Jemena Gas Networks (NSW) Ltd

Catalytic Heaters Project Package Phase 2

Options Analysis

BAB-RFT-000068

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Jemena

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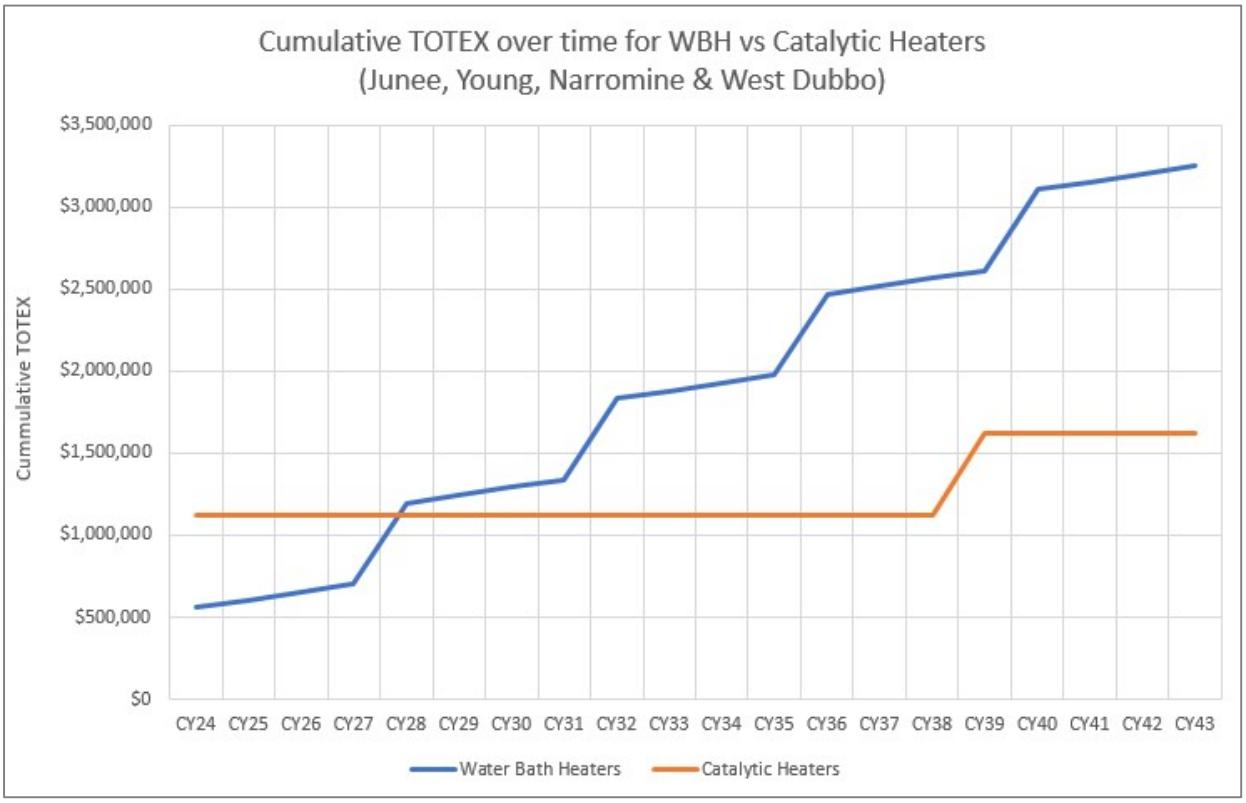
EXECUTIVE SUMMARY

Natural gas needs to be heated prior to a significant pressure reduction to ensure the cooling effect created by the Joule-Thomson effect does not cause damage to connected process equipment or impact the downstream gas network and its customers.

At the West Dubbo Packaged Offtake Station (**POTS**), Narromine POTS, Junee Trunk Receiving Station (**TRS**), and Young TRS, the heating of supply gas is provided by immersive Water Bath Heaters (**WBH**). These heaters are large, prone to breakdown and incur significant operating expenditure to keep in a reliable state.

Heating via catalytic heaters (where applicable) is a viable alternative to WBH's that doesn't require significant expenditure for upkeep and maintenance and is significantly smaller and more energy efficient.

The direct savings achieved by replacing the WBH's with catalytic heaters offsets the expenditure for their installation directly following the point in time when the costly 4-yearly internal inspections would occur. As seen in the expenditure modelling below.



The option to replace the WBH's at West Dubbo, Narromine, Junee and Young with catalytic heaters and mothballing / isolating the existing WBH's, is the preferred option given its net financial benefit to the business with only minimal associated limitations. This proposed project is Phase 2 of a four (4) Phase program to replace a majority of the WBH fleet. Phase 1 is currently in construction.

1. INTRODUCTION

1.1 PURPOSE

The purpose of this document is to summarise the available options in the installation of Catalytic Heaters at West Dubbo POTS, Narromine POTS, Junee TRS and Young TRS and identify the most prudent options to address the key issues required to improve safety and reduce ongoing operating expenditure.

1.2 OBJECTIVES

The objectives of this report are as follows:

- Assess the long term viability of catalytic heaters vs water bath heaters from preventing excessive cold and associated ill effects on the downstream gas distribution networks;
- Provide a high level desktop cost of the available options; and
- Confirm the most prudent option in terms of Total Expenditure (**TOTEX**).

2. PROJECT DETAILS

2.1 PROJECT BACKGROUND

The West Dubbo POTS, Narromine POTS, Junee TRS and Young TRS supply natural gas to their associated regional centres by taking supply from high pressure gas transmission pipelines and reducing the pressures down to distribution pressures for the local gas network with eventual supply to customers.

Each of the high pressure facilities is equipped with a Water Bath Heater that submerges a portion of the process piping in heated water. The water within the WBH is heated by burning a portion of the supply gas (fuel gas). The heated water then raises the temperature of the gas within the process piping prior to pressure reduction via control valves.

Figure 1 : West Dubbo POTS WBH

Figure 2 : Narromine POTS WBH

Figure 3 : Junee TRS WBH

Figure 4 : Young TRS WBH

Pressure reduction of natural gas results in a cooling of the gas via the Joules-Thomson effect. Inadequate preheating of the natural gas may result in:

- condensation of higher molecular weight components of natural gas; or
- icing-over or condensation on process equipment and piping.

Liquids within the gas distribution system can damage connected devices downstream of the pressure reduction point while resulting ice or condensation on connected equipment may damage coatings, degrade seals or mechanical fixtures and break connected equipment.

WBH's ensure that the natural gas is adequately heated but are costly to run and maintain. Heating of the water requires a significant amount of energy and hence a significant amount of fuel gas. They also require ongoing maintenance and routine internal inspections that are costly and can be difficult to perform.

A different technology is available in the market (where applicable), being catalytic heaters, that is able to preheat the gas supply via an enclosed heating element that directly heats the process piping. This heating is more efficient by directly heating the process piping, removing the need to heat the immersion water which has a high specific heat capacity and hence energy intensive to heat.

Following on from the Catalytic Heater initiative as assessed by the Jemena End-to-End Project[1] in 2021, substituting Water Bath Heaters with Catalytic Heaters was a viable option for trial and further implementation across the JGN fleet.

[1] Refer to initiative GDAM11

2.2 ASSUMPTIONS AND CONSTRAINTS

Table 1 : Assumptions

No.	Description	Implication	Criticality
1	The catalytic heaters will have sufficient heating output to prevent liquid dropout and ice formation at these stations.	Damage to process and downstream equipment connected to the gas distribution network.	High
2	The catalytic heaters will be hazardous area compliant.	Additional work or measures required to ensure compliance depending on selected equipment.	Medium
3	Supply side pressure (in kPa) won't increase in the future.	Additional pressure differential resulting in a greater cooling effect from gas expansion and requiring greater heating beyond limits of catalytic heaters.	Medium
4	The total annual fuel gas usage of the Catalytic Heaters is less than the total annual fuel gas usage of the WBH's per individual site.	The benefits realisation of gas usage savings may be diminished and fugitive emissions may be more.	Medium
5	West Dubbo POTS, Narromine POTS, Junee TRS and Young TRS will continue to supply gas for the next 20 years.	Impact the prudency of investment in preferred options.	Low

3. CREDIBLE OPTIONS

The following options were identified for the 4 sites at West Dubbo, Narromine, Junee and Young as part of the Phase 2 works package :

- Option 1: Maintain Status Quo
- Option 2: Mothball Water Bath Heaters (without replacement)
- Option 3: Install Catalytic Heaters and mothball / isolate the current WBH's.
- Option 4: Install Catalytic Heaters and decommission / scrap the current WBH's.

The credible options are explained in detail below.

3.1 OPTION 1: MAINTAIN STATUS QUO

3.1.1 SCOPE

This option involves no change to the existing stations.

3.1.2 BENEFITS

This option incurs no additional CAPEX or OPEX.

3.1.3 LIMITATIONS

Although there is no additional immediate OPEX, the ongoing cost of maintaining these WBH's will continue to grow in the future years ahead, especially with the significant increase observed in the internal inspections projects of the WBH which are scheduled in every 4 years.

Theoretically, most WBH's are required to perform during the winter periods when the ambient temperatures are low and gas consumption is high. An operational option was to switch off these WBH during the summer periods, however, the water within the WBH is required to be continually heated (above 50^{o}C) and treated to prevent microbial induced corrosion, hence, cannot be shut off periodically.

3.1.4 SUMMARY

This option is not considered the preferred option due to the limitations above and the other options having greater benefits in the long term.

3.2 OPTION 2: MOTHBALL WATER BATH HEATERS (WITHOUT REPLACEMENT)

3.2.1 SCOPE

This option involves mothballing the WBH's at the West Dubbo and Narromine and isolating the WBH's at Junee and Young facilities without using an alternative gas heating method to remove the associated OPEX. Mothballing and isolating the WBH's, as opposed to a complete decommissioning is preferred, to satisfy the upstream operational conditions imposed by a third party and the potential for future pipeline owners to alter conditions.

Mothballing of the WBH's is estimated at a one-off OPEX cost of $178K. If a WBH were to be recommissioned, additional OPEX would be required.

3.2.2 BENEFITS

Maintenance of the WBHs involves (estimated):

- Regulator maintenance and upkeep: approximately $12K per annum, per site and
- 4-yearly internal inspections and repairs of :
    - $160k per WBH (Junee, Young)
    - $95k per WBH (West Dubbo, Narromine)

Removal of the WBH's would also eliminate the risk of working at heights that exists for our technicians when maintaining and inspecting the WBHs.

3.2.3 LIMITATIONS

Removing the WBH's without installing an alternative heating method would cause icing of portion of the POTS / TRS equipment / piping and potential brittle failure of the downstream 210kPa plastic gas networks at West Dubbo, Narromine and Junee. Young TRS has a slightly higher tolerance to lower temperatures on the downstream gas network as it is constructed of secondary steel (1050kPa). This would introduce two new risks to the gas distribution network as per Table 2.

Table 2 : Risk assessment for introduced risks resulting from removal of WBHs.

Risk description	Risk assessment		
	Consequence	Likelihood	Risk
Loss of supply to downstream customers resulting from brittle failure of the plastic gas mains supply.	Severe	Likely	High
Loss of supply to downstream customers resulting from damage to the POTS / TRS equipment and piping from icing or condensation.	Major	Unlikely	Significant

3.2.4 SUMMARY

This option offers significant OPEX reduction, however, it introduces risks that are intolerable for Jemena and customers connected to the gas distribution network downstream of the POTS.

3.3 OPTION 3: INSTALL CATALYTIC HEATERS & MOTHBALL / ISOLATE WBH'S

3.3.1 SCOPE

This option involves the installation of at least two (2) pipeline catalytic heaters per site, followed by the mothballing of the existing WBH's at West Dubbo and Narromine and isolating the existing WBH's at Junee and Young.

The mothballing / isolation activities would incur a one-off OPEX cost of $178K and the installation of the catalytic heaters would incur a CAPEX cost of $928K across the 4 sites.

Installation of the Catalytic Heaters involves:

- 2x Catco enclosed heater packages with 4 tiles each;
- Natural gas fuel line to be connected from the outlet of the station;
- Installation of appropriate metering to the fuel line to measure gas consumption;
- Fabrication and installation of "Caution Hot" signage; and
- Fabrication and installation of weather shields per enclosed heater package.

Mothballing / Isolation of the WBH's involves:

- Isolation of the WBH's to be capped at the flange;
- Draining and treating the WBH water prior to disposal;
- Visual inspection of WBH integrity (using borescope where necessary);
- Blanketing pressure containing components with $N_{2;}$ and
- Installation of desiccant sacks to prevent moisture ingress in all other enclosed portions.

3.3.2 BENEFITS

This option would remove the OPEX associated with maintaining these four (4) WBH's ($3.3M over 20 years). The catalytic heaters are maintenance free and incur no ongoing OPEX besides possible heater tile failures due to bad weather. They also introduce no additional risk to the business.

The cost spent to install the catalytic heaters provides a net benefit in TOTEX of the business after the second cancelled internal inspections of the WBH's. This is shown in Figure 5 where the second year of cancelled internal inspections is modelled in CY28. At this point, the cumulative TOTEX for catalytic heaters is less than the WBHs.

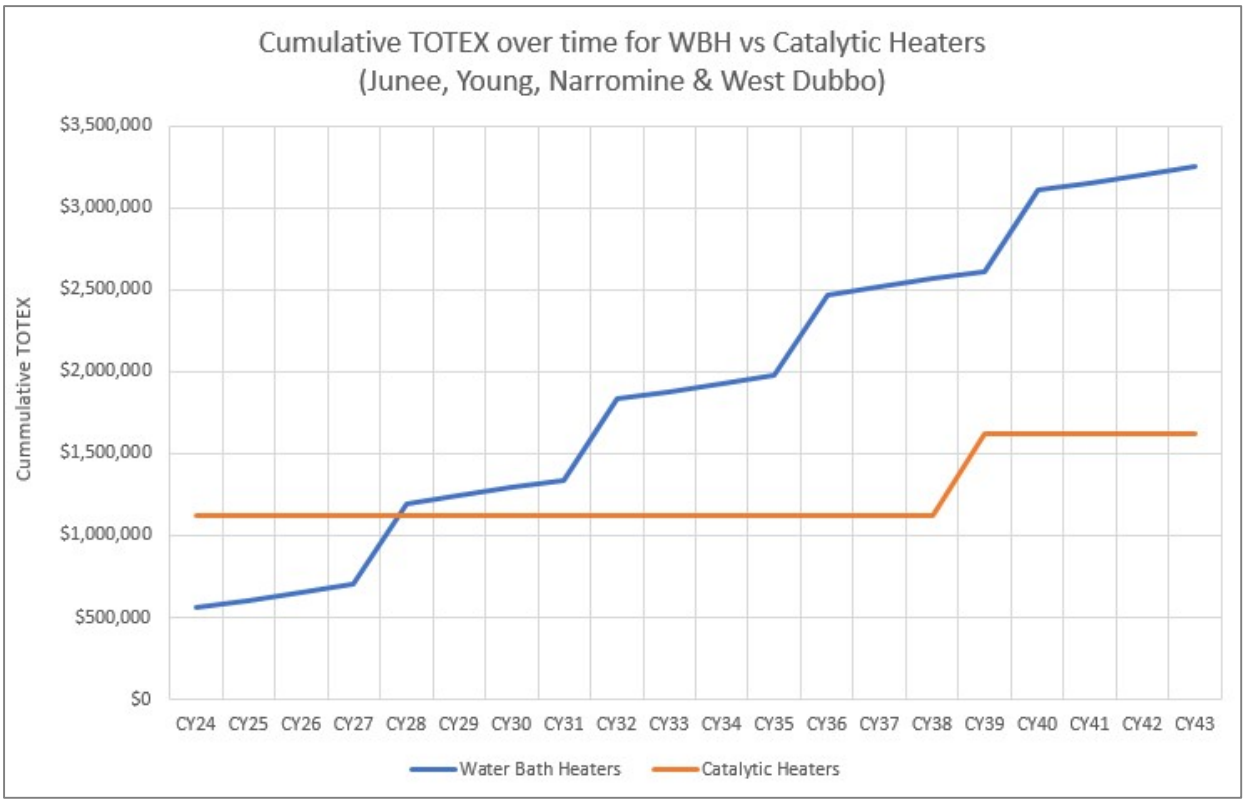


Figure 5 : Cumulative TOTEX over 20 year for mothballing WBHs vs catalytic heaters.

The mothballed WBH's will be preserved in place to ensure the business is able to react to an increase in supply pressure which may be beyond Jemena's control. The mothballing of these WBH's ensures the Regulatory Asset Value (**RAB**) remains until its design life, or in the event that they need to be scrapped / decommissioned, they will be removed from the RAB and expensed under OPEX.

3.3.3 LIMITATIONS

The catalytic heaters may not have sufficient heating ability, should the supply pressure be increased at West Dubbo POTS or Narromine POTS. If this were to occur, Jemena has the optionality to either return to service the mothballed WBH's which would incur additional OPEX or install additional pipeline or pilot regulator catalytic heaters which would incur additional CAPEX. In the future, there may be other heating alternatives that are more economical which would be investigated. Junee TRS and Young TRS are supplied off different pipelines to that of West Dubbo and Narromine and have operated at those lower pressures since inception.

3.3.4 SUMMARY

This option has the best net benefit to the business over the next 10 and 20 years and is the lowest cost option when considering the ongoing operating costs of the existing WBHs. It also provides additional optionality in the future, in the event of changing third party operations. Hence, this option is the recommended option.

3.4 OPTION 4: INSTALL CATALYTIC HEATERS & DECOMMISSION / SCRAP WBH'S

3.4.1 SCOPE

This option involves decommissioning and scrapping the existing WBH's at each site and installation of at least two pipeline catalytic heaters per site. The decommissioning activities at all four (4) sites would incur a one-off OPEX cost of $178K and the scrapping costs of $1,069K. The installation of the catalytic heaters would incur a CAPEX cost of $928K across the 4 sites.

Installation of the Catalytic Heaters involves:

- 2x Catco enclosed heater packages with 4 tiles each;
- Natural gas fuel line to be connected from the outlet of the station;
- Installation of appropriate metering to the fuel line to measure gas consumption;
- Fabrication and installation of "Caution Hot" signage; and
- Fabrication and installation of weather shields per enclosed heater package.

Decommissioning of the WBH's involves:

- Draining and treating the WBH water prior to disposal;
- Mechanical and electrical isolation of WBH and its components; and
- Removal from site and scrapping of the WBH and its components.

3.4.2 BENEFITS

This option would remove the OPEX associated with maintaining the WBH's ($3.3M over 20 years). The catalytic heaters are maintenance free and incur no ongoing OPEX besides possible heater tile failures due to bad weather.

The cost spent to install the catalytic heaters and decommission the WBH's provides a net benefit in TOTEX of to the business after the fourth scheduled of cancelled internal inspections of the WBH's. This is shown in Figure 6 where the fourth scheduled of cancelled internal inspections is modelled in CY36. As opposed to option 3, the upfront cost of decommissioning and scrapping of the WBH pushes out the breakeven comparison in TOTEX to CY36 for catalytic heaters versus WBH's.

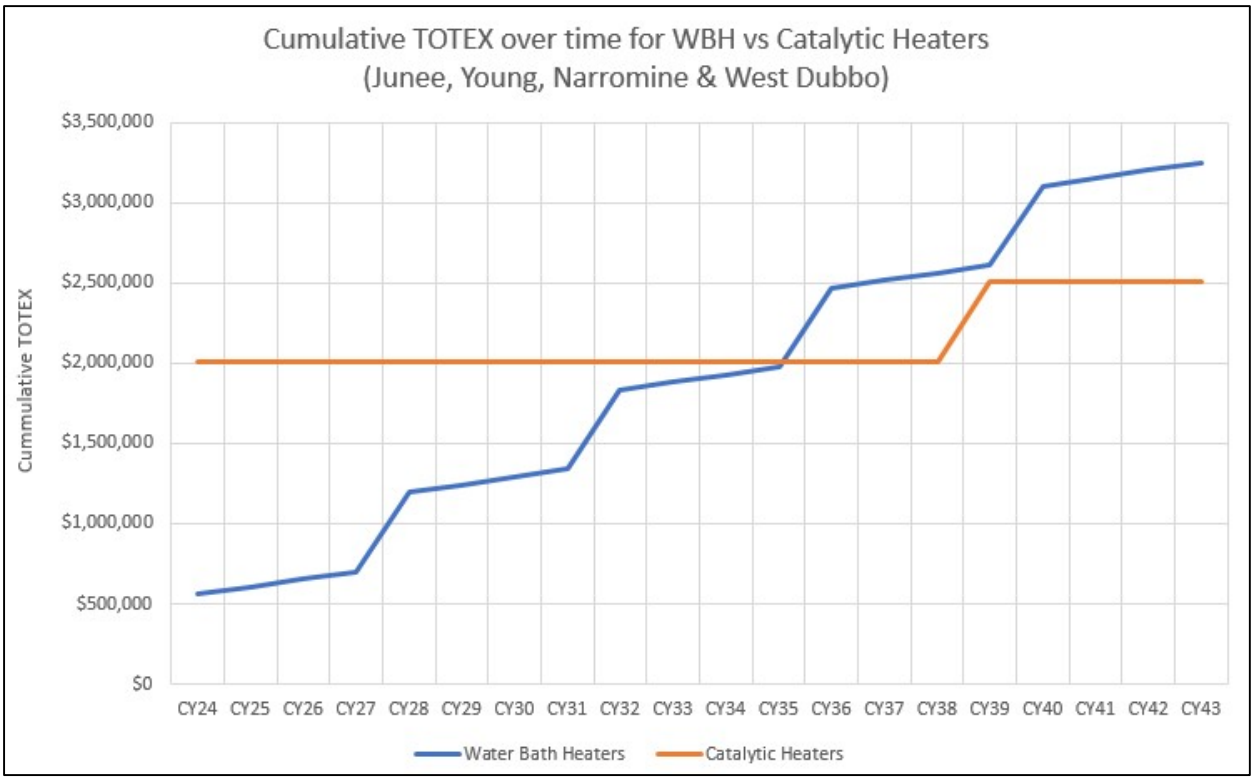


Figure 6 : Cumulative TOTEX over 20 years for decommissioning WBHs vs catalytic heaters.

3.4.3 LIMITATIONS

The decommissioning / scrapping of these existing WBH's requires a significant up front TOTEX of $2M. This includes the scrapping costs of the WBH's against their current Regulatory Asset Base (**RAB**) values (approximately $267K each), which would need to be expensed under OPEX.

The catalytic heaters may not have sufficient heating ability, should the supply pressure be increased at West Dubbo POTS or Narromine POTS. If this were to occur, Jemena has the optionality to either return to service the mothballed WBH's which would incur additional OPEX or install additional pipeline or pilot regulator catalytic heaters which would incur additional CAPEX. In the future, there may be other heating alternatives that are more economical which would be investigated. Junee TRS and Young TRS are supplied off different pipelines to that of West Dubbo and Narromine and have operated at those lower pressures since inception.

3.4.4 SUMMARY

This option still has a net benefit to the business over the next 20 years, however requires significant upfront TOTEX of $2M, especially in CY24 in scrapping the WBH's and removal from the RAB. In the future, in the event of changing third party operations, the WBH's cannot be reinstated and only additional catalytic heaters can be installed . Hence, this option is the not recommended.

3.5 COMPARISON OF OPTIONS

Table 3 : Options Summary Including Risk, Benefits and Cost

Criteria	Option 1	Option 2	Option 3	Option 4
Option Description	**Maintain Status Quo**	**Mothball / Isolate Water Bath Heaters (without replacement gas heating)**	**Install Catalytic Heaters and mothball / isolate the current WBH's**	**Install Catalytic Heaters and decommission / scrap the current WBH's**
Cost	No Capex	$0.2M OPEX	$1.1M TOTEX	$2.0M TOTEX
Benefit	• No CAPEX or OPEX change • Future flexibility for increases to supply pressure	• $2.79M net benefit over 20 years	• $1.7M net benefit over 20 years • No additional risks introduced • Remove working at heights risk	• $0.74M net benefit over 20 years • No additional risks introduced • Remove working at heights risk
Limitation	• Ongoing OPEX to maintain WBHs totalling $3.3M over 20 years.	• Introduce supply risks not present for other options. • Requires further expenditure to reinstate WBHs in future if required (estimated at $356K).	• Not the lowest cost option. • Requires further expenditure to reinstate WBHs in future if required (estimated at $356K). Additional catalytics can be installed as an alternative.	• The decommissioning / scrapping of the existing WBH's would need to be expensed at approx. $267K each ($1.07M total for CY24). • The WBH's would need to be removed from the RAB. • Not the lowest cost option. • The WBHs would not be able to be reinstated in future if required. Only additional catalytics could provide an alternative solution.
Treated Risk Rating	Not applicable	High	Not applicable	Not applicable
Recommendation Ranking	4 Not recommended	3 Unacceptable Risk	**1** **Recommended**	2 Not recommended

4. RECOMMENDATION

4.1 RECOMMENDED SOLUTION

This proposed project is Phase 2 of the planned program to replace the WBH fleet and Phase 1 is currently in construction scheduled to be completed early 2024.

The recommended option is **Option 3**, which is to install catalytic heaters at West Dubbo POTS, Narromine POTS, Junee TRS and Young TRS. This option incurs $1.1M in upfront TOTEX, however, it produces a net saving to the business by removing costly OPEX for the maintenance of the existing WBH's at these sites. This savings is achieved without introducing any additional risks to the business.

Part of the scope of Option 3 is to retain the existing WBHs through mothballing to be available for future use or install additional catalytic heating on the pipeline and regulators. This ensures that Jemena maintains its ability to react to changing supply pressures if it occurs in the future.