Record

Geometric ILI Summary Document

Line 5 WNO-WMA 2019 BH Geopig

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1.0 Purpose

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

- ILI QA/QC results and remarks
- Summary of preliminary results, as well as learnings from previous excavation program
- Summary of preliminary field results and trending (if available)
- Back to back ILI inspection comparison
- Summary of priority notification features
- Summary of pressure restrictions associated with geometric features reported by the Inspection
- Summary of geometric features meeting “Code Criteria” as per Table 3 of PI-43
- Summary of geometric features meeting “Investigative Criteria” as per Table 4 of PI-43
- Summary of geometric features identified through threat integration
- List of geometric feature selected for detail feature review
- Risk mitigation assessment data.

It is important to consider that this document is a working file that tracks learnings and/or status of the deformation 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 as part of the Fitness for Service (Offs) process defined further in Integrated Management System IMS-09.

3.0 Basic Inspection Remarks

Please indicate in this section important information regarding the inspection; contents of this section include but are not limited to:

- This is the seventh geometry inspection on the West Straits
- The last two geometric inspections were in March and April 2018; as per the PIPES ACT, the Straits have had annual corrosion and geometry inspections since 2016.

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Table 1 Inspection Parameters

ILI inspection Parameter	Absolute units (in)	Alternative
Sizing accuracy	± 0.1	± 0.5 % OD
Orientation accuracy	NG	NG
Reporting Threshold	0.1	0.5 % OD
Minimum deformation detection threshold	0.1	0.5 % OD
Circumferential sensor/arm spacing	0.4	50 sensors

- This inspection is considered to be a high resolution inspection level 2 (please note high resolution inspection level 1 is a circumferential spacing less than 25.4 mm (1 in), level 2 greater than or equal to 25.4 mm (1 in) and less than 50.8 mm (2 in), and level 3 greater than or equal to 76.2 mm (3 in))[1]

[1] Please note that the resolution levels defined is this document does not correspond to any industrial standard classification and have been defined for Enbridge internal use only.

4.0 Inspection Report Review (PI-47) and Remarks

Complete the review of the ILI report as per guidelines of PI-47

1. Was this a degraded inspection?

☒ No

☐ Yes

BHGE Job Number	451356 20B Issue1
Pipeline Operator	Enbridge Energy, Limited Partnership,
Segment Name	NPS20 Line5 North Straits West - Mackinaw
Launch Site	Ignace, Michigan
Receive Site	Mackinaw City, Michigan
Pipeline Nominal Diameter	20"
Product	Oil
Section Length	4.15mi
Date of GEOPIG Inspection	February 20, 2019
Duration of GEOPIG Inspection	48 minutes
Field Project Manager	Jeff Lee

Table 1. Operational Details

Pre-launch inspections procedures to the GEOPIG™ were performed at the BHGE (Location) office. After passing all of the BHGE pre-run inspection procedures, the tool was launched at 08:44 EDT on 2/20/2019. The tool entered the receive site at 09:32 EDT the same day. The tool was received covered in oil with no visible damage. The data was downloaded off-site and later analyzed. 100% valid caliper, IMU and odometer data was collected during the run.

2.2 Reporting threshold

The reporting criteria are to report

- Dents greater than or equal to 0.5% of nominal O.D. of the pipeline;
- Outward wrinkles greater than or equal to 2% O.D.
- Ovalities greater than or equal to 5% O.D.
- Areas of pipeline movement with bending strain difference exceeding 0.1% and spanning more than 1 pipe joint.

Based on the vendor's inspection summary shown above, the inspection was successful and a complete set of caliper data was collected for the run.

2. Are there features meeting immediate reporting requirements not previously reported?

☒ No
☐ Yes

3. Is reported feature density what was expected?

☒ Yes
☐ No

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Note that the reporting threshold for this 2019 inspection was changed to 0.5% OD. Previous inspections had a reporting threshold of 2% OD. Given this, there are a number of geometric anomalies reported in the 2019 inspection that were not previous reported. This is within expectations.

4. Do reported features align with known existing features?

☒ Yes
☐ No

5. Based on Report Review, is the inspection acceptable for further analysis?

☒ Yes
☐ No

5.0 Priority Notification for Imperative Condition

Were there any features reported meeting imperative condition?

☒ Yes
☐ No

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

☐ Yes
☒ No

GW 3540: 3.5% OD top-side dent.

The dent on GW 3540 was a result of the April 2018 anchor strike.

It was issued for excavation as part of the April 7, 2018 Geopig program and has already been inspected by ROV and divers; two dents were confirmed. The south dent had one minor scrape located within it, which was lightly hand filed and removed at < 10% NWT. Four rub marks (gouges) were identified above the north dent which were hand filed and removed (maximum depth before filing was approximately 6.6% NWT). There are no longer any surface indications present. Both have been repaired with a composite sleeve repair.

Further details can be found in the Detailed Feature Review and NDE Reports.

GWs 6080 and 6100:

Two ovalities were flagged for priority notification based on Minimum ID criteria (17.9") as specified in Table 3 of ILI Minimum Reporting Requirements. OVL 1 and OVL 2 have Minimum IDs of 17.40" and 17.85", respectively. They were flagged to highlight possible tool passage concerns and are not an issue from a FfP perspective.

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No further actions are required at this time for the following reasons:

- ✓ Per API 579 out-of-roundness assessment methodology, the RSFs for OVL 1 and OVL 2 are 1.24 and 1.68, respectively. These values are > 0.9, and thus are not an issue from a FfP perspective.
- ✓ Both ovalities have been identified in the 2005, 2013, 2017, 2018 caliper inspections with no significant changes in depth; all fluctuations are within tool tolerance (± 1% OD). Using CSA Z662 Ovality sizing methodology, the depths are:

Caliper Inspection	OVL 1 Depth GW 6080	OVL 2 Depth GW 6100
2005 Geopig	8.3% OD	5.3% OD
2013 Geopig	8.75% OD	5.45% OD
2017 Geopig	7.9% OD	5.6% OD
Mar 2018 Geopig	8.5% OD	5.3% OD
Apr 7, 2018 Geopig	8.2% OD	5.3% OD
Apr 18, 2018 GEMINI CAL	7.8% OD	5.2% OD
2019 Geopig	8.5% OD	5.5% OD

- ✓ Both ovalities are reported to be associated with field bends (29.6° for OVL 1 and 27.3° for OVL 2).
- ✓ No interacting features were identified through Threat Integration.
- ✓ No strain sites are reported at the ovality locations.
- ✓ Both ovalities were inspected by divers in 2014, no observable anomalies were reported.
- ✓ In February 2018, a fatigue reliability assessment was performed on both ovalities using numerical and analytical modelling methods. These assessments estimate fatigue lives > 200 years for both ovalities.

These features will be monitored in future inspections.

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6.0 Summary of Feature Selection

6.1 SUMMARY OF FEATURES MEETING CODE CRITERIA (PI-43)

Table 2 summarizes all features meeting the code criteria as defined by PI-43.

Table 2 Features meeting code criteria

Category	Sub-Category d = depth D = Diameter	Number of Features Reported	Number of Features Issued for Excavation
Topside Dent Features	d > 6%	0	0
	D < 12", d > 0.250" D ≥ 12", 6% ≥ d ≥ 3%	1	0
	D < 12", d = 0.250" D ≥ 12", 3% > d ≥ 2%	1	0
	Associated with metal loss, cracking, or stress concentrator	0	0
Bottom Side Dent Features	Bottom of pipe dent, d > 6%	0	0
	Associated with metal loss, cracking, or stress concentrator	0	0
Dents Affecting Pipe Curvature at a Weld	D < 12", d > 0.250" D ≥ 12", d ≥ 2% Associated with girth weld	0	0
	D < 12", d > 0.250" D ≥ 12", d ≥ 2% Associated with long seam weld	0	0
Totals		2	0

Two topside dents are located on the same pipe joint (D/S of GW 3540). These features are a result of the April 2018 anchor strike and have already been inspected by ROV and divers; two dents were confirmed. The south dent had one minor scrape located within it, which was lightly hand filed and removed at < 10% NWT. Four rub marks (gouges) were identified above the north dent which were hand filed and removed (maximum depth before filing was approximately 6.6% NWT). There are no longer any surface indications present. Both plain dents were issued for excavation as part of the April 7, 2018 Geopig program and have been repaired with a composite wrap repair.

6.2 SUMMARY OF FEATURES MEETING INVESTIGATIVE CRITERIA (PI-43)

Table 3 summarizes all features meeting the investigative criteria as defined by PI-43.

Table 3 Features meeting investigative criteria (PI-43)

Category	Sub-Category/Comments	Number of Features Reported	Number of Features Issued for Excavation
Other Features of Interest	Top of pipe geometric anomalies in close proximity (within 10' axial and 60° radial positions)	0	0
	Bottom of pipe dents or geometric anomalies in Close Proximity (within 5' axial and 60° radial positions)	0	0
	Multiple Apex Dent	0	0
	Other dent/geometry features of interest including buckles, wrinkles and ovalities (Ovalities excavation selection based on Minimum Allowable ID as per OMM Book 3 05-03-03)	2	0
Interacting Features Identified Through Threat Integration Processes	Dent with possible stress concentrator	0	0
	Totals	2	0

The two features listed in Table 3 refer to OVL 1 and OVL 2 which have Minimum IDs of 17.40" and 17.85", respectively. These are below the minimum allowable ID (17.9") as per OMM Book 3 05-03-03. These IDRs do not pose an integrity threat; they are provided by the ILI vendor for operability reasons.

These features will be monitored in future inspections.

6.3 TOTAL DIG SELECTION SUMMARY

Table 4 Total number of digs selected based on Code Criteria and Investigative Criteria

Criteria	Number of Features Reported	Number of Features Issued for Excavation
Code	2	0
Investigative	2	0
Totals	4	0

7.0 Features Identified Through Data Integration (PI-32)

Please include in Table 5 all features that have been identified as potential associated with secondary feature. Also, indicate which features require detail feature review. It is important to note that all features identified as requiring detail feature review should be included in the detail feature review document.

Table 5 List of Features Identified as Potentially Associated with Metal Loss Indications Through Data Integration (PI-32)

No interacting features based on the latest threat integration.

Feature ID	GW Number	Actions and Remarks	Detail Feature Required (Y/N)
NA			

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8.0 Graphical Representation of the Integrity Status of the Line

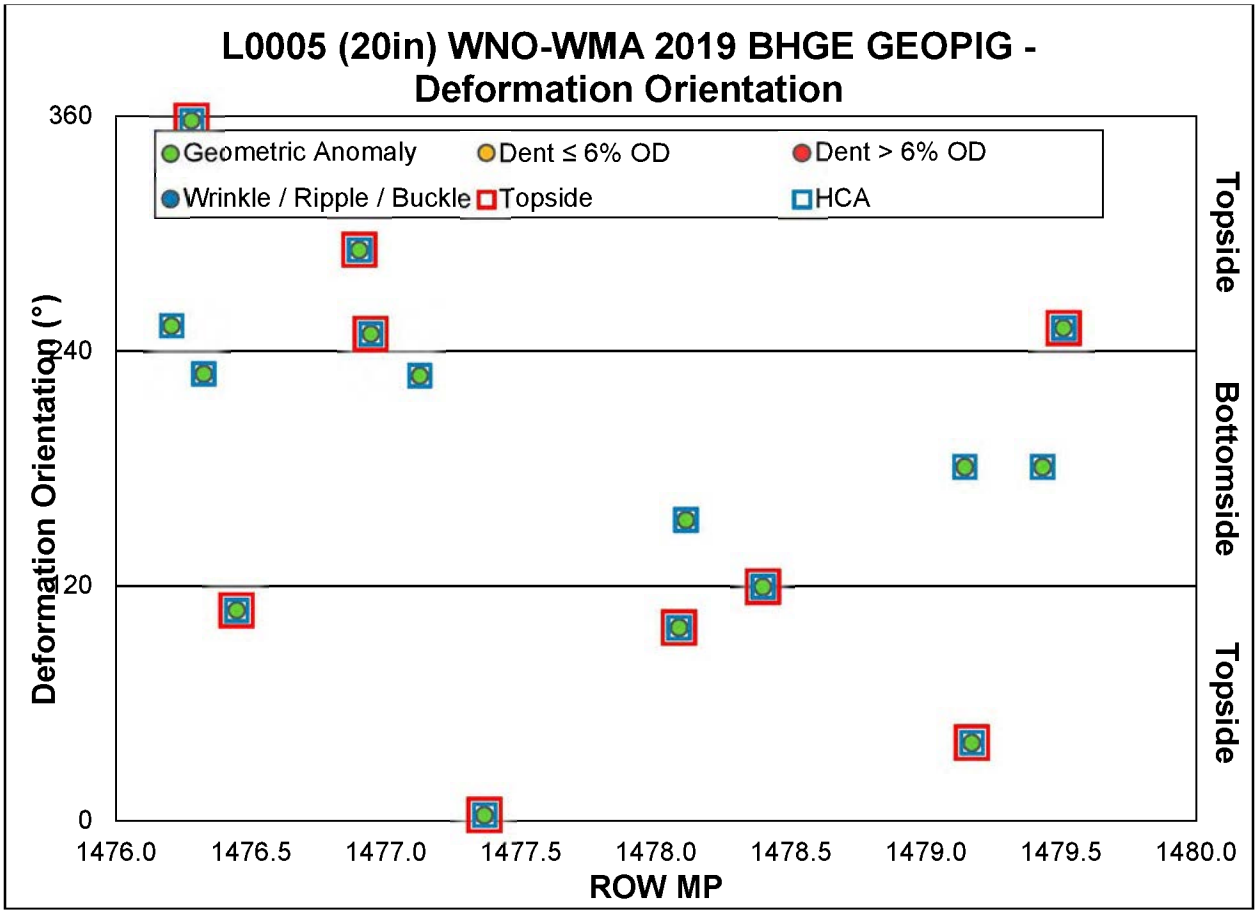


Figure 1 Orientation of all reported deformation features on the pipeline system based on the 2019 Geopig program.

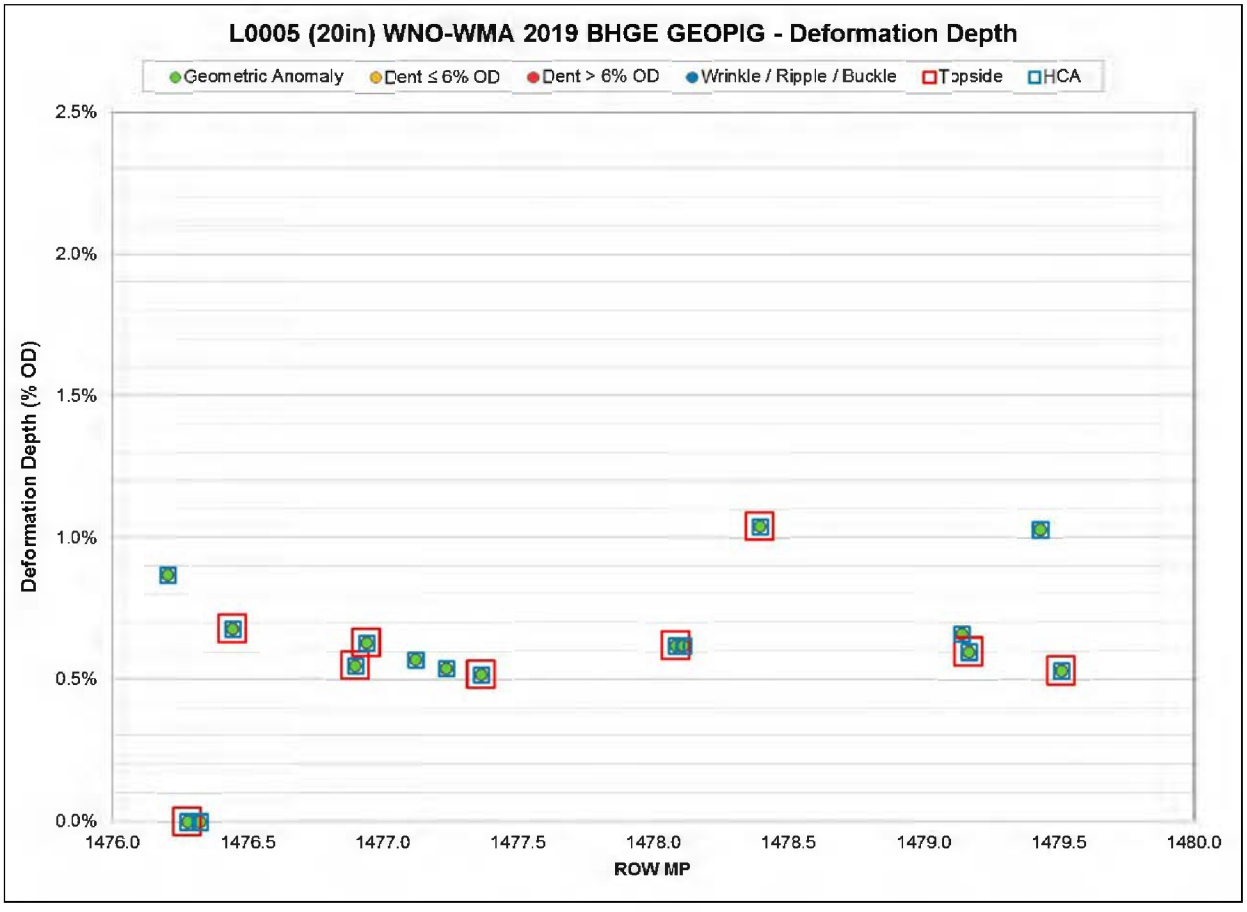


Figure 2 Depth of all reported deformation features on the pipeline system based on the 2019 Geopig program.

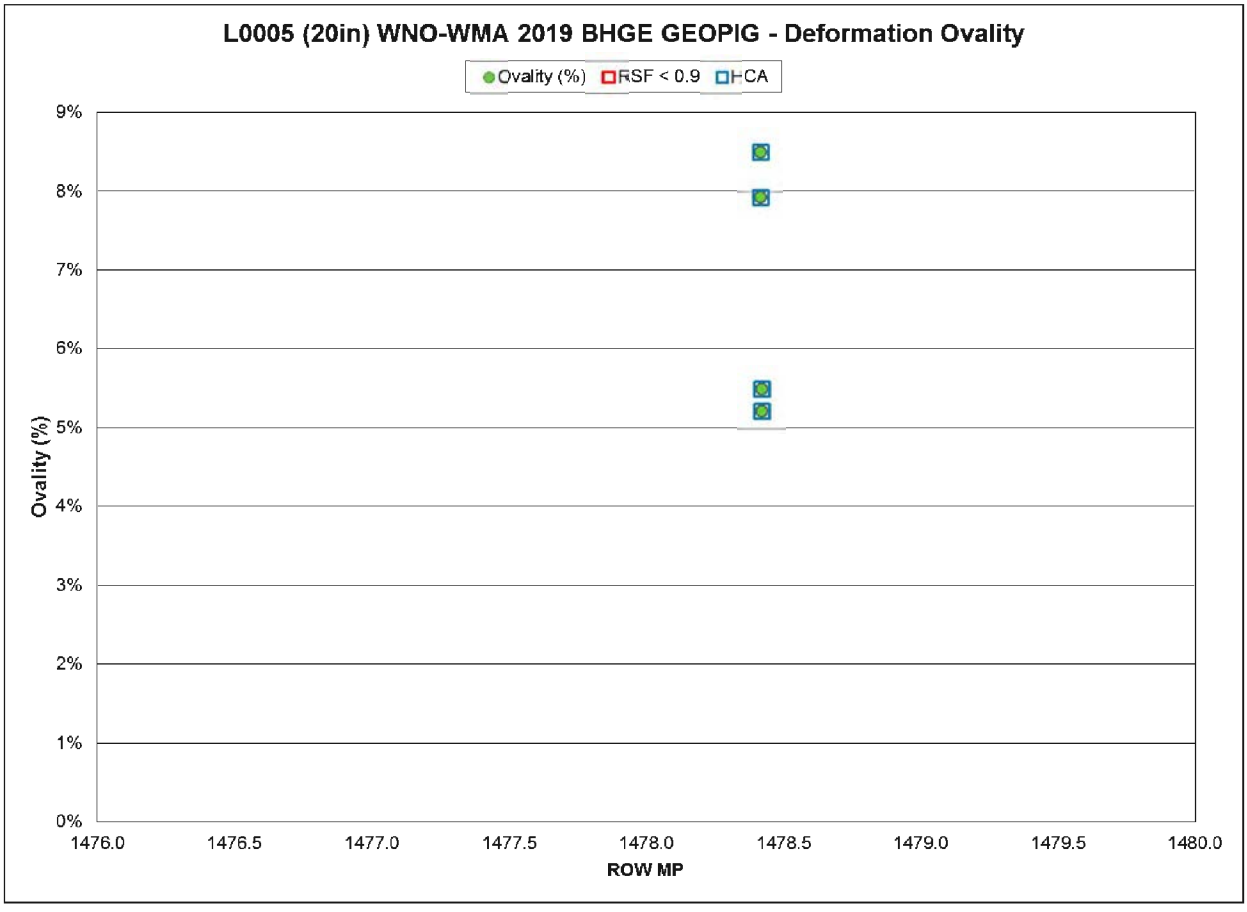


Figure 3 Depth of all reported ovality features on the pipeline system based on the 2019 Geopig program.