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apa

## In-Line Inspection

**December 15, 2023**

# Business Case

# document control

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*Table 1.1: Revision Record*

| Version | Changes Made |
| --- | --- |
| *0.1* | *Initial draft* |
| *0.2* | *Feedback received from document review* |

*Table 1.2: Review and Distribution*

| Name | Role | Action | Sections |
| --- | --- | --- | --- |
| [redacted] | [redacted] | *Initial draft* | *All* |
| [redacted] | [redacted] | *Review and Input* | *All* |
| [redacted] | [redacted] | *Review and Input* | *All* |
| [redacted] | [redacted] | *Review and Input* | *All* |
| [redacted] | [redacted] | *Review and Input* | *All* |

This document requires the following approvals. Approvals are inserted as an object in the table below (preferred) or stored with the approved document in electronic version on the Project Site in Project Server.

*Table 1.3: Approvals*

| Name | Role | Approval | Date Approved |
| --- | --- | --- | --- |
| [redacted] | [redacted] | *Approval* | *07 Dec 2023* |
| [redacted] | [redacted] | *Approval* | *15 Dec 2023* |

*Other project specific approvers can be added if required.*

Delegation Policy

# Contents

# 1. Executive Summary

## 1.1. Action Requested

This business case proposes the investment of $18.8 million (CY$2023) for the In-line Inspection (ILI) of the GGP to monitor and identify integrity threats. This project includes the following up direct inspection of anomalies and remediation and repair. The project is due to commence in CY2024 and will be completed in CY2026. In AA5 $18.3 million (CY$2023) will be incurred of which $12.9 million (CY$2023) will be allocated to the covered pipeline.[1]

## 1.2. Options Considered

- Option 1 – ILI compliant with the PIMP and Asset Performance and Lifecyle Plan (**Recommended Option**)
- Option 2 – Defer ILI by 5 years
- Option 3 – ILI with EMAT Survey
- Option 4 – ILI without MFL-C
- Option 5 – ILI with Tri-axial instead of MFL-C

## 1.3. Project Overview

Periodic inspection using ILI tools is a critical component of the GGP's Pipeline Integrity Management Plan (PIMP). ILI is the most efficient, comprehensive, and accurate inspection technology available. ILI tools allow defects to be identified, monitored, and, where required, rectified to manage the risk of a catastrophic failure, which could result in injuries, fatalities, and disruptions to infrastructure and gas supply.

The PIMP indicates that an ILI is due in 2025 with calliper and two kinds of Magnetic Flux Leakage (MFL) tools: one employing an axially oriented magnetic field (MFL-A) and another with a circumferentially oriented magnetic field (MFL-C).

This business case considers whether to undertake the ILI as planned, whether to delay the ILI by 5 years, or whether to adopt different tools. Alternative options include the omission of the MFL-C tool (sacrificing visibility of long narrow axially oriented metal loss defects) or the substitution with a Tri-axial MFL tool. Also considered is whether to adopt the use of an Electromagnetic Acoustic Sensors Tool (EMAT), which excels at identifying cracks.

Key considerations include cost, compliance with regulatory requirements, AS/NZS 2885: the Standard for High Pressure Pipeline Systems (AS 2885), accepted good industry practice, as well as risk and the effectiveness of existing controls.

We find that lower cost options (relative to the approach in the PIMP and Asset Performance and Lifecycle Plan) result in only marginal cost savings but bring an unacceptable increase in risk due to decreased visibility of key defects. We also find that the use of an EMAT tool is not justified given the marginal additional risk reduction it would provide. This is primarily because we have not identified specific risk factors such as age, pipeline movement, or the detection of certain types of cracks.

[1] As the costs of undertaking the ILI campaign cannot be attributed to a specific compressor unit and the costs relate to the distance of the pipeline, costs are allocated to the covered pipeline inline with the covered percentage of TJ/km of contracted capacity.

As a result, the recommended option is to undertake the ILI as set out in the GGP's PIMP. This option aligns with both regulatory requirements and industry best practice, providing a balanced approach to managing risk and cost.

# 2. Background

Pipelines are vulnerable to various forms of degradation such as corrosion, cracking, fatigue, stress-related failures, vibration, wear, and external damage. These vulnerabilities can lead to catastrophic failures ranging from pin-hole leaks to the complete 'unzipping'[2] of the pipeline. If ignition occurs, this can result in injuries, fatalities, damage to nearby infrastructure, and a disruption to downstream gas supply.[3]

To mitigate these risks, good industry practice is to conduct periodic inspections using In-Line Inspection (ILI) tools, commonly known as pigs. These tools are inserted into the pipeline and are propelled by the gas stream. The tools undertake a thorough assessment of the pipeline's condition by detecting and monitoring potential issues like corrosion, cracks, and deformations.

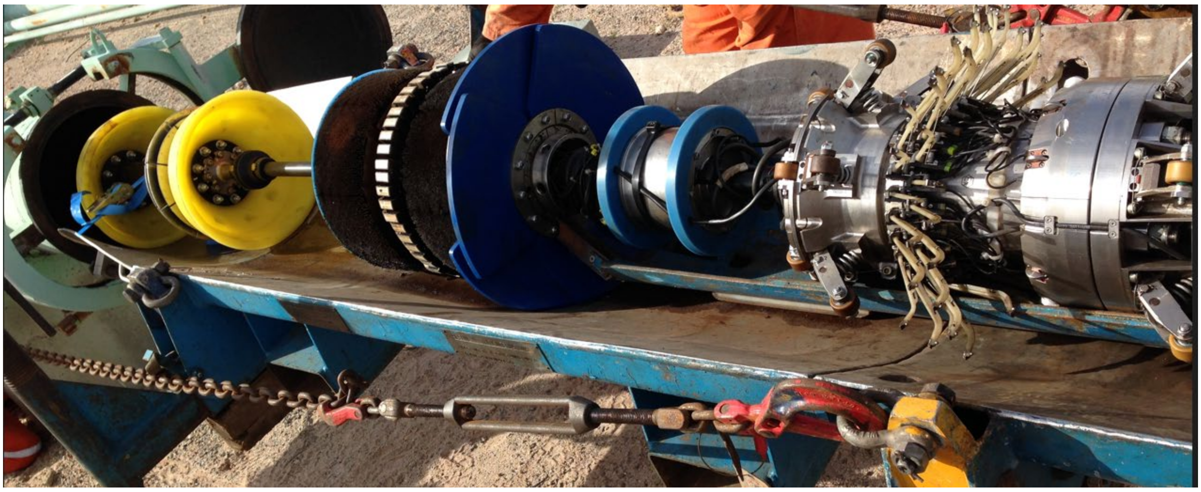
Regular inspections allow for the early identification of issues, which are then either rectified or closely monitored, depending on their severity and growth rate. In turn, these inspections prevent catastrophic failures, reduce supply risks, and maintain safety of the pipeline.

Compared to other inspection methods, ILI is more efficient, comprehensive, and accurate. For example:

- Hydrostatic testing requires a shutdown to fill the pipeline with water to test integrity.
- Direct Current Voltage Gradient (DCVG) surveys only identify defects in the pipeline coating.
- Direct inspections require digging up sections of the pipeline, are limited to detecting visually observable defects and cannot provide a comprehensive review of the pipeline integrity (as the whole pipeline cannot be inspected).

Due to these advantages, periodic ILI inspections are accepted good industry practice both in Australia and internationally.

**Figure 1 ILI tool**



[2] Rapid, self-propagating failure of the pipeline where a crack of defect expands along the length of the pipe, leading to a significant rupture.
[3] Recent examples of a catastrophic failure of a pipeline due to a leak include the San Bruno Pipeline explosion, the 2004 Ghislenghien pipeline explosion and the 2019 Enbridge gas pipeline explosion.

## 2.1. ILI technology

ILI tools generally fall into three categories geometry detection, metal loss detection – primarily using Magnetic Flux Leakage (MFL) – and crack detection using ultrasonic or Electromagnetic Acoustic Sensors Tools (EMAT).

Calliper tools were among the initial ILI technologies, designed to gauge pipeline geometry and identify deformations such as dents or ovalities. While calliper tools do not directly detect mechanical stress cracking, they can identify features and deformations that may be indicative of conditions that could potentially lead to cracking.

Magnetic Flux Leakage (MFL) tools have become the standard for detecting metal loss. Axial Field MFL (MFL-A), the oldest MFL technology, employs a magnetic field orientated in the direction of the pipeline axis. MFL-A has a proven history of identifying the majority of corrosion threats, such as general corrosion and pitting. However, it has known limitations in detecting long, narrow axially aligned metal loss.

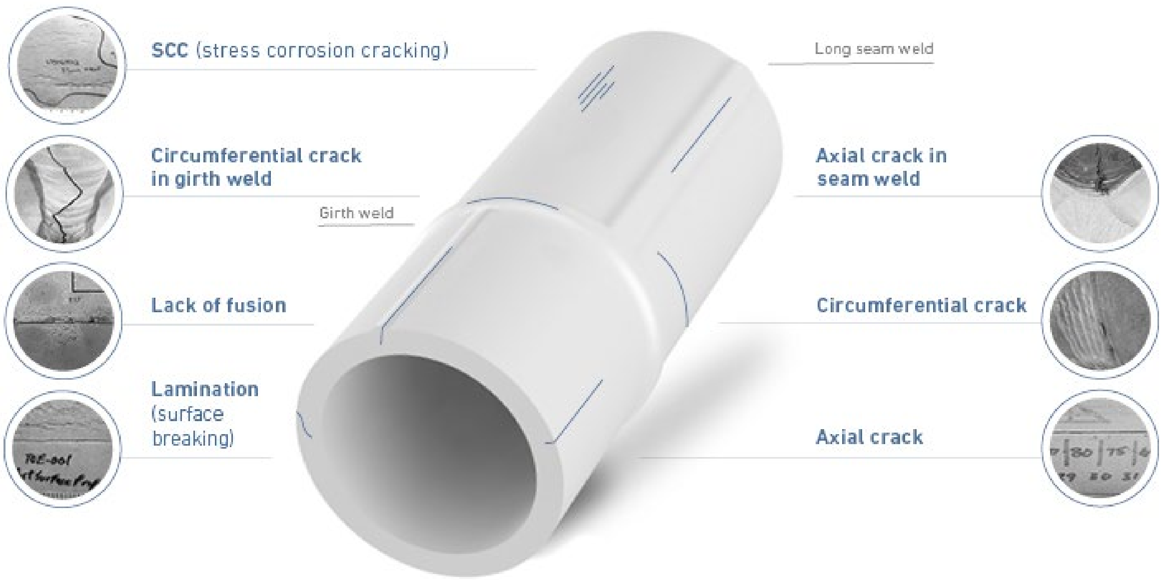
Long, narrow axially aligned metal loss is corrosion or wear that extends in the same direction as the pipeline but is relatively narrow in width. This type of defect is particularly challenging to detect but is crucial because it can compromise the structural integrity of the pipeline over time.

Circumferential Field MFL (MFL-C) uses a magnetic field oriented circumferentially around the pipeline, perpendicular to the direction of the MFL-A tool. As a result, MFL-C excels in identifying long narrow axially orientated metal loss defects. MFL-C is generally used as a complement to MFL-A.

Tri-axial MFL sensors, the latest advancement, using three orthogonal sensors to measure magnetic fields in multiple directions, providing higher resolution detection of complex anomalies. While Tri-axial MFL sensors offer the advantage of multidirectional anomaly detection, they are not as effective as MFL-C in identifying specific types of defects. For instance, Tri-axial MFL is less capable of detecting axial growing defects or axial slotting. Therefore, it's not considered a direct substitute for MFL-C technology, which excels in these areas.

EMAT and ultrasonic tools are specialized tools for detecting stress corrosion cracking. They generate ultrasonic pulses to identify cracks and coating disbondment.

**Figure 2 Diagram of pipeline defects**




Source: Rosen.

## 2.2. Regulatory obligations

Consistent with the regulatory requirement in Pipeline Licence 24,[4] the GGP is operated in accordance with AS 2885, the Australian Standard for high-pressure gas pipelines designed, constructed, and operated throughout Australia.

**AS 2885**

AS 2885 adopts a risk-based approach to manage safety. Risks are initially identified through a Safety Management Study (**SMS**). This study considers technical, environmental and operational factors such as age, material, condition, whether the pipeline traverses through areas of high community risk, etc. These identified risks are then managed to a level that is as low as reasonably practicable (**ALARP**) through a combination of design, physical, and procedural controls. The risk assessment of the threats and execution of these controls is outlined and overseen through a Pipeline Integrity Management Plan (**PIMP**).

**Australian good industry practice**

Due to the catastrophic risks from a loss of integrity together with the efficiency and effectiveness of ILI, it is universally employed, where possible.

Good industry practice is to undertake inspections at a maximum frequency of 10-years unless specific risk factors require more regular intervals.[5] We note that AGIG's Dampier to Bunbury mainline and loops are inspected at 8-year intervals.[6] Jemena expects the pigging frequency of its Eastern Gas Pipeline (commissioned in 2000) to be between 5 and 10 years.[7]

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[4] Clause II(1)
[5] This is a consistent view across ATCO Gas (page 46), AGIG (page 68), Jemena (page 28) and Evoenegry (page 1).
[6] See here (page 68)
[7] See here (page 23).

Not all pipelines are inspected using ILI. Pipelines built in the 1960s and 1970s (before ILI tools were commonplace) were not designed to accommodate ILI and typically rely on other less effective techniques (DCVG surveys and direct inspection). Across Australia these pipelines are being modified to allow ILI to occur or, in some locations, de-rated, to manage integrity risks as the pipelines age. Examples include APA's Victorian Transmission System, JGN's Sydney Primary Main, AGIG's AGN and MGN distribution networks, as well as ATCO Gas' East Perth Lateral and Harrow Road pipelines.

**International good industry practice**

Similarly, international good industry practice generally requires a risk-based approach. However, in many cases a maximum ILI interval is determined or recommended. For instance:

- The Institution of Gas Engineers and Management's standard for steel pipelines for high pressure gas transmission (IGEM/TD/1) requires a risk-based approach to determining inspection intervals. If that approach is not practical the maximum interval between inspections should not exceed 10 years.
- The American Society of Mechanical Engineers Standard for Managing System Integrity of Gas Pipelines (ASME B31.8S) recommends a maximum inspection frequency of 10 years.
- The US Department of Transportation Pipeline and Hazardous Materials Safety Administration requires assessments in high consequence areas at least every 7 years.
- The Indian Petroleum and Natural Gas Regulatory Board requires ILI to occur at least once in 10 years.[8]

## 2.3. GGP Pipeline Integrity Management Plan and In-Line Inspection Policy

GGP's PIMP identifies the pipeline integrity threats, risks and controls. The PIMP was recently reviewed and updated in November 2023. The PIMP takes into account:

- Asset specific factors, including the commissioning date (1996), technology used to construct the GGP and gas moisture content.
- Integrity data, including from the previous GGP ILI campaign such as defect growth rate, manufacturing features and the importance of high-resolution data to differentiate between the two.
- Recent developments with ILI technology, including the general industry shift towards greater use of MFL-C (as part of a multi tool strategy with MFL-A), Tri-axial and EMAT technology.
- APA's experience in undertaking ILI campaigns across Australia, in particular the level of confidence that each tool provides to identify defects.

As a result of this analysis, the PIMP sets out ILI inspections to be undertaken consistent with APA's ILI policy. Specifically, inspections every 10 years with alternate use of calliper, MFL-A and MFL-C tools and in the subsequent inspection calliper and tri-axial MFL tools.

[8] Petroleum and Natural Gas Regulatory Board (Technical Standards and Specifications including Safety Standards for natural gas pipelines) Regulations, 2009. See here.

This inspection regime prescribed by the PIMP adheres to the maximum allowable interval under APA's ILI policy with special considerations given to:

- The defect growth rate.
- No special integrity concerns.
- No regulatory obligations mandating more frequent inspections.
- The GGP traversing rural rather than high-consequence areas.
- Low risk of cracking defects.

This inspection regime will be reviewed following the results of this ILI. Notably, the GGP has only been inspected using MFL-A technology so there may be undetected long narrow axially orientated metal loss defects which only MFL-C can detect.

# 3. Options Considered

Four options have been considered:

- Option 1 – ILI complaint with PIMP and Asset Performance and Lifecyle Plan (Recommended Option).
- Option 2 – Defer ILI by 5 years.
- Option 3 – ILI with EMAT Survey.
- Option 4 – ILI without MFL-C.
- Option 5 – ILI with Tri-axial MFL.

We have not considered options such as DCVG, direct assessment or hydrostatic testing on the basis that they are more expensive, have greater operational impacts or provide less comprehensive integrity assessments. We also have not considered de-rating the pipeline given the current levels of contracted capacity.

## 3.1. Option 1 – ILI compliant with PIMP Asset Performance and Lifecycle Plan.

Under this option we undertake an ILI in CY2025 using calliper, MFL-A and MFL-C tools.

This option is compliant with the PIMP, accepted good industry practice and APA's ILI Policy. It will ensure that the residual risk of internal corrosion, stress corrosion cracking and mechanical induced cracking remain low. The risk of external corrosion has a residual intermediate risk.

This option costs $16.8 million in present value terms.

**Table 3.1 Option 1 Integrity risk (treated)**

| Threat | Occurrence | Frequency | Severity | Mitigation measure | Residual risk |
|---|---|---|---|---|---|
| Internal corrosion | Low, relative elevation | Hypothetical | Major | ILI | Low |
| External Corrosion | Dis-bonded coating (or HSS) | Remote | Major | ILI<br>Cathodic Protection<br>Coating repairs | Intermediate |
| Stress Corrosion Cracking | Not detected | Remote | Severe | Magnetic Particle Inspection with selected excavations. | Low |
| Mechanical (Stress) induced cracking | External interface | Remote | Severe | External corrosion direct assessment of all dents with metal loss | Low |

## 3.2. Option 2 – Defer ILI by 5 years.

In this option the ILI is delayed until CY2030.

The benefit of this option is the time value of money achieved in deferring the spend 5 years and results in a cost of $13.1 ($2023) million in present value terms.

This option would delay the identification of any defects which have arisen (in particular, axially orientated defects) or changes in defect growth rate. This approach increases the residual risk of external corrosion to high, is not compliant with the PIMP or good industry practice.

**Table 3.2 Option 2 Integrity risk (treated)**

| Threat | Occurrence | Frequency | Severity | Mitigation Measure | Residual Risk |
|---|---|---|---|---|---|
| Internal corrosion | Low, relative elevation | Hypothetical | Major | ILI | Low |
| External Corrosion | Dis-bonded coating (or HSS) | Unlikely | Major | ILI<br>Cathodic Protection<br>Coating repairs | High |
| Stress Corrosion Cracking | Not detected | Remote | Major | Magnetic Particle Inspection with selected excavations. | Low |
| Mechanical (Stress) induced cracking | External interface | Remote | Major | External corrosion direct assessment of all dents with metal loss | Low |

## 3.3. Option 3 – ILI with EMAT survey

In this option an EMAT tool is added to the ILI campaign to identify cracking risks.

Relative to option 2, adding this tool to the ILI campaign will increase costs by $15.9 million ($2023) in present value terms. The higher cost is due to the use of the more advanced tool together with the pipeline throttling measures which would need to be put in place (due to a lower maximum velocity limit).

EMAT tools excel at identifying pipeline cracks. The EMAT tools would improve the detection of both stress corrosion cracking and mechanical stress induced cracking. This option goes beyond the requirements outlined in APA's ILI Policy as no significant axial environmental cracking or longitudinal seam weld cracking has been previously detected. The current risk of these defects is "low" due to:

- the results of the stress corrosion cracking susceptibility study;
- no reported crack indications on the pipeline to date; and
- due to the pipeline does not traversing through high consequence areas.

We consider that the current controls specified in the PIMP (opportunistic Magnetic Particle Inspection especially targeting downstream of compressor stations) is adequate to monitor and manage the risk.

As a result, there is no material difference in risk between option 1 and option 3.

**Table 3.3 Option 3 Integrity risk (treated)**

| Threat | Occurrence | Frequency | Severity | Mitigation Measure | Residual Risk |
|---|---|---|---|---|---|
| Internal corrosion | Low, relative elevation | Hypothetical | Major | ILI | Low |
| External Corrosion | Dis-bonded coating (or HSS) | Remote | Major | ILI<br>Cathodic Protection<br>Coating repairs | Intermediate |
| Stress Corrosion Cracking | Not detected | Hypothetical | Major | Magnetic Particle Inspection with selected excavations. | Low |
| Mechanical (Stress) induced cracking | External interface | Hypothetical | Major | External corrosion direct assessment of all dents with metal loss | Low |

## 3.4. Option 4 – ILI without MFL-C

In this option we undertake an ILI in CY2025 using calliper and MFL-A but not the MFL-C tool.

The primary benefit of this option is the lower cost of $14.1 million ($2023) in present value terms.

The drawback of this option is that without the use of the MFL-C tool we will continue to have no visibility of any circumferential defects, until at least 2035 (assuming the MFL-C too is used then) when the pipeline is almost 40 years old. A lack of visibility means that any possible defects cannot be identified, rectified, or monitored. As a result, this option bears a high risk of external corrosion.

**Table 3.4 Option 4 Integrity risks (treated)**

| Threat | Occurrence | Frequency | Severity | Mitigation Measure | Residual Risk |
|---|---|---|---|---|---|
| Internal corrosion | Low, relative elevation | Hypothetical | Major | ILI | Low |
| External Corrosion | Dis-bonded coating (or HSS) | Unlikely | Major | ILI<br>Cathodic Protection<br>Coating repairs | High |
| Stress Corrosion Cracking | Not detected | Remote | Major | Magnetic Particle Inspection with selected excavations. | Low |
| Mechanical (Stress) induced cracking | External interface | Remote | Major | External corrosion direct assessment of all dents with metal loss | Low |

## 3.5. Option 5 – ILI with Tri-axial instead of MFL-C

In this option we undertake an ILI in CY2025 using calliper and Tri-axial MFL (rather than MFL-C and MFL-A).

The primary benefit of this option is the lowest cost $15.9 million ($2023) in present value terms. The cost reduction is due to not using the MFL-C tool but is not as low as option 4 due to the higher cost of the Tri-axial MFL tool relative to the more established MFL-A tool.

As with option 4, the external corrosion risk is high due to absence of the MFL-C tool. The Tri-axial tool combines the conventional axial magnetic field of MFL-A with tri-axial sensors and more complex post-processing, which the vendor claims is able to identify circumferential anomalies [redacted] As a result, there remains a risk that these anomalies are not identified and in turn cannot be rectified and poses an unacceptable risk to the pipeline.

### Table 3.5 Option 5 GGP Integrity risks

| Threat | Occurrence | Frequency | Severity | Mitigation Measure | Residual Risk |
|---|---|---|---|---|---|
| Internal corrosion | Low, relative elevation | Hypothetical | Major | ILI | Low |
| External Corrosion | Dis-bonded coating (or HSS) | Unlikely | Major | ILI<br>Cathodic Protection<br>Coating repairs | High |
| Stress Corrosion Cracking | Not detected | Remote | Major | Magnetic Particle Inspection with selected excavations. | Low |
| Mechanical (Stress) induced cracking | External interface | Remote | Major | External corrosion direct assessment of all dents with metal loss | Low |

# 4. Preferred option

The preferred option is option 1 ILI compliant with PIMP and Asset Performance and Lifecycle Plan.

While alternative options (2, 4 and 5) had marginally lower cost, these savings came at the expense of reduced identification of pipeline defects or defect growth resulting in a high external corrosion risk - which is not ALARP. This lack of visibility limits our ability to monitor, introduce additional controls or take action to rectify defects to prevent a catastrophic failure. In turn these options are not compliant with the application of AS 2885 (and in turn licence/regulatory requirements) or with accepted good industry practice.

In contrast, the EMAT tool incurs a higher cost without material change to the residual risk. Or put another way incurring additional cost to deploy the EMAT tool, at this stage, would be grossly disproportionate to the risk reduction achieved.

**Table 4.1 Cost comparison ($CY2023, millions)**

| Option and Description | Capex | Present Value[9] |
|---|---|---|
| 1. ILI compliant with PIMP and Asset Performance and Lifecycle Plan | [redacted] | 16.8 |
| 2. Defer ILI by 5-years | [redacted] | 13.1 |
| 3. ILI with EMAT Survey | [redacted] | 29.0 |
| 4. ILI without MFL-C | [redacted] | 14.1 |
| 5. ILI with Tri-axial instead of MFL-C. | [redacted] | 15.9 |

[9] 4.25% WACC, discounted back to 2024.

**Table 4.2 Risk comparison**

| Option and Description | Internal corrosion | External Corrosion | Stress Corrosion Cracking | Mechanical (stress) induced cracking |
|---|---|---|---|---|
| 1. ILI complaint with PIMP and Asset Performance and Lifecycle Plan | Low | Intermediate | Low | Low |
| 2. Defer ILI by 5-years | Low | High | Low | Low |
| 3. ILI with EMAT Survey | Low | Intermediate | Low | Low |
| 4. ILI without MFL-C | Low | High | Low | Low |
| 5. ILI with Tri-axial instead of MFL-C. | Low | High | Low | Low |

## 4.1. Consistency with the National Gas Rules

The preferred option meets the requirements of Rule 79 and is conforming capital expenditure.[10]

**Prudent and good industry practice**

Using ILI to maintain the integrity of pipelines is accepted good industry practice and achieves the lowest sustainable cost of providing services relative to other techniques.[11] ILI is a proven technology used worldwide for monitoring pipeline integrity.

ILI is an essential part of the GGP's PIMP and is in turn necessary to maintain the safety and integrity of services by reducing the risk of a catastrophic failure.[12] The program is necessary to maintain and improve the safety of services and maintain the integrity of services to GGP customers and GGT personnel and is of a nature that a prudent service provider would incur.

ILI is also necessary to comply with regulatory obligations (regulatory requirement) and to maintain capacity to meet current levels of demand (by avoiding a requirement to de-rate the pipeline or the weeks/months it would take to restore service following a catastrophic failure).[13]

**Efficient**

GGT/APA tenders the provision of ILI services on a competitive basis. The works will be subject to APA procurement policies. The works will be carried out by external contractors who demonstrate specific expertise in completing the installation of the facilities in a safe and cost effective manner. The expenditure can therefore be considered complaint with the expenditure that a prudent service provider acting efficiently would incur.

**To achieve the lowest sustainable cost of delivering pipeline services**

ILI is the most cost effective solution and has been approved by the regulators for many other pipeline assets.

[10] The allocation of costs between the notional covered and uncovered GGP pipelines is addressed separately.
[11] Rule 79(1)(a)
[12] Rule 79(2)(c)(i)&(ii)
[13] Rule 79(2)(c)(iii)&(iv)

# Appendix 1 – Cost estimate

The estimated costs for the project are set out in **Error! Reference source not found.**.

**Table 4.3 ILI project ($CY2023, millions)**

| | 2024 | 2025 | 2026 | Total |
|---|---|---|---|---|
| Labour | [redacted] | [redacted] | [redacted] | [redacted] |
| Materials | [redacted] | [redacted] | | [redacted] |
| Plant | [redacted] | [redacted] | | [redacted] |
| Subcontractor | [redacted] | [redacted] | [redacted] | [redacted] |
| Other | [redacted] | [redacted] | | [redacted] |
| **Total** | **0.50** | **13.92** | **4.38** | **18.80** |