Jemena Gas Networks (NSW) Ltd

Sydney Primary Main (SPM) - Putney to Stringybark Pigging Facilities

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1. Summary

This business case proposes to reconfigure the Putney to Stringybark section of the Sydney Primary Main (SPM) to make it suitable for in-line inspection (ILI or 'pigging'). Reconfiguring this section of the SPM is the next stage of JGN's management strategy for the pipeline, which is ageing and nearing the end of its design life.

The SPM supplies gas to over 500,000 domestic and industrial customers across the Sydney region. Recent and historical spot check inspections along the SPM and other assets of similar vintage have identified and confirmed active corrosion under a number of disbonded coatings, resulting in thinning of the pipe wall. This can lead to a high pressure gas escape resulting in a massive sinkhole or gas explosions with catastrophic consequences.

The Putney to Stringybark section supplies gas to primary receiving stations (PRS) that feed gas into the secondary network supporting greater than 160,000 customers within the Ryde to Willoughby area. It is the third stage of the SPM reconfiguration strategy:

- Stage 1, the first 22 kms of the SPM between Horsley Park to Lidcombe were converted using a permanent launcher facility at Horsley Park and a temporary receiver at Lidcombe. The pipeline was inspected via an ILI tool in 2021, the first time since it has been in operation. The results were found to be favourable for JGN to continue with its strategy of reconfiguring the remaining sections of the SPM.
- Stage 2, the next section of SPM between Lidcombe and Banksmeadow will be reconfigured. This project is currently undergoing front end engineering and design (FEED) with the implementation planned for 2026.
- Stage 3 (this project), we will reconfigure the Putney to Stringybark section of the pipeline. Putney to Stringybark is approximately 7.5kms and does not have provisions for inserting ILI. As part of this project the pipeline would need to be modified to allow for insertion of the ILI tools.

Once the pigging facilities are constructed, the pipeline will be inspected via an ILI inspection tool, and based on the data, validation digs / integrity digs will be undertaken to confirm pipeline condition and repair any significant defects. The ILI inspection and validation digs are subsequent projects following the construction of the pigging facilities. The following options were assessed for this project and are provided in table below.

Table 1–1: Options assessment summary

Options	Option Name	Description	Cost (A$000's) in present value terms		Risk	
					Jemena	AS2885
1	Maintain Status Quo (Not Recommended)	This involves existing inspection techniques including digging up the main and inspecting the pipeline for any metal loss.	Capex	Nil	High	High
			Opex	1,200[1]		
			Opex	31,632[2]		
2	Reconfigure the pipeline to enable in-line	In-Line Inspection (pigging) is capable of inspecting the entire pipeline condition and it doesn't	Capex	9,888	Moderate	Low

[1] 3 digs per year at a total cost of $400k per dig.

[2] The cost comprises of $7,788k for undertaking the hydrostatic testing while $23,835k is included for loss of supply based on $1,135k per day, and it is estimated that the pipeline will need to be out of service for a minimum of 21 days.

	inspection (pigging facilities) **(Recommended option)**	impact customers supply. Using this technology is industry standard and recognised as an efficient means of managing a pipeline	Opex	Nil		
3	De-rate Putney to Stringybark section (Not Recommended)	This option explores de-rating the pipeline section between Putney to Stringybark to secondary pressure. This option would result in a network not able to serve customers that currently take gas at pressures higher than secondary.	Capex	$35,000	Moderate	Low
			Opex	Nil		
			Opex	Nil		

1.1 Business need

The Putney to Stringybark section of the SPM is an underground pipeline in Sydney, making direct inspection challenging. As it ages, the need to assess its condition for safety and reliability becomes increasingly important. Historically, integrity checks were conducted through spot checks (integrity digs) which were cost effective when the pipeline was within its design life. However, two critical factors have necessitated a change in the strategy:

1. Deteriorating condition: The SPM is ageing, and as it approaches 50 years of operation, a comprehensive assessment of its condition is vital.
2. Escalating cost: The cost of conducting integrity digs is on the rise, making our traditional spot-checks approach increasingly inefficient and costly. The cost escalation necessitates a more sustainable and cost-effective approach to maintaining the SPM's integrity.

The potential consequences of corrosion leading to gas escape are severe. Pipeline failure can cause a massive sinkhole, or worse, an ignition resulting in fatalities and building destruction. As such, it is essential we have the ability to accurately monitor and measure the SPM's condition.

The SPM reconfiguration is necessary to maintain the safety of the public, as well as maintaining the integrity of JGN's gas distribution system in compliance with regulatory requirements. Additionally, it is imperative to mitigate the risk of unforeseen and costly repair works as the asset continues to deteriorate. Therefore, by proactively addressing these threats and risks, Jemena can continue to facilitate the continuity of gas supply to its customers, maintain an efficient and safe gas distribution system, and ensure the long term sustainability of its operations.

1.2 Customer feedback

Customers have told us they value a safe and reliable gas supply, and expect JGN to ensure the gas network remains safe and that gas is available when customers need it. In recent engagements, customers have indicated a preference for targeted investment in safety and reliability, encouraging JGN to proactively manage integrity issues with the aim of reducing ongoing maintenance costs. A strong theme that emerged from our customer engagement program is that while customers expect JGN to keep costs as low as practicable and encourage non-critical investments to be deferred where prudent to do, safety must not be compromised.

Customers have suggested JGN should carefully consider the pace of investment, and take a considered approach to how the network may be used in the future. Customers want us to consider affordability over the short and long term when making decisions. Customers expect us to act now and plan for a net zero emissions future, rather than delaying investment. This includes looking at how new technology could be applied to improve asset management.

Customers continue to connect to the gas network. While growth in demand for natural gas services has slowed in recent years, new connections will continue during the next regulatory period, with growth expected in some pockets of the network. The distribution network is expected to continue to play a major role in NSW's energy future. Customers have told us that that they value choice and diversity in their energy supply. Though there is a current trend towards electrification of industries, 85% of Sydney customers agree that NSW needs a mix of energy sources – including solar, wind and gas – and that we should not 'put all energy eggs in one basket'. 78% of customers support having the choice of renewable gas options as part of the energy transition.[3]

Thousands of customers remain dependent on the gas network, with many not be willing or able to switch away from gas as an energy supply. As such, while investment in network growth may be more conservative than compared to historical levels, it is important JGN continues to invest to sustain the network and ensure compliant pressures and uninterrupted supply.

1.3 Recommendation

Based on analysis of the identified threats, associated risk ratings, and the pressing business needs, it is recommended that the most viable and cost effective solution for addressing the integrity issues associated with the SPM (Putney to Stringybark) pipeline is to proceed with the reconfiguration of the pipeline to enable ILI.

Consistent with customer feedback, the recommended solution applies new technology to improve asset management and keep ongoing costs as low as practicable, without compromising safety. While the capital cost of reconfiguring the pipeline is significant, it will reduce the intensity of ongoing operating costs by reducing the need and frequency of integrity digs, which can prove costly and disruptive. Having access to the more accurate pipeline condition data provided by ILI may also enable us to extend the useful life of the SPM further, negating the need to incur the high costs of pipeline replacement.

Reconfiguring the pipeline to enable in-line inspection not only represents the most prudent approach to addressing asset integrity issues but also stands as a fiscally responsible choice that aligns with long term sustainability objectives. It provides the necessary assurance of safety, reliability, and compliance while mitigating the financial risks associated with unexpected and costly repair works. This recommendation underscores the significant benefits and prudent risk mitigation offered by this option, making it the best choice for Jemena's strategic approach to the Putney to Stringybark pipeline's project.

1.4 Consistency with the National Gas Rules and National Gas Objective

When developing this business case, we have given regard to the requirements of the National Gas Rules (NGR) and the National Gas Objective (NGO).

NGR 79(1)

We submit that the proposed solution is prudent, efficient, consistent with good industry practice, and will achieve the lowest sustainable cost of providing services.

- **Prudent** – The expenditure is necessary in order to ensure the ongoing integrity of the SPM is maintained and to reduce the risk of major gas escapes that could impact public safety and reliability of supply. ILI is proven to help address the risk associated with high pressure pipelines and therefore represents an investment that a prudent pipeline operator would incur.
- **Efficient** – The forecast expenditure is based on rates applied in previous ILI reconfiguration projects, and costs will be undertaken subject to a detailed engineering assessment and design.

[3] Redbridge, Sydney energy attitudes and sentiments, December 2023.

- **Consistent with accepted and good industry practice** – ILI is accepted industry good practice and has become commonplace among Australian gas distribution pipeline operators. AS2885.3 mandates that pipeline integrity and condition be assessed to confirm the pipeline's ability to safely operate at the nominated MAOP. AS2885.3 requires ILI to be considered where practicable.
- **Achieve the lowest sustainable cost of delivering pipeline services** – The proposed expenditure is necessary to maintain the long term integrity of the SPM. Failure to do so would result in additional expenditure (reactive response to a major gas escape and bringing forward replacement) and increase the long term operating cost of the pipeline. The project is therefore consistent with the objective of achieving the lowest sustainable cost of delivering services. It may also enable us to extend the technical design life of the SPM and manage the future replacement/maintenance schedule more efficiently. Deferring replacement costs and being able to utilise fully depreciated assets for as long as is safe and practicable will eventuate in the lowest sustainable cost of providing pipeline services.

NGR 79(2)

The proposed capex is justifiable under NGR 79(2)(c)(i) and 79(2)(c)(ii), as it is necessary to maintain the safety and integrity of services. Corrosion is one of the primary failure modes associated with steel high pressure pipelines, and any pipeline failure has the potential to interrupt supply to thousands of customers at any one time. Early detection of corrosion is essential to maintain the safety and integrity of services, particularly with pipelines that are beyond their design life.

The current practice of DCVG surveys and dig ups alone is insufficient to manage the integrity risk to an acceptable level, as urban encroachment means there are too many sections of the SPM that cannot be dug up or inspected without inserting an inline inspection tool. It is therefore prudent to reconfigure the pipeline to allow pigging and extend the life of the asset, negating the need to incur the high costs of pipeline replacement.

NGR 74

The forecast costs have been arrived at on a reasonable basis by following realistic assumptions of costs, informed by previous ILI reconfiguration projects along the SPM. Rates are comparable with the market and the volume of pipeline that is to be reconfigured is being limited for the next access arrangement period, with a view to informing more accurate forecasts in future periods. We therefore consider the costs estimates represent the best forecast possible in the circumstances.

NGO

The SPM is vital to the gas distribution network in Sydney and will continue to provide gas distribution services to customers throughout the next regulatory period and for the foreseeable future. The SPM is likely to have a significant role throughout Australia's energy transition, therefore maintaining its efficient operation is in the long term interests of consumers.

1.5 Financial information

The total cost estimate (Gate 1 ±50%) for this option including overheads is $9.89M.

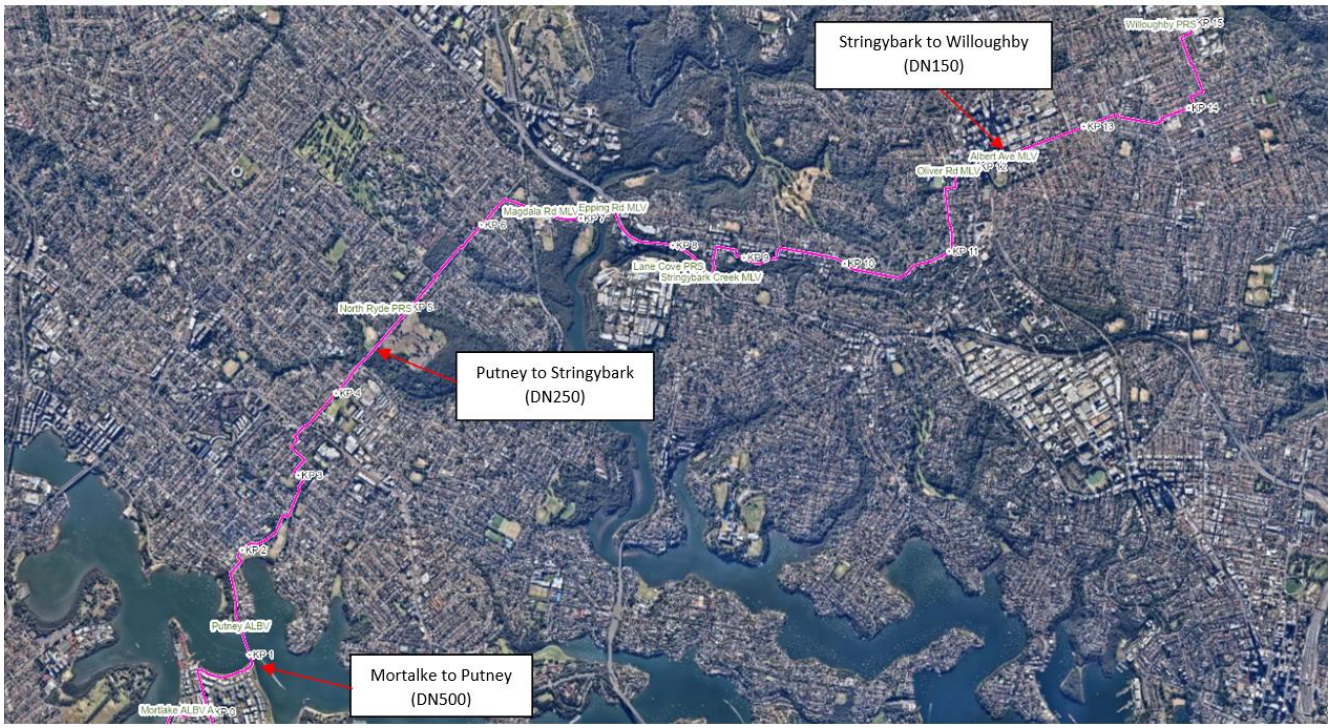
2. Background

The SPM supplies gas to more than 500,000 customers across Sydney. The maximum operating pressure of the Primary Main is 3.5 MPa, and it operates in compliance with the Gas Supply (Safety and Network Management) Regulation (2013), and by extension, the Australian Standard AS2885.3.

The Mortlake to Willoughby section of the SPM consists of three different diameters and currently lacks provision for ILI. Therefore, this section of the pipeline cannot be inspected using a single ILI tool, necessitating inspection in multiple segments with different sizes of ILI tools, and requiring multiple pig launcher and receiver facilities. The Mortlake to Willoughby section comprises of the following segments:

- Mortlake to Putney – DN500, approximately 1.3km
- Putney to Stringybark – DN250, approximately 7.5km
- Stringybark to Willoughby – DN150, approximately 8.5km

Figure 2–1: SPM (Mortlake to Willoughby) Configuration



AS2885.3 mandates that pipeline integrity and condition be assessed to confirm the pipeline's ability to safely operate at the nominated maximum allowable operating pressure (MAOP). Historically, the SPM has met this regulatory obligation through integrity digs. This method was acceptable in the past due to reliance on the pipeline's design to manage any corrosion that occurred.

However, the SPM is an aged asset, with certain sections installed between 1968 to 1982. As the pipeline approaches 50 years of operation, it is imperative to fully understand the pipe wall condition to confirm its ability to continue safe and reliable operations. This can be efficiently confirmed by measuring the pipe wall thickness, best provided by performing ILI.

Ensuring the pipeline's safe operation is of paramount importance, especially as the Mortlake to Willoughby section of the SPM traverses high density urban environments, where the consequence of a loss of containment event would be catastrophic.

The “Putney to Stringybark – Pigging Facilities” project is a proposed continuation of works to improve the safety and integrity of the SPM asset. The DN500, Mortlake to Putney is planned for reconfiguration and inspection in 2026, while the Stringybark to Willoughby (DN150) section will be de-rated to secondary pressure by augmenting the distribution network in 2025. Consequently, the Putney to Stringybark pigging facilities will be the final section to be reconfigured and is now scheduled for delivery in 2028. This aligns with Jemena Asset Class Strategy aimed at maintaining the integrity of the Sydney Primary Main pipeline sections.

2.1 Risk analysis

The key driver for the project, “Putney to Stringybark – Pigging Facilities” is the need to proactively address the aging SPM pipeline’s integrity and safety concerns, aligning with regulatory compliance and cost efficiency goals, while safeguarding public safety and the financial stability of Jemena.

Examples of recent findings of corrosion under disbonded coatings and major anomalies discovered on SPM pipeline sections and other JGN assets of similar vintage are listed below:

- In 2022, corrosion cluster with approximately 66% of metal loss was identified along the 2m of pipe on SPM (HP-Lid) after being inspected via ILI for the first time in 2021. The pipe coating had disbonded and had completely fallen off. Although the corrosion did not lead to a gas leak, the pipeline still required a permanent repair using a Type B welded full encirclement sleeve.
- In 2022, isolated wall defect was identified on the SPM (HP-Lid) pipeline after the first ILI in 2021. The maximum wall loss found was 71%, and approximately 40mm long and wide. The pipeline was repaired using a clock spring.
- In 2022, an ILI anomaly identified on Northern Trunk in 2018 ILI was inspected, which was found to have a corrosion cluster with a maximum wall loss of 90% at the girth weld under a disbonded HSS. Although, this did not result in a gas leak, it impacted the MAOP of the pipeline and was repaired using a Type B Sleeve.
- In 2020, a corrosion cluster was found under a disbonded HSS on Licence 8b pipeline when it was first inspected via ILI in 2018. A maximum wall loss of 97% was recorded in the field which resulted in a major repair using Type B sleeve.
- In 2020, multiple crack like features similar to SCC were identified on a pipe body on SPM (Putney to Stringybark) section as part of an encroachment dig up. One of this features had a maximum depth of 1.58mm (25% wall loss) with an approx. length of 710mm. Although, there was no correlation between the contributing factors and actually finding crack like anomalies similar to SCC on the pipeline, the risk of SCC on SPM, particularly Putney to Stringybark section cannot be completely ignored. Pipeline was repaired using Petro Sleeve (compression sleeve) and wrapped with STOPAQ.

External corrosion threats have been identified on the SPM and have the potential to affect the pipeline integrity resulting in a risk of loss of containment, loss of supply or financial and reputation loss. Depending on the location of loss of containment event, it could have serious operational / customers / reputation and financial impacts to JGN. Since the pipeline downstream of Putney ALBV is a single feed supply, loss of containment at these locations could lead to curtailment or failure of gas supply to North Ryde, Lane Cove and Willoughby PRS supplying more than 160,000 customers including residential homes, small businesses, and large industrial users.

A summary of identified threats and associated risk ratings (as per Jemena Group risk management manual and AS2885.1 Risk Matrix) are provided below. The untreated risk levels as determined by the Jemena and AS2885 risk assessment matrices is shown in Table 2–1: Untreated risk ratings

Table 2–1: Untreated risk ratings

Threat type	Threat cause	Threat consequence	Untreated JGN risk rating	Untreated AS 2885 risk rating
People (safety)	Through wall corrosion leading to loss of containment resulting from corrosion under disbonded HSS due to CP shielding (Pin hole gas leak assuming 20 mm hole results in unacceptable heat contours at 12.6kW/m^2 = 10 m & 4.7 kW/m^2 = 17 m)	Corrosion failure will result in gas escape leading to a massive sinkhole which would potentially shutdown traffic, and would sink surrounding properties and infrastructure, affecting public safety. If the gas leak were to ignite, fatalities would occur within a radius of 17m and buildings would be destroyed.	High	High
Supply		Inability to provide gas to all customers during planned or emergency shutdown (minimum 5 to maximum 21 days) DUE TO necessary reduction of pipeline MOP or lack of pressure containment capabilities. This would impact more than 160,000 customers downstream of Putney ALBV.	Significant	Intermediate
Environmental		Crater formation close to source of leak. Damage to buildings and infrastructure Release of significant amounts of unburnt natural gas to atmosphere.	Moderate	Intermediate
Financial		Necessary permanent repair at location of pipe wall defect. Requiring unplanned or unbudgeted expenditure for repair works (> $1M < $10M)	Moderate	N/A

Figure 2–2: Wednesday, Feb.6, 2019, A 4-inch plastic gas pipe explosion in San Francisco

The risk of gas escape resulting in either; a sinkhole substantially impacting road or leading to jet fire affecting public safety is rated as *HIGH* which is above the broadly accepted level defined in the Jemena Risk Manual[4] and AS 2885 and requires further risk reduction, if the risk cannot be shown as low as reasonably practicable (**ALARP**).

If the problem is not treated JGN will not be able to meet its obligations under the Gas Supply Act 1996 No.38[5]

- *Facilitate the continuity of supply of natural gas to customers;*

  The pipeline along Putney to Stringybark has a history of external corrosion under disbonded coating and a possibility of Stress Corrosion Cracking (as found in 2020 at Cressy Road). If not identified in time, this could lead to pipeline failure, resulting in a pin hole gas leak. Consequently, in the event of a pipeline failure, the supply of gas to customers would be affected, and thus, the current controls (CP and DCVG) do not fully satisfy the requirements of the Act. This includes maintaining pipeline integrity, complying with AS2885.3 requirements, and ensuring the security of supply to customers.

- *Consider the development of efficient and safe gas distribution systems*

  The SPM is an aging asset, primarily situated in a high consequence urban environment and is susceptible to corrosion. Since corrosion serves as a precursor to pipeline failures, it is imperative that these issues are promptly identified and addressed. In the event of a corrosion related failure, a sudden pipeline breach could lead to a pin hole gas leak, potentially resulting in fatalities and damage to public properties due to ignition. Consequently, the existing controls (CP and DCVG) cannot be deemed effective in meeting the requirements for maintaining an efficient and safe gas distribution system by ensuring pipeline integrity.

[4] Refer to: JAA MA 0050 – Group Risk Management Manual – Figure 9: Risk Evaluation, Escalation and Reporting Table

[5] Gas Supply Act 1996 No.38, Part 1 – Preliminary: 3) Objects (1) (b), 3 (a) (b) and 3A (a) (b)

2.2 Consistency with asset class strategy and plans

As part of Jemena Asset Management System (AMS), annual asset condition assessments are performed for all assets, which inform the life expectancy for an asset and informs when preventive actions are required. Based on findings discovered on pipelines of similar vintage, the threat related to undetected corrosion under disbonded HSS on SPM have been identified in an asset condition assessment, namely the JGN Pipeline Asset Performance and Integrity Report (APAIR) and captured within the SPM Integrity Risk Register, which both feed the JGN Asset Class Strategy (ACS).

Our strategy for trunk and primary mains is to prudently extend the life of network assets through proactive condition and assessment programs. Provided the assets meet operational and performance measures, we do not enforce an artificial replacement age. Historically, we have managed trunk and primary mains through spot checks (integrity digs) inspecting the condition of the pipework. We then use the data collected to infer the pipe condition and operational safety elsewhere in similar locations. This practice is acceptable where pipelines are within their design life and the cost of undertaking a spot check is reasonable.

However, for ageing, critical assets such as the SPM, we have changed our strategy for managing the SPM to account for two things:

1. the condition of the SPM is deteriorating; and
2. the cost of integrity digs is increasing, which means spot checks are becoming less efficient.

Our strategy is therefore to de-rate the main where achievable. Where de-rating is not feasible, we will look to reconfigure the pipeline to enable pigging. De-rating reduces the risk from loss of containment, which is especially important given the SPM traverses through densely populated parts of Sydney. Reconfiguring the main to enable pigging means we can detect corrosion and any potential damage early, allowing for prompt repairs to the pipeline before the loss of containment occurs.

To meet customer needs for safety and reliability requirements, JGN monitors and assesses each network asset in compliance with relevant legislative requirements in accordance with AS/NZS 2885 Pipelines and its constituent parts. Jemena as a prudent gas operator, takes into account and complies with relevant standards (such as codes, Australian Standards, guidelines or other requirements) when operating a gas network.

The external corrosion threats which have been identified on the SPM cannot be mitigated with current measures and if not checked can affect the pipeline's integrity resulting in a risk of loss of containment, loss of supply or financial loss. Therefore, reconfiguring the Putney to Stringybark section by installing temporary pigging facilities aligns with Jemena Asset Class Strategy aimed at maintaining the integrity of the SPM.

3. Options

The following options were identified to address the threat of external corrosion on SPM (Putney to Stringybark):

- Option 1: Maintain Status Quo (continue with DCVG every 5 years and 3 integrity digs every year).
- Option 2: Reconfigure the pipeline section to enable in-line inspection.
- Option 3: De-rate the entire SPM - Putney to Stringybark section.

We considered two further options, but have not progressed them in this business case due to the impracticality and high cost associated with them. These options were:

- Conduct hydrostatic pressure testing to assess the integrity of the pipe, on a 1—year frequency.
- Replace the entire Putney to Stringybark section with new pipe.

While both these are technically feasible solutions, both would require significant disruption to customer supply, as well as high capital costs. Hydrostatic testing would provide evidence of the pipeline's current integrity, however the sections being tested would need to be out of service between 14 and 21 days. This part of the SPM has no back up supply and would result in customers having no gas supply during the works. Replacing the Putney to Stringybark pipeline with new, modern materials suitable for ILI would be high cost (~$45 million), as well as extremely challenging from an engineering perspective due to urban encroachment over the past five decades.

3.1 Option 1 – Maintain status quo (integrity dig program)

This option is no longer considered to be an acceptable method of validating the ongoing safe and reliable operation of this pipeline. Knowledge of the pipelines condition and specific threat that cannot be mitigated, requires a more complete understanding of the condition of this asset.

Under this option, JGN would continue undertaking integrity digs in areas where corrosion is inferred to be more susceptible. This can include locations where the pipeline has historically had poor coating, issues with CP and where the pipe is subject to changing wet and dry conditions.

These locations would then be inspected by digging up the main and physically removing the HSS and inspecting the pipeline for any metal loss. The data gained can then be extrapolated across other areas of Putney to Stringybark pipeline. However, this does not give the same level of confidence as undertaking direct inspection of the pipe wall along the full pipeline length. This option would require three integrity digs performed each year on this section of the pipeline and a DCVG survey performed every five years.

3.1.1 Constraints

The following constraints apply to Option 1.

Table 3–1: Constraints for Option 1

Description	Implication
Some sections of pipeline are inaccessible as they are under major road, adjacent to railway lines, or within a reserve or traverse through mangroves.	The condition of the pipeline at these locations will remain unknown, and will be at risk of failure. If dig ups are performed it will require a significant capital cost, in the range of ($500k to $800k for one dig up).
Disbonded HSS cannot be detected through above ground inspection techniques such as DCVG.	Random locations will be selected for dig ups which reduces the probability of finding the actual defect. More length of pipeline would need to be exposed to search for girth welds with disbonded HSS which substantially increase the cost of dig ups.

Description	Implication
There are approximately 625 welds on this section of SPM and it is not possible to confirm which of the welds would result in a failure.	Based on available records, 75% of HSS were found to have disbondment, thus approximately 470 welds would need to be exposed and inspected. If 5m length of pipe is exposed during each dig up activity, it would result in a cost of approximately $141M based on an average cost of $300k per dig.

3.1.2 Benefits and limitations

The expected benefits and limitations of this option are provided in the following table.

Table 3–2: Benefits and limitations of Option 1

Benefits	Limitations	Risk reduction	
		Jemena	AS2885
• Validate identified threats, pipeline condition and confirm MAOP of the pipeline localised to locations where integrity digs have been performed • Allows the repair of any identified defect immediately during dig up such as coating or metal loss anomalies as these can be repaired prior to the occurrence of through wall corrosion at the targeted location. • Avoid initial capital outlay by spreading the cost overtime • Allows finding other integrity issues which are currently unidentified and provides data for trending purposes	• Public safety and security of supply will be at “High” risk due to pipeline failure • No guarantee against high consequence events • Does not address the pipeline overall safety, supply and integrity concerns as the rate of anomaly deterioration / corrosion rate cannot be determined to adequately evaluate pipeline remaining life, thus the pipeline refurbishment activities cannot be efficiently planned. • Integrity dig at a specific location does not represent statistically the entire pipeline condition, thus the overall pipeline condition remains unknown. • The chances of finding a defect in the exact location where an integrity dig takes place is low, can give false indication of condition of the coating and pipeline. • JGN reputation and gas distribution business would be at stake. • The cost of dig ups will continue to rise due to the continuous growth of Sydney population and infrastructure, thus in long term the cost will be disproportionate to the benefit achieved. • Unbudgeted opex would be required to undertake ad-hoc repairs. • This option will cause more frequent disturbance to environment and community.	High	High

3.2 Option 2 – Reconfigure the pipeline to enable in-line inspection – Constructing pigging facilities

ILI involves the use of devices known as pigs, which clean the pipeline and are capable of checking pipeline condition. It requires a pig trap to insert a pig into the pipeline and a receiver at the end of the pipeline to receive the pig once it has travelled the length of the pipeline. The ILI of the pipeline would be used to identify areas where pipe wall integrity has deteriorated, informing where repair works would take place. Once the initial ILI has been performed, ongoing integrity of the pipeline will be maintained by operating in accordance with the JGN ACS.

ILI is the pipeline industry preferred integrity assessment technique to validate the structural integrity of high pressure pipelines. The method measures pipeline wall conditions throughout the length of the pipe and records the location and characteristics of any anomalies found. It is a cost effective method for detecting integrity anomalies such as corrosion (capable of detecting corrosion under HSS), stress corrosion cracking, manufacturing issues and mechanical damage.

This option includes all necessary pre-work for performing the **ILI**, which involves performing feasibility assessment based on the existing bends / tees records and pipeline alignment, modifying existing pipework, installing ILI launcher/receiver infrastructure, detailed selection of an inspection tool, and finally undertaking the ILI inspection. This project will only involve the construction of the pigging facilities, while the actual pigging will be carried out by a subsequent project.

3.2.1 Constraints

The following constraints apply to Option 2.

Table 3–3: Constraints for Option 2.

Description	Implication
Pipeline construction details are not adequately available to confirm that the pipeline is piggable	To determine the piggability of pipeline, feasibility assessment will be required to confirm the characteristics and geometry of the existing bends. The results of the investigation will determine if any pipeline modification are required for the pigging.
There are no pig launcher or receiver facility on existing SPM pipeline (Putney to Stringybark) to allow ILI activity.	Pipeline modification will be required to install temporary launcher and receiver facility.
The connections to the existing stations may cause hindrance or obstruction to ILI tool	Pipeline may need to be inspected in multiple segments or modification of the pipework will be required at these stations.

3.2.2 Benefits and limitations

The expected benefits and limitations of this option are provided in the table below.

Table 3–4: Benefits and limitations of Option 3

Benefits	Limitations	Risk reduction	
		Jemena	AS2885
• Provides quantitative data to accurately assess any anomalies found on the pipe wall and allows targeted repairs to be undertaken to ensure safety and security of supply, including minor repairs prior to worsening of any identified anomaly	• Modification to pipework will be required to implement pigging activity • Due to the configuration of the asset, minimum two launcher / receiver facilities system may be required. • Validation digs will be required to validate pigging results	Moderate	Low

• Reduces number of random dig ups, frequent disturbance to environment and community, and long term cost o by minimising dig up footprints • The ILI will determine the presence of corrosion under disbonded HSS, thus the actual data of the entire pipeline and ability to target problematic areas minimises the likelihood of through wall corrosion occurring. • Ability to conduct ILI without removing the line from service thus maintaining supply. • Determine threats along the pipeline which may have been unidentified prior to ILI and assess the associated risk. • Confirm the ability to continue operating at MAOP as required for a ten-yearly AS2885.3 Remaining Life Review[6] • Ability to establish appropriate intervals to monitor for changes in existing anomalies or newly identified anomalies and determine an effective corrosion rate for all identified anomalies; and • Provides a reliable and comprehensive dataset for continued management of long term integrity of the Pipeline and ensure security of supply	• Not all ILI tools from various vendors have the same detection and characterisation capabilities		

3.3 Option 3 – De-rate Putney to Stringybark Section

This option is to de-rate the entire Putney to Stringybark section of the SPM to operate at secondary pressure. De-rating this section would require excessive augmentation to the secondary network. Consequentially would include reconfiguring trunk receiving stations and decommissioning multiple primary reducing stations such as North Ryde and Lane Cove PRS. This option effectively requires a total re-design of the way this section of the network is operated.

Whilst the pressure reduction will reduce the consequence of a leak failure with ignition, due to lower pressure in the pipeline (reducing the overall risk rating), reducing operating pressure will result in loss of supply to existing customers. Currently, to successfully de-rate this section of SPM to secondary pressure (1,050 kPa), a 50% reduction in total gas load is required. A decrease of this magnitude is not expected to occur in the near future.

Note: A de-rating option is currently feasible only for Lane Cove to Willoughby section of SPM (DN150) without any reduction of load, however, network augmentation is required to maintain supply to existing customers. This project is SPM Integrity Management Stage 2.

3.3.1 Constraints

The following constraints apply to Option 3.

[6] Refer to **AS**2885.3 – Pipeline – Gas and liquid petroleum – Part 3: Operation and maintenance – Section 10.3

Table 3–5: Constraints for Option 3

Description	Implication
Downgrading the primary main to secondary pressure will result in supply constraints	Significant secondary network augmentation will be required to offset supply requirements, increasing the capital expenditure.

3.3.2 Benefits and limitations

The expected benefits and limitations of this option are provided in the table below.

Table 3–6: Benefits and limitations of Option 3

Benefits	Drawbacks	Risk reduction	
		Jemena	AS2885
• Pressure reduction will reduce catastrophic failure (ignition resulting in fatality) to remote. • Reduces overall risk ranking from High to Low (AS2885) • No mandatory requirement to perform ILI as per AS4645. Corrosion threat can be controlled by BAU activities (CP surveys and gas leakage surveys)	• Result in network capacity constraints and loss of security of supply. • The capital expenditure required to augment the network to maintain supply is disproportionate to the benefit achieved as there will still be limited supply to the existing customers.	Moderate	Low

3.4 Options analysis summary

A summary of the options analysis is provided in the table below**.**

Table 3–7: Summary of options analysis

Criteria	Option 1	Option 2	Option 3
Option description	Maintain Status Quo	Reconfigure for ILI – Install Pigging Facilities	De-rate the entire Putney to Stringybark section
`Safety	Fatality risk exists	Majority of defects will be detected prior to failure	Failure rate and consequence will be reduced
Integrity	Limited applicability	Majority of defects will be detected prior to failure	Failure rate and consequence will be reduced
Supply Reliability	Un-planned repairs due to pipe failure	No impact to supply	Result in supply constraint
Regulatory Compliance (AS2885)	Limited compliance	Meets compliance	Meets compliance
Strategic Benefit	Limitation in forecasting future asset integrity planning works	Allows long term capital & operational works planning & expenditure	No major benefit

Criteria		Option 1	Option 2	Option 3
Delivery Constraints		• Restrictions exist on the location of integrity dig (busy arterial road or railway corridor). • Require traffic management.	• Availability and approval for suitable land in road reserve • Feasibility assessment to confirm piggability. • Design of launching receiver system to perform pigging • Modification to existing pipeline will be required.	• Augmenting of network will be required. • Delays to construction due to other utility's and council approvals. • Disturbance to community and environment during construction. • Require traffic management.
Treated Risk Ranking	Jemena	High	Moderate	Moderate
	AS2885	High	Low	Low
Cost Estimate[7] (10 year period – excluding risk)		A$ 1,200 k	A$ 9,888 k	A$ 35,000 k
Options Analysis		○ Does not address the issue	● Fully addresses the issue	◑ Partially addresses the issue
Recommended order of preference for options		**3**	**1**	**2**

[7] Cost estimates exclude the risk cost of failure to JGN and cost is in present value terms (applied discounted cost).

4. Recommendation

Option 2 (Reconfigure pipeline to enable In-Line Inspection – by constructing pigging facilities) is recommended as it makes the pipeline safe and is the lowest total cost option.

At present, the ILI method offers the only way to positively identify all external metal loss in the pipeline in a non-destructive manner. This option will provide a wholistic data set to assess the entire pipeline condition and confirm MAOP and will allow JGN to ascertain critical pipeline asset integrity information that will assist in defining the prudent and efficient long term capital and operational works planning and expenditure.

Accurately validating the pipeline integrity using In-line inspection will mitigate the safety, supply, compliance and integrity risk to low as per AS2885 risk matrix and Moderate in terms of Jemena Risk Management Manual. This option is also the most economical (long term) and efficient option as it meets the requirements of AS2885.3 and Jemena obligations under the Act.

4.1 Economic analysis

Refer to Costs and Benefits Analysis Model – JGN - RIN - 4.3 - 10033695 - SPM - Putney - Stringybark Pigging Facilities - CBAM - 20240628 - Public

Based on the Costs and Benefits Analysis Model, the preferred option is Option 2. It is recommended as it delivers the highest net customer benefit and a positive net financial benefit to investors. This recommendation is solely based on financial metrics.

4.2 Preferred option cost estimate

The cost estimate for Option 2 is provided in the Project Estimating Model (PEM)

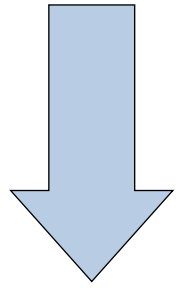
Refer to PEM – JGN - RIN - 4.3 - 10033695 - SPM - Putney - Stringybark Pigging Facilities - PEMO - 20240628 - Public

4.3 Risk outcomes for the preferred option showing how risks is mitigated / reduced.

A risk assessment was conducted to determine the level of risk severity of the untreated risk. The table below shows the summary of results and then the treated risk summary for each option. The risk assessment was undertaken in accordance with the Jemena Risk Manual JAA MA 0050 Revision 10 (22/5/2023).

	UNTREATED IMPACT/CONSEQUENCES							UNTREATED RISK SUMMARY		
Contributing Factors/ Scenario	**Strategic**	**Financial**	**Safety**	**Operational**	**Regulatory & Compliance**	**Reputation**	**Comments**	**Consequence (Highest Impact)**	**Likelihood**	**Risk Level**
(People – Safety) Pipeline integrity issue i.e. metal loss corrosion failure due to CP shielding or metal loss combined with third party damage resulting in Loss of containment with ignition causing jet fire	N/A	Major (Jemena)	Catastrophic (Jemena) Catastrophic (AS2885)	Major (Jemena) Severe (AS2885)	Major (Jemena)	Major (Jemena)	○ SAFETY: CATASTROPHIC – Potential fatality (1 to 5) associated with Loss of Containment anywhere on line ○ REGULATORY: MAJOR – Government/regulator review results in fines and/or litigation/ or loss of license ○ REPUTATIONAL: MAJOR - Reputation impacted in pipeline industry, government and community stakeholders. Significant stakeholders criticism / negativity ○ OPERATIONAL: MAJOR – Loss of Supply to 50,000 to 160,000 customers	Catastrophic (Jemena) Catastrophic (AS2885)	Unlikely (Jemena) Unlikely (AS2885)	High (Jemena) High (AS2885)
(Supply) Inability to maintain supply to all customers during emergency or planned repairs as a result of pipeline failure causing loss of supply to customers downstream of Putney ALBV or Tempe PRS	N/A	Severe (Jemena)	N/A	Major (Jemena) Severe (AS2885)	Major (Jemena)	Severe (Jemena)	○ FINANCIAL: SEVERE – Loss of supply during repair works of SPM (minimum 3 days to maximum 21 days). Financial consequence includes lost transmission and distribution profits, claims for lost profits by customers, breach of supply contracts, etc ○ OPERATIONAL: MAJOR – Loss of supply (minimum 3 days to maximum 21 days), 70,000 plus small customers and 7 large customers affected but less than 15% customers (195,000) ○ REGULATORY & COMPLIANCE: MAJOR – Violation of Gas Supply Act requirement to ensure the continuity supply of natural gas to customers requiring formal explanation by senior management and regulatory review ○ REPUTATION: SEVERE – Persistent public scrutiny for loss supply for large scale loss of supply to large customers including airport and major customers.	Major (Jemena) Severe (AS2885)	Unlikely (Jemena) Unlikely (AS2885)	Significant (Jemena) Intermediate (AS2885)

(Environmental) Through wall corrosion resulting from CP shielding under disbonded HSS result in a gas leak leading to either a crater formation, damage to nearby buildings and/or release of CO_2 to atmosphere	N/A	Serious (Jemena)	Severe (Jemena) Severe (AS2885)	N/A	Severe (Jemena)	Severe (Jemena)	○ FINANCIAL: SERIOUS – ($1M - $10M) impact absorbed under normal operating condition. ○ ENVIRONMENT: SEVERE – Harm to natural environment that can be remediated (<1 year management). ○ REGULATORY & COMPLIANCE: SEVERE –Regulator requires formal explanation and remedial plans, fines or penalties. ○ REPUTATION: SEVERE – Reputational impacted with some stakeholders.	Severe (Jemena) Severe (AS2885)	Unlikely (Jemena) Unlikely (AS2885)	**Moderate (Jemena)** Intermediate (AS2885)
(Financial) Necessary permanent repair of pipe wall defect DUE TO metal loss / external corrosion (<200mm in length, pin hole 50mm) resulting from CP shielding or CP under protection at coating defects or metal loss combined with third damage	N/A	Serious (Jemena)	N/A	Severe (Jemena)	N/A	N/A	○ Financial: SERIOUS - unplanned or unbudgeted expenditure for dig up, hot-tap, repair, and remediation of site (cost between $1M to $10M) ○ OPERATIONAL: SEVERE – Potential restriction of supply for < 3000 customers. Business interruption 1 to 7 days.	Severe (Jemena) N/A	Unlikely (Jemena) N/A	**Moderate (Jemena)** **N/A**



PREFERRED OPTION – Risk assessment summary				TREATED RISK SUMMARY		
Preferred Option/Treated risk	Cost	Benefit	Key Mitigations	Consequence	Likelihood	Risk Level
Option 2 – Reconfigure pipeline to enable In-Line inspection	3. A$ 9,888	- Pigging the pipeline will provide data to accurately assess any anomalies found and if required undertake repairs to ensure safety and security of supply - Pigging can be conducted without removing the line from service thus maintaining supply. - This option will validate the pipeline condition along the pipe wall. - Assist in targeting locations and reduce ongoing cost for the validation dig program; - Once an ILI base line is established, it is feasible to rerun inspection tools at appropriate intervals to monitor for changes in anomalies or new anomalies. - Provide a reliable and comprehensive dataset for continuing management of long term integrity and ensure security of supply;	People (Safety) ○ Confirmation of the Pipeline's ability to continue operating at MAOP in its entirety. ○ Identify pipe wall defects in need of further investigation and possible repair to ensure continued operability of the Pipeline at MAOP in its entirety. ○ Identify areas on the pipe wall potentially subject to active corrosion and undertake further investigation, initiating digs and perform repairs where necessary to prevent loss of containment events. ○ Satisfy the requirements of AS2885.3 Section 6 "Pipeline Structural Integrity".	Major (Jemena)	Rare (Jemena)	Moderate (Jemena
				Major (AS2885)	Hypothetical (AS2885)	Low (AS2885)
			(Supply) ○ Identify areas on the pipe wall potentially subject to active corrosion and undertake further investigation, initiating digs and perform repairs where necessary to prevent loss of containment or loss of supply events.	Major (Jemena)	Rare (Jemena)	Moderate (Jemena)
				Severe (AS2885)	Remote (AS2885)	Low (AS2885)
			(Environmental) ○ Identify anomalies on the pipe wall prior to pipe failure resulting in gas escape.	Severe (Jemena)	Rare (Jemena)	Moderate (Jemena)
				Severe (AS2885)	Remote (AS2885)	Low (AS2885)
				Severe (AS2885)	Remote (AS2885)	Low (AS2885)
				N/A (AS2885)	N/A (AS2885)	N/A (AS2885)