Australian Pipeline Trust

ROMA – BRISBANE PIPELINE NETWORK

Optimised Replacement Cost Study

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Prepared by

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1. SUMMARY

This document presents a review of the report "Optimised Replacement Cost of Roma Brisbane Pipeline" prepared by Sleeman Consulting (Sleeman).

This review was undertaken to identify material technical and cost differences between the Sleeman optimised design and the Venton and Associates (Venton) optimised design.

Venton considers that the modelling approach adopted by Sleeman has resulted in a pipeline solution that is too small (in both diameter and compression) to supply the variable load imposed on the pipeline by current loads. This, together with construction cost estimates that do not reflect current costs has resulted in the Sleeman optimised replacement cost being approximately 80% of that estimated by Venton for a pipeline that meets current loads only.

Venton considers that if:

1. Sleeman developed a design using unsteady state modelling to accommodate the dominant load characteristics imposed by current peak load power stations Sleeman would conclude that the optimised design requires a larger diameter pipeline, and;
2. If Sleeman re-assessed the unit pipeline construction and compressor station cost to reflect current costs, particularly compression and construction costs, and;
3. If Venton and Sleeman adopted a common approach to estimating the cost of interest during construction, and;
4. If the contingency in the Sleeman estimate was re-assessed to reflect the quality of the estimate;

Then the estimated cost of the Sleeman and the Venton optimised designs would be similar, within the limits of the high level estimating accuracy.

Sleeman only considered current pipeline load, whereas Venton considered current and future load. In order to facilitate "like with like" comparison Venton considers that based on current loads only the design would be revised to a DN 500 (Wallumbilla to Swanbank) / DN 400 (Swanbank to Gibson Island) design with a single compressor station operating at 10.2 MPa The Venton optimised design based on a whole of forecast period as previously provided remains unchanged.

2. DESIGN APPROACH

Venton and Associates (Venton) recommended the Roma Brisbane pipeline would be optimised by a DN 500 pipeline with 2 installed compressor stations, and designed for 12.5 MPa to satisfy the forecast 2017 load.

As noted in Section, to meet the current load Venton recommends a DN 500 pipeline with a single mid line compressor station, with a maximum operating pressure of 10.2 MPa.

Sleeman recommends a DN 350 pipeline between Wallumbilla and Arubial and a DN 400 pipeline between Arubial and Gibson Island, with two compressor stations to satisfy the notional 2005 load.

There are fundamental differences in the hydraulic modelling approach undertaken by Sleeman and Venton. These have a significant impact on the optimised design. Venton considers that the approach adopted by Sleeman is incorrect as it does not recognise the characteristics of the gas supply and demand. The result is that Sleeman proposes a smaller pipeline, and this lowers the cost of the proposed design.

2.1 TRANSIENT VS STEADY STATE MODELLING

The hydraulic modelling undertaken by Venton adopted an unsteady state modelling approach because the characteristics of the power station loads (5 part day operation followed by 2 days idle, and weekly fuel demand supplied in equal daily quantity over 7 days) require unsteady state modelling to adequately reflect the "pack and draft" nature of the pipeline's operation.

The hydraulic modelling undertaken by Sleeman adopted a steady state modelling approach. He states (Section 5.1 para 2) that:

it is widely accepted that the use of steady state rather than transient modelling techniques will lead to conservative pipeline sizing decisions.

The "wide acceptance" relates to the application of steady state modelling to a pipeline whose demand fluctuates on a daily basis.

However this is not a suitable technique for the RBP as:

1. Venton's optimal pipeline is based on the Swanbank power station consuming gas at a rate of 65 TJ/d for 14 hours, Monday – Friday. On Saturday and Sunday the power station effectively consumes nothing.
2. Venton's optimal pipeline is based on the Swanbank power station injecting gas at a rate of 27 TJ/d each day.
3. During Saturday and Sunday, these gas receipts create a positive pipeline imbalance, and this is stored in the pipeline. Compression is required to raise the pipeline pressure.
4. On Monday to Friday 40% more gas is delivered from the pipeline than is received into it. The deficit is supplied from line pack. The delivery rate (2.7 TJ/h) is 240% of the receipt rate (1.125 TJ/h).

This very large daily imbalance means that a steady state solution is non conservative.

Although smaller pipelines may, with compression, be able to deliver the gas, the physical size of the pipeline (internal volume) must be sufficient to store the positive line pack during the "pack period" (Saturday and Sunday), and to deliver the line pack at the required rate during the "draft period".

Steady state modelling does not consider the "pack and draft" nature of the pipeline's operation, and is likely to under-predict the diameter by using a simple flow basis.

Overall the RBP capacity cannot be analysed using steady state modelling due to the characteristics of the power station load. In particular steady state modelling does not take account of

- the requirement for gas to be stored in the pipeline during periods when the power station is idle
- the fact that the gas supply is constrained to the average of the weekly pipeline demand – that is, in 2005, the average inflow is approximately 140 TJ/d. The fact that the pipeline, if provided with an unlimited supply, could transport approximately 180 TJ/d is not relevant.

2.2 RECEIPT CHARACTERISTICS

Sleeman has assumed that gas is received at the same rate that it is delivered. This is theoretically the most efficient method of operating a pipeline but ignores the realities of power station load characteristics for this pipeline, where that the weekly (5 day) delivery is received into the pipeline at a constant rate averaged over 7 days.

The Sleeman approach is inconsistent with the commercial requirements of the shippers to peak load power stations[1].

2.3 RECEIPT LOCATIONS

Sleeman has identified that the gas supplied from Woodroyd/Peat/Scotia is substantial and has proposed a smaller diameter pipeline between Wallumbilla and Arubial, consistent with the steady state demand.

Venton recognises that there may be some validity in this proposal.

It is possible that further unsteady state modelling of the pipeline by Venton may show that the pipeline diameter could be reduced between Wallumbilla and Arubial. If this is true, it is probable that compression costs will increase, because the volume of the DN 500 optimised pipeline design is used in the unsteady state modelling to absorb line pack.

2.4 METROPOLITAN PIPELINE

Sleeman proposes a thin wall thickness (7.1 mm) pipe installed in the metropolitan section of the pipeline on the basis that it operates at a hoop stress of 30% of SMYS. While this satisfies the basic "no rupture" objectives of AS 2885.1, the 7.1 mm pipe has modest resistance to penetration.

Venton adopted a design thickness of 10 mm for the metropolitan pipeline section on the basis that the high population density through the metropolitan section, and the fact that the

[1] Sleeman (Page 8, Paragraph 1) indicates that load profile data was not made available for modelling. The characteristic fuel receipt and delivery required of various power stations is provided in Section 4 of the Venton Report.

pipeline route shares an easement with major power transmission lines means that pipeline safety should be afforded a high level of importance.

These parameters combined require effective penetration resistance as a base design criteria because:

1. It controls the risk to people by effectively eliminating the risk of puncture and;
2. It controls the risk of damage to overhead power transmission lines (and the associated security of electricity supply that would result from pipeline puncture and subsequent ignition of the released gas.

The impact of this difference is that the Venton design cost is approximately $2 million higher than the Sleeman design, because of the increased steel tonnage.

2.5 NEW ROUTE

Sleeman has adopted a similar route to that selected by Venton between Redbank Plains and Gibson Island, although Sleeman has decided to retain the existing route between Haigslea and Redbank Plains.

The effect of this is that Sleeman advises (Section 5.1 (d) – Page 8) that the overall length of the pipeline is 454 km, similar to that of the alternative route proposed by Venton.

However it is noted that the total pipeline length estimated by Sleeman is 613 km. The total length estimated by Venton was 584 km. It is believed that part of this difference relates to an existing loop (loop 3) downstream of Arubial, and to the Swanbank lateral.

2.6 DELIVERY CAPACITY AND ADEQUACY

The pipeline proposed by Sleeman has the following parameters:

- Pressure
  - 12.5 MPa between Wallumbilla and Redbank
  - 4.5 MPa between Redbank and Gibson Island
- Diameter
  - DN 350 Wallumbilla to Arubial
  - DN 400 Arubial to Gibson Island,
- Compression - single 4.57 MW compressor station at Wallumbilla

The analysis below demonstrates that this pipeline is not capable of satisfying the 2005 load adopted by Venton and Associates. The same 2005 load was used by Sleeman Consulting.

The following figures show outputs from Flowtran. These outputs are based on an unsteady state design.

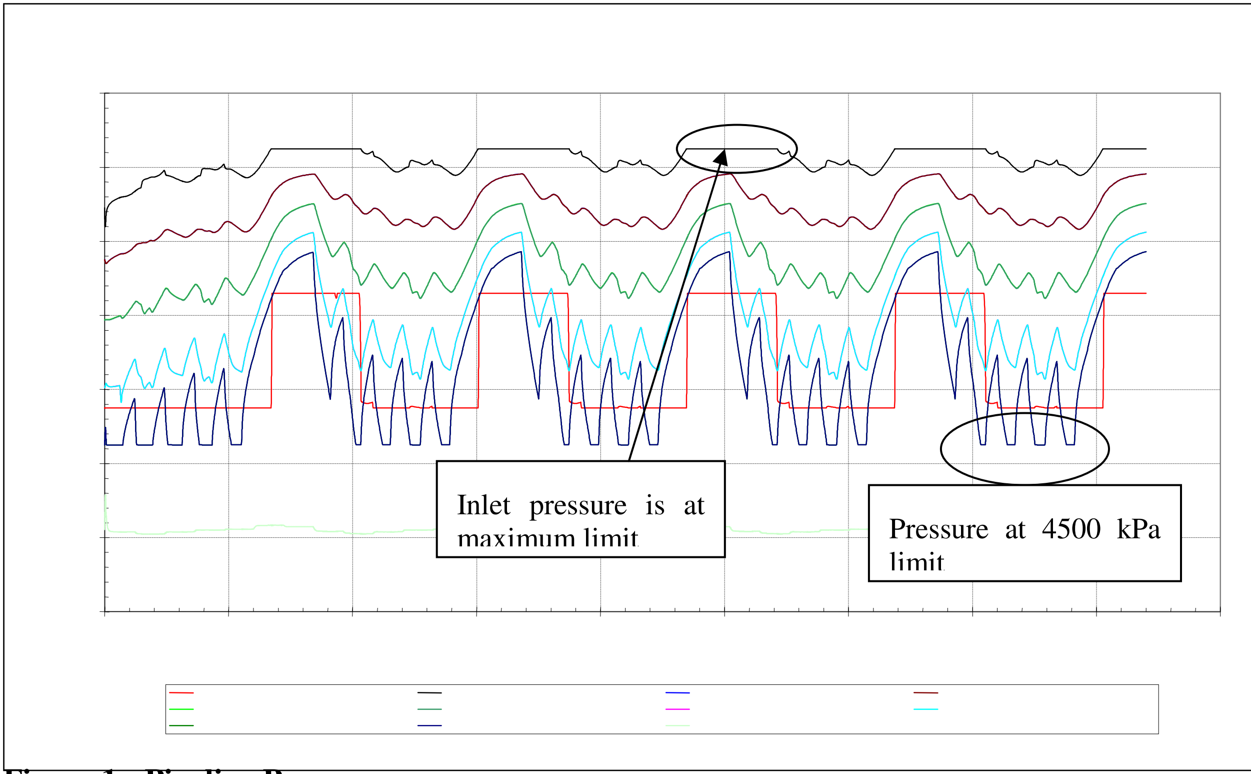

Figure 1 - Pipeline Pressures

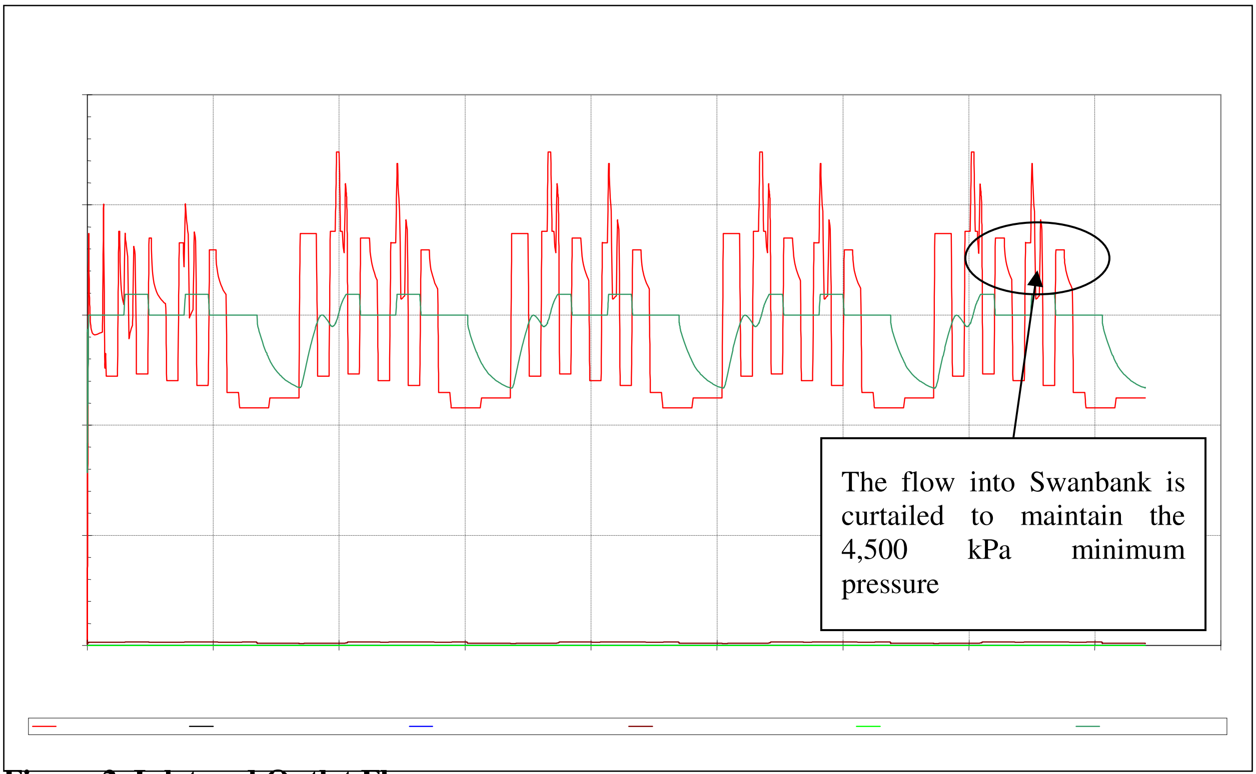

Figure 2 Inlet and Outlet Flows

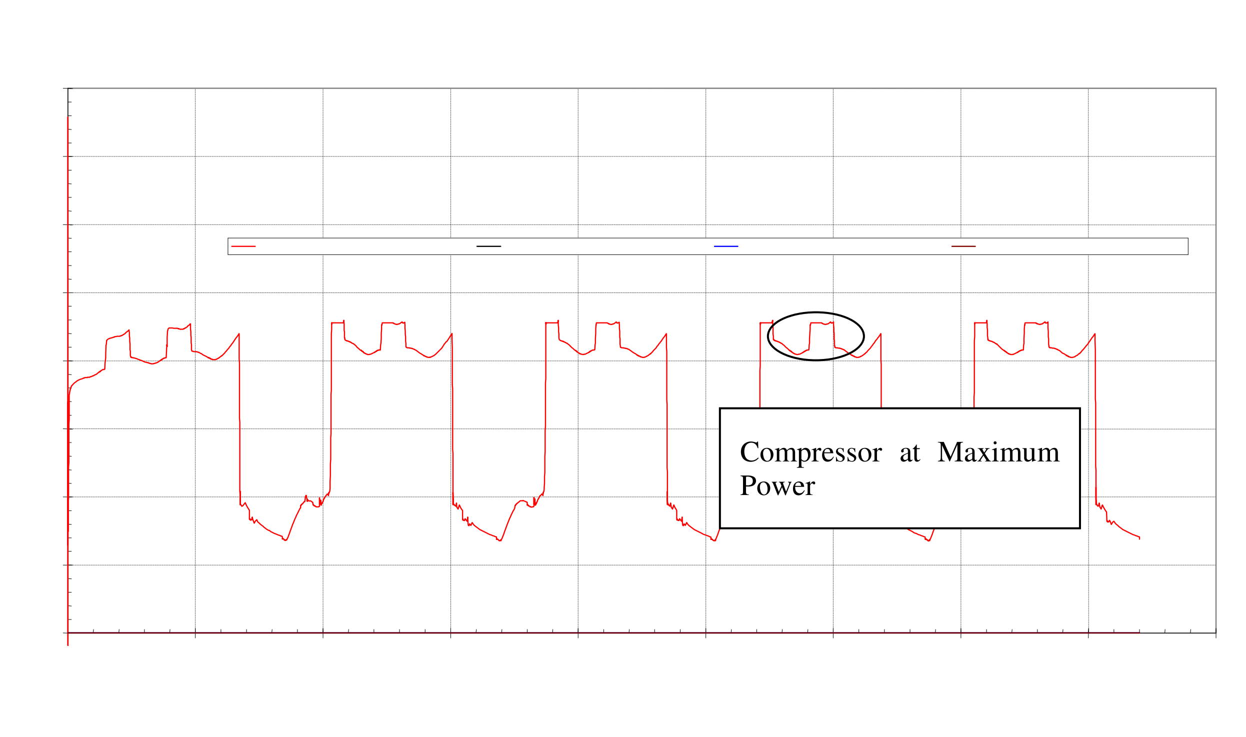

Figure 3 Compressor Power

Figure 1 - Pipeline Pressures shows that:

1. The compressor discharge pressure at Wallumbilla reaches maximum inlet pressure about 2/3 through the weekend pipeline packing cycle, and remains at that value for about 50% of the weekly cycle.
2. The delivery pressure at Swanbank falls to the minimum value (4,500 kPa) on the 2nd, 3rd, 4th, and 5th cycle day. When the model maintains the delivery pressure at minimum value, if means that flow to the load is curtailed.

Figure 2 Inlet and Outlet Flows shows that:

1. The pipeline inlet flow is curtailed during each weekend packing cycle, because the pipeline inlet pressure (Wallumbilla) is at the maximum pressure, and it is not possible to accept more gas without installing another compressor in the pipeline.
2. The delivery flow to the Swanbank power station is curtailed on the 2nd, 3rd, 4th, and 5th cycle day (instead of the load being a rectangular shape, the flow at the latter part of the delivery cycle is truncated. This is consistent with the pressure at the Swanbank delivery point falling to the minimum value.

Figure 3 Compressor Power shows that the compressor power cannot be utilised during the packing part of the operating cycle (Saturday and Sunday). This is because the pipeline inlet pressure is at the maximum possible value.

Note that a check calculation was run to test the Sleeman Consulting steady state design This showed that in steady state, the Sleeman Consulting design would deliver nominally 180 TJ/d. This was the licenced capacity of the pipeline in 2005 but as discussed above the RBP capacity cannot be analysed using steady state modelling. Unsteady state modelling shows the Sleeman Consulting optimised pipeline cannot meet 2005 load.

3. CAPITAL COST ESTIMATES.

3.1 GENERAL

The Sleeman capital cost of the optimised pipeline designed to supply a 2005 load is $364M.

The Venton capital cost of the pipeline constructed in 2005, but optimised to reflect the forecast demand between 2005 and the peak year in the forecast period (2017) is $456 million.

As outlined in section 1 of this report Sleeman considered current pipeline load, whereas Venton considered current and future load. In order to facilitate "like with like" comparison Venton considers the capital cost of the pipeline constructed in 2005 to reflect a 2005 load is $427.3 million, using costs from the original report factored to the 2005 Venton design outlined in Section 1 of this report.

There are two reasons for the cost difference between the two pipelines designed for 2005 load:

1. The technical difference in the design due to the requirements of the power station loads, as discussed above.

   Venton considers that the technical design offered by Sleeman will not satisfy the required characteristics of the pipeline.

2. Differences in the construction cost estimate, and the estimated allowance for project costs (contingency and interest during construction).

The capital cost estimates for the Venton optimised design was prepared by a professional pipeline estimator who has been involved with developing capital cost estimates for pipeline projects for approximately 20 years. This experience is current, including the preparation of capital cost estimates for major gas pipeline projects proposed in Queensland (PNG Gas Project).

Checks against other estimates, actual pipelines, and construction cost indices provide a basis for developing confidence in the estimate.

Venton reviewed the estimate and considers it reasonably reflects current costs.

3.2 REVIEW OF SLEEMAN ESTIMATE

Venton (and Aust-Wide Estimating) reviewed the Sleeman estimate (Attachment 1). The review considers that:

1. The line pipe cost is nominally the same as that developed for the Venton estimate, having regard to the differences in diameter and pipe grade.
2. The Sleeman construction estimates are generally lower than the Venton costs and appear to reflect costs that are typical of the mid 1990's, not those that apply in 2005.
3. The Sleeman construction estimates for DN 150, 200, 250, 350, and 400 pipe ($101M) are 46% lower than the Venton estimates. While part of this may relate to the smaller diameter DN 350 / DN 400 pipe between Wallumbilla and Redbank

(Swanbank in the Venton estimate), the main reason for the difference is believed to relate to the currency of construction cost data used by Sleeman.

It seems probable that the Sleeman estimate may hot have made adequate allowance for the construction cost.

4. The Sleeman estimate for road, rail, creek, river and other service costs ($18.6 M) is lower than the Venton estimate by approximately 60%. It seems probable that the Sleeman estimate may not have made adequate allowance for these construction costs.
5. Receipt and delivery facility costs differ from those estimated by Venton, but generally appear to be similar.
6. The Sleeman estimate for two Solar Centaur C50 compressor stations ($26 million) is considered low by $10-12 million, based on recent experience. $26 million is approximately the turnkey cost quoted for the supply of a single unit Solar C50L station 12 months ago, by a contractor who had recently completed construction of a similar facility. While a dual station (as proposed by Sleeman) would not be twice this cost it would certainly be considerably more than $26m[2].
7. The Sleeman camp cost is reasonable, but the provision for mobilisation and relocation is considered low.
8. Sleeman's estimate of costs associated with approval, engineering, and indirect costs differ from those estimated by Venton as shown in the following table.

Cost Item	Estimated Cost ($M)		
	Sleeman	**Venton**	**Relative Cost (Venton = Base)**
Approval / Land Management	6.0	5.0	120%
Land Acquisition	9	8.7	103.5%
Geotechnical	0.4	0.9	44%
Survey	1.5	1.9	79%
Office	1.7	1.7	100%
Line Pack	0.2	0.7	29%
EPCM	22.2	19.2	116%
Owners Cost	6.0	7.4	81%
Provision for unspecified items	20.1	31.6	64%
Interest During Construction	18.4	27.0	68%
Total	**85.5**	**104.1**	
Difference	**-18.6**	**Base**	
	82%	**Base**	

[2] Additional information on compressor costs was supplied in an email from APT to Sleeman on 31 March 2006.

The most significant items relate to Sleeman's estimate of "*unspecified items*" (contingency in the Venton estimate) (-$11.6M) and the allowance provided for interest during construction (-$8.6M).

In addition to the lower base capital cost, the Sleeman estimate for unspecified items (contingency) is nominated as 7.04% of the estimated capital cost, less project costs. The Venton estimate of contingent items was 7.4% of the capital cost excluding only interest during construction (effective %). There is no reason to believe that the costs associated with engineering and project management should be immune from "unspecified items" (or contingency).

Sleeman has not nominated the basis for the provision. However, given that the Sleeman estimate has a nominated accuracy of ±30%; it seems that the allowance should be greater than 7%.

The Sleeman allowance for interest during construction differs from that estimated in the Venton report. Since the interest cost should be independent of the capital cost, it is recommended that a common basis is applied to both the Venton and the Sleeman estimate in any future comparison.

It is recognised that both Venton and Sleeman appeared to take instruction from their respective clients on this issue. This issue may be better addressed by the clients.

3.3 CONCLUSION

Overall the costs outlined by Sleeman are lower than those presented by Venton. This is due largely to underestimation of construction cost by Sleeman. Diameter is not a major determinant of construction cost.