in Integrated Management System IMS-09.

3.0 Basic Inspection Remarks

Table 1 Previous Inspections

Year Month	ILI Corrosion Tool	ILI Vendor
1998 Sept	MFL	PII
2003 June	MFL	PII
2008 May	MFL3	GE
2013 Aug	MFL3	GE
2017 Apr	GEMINIMFL	BH
2018 Mar	MFL3	GE
2018 Apr	GEMINIMFL	BH
2019 Mar	MFL3	BHGE

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4.0 Priority Notification for Imperative Condition

Were there any features reported meeting Priority Notification criteria?

☐ Yes
☒ No

Were there any features not reported as imperative condition that meet the Priority Notification criteria?

☐ Yes
☒ No

Was the imperative condition confirmed by NDE?

☐ Yes
☒ No

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5.0 Inspection Report Review (PI-36) and Remarks

Prepared by: Devin Engel Date: 07/04/2019

Approved by: Samuel Cheng Date: 07/10/2019

Complete review based on PI-36 Data Quality Review In-Line Inspection.

Step 1.0 Was the data degraded?

☒ Yes

☐ No

1.3. Inspection Quality

Inspection data was obtained for the full length (4.1 miles) of the pipeline.

The primary sensors for metal loss detection CHs 1, 2, 29, 31, 84 and 145 were under responding throughout the inspection. CH 34 was intermittently noisy. For the non-adjacent sensors, we can meet full contractual detection and sizing specifications.

For the 2 adjacent under-responding sensors (CHs 1 and 2), we can offer the following revised HR specifications. Please refer to the table below for further details.

Seamwelded Pipe

Faulty Channel	No.	Start Distance (ft)	End Distance (ft)	Affected Distance	Circumferential Impact	Min diameter for sizing/ detection	Detection (90%POD)		Sizing Specification (80% Confidence Level)		
							General Corrosion / Circum. Groove	Pitting / Axial Groove	Pitting / General Corrosion	Axial Groove	Circumferential Groove
Main T1	1,2	0	21832	21832	1.2%	0.55 in	12%	15%	+7/-17%	-22/+7%	-7/+22%

Seamless Pipe

Faulty Channel	No.	Start Distance (ft)	End Distance (ft)	Affected Distance	Circumferential Impact	Min diameter for sizing/ detection	Detection (90%POD)		Sizing Specification (80% Confidence Level)		
							General Corrosion / Circum. Groove	Pitting / Axial Groove	Pitting / General Corrosion	Axial Groove	Circumferential Groove
Main T1	1,2	0	21832	21832	1.2%	0.55 in	15%	20%	+7/-17%	-22/+7%	-7/+22%

Apart from this, the quality of the inspection data is satisfactory and this has enabled a comprehensive assessment of the pipeline to be carried out.

1.3.1. Velocity Plot

The velocity plot shows the speed of the inspection vehicle during the inspection run.

The red line on the velocity plot indicates the specified maximum velocity for the inspection vehicle. If the vehicle exceeds the specified maximum velocity then the performance of the inspection vehicle may be degraded.

The velocity of the inspection vehicle exceeded the specified maximum velocity in three occasion, but only one significant at the launch area. This speed excursion covered a total distance of 2 ft.

Within this excursion area, it is possible that some small area or narrow, axially oriented metal loss features may not have been identified from the inspection data; and that the sizing of detected metal loss features may be impaired.

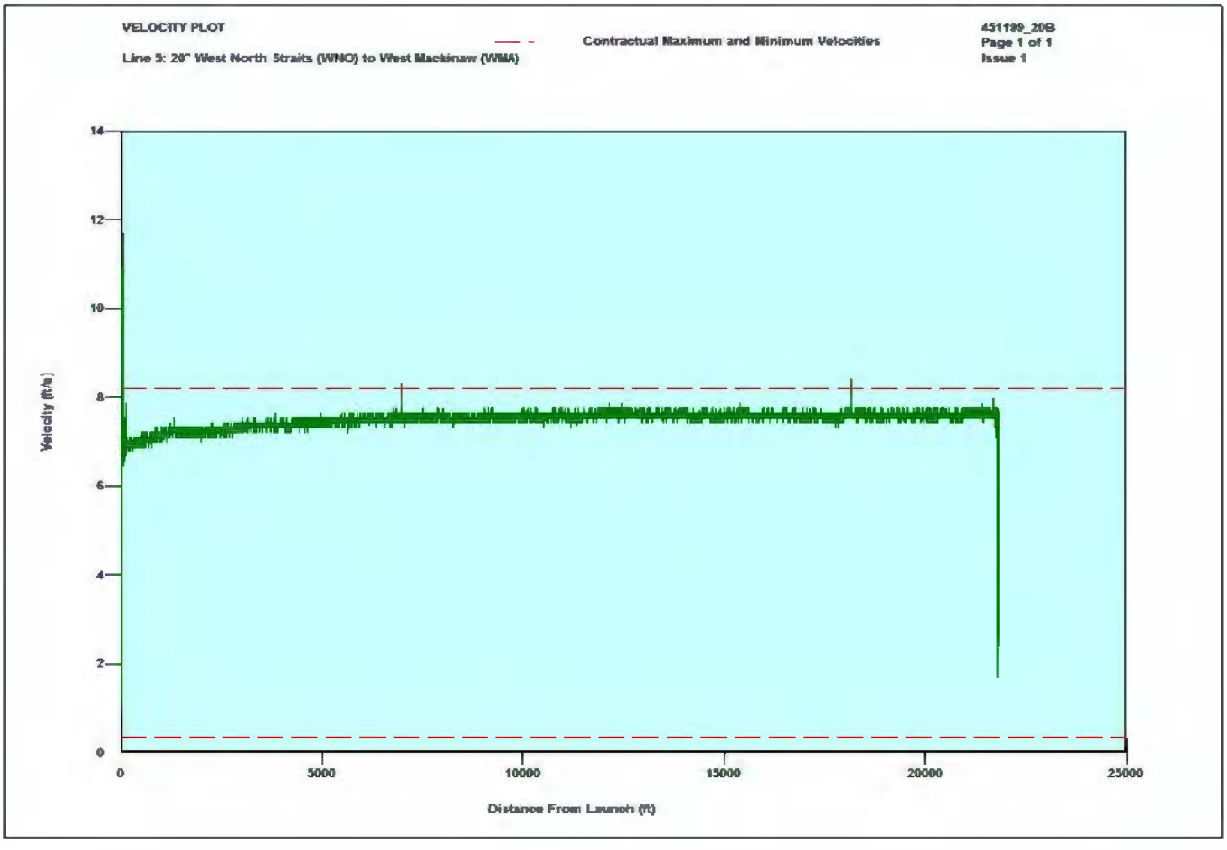
The location and extent of this excursion area is given in the table below:

ABSOLUTE DISTANCE (ft)		GIRTH WELD		DISTANCE OF SPEED EXCURSION (ft)
FROM	TO	FROM	TO	
33.1	35.1	61	61	2

The inspection vehicle's average velocity during the inspection run was 7.5 ft/s.

The velocity profile plot is presented overleaf.

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For the non-adjacent sensors, the vendor stated they meet full contractual detection and sizing specifications. However for the 2 adjacent sensors were affected:

Channel	Orientation start (deg)	Orientation end (deg)
1	16.5	18.5
2	18.5	21

The most recent previous tools were reviewed – 2018 GeminiMFL, 2018 MFL3, and 2017 GEMINIMFL and there were no corrosion features reported. All previous tools reported manufacturing defects. Also there was no feature reported on GW 61 in previous tools where the 2019 tool exceeded the velocity significantly.

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Step 2.0 Do features align with expectations?

☒ Yes

☐ No

Use Appendix A of PI-36 as guidance.

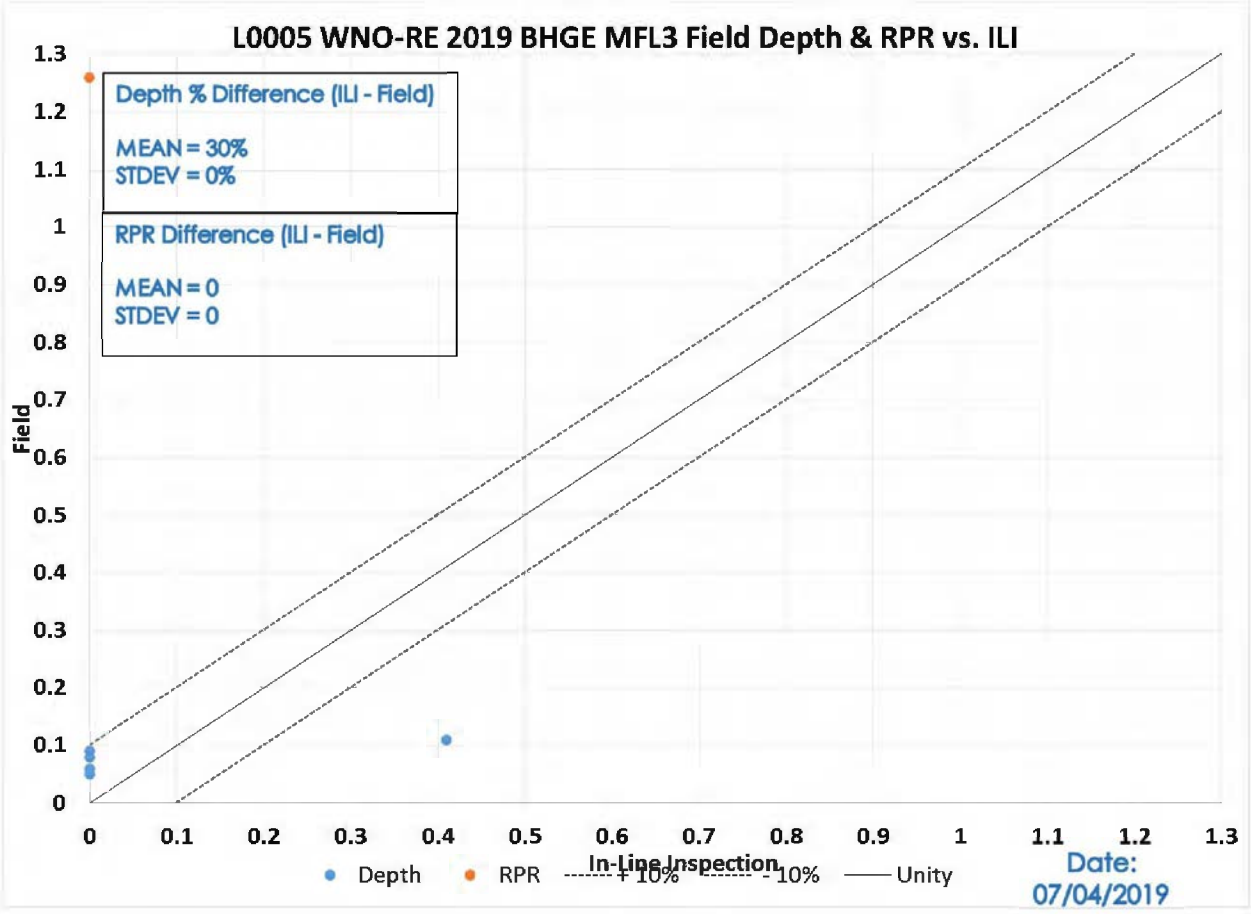
1) No Matched features

Table 2 No matched features cases in PI-36

2019 MFL3 BHGE	2018 MFL3 GE	Description	# of features	Comments
	>= 40%	No Match	0	
	1.0 < RPR <1.05	No Match	0	All manufacturing defects, no RPR values

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2) Preliminary Unity Plot



Overall Validation										CEPA Check				
ILI Certainty	Confidence Level	z_α	z_α^2	X	n	$\hat{n}$	$\hat{p}$	p_{upper}	Result	Avg Combined Tolerance	Std Dev of Error	Result	Mean of Error	General Result
80%	95%	1.645	2.706	1	1	3.706	63.5%	100.0%	ACCEPTABLE	#DIV/0!	#DIV/0!	#DIV/0!	30.0%	OVERCALL

RPR		
Std Dev of Error	Mean of Error	General Result
#DIV/0!	-1.280	OVERCALL

Normal Distribution Check (Depth)			Normal Distribution Check (RPR)		
Skewness	Kurtosis	Result	Skewness	Kurtosis	Result
#DIV/0!	#DIV/0!	N/A	#DIV/0!	#DIV/0!	N/A

Refresh Validation Analysis

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Probability of Sizing Analysis								
	Pitting	Extended Corrosion	Axial Slotting	Circumferential Slotting	Pinhole	Circumferential Grooving	Axial Grooving	Overall POS
Number of True Positive Features Above Threshold	-	-	-	-	-	1	-	1
POS (%)	-	-	-	-	-	0%	-	0%

Probability of Detection Analysis								
	Pitting	Extended Corrosion	Axial Slotting	Circumferential Slotting	Pinhole	Circumferential Grooving	Axial Grooving	Overall POD
Number of Features Above Threshold	-	-	-	-	-	-	-	-
POD (%)	-	-	-	-	-	-	-	-

3) Near miss and safety and resource (defined in WI-13) outliers of Preliminary Unity Plot

Table 3 Summary of significant outliers of Preliminary Unity plot

GW	ILI		Field		Brief Explanation
	Depth	RPR	Depth	RPR	

No near-miss or safety outliers were identified in the Preliminary Unity Plot.

4) Is Orientation plot as expected?

☒ Yes

☐ No

Metal Loss Feature Summary								
		2019 BHGE MFL3	2018 GE MFL3	Percentage Change				
	Internal Corrosion Features	0	0					
	External Corrosion Features	0	0					
	Int and Ext Corrosion Features	0	0					
	Internal Corrosion/Total	#DIV/0!	#DIV/0!	#DIV/0!				
>= MinDepth	< MaxDepth	2019 BHGE MFL3 INTERNAL	2018 GE MFL3 INTERNAL	2019 BHGE MFL3 EXTERNAL	2018 GE MFL3 EXTERNAL	2019 BHGE MFL3 OTHER	2018 GE MFL3 OTHER	
0%	10%	0	0	0	0	0	0	
10%	20%	0	0	0	0	0	0	
20%	30%	0	0	0	0	0	0	
30%	40%	0	0	0	0	0	0	
40%	50%	0	0	0	0	0	0	
50%	60%	0	0	0	0	0	0	
60%	70%	0	0	0	0	0	0	
70%	80%	0	0	0	0	0	0	
80%	90%	0	0	0	0	0	0	
90%	100%	0	0	0	0	0	0	
	Depth Not Provided	0	0	0	0	0	0	
	Tool Run	Metal Loss >= 40%	All Feature Types >= 40%					
	2018 GE MFL3	0	1					
	2019 BHGE MFL3	0	1					
	Density Change %	#DIV/0!	0.0%					

Manufacturing Defect Summary				
		2019 BHGE MFL3	2018 GE MFL3	% Count Change
	Manufacturing Defects	313	292	7.2%
>= MinDepth	< MaxDepth	2019 BHGE MFL3 Manufacturing Defects	2018 GE MFL3 Manufacturing Defects	% Count Change
0%	10%	82	83	-1.2%
10%	20%	118	122	-3.3%
20%	30%	72	73	-1.4%
30%	40%	14	13	7.7%
40%	50%	1	1	0.0%
50%	60%	0	0	
60%	70%	0	0	
70%	80%	0	0	
80%	90%	0	0	
90%	100%	0	0	
	Depth Not Provided	26	0	

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5) Unexpected feature type?

☐ Yes

☒ No

There were no corrosion features reported in either the 2019 or 2018 MFL3 tool runs. For manufacturing defects, there were 313 and 292 reported by the 2019 and 2018 MFL3 tools, respectively, yielding a change in total features of 7.2 %.

6) Change in density (+/- 20%) of features >=40%?

☐ Yes

☒ No

There was a single manufacturing defect reported with a depth ≥ 40 % by both the 2019 and 2018 MFL3 tools. Therefore the change in density of features >=10% were checked.

Tool Run	ML >=10%	All Feature Types >=10%
2018 GE MFL3	-	205
2019 BHGE MFL3	-	209
Density Change%	-	2%

7) Do more than 60% of the features have ILI reported depth >= 20% deeper or >= 20% shallower than previously reported?

☐ Yes

☒ No

Of the 194 depth based matches in the 2019 MFL3 Feature Match file there are no matches with a depth difference ≥ 20 %

8) Is severity, density or unexpected feature type driving investigative dig program and expedite excavation deadlines?

☐ Yes

☒ No

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End of PI-36

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6.0 Consent Decree Excavation Criteria

Prepared by: Devin Engel Date: 07/04/2019

Approved by: Samuel Cheng Date: 07/10/2019

Table 4 Consent Decree Corrosion Feature Excavation Selection

Criteria	Unmitigated features are selected for excavation (Y/N/NA)
Any corrosion feature with a depth >80% of the wall thickness of the joint where the feature is located	N/A
Any corrosion feature with a Predicted Burst Pressure < the established MOP	N/A
Any corrosion feature with a Predicted Burst Pressure < 1.39 MOP	N/A
Any corrosion feature with a depth>50% wall thickness but < 80% WT	N/A
For Line 3 outside an HCA, any corrosion feature with a depth >65% wall thickness but <80% WT	N/A
Any corrosion feature with a remaining life < 5 years (Not applicable to Line 3)	N/A
Any corrosion feature with a remaining life < 2 times the planned re-inspection interval	N/A

No reported features meet Consent Decree excavation criteria.

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Table 5 Remaining Unmitigated Features **(Updated on 07/10/2019)**

Remaining Unmitigated Features	
The worst depth (%)	41% NWT (Manufacturing Defect)
The lowest Safety Factor	N/A
The shortest remaining life (years)	N/A

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7.0 Consent Decree Threat Integration Excavation Selection

Prepared by: Devin Engel Date: 07/05/2019

Approved by: Samuel Cheng Date: 07/10/2019

Table 6 Consent Decree Threat Integration Excavation Selection

Criteria	Unmitigated features are selected for excavation (Y/N/NA)
Any dent located in the top of the pipeline that has any indication of metal loss, cracking, or a stress riser	N/A
Any dent located in bottom of the pipe that has any indication of metal loss, cracking, or stress riser	N/A
Any case in which a crack feature intersects or interacts with a corrosion feature and the Predicted Burst Pressure of such interacting or intersecting features determined using the CorLAS ™ model is less than 1.25 MOP	N/A
Any intersecting or interacting crack/corrosion feature with a remaining life < 5 years	N/A
Any intersecting or interacting crack/corrosion feature with a remaining life < 2X planned re-inspection	N/A

No reported features meet Consent Decree threat integration excavation criteria.

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8.0 Summary of Consent Decree Excavation Selection

Table 7 Summary of Consent Decree Excavation Selection

Criteria	Number of Features Issued

9.0 Updates based on Statistical Analysis of field data

Prepared by: Samuel Cheng Date: 07/10/2019

Approved by: Yanping Li Date: 07/12/2019

Are additional digs required based on statistical analysis of field data

☐ Yes

☒ No

Based on the Preliminary Unity Plot, no bias was identified and no further action is required.

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