Victorian Transmission System
Access Arrangement 2018 – 2022

Review of Forecast Capex
for
Selected Projects

Report
to
Australian Energy Regulator
by
Roland Sleeman

27 April 2017

Sleeman Consulting

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1. Background

1.1 APA VTS Australia (Operations) Pty Limited (**APA VTS**) has submitted to the Australian Energy Regulator (**AER**) proposed terms for access to the Victorian Transmission System (**VTS**) for the period from 1 January 2018 to 31 December 2022.

1.2 I have been asked by the AER to review capital expenditure (**Capex**) forecasts for selected projects either already completed by APA VTS or included in APA VTS's plans for the VTS over the period 2018 to 2022.

1.3 The objective of the review is to investigate whether the proposed Capex is prudent and efficient and, if necessary, make recommendations regarding the level of Capex that might be prudent and efficient. To be allowable for tariff setting purposes, Capex must be such as would be incurred by a prudent service provider acting efficiently, in accordance with accepted good industry practice, to achieve the lowest sustainable cost of providing services. In addition:

a) the overall economic value of the Capex must be positive; or

b) the present value of incremental revenue generated by incurring the Capex must exceed the present value of the Capex itself; or

c) the Capex must be necessary to:

i) maintain and improve the safety of services; or

ii) maintain the integrity of services; or

iii) comply with a regulatory obligation; or

iv) maintain capacity to meet levels of demand for service existing at the time the Capex is incurred.

1.4 My review, and my recommendations to the AER regarding prudent and efficient APA VTS Capex, are set out in the following sections of this Report.

2. Encroachment High Consequence

2.1 Australian Standard AS2885 "*Pipelines–Gas and liquid petroleum"* (**Code**) sets out (in "*Part 1: Design and construction*") specific, location-dependent requirements for both the design of new pipelines [1] and ongoing management of existing pipelines. Among other things, clause 4.7.4 of Part 1 the Code requires that existing pipelines, in respect of which surrounding land use changes (to allow residential, high-density, industrial or sensitive developments), be assessed against the requirements that apply to new pipelines and, if necessary, risk mitigation measures implemented. The purpose of the risk mitigation measures is to reduce to a level that is "as low as reasonably possible" the risk of an incident leading to rupture of the pipeline in question.

2.2 Within the VTS there are several pipelines for which existing or potential land zoning changes and/or urban encroachment have necessitated or will necessitate an assessment of the ongoing safety of the pipelines. APA VTS has identified the following pipelines as being affected:

Table 1: Pipelines Affected by Rezoning or Urban Encroachment

Pipeline	Affected length (km)	
	Already built-up	Rezoned, not yet built-up
Brooklyn-Corio	5.65	3.53
Wollert-Wodonga	0.5	13.2
Brooklyn-Lara	1.0	15.6

2.3 APA VTS has presented the results of standard engineering calculations[2] to show that all of the pipelines identified in Table 1 are susceptible to rupture in the event they suffer mechanical damage (for example, through impact by an excavator bucket) in excess of threshold levels. I do not consider it necessary to attempt to duplicate these calculations. I accept that compliance with the Code requires risk mitigation measures to be implemented either now, in respect of pipelines in areas that are already built-up, or otherwise prior to the surrounding areas being built-up.

2.4 Risk mitigation measures to be investigated in accordance with the Code[3], each of which APA VTS has considered, are:

i) Reducing the operating pressure of the pipeline so that it is no longer susceptible to rupture. The material downside of this measure is a consequent reduction of the capacity of the pipeline in question;

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1 In particular, clause 4.7.2 of Part 1 provides that a pipeline in residential, high-density, industrial or sensitive (eg hospital or school) locations should be designed so that it cannot rupture and clause 4.7.3 of Part 1 limits the allowable rates of energy release from a punctured (but unruptured) pipeline.

2 APA VTS has quantified the pipeline damage that could be caused by machinery (specifically excavators) that could credibly operate within a built-up area.

3 Clause 4.7.4 of Part 1 of the Code.

ii) Replacing the affected section of pipeline with thicker walled pipe so that it is no longer susceptible to rupture;

iii) Relocating the affected pipeline so that it is no longer within a built-up area;

iv) Modifying the allowable land use in the area surrounding the affected pipeline so as to remove the need for risk mitigation. I note that this initiative is highly unlikely to be practical;

v) Implementing physical and/or procedural measures to control the threat of third party interference with and mechanical damage to the pipeline. In my experience this is the most commonly adopted means of risk mitigation.

2.5 My desktop assessment of and comments on the applicability of the possible risk mitigation measures to each of the affected pipelines are outlined in Table 2.

Table 2: Assessment of Risk Mitigation Measures

<table>
<tr><td rowspan="3">Risk Mitigation Measure</td><td colspan="3">Affected Pipeline</td></tr>
<tr><td>Brooklyn-Cario</td><td>Wollert-Wodonga</td><td>Brooklyn-Lara</td></tr>
<tr><td>Dia: 350 mm
7.39 MPa</td><td>Dia: 300/500 mm
8.8 MPa</td><td>Dia: 500 mm
10.2 MPa</td></tr>
<tr><td rowspan="2">Reduce pipeline operating pressure</td><td colspan="3">Pipeline capacity is compromised</td></tr>
<tr><td>See §2.7(i)</td><td>See §2.7(ii)</td><td>See §2.7(iii)</td></tr>
<tr><td>Replace pipeline</td><td colspan="3" rowspan="2">The costs of replacing or relocating the affected pipelines are of similar order of magnitude. APA VTS estimates at least $150m cost. My estimated costs[4] are set out below:</td></tr>
<tr><td rowspan="2">Relocate pipeline</td></tr>
<tr><td>$25.7m</td><td>$52.5m</td><td>$66.4m</td></tr>
<tr><td>Modify land use</td><td colspan="3">This measure is not realistically achievable.</td></tr>
<tr><td rowspan="2">Physical measures</td><td colspan="3">Installation of slabbing to protect against vertical pipeline interference is common place[5]. Estimated costs (see §2.6) are set out below:</td></tr>
<tr><td>$3.5m immediate
$2.1m ongoing</td><td>$0.3m immediate
$7.8m ongoing</td><td>$0.7m immediate
$10.2m ongoing</td></tr>
<tr><td>Procedural measures</td><td colspan="3">Procedural measures (signage, patrols, etc) are already in place. Other measures must be implemented to achieve appropriate level of risk mitigation.</td></tr>
<tr><td>Do nothing</td><td colspan="3">To do nothing is not acceptable. Workable risk mitigation measures are available.</td></tr>
</table>

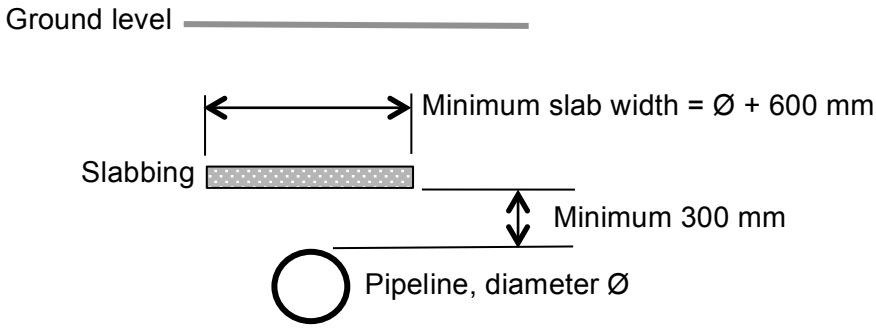
4 These estimated capital costs are based upon $0.2m per inch-km, being a cost I consider appropriate in order of magnitude terms for short construction lengths with tie-ins, traffic management, etc.

5 Physical exclusion, by fencing, whilst technically an option is not practical in a suburban setting.

2.6 The costs of slabbing, as presented in Table 2, are as estimated by APA VTS. I note the following:

i) The typical minimum requirement for installation of slabbing is depicted in Figure 1.

Figure 1: Typical Minimum Slabbing Requirement



ii) APA VTS has advised[6] that it installs slabbing with a width that extends to 600 mm either side of the pipeline to be protected.

iii) Provided APA VTS's slabbing cost estimates are based upon field experience using contracted services, and have regard for excavation conditions on either side of the original trench within which the pipeline is laid, then I consider the estimates to be reasonable. I recommend it be confirmed that the cost estimates are based upon field experience.

2.7 In all cases set out in Table 1, a reduction of pipeline operating pressures can remove the risk of pipeline rupture and is therefore an alternative to installation of slabbing. However, operating pressure reductions will also lead to a reduction of the capacity of the pipelines in question. Specific observations in relation to each affected pipeline are:

i) Brooklyn-Corio Pipeline

Modeling[7] carried out by the Australian Energy Market Operator (**AEMO**) indicates that reduction of the pipeline operating pressure (to the level necessary to avoid risk of pipeline rupture) will reduce the western haul capacity of the South West Pipeline by more than 40 TJ/d. This capacity reduction is unacceptable given that the requirement for western haul capacity is increasing[8].

APA VTS has provided estimates[9] of the cost of implementing a reduction of pipeline operating pressure. I have inspected the

6 Telephone conference 3 March 2017.
7 See section 6.1 of "*AEMO Submission on the APA 2018-2022 Access Arrangement Proposal*", 3 March 2017.
8 See Section 6 of this Report.
9 See table on page 10 of APA Business Case Number 230, "*Encroachment High Consequence*".

components of the cost estimates and consider them to be reasonable.

Since the estimated cost of implementing a pressure reduction ($14.8m[10]) is considerably in excess of the cost of slabbing and the capacity related consequences of a pressure reduction are unacceptable, a reduction of pipeline operating pressure is not recommended.

ii) Wollert-Wodonga Pipeline

The option exists to reduce the operating pressure of approximately 26 km of pipeline T74 between Wollert and Wandong, with that section of pipeline still potentially supplied with gas from both its southern end (Wollert) and its northern end (from Pipeline T120 via the section of T74 to the north of Wandong that will continue to operate at 8.8 MPa). APA VTS's estimated cost[11] of implementing this option is $7m. I have inspected the components of the cost estimates and, while I consider the estimates to be reasonable, I question:

- the inclusion of a provision of $2.04m for installation of a PRS at either Wandong, Seymour, Broadford or Euroa since I understand[12] such facility already exists at Euroa; and
- the inclusion of a provision of $2.2m for demolition of Wollert compressor units 1, 2 and 3 (**Wollert A**), shut down of which should in any case be separately considered given potential for supply of gas from pipeline T120 into pipeline T74 at multiple locations, the ability to upgrade the operating pressure of pipeline T120 to overcome the capacity reductions, and the financial benefits (such as avoided operations and maintenance costs) that would flow from shut down of Wollert A.

Although the estimated cost of the pressure reduction option is less than the estimated $8.1m cost of installing slabbing, in view of the consequent reductions in both the capacity of the Wollert-Wandong pipeline section and the capacity for export of gas to NSW, APA VTS considers installation of slabbing to be preferable to pressure reduction. I do not consider that APA VTS' conclusion has been adequately substantiated. I recommend a more rigorous, net present value based comparison be made of the slabbing and pressure reduction options having regard for:

- the lower overall capital cost of the pressure reduction option (which favours pressure reduction) versus the fact that less than 5% of the estimated 13.8 km of slabbing is required immediately, with

10 APA Business Case Number 230, "*Encroachment High Consequence*", page 10.

11 See table on page 12 of APA Business Case Number 230, "*Encroachment High Consequence*". The sum of all costs set out in the table is $9.05m, compared to an amount of $7m set out in text below the referenced table.

12 See section 6.2 of "*AEMO Submission on the APA 2018-2022 Access Arrangement Proposal*", 3 March 2017, which advises there is already a PRS located at Euroa.

installation of the balance to proceed over an extended period[13] (which favours slabbing in present value terms);

- cost savings realisable through shut down of Wollert A; and
- the way in which pipelines T74 and T120 may be operated, with the pressure of T120 potentially marginally increased to mitigate possible capacity related concerns.

iii) Brooklyn-Lara Pipeline

While the risk of pipeline rupture could be mitigated through a reduction of pipeline operating pressure, the overall capacity of the South West Pipeline to deliver gas from Iona to Melbourne would be materially reduced. AEMO [14] modeling has confirmed that the reduction in capacity is not desirable in view of the risk to supply of gas during winter.

2.8 Having regard for the information set out in preceding paragraphs it is my opinion that the implementation of measures to mitigate against the risk of damage to and rupture of the pipelines identified in table 1 is necessary to ensure continued compliance with regulatory obligations (ie, the Code).

2.9 I conclude that implementing physical measures, specifically the installation of slabbing above the affected sections of pipeline, is the preferred risk mitigation measure for the Brooklyn-Corio and Brooklyn-Lara Pipelines. Installation of slabbing is such as would be incurred by a prudent service provider acting efficiently, in accordance with accepted good industry practice, to achieve the lowest sustainable cost of providing services. Slabbing needs to be installed immediately in areas where encroachment has already occurred, with further installation in and when further encroachment occurs.

2.10 For the Wollert-Wodonga Pipeline I recommend that a more thorough, net present value based comparison be made of the slabbing and pressure reduction options. This will ensure the selected option is such as would be incurred by a prudent service provider acting efficiently, in accordance with accepted good industry practice, to achieve the lowest sustainable cost of providing services.

2.11 I note that less than 20% of APA VTS's proposed slabbing Capex is required immediately. The balance of the Capex will be incurred progressively subject to finalisation of Precinct Structure Plans (pursuant to which land rezoning is taking place) and subsequent development of the rezoned land. While I am however unable to provide a definitive opinion regarding the timing of expenditure, I note (as per footnote 13) that expenditure may take place over a timeframe well beyond the forthcoming access arrangement period.

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13 By way of example, "*Information Sheet: Wyndham North PSPs*", 13 December 2011, noted (in relation to that development of land will occur over a 20 to 30 year period.

14 See section 6.3 of "*AEMO Submission on the APA 2018-2022 Access Arrangement Proposal*", 3 March 2017.

3. Pipeline Integrity

3.1 In accordance with "*Part 3: Operation and maintenance*" of the Code, the integrity of gas pipelines must be routinely monitored to identify and rectify problems that could lead to failure of the pipeline or escape of gas. There are two ways of doing this. In-line inspection (**ILI**) techniques, which involve passing an "intelligent pig" through a pipeline in order to get information regarding the integrity of that pipeline (such as metal thickness, presence of defects or presence of cracks) for its entire circumference and length, are the most accurate and reliable. The less reliable alternative to ILI is "direct assessment", which typically involves a combination of "direct voltage gradient surveys" and physical dig-ups.

3.2 There are several pipelines within the VTS that cannot be inspected using ILI techniques. The Code[15] specifically requires that *consideration be given to*, but does not mandate, modification of such pipelines to allow the use of ILI techniques.

3.3 While ILI is preferable to direct assessment, this does not mean that modification of pipelines to allow ILI should be carried out regardless of the expense of the modifications.

A cost benefit analysis should be undertaken to ascertain whether such modifications are consistent with achieving the lowest sustainable cost of providing services.

3.4 APA VTS has:

i) proposed that three pipelines, all operating at a stress level of ≥30% SMYS[16] and capable of being modified to allow ILI, should be modified[17] to allow ILI; and

ii) carried out a single, high-level cost benefit analysis of modifying the three pipelines to allow ILI.

3.5 While it is prudent, indeed obligatory, to give consideration to whether a pipeline needs to be modified to allow ILI, it is imprudent to undertake the cost benefit analysis on a grouped (rather than individual pipeline) basis. This is because a grouped analysis can be biased to the extent that compelling benefits of modifying some pipeline(s) do (or don't) outweigh the disadvantage of modifying others.

3.6 Table 3 sets out a pipeline by pipeline cost benefit analysis of APA VTS's proposed pipeline modifications.

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15 Clause 6.6.1 of "*Part 3: Operation and maintenance*".

16 Conventional wisdom is that pipelines operating at pressures that cause the hoop (circumferential) stress in the pipewall to exceed 30% of the specified minimum yield strength (SMYS) of the pipe material are susceptible to rupture.

17 APA GST actually refers to 'rectified' rather than ''modified'. The term 'modified' is consistent with the Code and avoids the connotation that there is a faulty with the existing pipeline(s).

Table 3: Cost Benefit Analysis of ILI Modifications

Pipeline	Tyers-Maryvale	James Street	Truganina
ILI Modification Cost[18]	$802k	$2,607k	$3,275k
ILI Survey Cost[19] (*10 yearly*)	$404k	$485k	$601k
DCVG Survey Cost[20] (*5 yearly*)	$30k	$41k	$50k
Avoided Dig-up Costs[21] (*annual*)	$56k	$168k	$252k
NPV, unindexed pre-tax[22]			
at 3%	-$535k	-$723k	-$290k
at 5%	-$605k	-$1,022k	-$765k
at 8%	-$672k	-$1,328k	-$1,258k

3.7 In preparing Table 3:

i) I have provided for Direct Assessment activities (dig-up and inspection of the pipeline) to be carried out annually if ILI is not implemented, but have made no provision for dig-up and inspection work if ILI is implemented. In reality, even with ILI implemented dig-ups will be required for calibration purposes and to inspect/repair any identified problems;

ii) I have made nominal provision for 5 yearly DCVG surveys but note that, to change the findings presented in the Table, such surveys considerably more expensive than assumed by me; and

iii) I have carry out analyses for a 20 year period. I note that a different period may be appropriate for regulatory purposes and that, for lower discount rates, longer analysis periods could result in some NPV figures being positive rather than negative.

3.8 On the basis of information provided by APA VTS, I am unable to conclude that modification of the Tyers to Maryvale, James Street or Truganina to Plumpton pipelines to allow use of ILI techniques is consistent with achieving the lowest sustainable cost of providing services. In the absence of a rigorous present value based assessment of each individual proposal for pipeline modification, it is preferable that Direct Assessment techniques be continued.

18 Source: Total cost of $6,683,901 set out in APA Business Case 257, 258, 259 has been apportioned between pipelines on a 0.6 power factor basis.

19 Source: Table 4 of APA Business Case 257, 258, 259. No provision has been made for the costs of verification dig ups (to confirm ILI findings) or possible remedial dig-ups.

20 Based upon $25,000 fixed cost per survey plus $3,000 per km.

21 Dig-ups have been provided for at a rate of 1 per kilometre, with minimum of 2 per pipeline, and a cost of $28,000 per inspection, based upon information provided in APA VTS Business Case 257, 258, 259. It has been conservatively assumed that dig-ups will take place annually.

22 I have based this assessment upon 20 years. I recognise it is possible a different time frame may be

4. Warragul Looping

4.1 APA VTS had approval for looping of the Warragul lateral during the 2013 to 2017 Access Arrangement Period in order to avoid a breach of minimum pressure requirements at the Warragul City Gate in the winter of 2014.

4.2 APA VTS did not carry out the looping project and, although actual peak gas demands were marginally below what had been forecast (as shown in Figure 2), a breach of the Warragul City Gate minimum pressure requirement occurred in 2014.

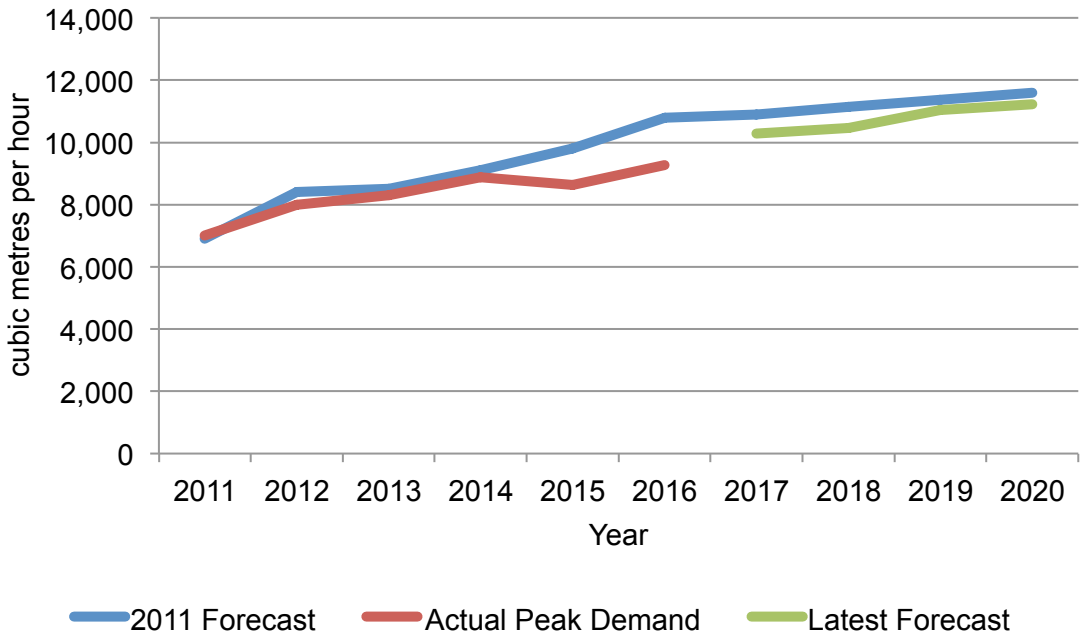
4.3 The following measures were implemented to ensure security of gas supply to the Warragul gas distribution network:

i) The supply pressure of gas into the Warragul network was reduced from 1,400 kPa to 1,150 kPa. This measure is not sustainable. With continued demand growth the supply pressure of 1,400 kPa must be reinstated to ensure security and safety of gas supply within the network[23]; and

ii) The pressure at which gas can be supplied into the Lurgi pipeline (from which Warragul is, in turn, supplied) has been increased on peak demand days to ensure gas supply to Warragul. This measure compromises the capacity of the Lurgi pipeline and is therefore unsustainable.

4.4 The AEMO forecasts[24] continued gas demand growth on the Warragul gas distribution network. This is illustrated[25] in Figure 2.

Figure 2: Forecast and Actual Peak Gas Flows at Warragul City Gate



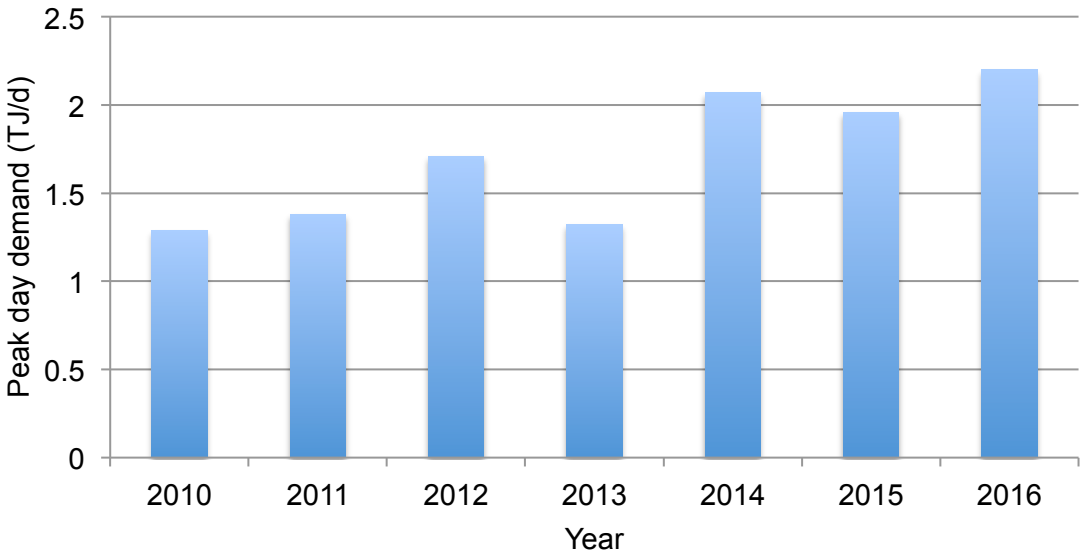
23 This has been confirmed by the AEMO. See page 13 of "*AEMO Submission on the APA 2018-2022 Access Arrangement Proposal*", 3 March 2017.

24 See Figure 28 on page 60 of "*Victorian Gas Planning Report*", AEMO, March 2017.

25 For ease of comparison I have converted AEMO TJ/d peak day demand figures into m^3/hr.

4.5 While I am unable to opine on the validity of the forecast demand growth, I am of the view that the peak demand growth that has been experienced represents a permanent, rather than temporary, change. As illustrated in Figure 3, it is clear that the Warragul Tariff D load(s) underwent a step increase in 2014.

Figure 3: Warragul Tariff D Historic Gas Demand[26]



4.6 Since:

i) the increase in Warragul peak gas demand is permanent and further demand growth is forecast; and

ii) the measures taken to ensure safety and security of gas supply to Warragul are temporary,

it is my opinion that the capacity for delivery of gas to Warragul should be increased in order to maintain both the safety and integrity of service. It is not acceptable to do nothing.

4.7 APA VTS has investigated the following options for increasing the capacity for delivery of gas to Warragul:

i) Installation of 4.8 km of 100 mm or 150 mm diameter pipeline to loop the existing Warragul lateral – cost $7.0m to $7.4m;

ii) Install a new lateral to Warragul from the Longford-Dandenong pipeline, together with a new city gate station – cost $8.7m; or

iii) install a small compressor on the existing Warragul lateral – cost $13.4m.

4.8 APA VTS proposes to loop the existing Warragul lateral with a new 150 mm diameter pipeline. Although marginally higher cost that using a 100 mm diameter pipeline the larger diameter loop affords around 80% more overall capacity that the smaller one. APA VTS's proposed approach is consistent with that previously

[26] Source of Information: Figure 28 on page 60 of "*Victorian Gas Planning Report*", AEMO, March 2017.

approved, although the capital cost as now estimated has risen from $2.4m (2012) to $7.4m (2016).

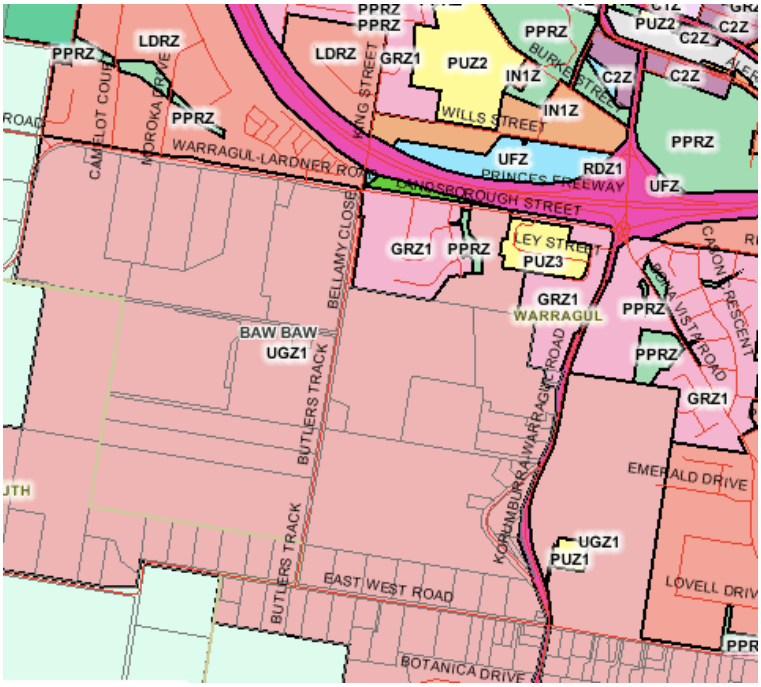
4.9 APA VTS has advised that reasons for the substantial increase in the estimated costs of the preferred, as well as other, options include more detailed specification of requirements (for example, including environmental and cultural heritage issues), change of land use along the Warragul lateral route, decline in the A$/US$ exchange rate and inclusion of quoted rather than indicative costs. A comparison of current and previous cost estimates is presented in Table 4.

Table 4: Estimated Cost of 150 mm Diameter Warragul Looping

	2012 Estimate	Current Estimate	Change
Project Management	$0.574m	$1.2m	+350%
Land and Approvals		$1.4m	
Procurement	$0.354m	$0.5m	+40%
Construction	$1.489m	$4.3m	+190%
Total Estimated Cost	$2.417m	$7.4m	+205%
$ per inch-km	$83,924	$256,944	

4.10 APA VTS has advised[27] that the principle driver of the three-fold increase in the estimated cost of the Warragul looping project is changes of land use and urban encroachment, which have resulted in higher land access and pipeline construction costs. I accept this proposition. While there is, as yet, little evidence of new development along the route of the proposed looping pipeline, it is clear that much of the route, along East West Road and Butlers Track, is now within urban growth area ('UGZ1'), as illustrated in Figure 4.

Figure 4: Warragul (south) Land Zoning



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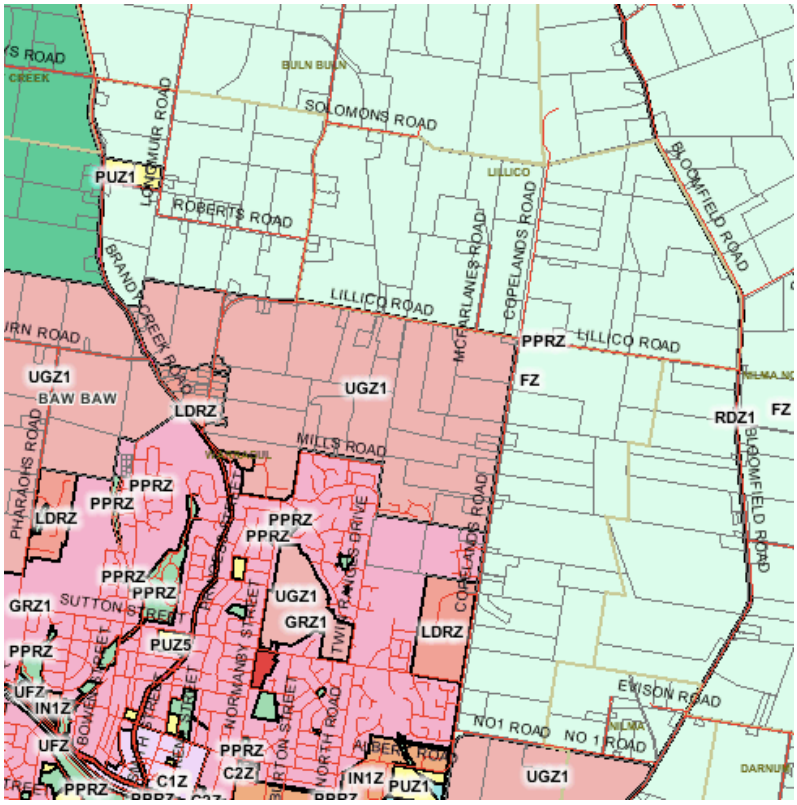
4.11 While land zoning and urban encroachment have impacted the cost of APA VTS' proposed Warragul looping project, the same cannot be said for the possible alternative development involving a new source of gas supply to Warragul from the Longford – Melbourne Pipeline (running north of Warragul). As shown in Figure 5, land to the east of Copelands Road (where the alternate pipeline would be located) is zoned for farming ('FZ').

Figure 5: Warragul (northeast) Land Zoning



4.12 I do not consider APA VTS' $8.7m estimate of the cost to install a new lateral to Warragul from the Longford-Dandenong pipeline, together with a new city gate station, (paragraph 4.7.ii above), up from $2.5m in 2012, to be substantiated.

4.13 AEMO has identified[28] that development of a new lateral to Warragul from the Longford-Dandenong Pipeline may deliver the following benefits not realisable with APA VTS' proposed looping project:

i) increased security of gas supply, since an additional source of gas supply will be connected; and

ii) reduced load on the Lurgi Pipeline, thereby supporting longer term demand growth on that pipeline.

28 "Update Victoria Gas Planning Report", AEMO, February 2016,

4.14 Having regard for the information presented above I am of the view:

i) that expansion of the capacity for delivery of gas to Warragul is necessary to maintain the safety and integrity of services; but

ii) that the pipeline looping project proposed by APA VTS may not be such as would be incurred by a prudent service provider acting efficiently, in accordance with accepted good industry practice, to achieve the lowest sustainable cost of providing services.

4.15 I recommend that the option of developing a new pipeline lateral (and city gate station) to supply gas to Warragul from the Longford-Dandenong Pipeline be more fully investigated.

5. Victorian Interconnect Expansion Project

5.1 In the Access Arrangement for the period 2013 to 2017, APA VTS had approval for works[29] (**Previous Works**) to accommodate a 30 TJ/d increase in the export of gas at Culcairn.

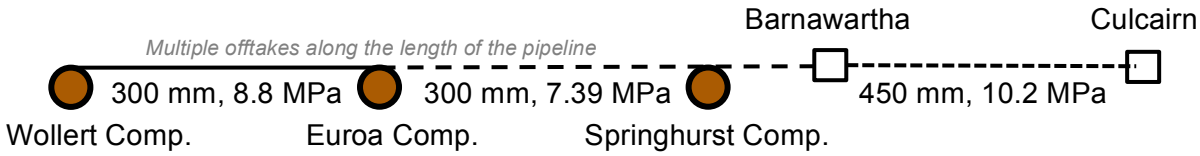
5.2 Prior to undertaking the Previous Works APA VTS received a series of requests for additional gas export capacity at Culcairn, increasing the total export requirement from 68 TJ/d[30] to 191 TJ/d[31].

5.3 APA VTS has provided confidential details to confirm the Culcairn gas export requirements and has advised[32] that shippers firm commitments for use of downstream infrastructure (specifically, in the contract carriage Moomba Sydney Pipeline, in both westerly and easterly directions) demonstrate that the requirements for export capacity are long term in nature.

5.4 Given the material increase in the requirement for export capacity at Culcairn, I am of the opinion that it was prudent to revisit plans for expansion of the capacity of the pipeline infrastructure between Wollert and Culcairn.

5.5 As a basis for considering options for expansion of capacity for export of gas at Culcairn, it is important to have regard for salient characteristics of the infrastructure in question as it existed in 2012. This is depicted in Figure 4 and described in the following sub-sections.

Figure 4: Simplified Pipeline Schematic (2012)



i) The pipeline system between Wollert and Culcairn effectively comprised a number of interconnected, individual pipelines serving gas loads in northern Victoria, including export to NSW.

ii) The southern section of the system, from Wollert to Euroa, was heavily loaded, with large offtakes of gas at Wandong and Euroa.

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29 The approved works included 35.4 km of 450 mm diameter Class 600 looping, an upgrade of the operating pressure of the pipeline between Euroa and Springhurst, and installation of a Centaur compressor at Winchelsea on the South West Pipeline.

30 APA VTS Business Case 230, "*Victorian Northern Interconnect Expansion Project*", refers (at page 3) to an export capacity of 72 TJ/d. Sleeman Consulting's records are that, after allowing for export capacity that was at the time spare, the export capacity had to be increased from 42 TJ/d to 68 TJ/d to accommodate the referenced request for 30 TJ/d of export capacity. See section 3.2.2 of "*Victorian Transmission System: Addendum to Review of Gas to Culcairn Project and Western Outer Ring Main*", Sleeman Consulting, 18 December 2012.

31 This is 42 TJ/d, as existing pre-expansion, plus 149 TJ/d requested additional capacity (see page 65 of APA "*Victorian Transmission System: Access Arrangement Submission*", 3 January 2017).

32 See APA VTS Business Case Number 230, "*Victorian Northern Interconnect Expansion Project*", section 2.

iii) Each section of the pipeline system was itself a potential bottleneck in terms of moving gas to Culcairn for export.

iv) The Previous Works represented a least-cost means for achieving the then required increase in export capacity. That programme involved increasing capacity between Wollert and Euroa (by partial looping of the inlet end of that pipeline section) and between Euroa and Springhurst (by increasing the operating pressure of that section).

v) To achieve an increase of the magnitude that was ultimately required would have, at least, necessitated:

- Looping of the Springhurst to Barnawartha pipeline section[33]; and
- Looping of the pipeline from Wollert via Euroa to Springhurst[34].

vi) Addition of further compression would not have been a viable alternative. The requisite export capacity increment would not have been achievable through addition of compression.

5.6 Had the demand for export capacity at Culcairn grown slowly, the Previous Works would not have been inappropriate. Looping work could have been undertaken progressively as necessary, with some beneficial deferral of expenditure realisable though the increase of pipeline operating pressure between Euroa and Springhurst. However, given the rapid growth of demand for export capacity, and the consequent need to expedite completion of the pipeline looping programme, I support APA VTS's conclusion[35] that the operating pressure upgrade was rendered redundant.

5.7 Sleeman Consulting has carried out a simple modeling exercise to investigate the relativity between installation of 400 mm and 450 mm diameter looping. The modeling indicates a Culcairn export capacity of around 205 TJ/d for 400 mm looping, rising to 225 TJ/d for 450 mm looping. This is comparable to the findings of the AEMO[36]. The modeling also indicates that 350 mm diameter looping would not have been adequate to meet the 191 TJ/d export capacity requirement.

5.8 The reason the export capacity potential of the 400 mm and 450 mm diameter pipelines (when both operated at a maximum pressure of 10.2 MPa) is of the same order of magnitude is that the pipeline section from Barnawartha to Culcairn is a 'bottle-neck' after completion of the looping programme.

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33 This is so that gas could be delivered at Culcairn at a pressure in excess of 8,600 kPa. Otherwise gas export flows would be constrained to a maximum of 172 TJ/d. See section 4.3.2 of "*Victorian Gas Planning Report*", AEMO, March 2017.

34 While short sections of pipeline immediately upstream of Euroa and Springhurst could from a purely technical gas export perspective have remained unlooped, this would a) necessitate pressure controlled interconnection between the pipelines; and b) severely compromise capacity to transport gas in a southerly direction.

35 Page 66 of APA "*Victorian Transmission System: Access Arrangement Submission*", 3 January 2017.

36 See Figure 12 on page 41 of "*Victorian Gas Planning Report*", AEMO, March 2017, which indicates an export capacity of the order of 215 TJ/d to 225 TJ/d after completion of the 450 mm looping programme.

5.9 If the Barnawartha to Culcairn bottle-neck is removed (for example, by looping), and compression power suitably upgraded, the ultimate export potential with 400 mm class 900 (15.3 MPa) looping is considerably (circa 25%) greater than would be achievable with 450 mm class 600 (10.2 MPa) looping.

5.10 I therefore consider APA VTS's decision to undertake looping with 400 mm class class 900 pipe, rather than 450 mm class 600 pipe, to be reasonable and prudent.

5.11 The capital cost of installation of 400 mm diameter looping of the pipeline from Wollert to Barnawartha (a distance of 262 km) was $298.9m[37]. On a unit basis this equates to $71,300 per inch-km. While this unit cost is higher than the approximate $63,000 per inch-km upon which the estimated cost of the Previous Works was based, I consider it to be reasonable since:

i) Thicker walled, class 900 pipe has been installed (rather than class 600 pipe), affording greater opportunity for future expansion of capacity;

ii) In completing the whole programme of looping, construction activity has taken place through the Great Dividing Range where hilly and tight conditions will have been experienced, adding to construction costs; and

iii) The overall cost of the looping project is comparable to what would have been achieved had the originally proposed, 450 mm diameter class 600 pipe been used.

5.12 As an adjunct to the expansion of the capacity of the Wollert to Barnawartha pipeline, APA VTS installed a Taurus 60 (rather than a Centaur 50) gas compressor at Winchelsea, on the South West Pipeline. The cost of this work was $40.3m compared with an approved provision of $38.7m for the Centaur 50 compressor. I am of the opinion that the cost of installation of the Taurus 60 compressor is reasonable[38].

5.13 The Taurus 60 compressor was installed since, after receipt of approval for installation of the Centaur 50 compressor additional shipper demand for pipeline capacity to Melbourne was contracted.

5.14 APA VTS has:

i) advised that the Centaur 50 compressor would have increased the capacity of the South West Pipeline by 61 TJ/d whereas the Taurus 60 compressor afforded a 76 TJ/d capacity increase. I agree with these estimates[39].

ii) provided confidential information to demonstrate that the entire 76 TJ/d of incremental capacity in the South West Pipeline was allocated to shippers.

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37 Table 5.5 of APA "*Victorian Transmission System: Access Arrangement Submission*", 3 January 2017.

38 See Table 7 of "*Victorian Transmission System: Review of Gas to Culcairn Project and Western Outer Ring Main*", Sleeman Consulting, 25 July 2012.

39 See Table 3 of "*Victorian Transmission System: Review of Gas to Culcairn Project and Western Outer Ring Main*", Sleeman Consulting, 25 July 2012.

5.15 In consideration of the above I conclude that work undertaken by APA VTS to:

i) expand the capacity for export of gas at Culcairn; and

ii) expand the capacity of the South West Pipeline to deliver gas to Melbourne

was:

iii) necessary to meet demand for services, although it is beyond the scope of my investigation to quantify or comment upon either overall economic value or incremental revenue; and

iv) such as would be incurred by a prudent service provider acting efficiently, in accordance with accepted good industry practice, to achieve the lowest sustainable cost of providing services.

6. South West Pipeline Westernhaul Expansion

6.1 APA VTS has proposed the following $3.4m programme of work to increase to 150 TJ/d the capacity of the South West Pipeline (**SWP**) to deliver gas in a westerly direction, primarily for refill of the Iona gas storage facility:

i) reconfiguration of Brooklyn compressor station to allow compression to be directed into the SWP; and

ii) modification of the Winchelsea compressor to allow bi-directional operation (thereby allowing compression of gas toward Iona).

6.2 The requirement for additional westernhaul capacity reflects rapidly changing east coast Australian energy market circumstances, and an increase in the role that gas storage will have in maintaining security of gas supply during peak periods. In particular, westernhaul capacity in the SWP is required at high rates during summer to refill the Iona gas storage facility in preparation for winter draw down.

6.3 The AEMO has specifically confirmed[40] the need for the westernhaul capacity of the SWP to be increased to 139 TJ/d, and has expressed a preference for the capacity to be increased to 180 TJ/d.

6.4 APA VTS has investigated logical options[41] for increasing the westernhaul capacity of the SWP, the key alternatives to the approach set out in paragraph 6.1 being:

i) installation of a gas compressor at Stonehaven, albeit at a cost ($35m) that is an order of magnitude greater than the cost of APA VTS's recommended approach; or

ii) operation of Brooklyn compressor unit 10 to assist with compression of gas into the SWP. Since Brooklyn unit 10 is presently a wet seal compressor, for continuous operation this option would necessitate upgrade of the compressor seals. I consider APA VTS' estimated cost of $8m to undertake such work to be reasonable. This option is also more expensive than APA VTS' proposed development.

6.5 While looping of the SWP would technically be a further option for capacity expansion, it does not warrant consideration. Based upon my experience, a looping programme would be more expensive than the options considered by APA VTS.

6.6 Sleeman Consulting has previously investigated SWP compression, capacity and cost related matters[42] and is of the opinion that the works proposed by APA VTS to increase the westernhaul capacity of the SWP represent the optimal means for achieving the required capacity increase, and are such as would be incurred by a prudent service provider acting efficiently, in accordance with accepted good industry practice, to achieve the lowest sustainable cost of providing services.

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40 See section 2 of "*AEMO Submission on the APA 2018-2022 Access Arrangement Proposal*", 3 March 2017.

41 See APA Business Case Number 505, "*Southwest Pipeline Westernhaul Expansion*".

42 See section 4.2.1(a) of "*Victorian Transmission System: Review of Gas to Culcairn Project and Western Outer Ring Main*", Sleeman Consulting, 25 July 2012.

7. Conclusions

7.1 Table 5 provides a summary of my findings, details of which are set out in sections 2 to 6 of this Report.

Table 5: Summary of Findings

Project	
Encroachment High Consequence	In all cases, action is required.
	Slabbing should be installed for the Brooklyn-Corio and Brooklyn-Lara pipelines.
	For the Wollert-Wodonga pipeline the NPVs of the slabbing and pressure reduction options should be investigated to confirm which approach is best.
Pipeline Integrity	Pipeline modification to allow ILI is not mandatory.
	An NPV benefit has not been demonstrated, hence the work is not consistent with achieving the lowest sustainable cost of providing services.
Warragul Looping	Capacity expansion is required but proposed approach may not be most reasonable, prudent and consistent with achieving lowest cost.
	Full consideration need to be given to the option of developing a new gas lateral (and city gate station) to Warragul from the Longford-Dandenong Pipeline.
Victorian Interconnect Expansion	Expansions of Culcairn gas export capacity and South West Pipeline capacity to Melbourne were justified
	Approach adopted by APA VTS was well considered and was consistent with achieving lowest cost
Southwest Pipeline Westernhaul Expansion	Expansion of westernhaul capacity is required
	Proposed approach is consistent with achieving lowest cost