Victorian Transmission System

Review of
Gas to Culcairn Project
and
Western Outer Ring Main Project

Public Version

25 July 2012

Sleeman Consulting

Contents

1 Executive Summary

This Report has been prepared to assist the Australian Energy Regulator with an assessment of the Gas to Culcairn Project and the Western Outer Ring Main (or 'WORM') Project. The projects have been proposed by APA GasNet Australia (Operations) Pty Ltd as necessary augmentations of the Victorian Transmission System to be taken into account in setting tariffs to apply for use of the system over the period 2013 to 2017.

In preparing this Report consideration has been given to:

- the need for the proposed projects and whether an appropriate range of alternatives has been considered;
- the timing of the proposed projects; and
- the estimated costs of the proposed projects and whether they are both efficient and consistent with accepted good industry practice.

The key observations and conclusions made within this Report are:

1.1 Gas to Culcairn Project

APA GasNet has proposed installation of:

- a Taurus 60 Compressor on the South West Pipeline, at a cost of $38.3m, to quickly increase the capacity of the South West Pipeline by 59 TJ/d; and
- 104.1 km of 450 mm diameter looping of Pipeline Vic:101 at a cost of $118.0m, to increase Culcairn gas export by 33 TJ/d (which, together with 12 TJ/d of capacity already available, will facilitate 45 TJ/d of new export).

Although it is confirmed the proposed works will deliver the stated capacity increases and the forecast project costs are reasonable, the proposed works are in excess of what is required.

With regard for advice from AGL Energy Limited, a corrected forecast of incremental capacity requirements is for receipt of [C-I-C] of gas at Iona and export of an incremental [C-I-C] of gas at Culcairn, both commencing [C-I-C].

To meet the corrected forecast requirement requires only:

- operation of the South West Pipeline with an inlet gas pressure at Iona of 10.2 MPa or, since this is outside of APA GasNet control and may not be achievable, installation of a gas compressor on the South West Pipeline.

It is recommended a Centaur 50 compressor be installed at Winchelsea or, preferably, at a new site close to Iona. At a forecast cost of $35m a compressor at one of these locations will give a considerably greater pipeline capacity increase than would a compressor at Stonehaven. Time is available to implement this recommendation.

- installation of 27.2 km of 450 mm diameter looping between Wollert and Wandong, on Pipeline Vic:101, at a forecast cost of $30.8m.

  As a complement to the pipeline looping programme it is recommended consideration be given to pursuing re-rating (to 8.8 MPa) of the operating pressure of Pipeline Vic:101 to the north of Euroa. It is envisaged this will allow improved pipeline operating efficiency, reduced compressor fuel usage and greater scope for future expansions of capacity. Re-rating of the pipeline south of Euroa has already been successfully achieved.

1.2 Western Outer Ring Main ('WORM')

The WORM Project involves installation of 49.3 km of new 500 mm diameter pipeline, together with installation of a Centaur 50 gas compressor and a gas pressure reduction station, both at Wollert. The forecast cost of these works is $92.4m, and is considered reasonable.

The WORM is proposed to, and justified on the basis that it will,:

- in particular, mitigate the effects of a major interruption to gas supply from Longford by facilitating delivery of gas from Iona; and

- deliver system benefits, particularly in respect of the need for ongoing operation and development of the Brooklyn Compressor Station.

However, it appears that:

- major upgrading of the Brooklyn Compressor Station should not be required if the WORM is not developed. On the contrary, some downgrading may be possible since, with the Sunbury lateral in place, the requirement for compression of gas to Ballarat is reduced; and

- the security of supply related benefits are realisable without need to develop the WORM. In the event of an interruption to gas supply from Longford, gas can be introduced to the large diameter, low pressure transmission system between Brooklyn and Dandenong and thereby used to support gas supply to domestic users.

Development of the WORM is not necessary for security of supply related benefits to be realised and, if the WORM not developed, it is not apparent that major upgrading of the Brooklyn Compressor Station will be required. Development of the WORM is not considered to be prudent since developing it will not be consistent with achieving the lowest sustainable cost of providing services.

Subject to the qualification set out below, it is recommended the following alternative arrangements, as identified by APA GasNet, be implemented at an estimated cost of $9.6m:

- upgrade isolation and loading valves, gas engine alternator and Ballarat filter at the Brooklyn Compressor Station;
- upgrade aftercoolers at Iona Compressor Station;
- upgrade instrumentation at Wollert compressor station; and
- extend the length of Kalkallo lateral.

If a compressor is installed on the SWP and gas can be reliably scheduled for receipt at Iona then the recommendation set out above should be varied as follows:

- the proposed new Rockbank Pressure Reduction Station (for supply of gas to Ballarat) should be developed;
- the Iona compressor station aftercooler upgrade should not be required; and
- upgrading requirements at Brooklyn Compressor Station will be reduced and further rationalisation of the station should be possible since it will no longer be required for compression to Ballarat.

Capital costs will be reduced marginally to an estimated $9.5m, and operating cost benefits will be realised through rationalisation of the Brooklyn Compressor Station.

1.3 Compression on the South West Pipeline

Maximising the rate at which gas can be received at Iona will make a major contribution to mitigation of impacts associated with an interruption to supply of gas from Longford. Expansion of the capacity of the South West Pipeline, through installation of pipeline compression, will give an immediate increase in the ability to receive gas at Iona. This reinforces the requirement for compression, if any, installed on the South West Pipeline to be efficiently located (for northward transport of gas) and, therefore, at or to the south of Winchelsea.

2 Introduction

This Report has been prepared to assist the Australian Energy Regulator ('AER') with an assessment of the Gas to Culcairn Project and the Western Outer Ring Main (or 'WORM') Project. The projects have been proposed by APA GasNet Australia (Operations) Pty Ltd ('APA GasNet') as necessary augmentations of the Victorian Transmission System ('VTS') to be taken into account in setting tariffs to apply for use of the system over the period 2013 to 2017.

3 Approach Adopted in Review of Proposed Projects

The proposed Gas to Culcairn and WORM Projects represent capital investments that are forecast to be required during the forthcoming Access Arrangement Period. Accordingly, key factors investigated in this Report are:

- whether there is a bona fide need to undertake the project in question;
- whether the proposed project represents the most appropriate approach to addressing the need in question;
- when does the project need to be undertaken; and
- whether the project cost as predicted by GasNet is as would be incurred by a prudent service provide acting efficiently in accordance with accepted good industry practice to achieve the lowest sustainable cost of providing services.

To assist with the above, Sleeman Consulting utilised a steady-state simulation of the performance of the VTS. While a steady-state simulation does not take linepack and daily load profiles into account, it reliably facilitates:

- quick review of gas pipeline pressure and flow constraints; and
- identification of alternative approaches to addressing system constraints.

Consideration has been given to documentation submitted by APA GasNet to the AER in relation to the access arrangement for the VTS, some of which was provided on a commercial in confidence basis. This includes use of APA GasNet's 'VTS AA Capex Forecast Final', dated 6 July 2012, to confirm and, where necessary, adjust cost information set out in earlier documents. Reports and submissions prepared by other parties, in particular the Australian Energy Market Operator ('AEMO'), have also been utilised and are referenced herein as appropriate.

4 Gas to Culcairn Project

4.1 Need for Project

The expressed need[1] for the Gas to Culcairn Project is to satisfy Shippers' requirements for receipt of an additional 53 TJ/d of gas at Iona, of which 45 TJ/d is to be delivered to Culcairn (the balance being for use in Melbourne). One of the Shippers[2] concerned has provided further information indicating it does not agree with APA GasNet's forecast of requirements for export of gas at Culcairn, and is seeking to maintain (rather than increase) its contracted capacity on the South West Pipeline. Accordingly, the corrected forecast for incremental volumes from Iona to Culcairn is as presented in Table 1.

Table 1: Corrected Forecast of Incremental Gas, Iona to Culcairn

Iona Receipt	Culcairn Delivery	Timing
[C-I-C] TJ/d	[C-I-C] TJ/d	[C-I-C]

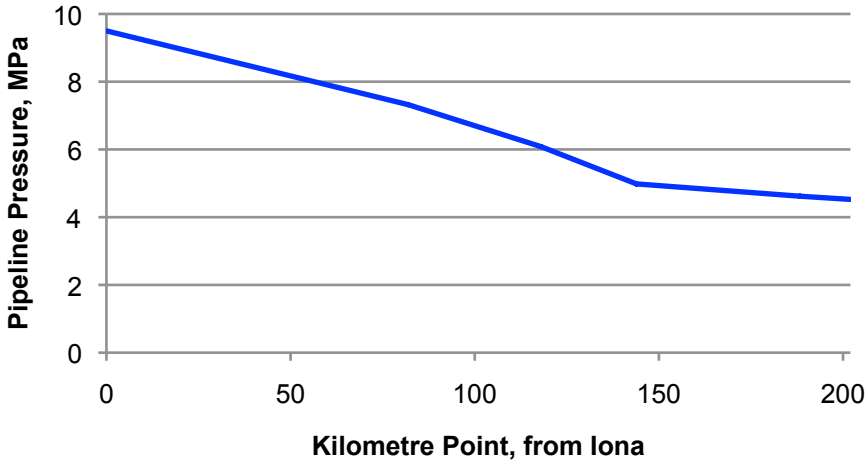
To handle additional gas receipt at Iona and additional gas delivery to Culcairn, two factors must be considered.

a) Receipt of gas at Iona

The present, northward capacity of the South West Pipeline is 353 TJ/d with a gas pressure at Iona[3] of 9.5 MPa. This has been confirmed through modelling undertaken by Sleeman Consulting, which indicates the operating pressure of the Brooklyn Lara Pipeline ('BLP') falls to around the minimum operational level of 4.5 MPa at Brooklyn with a gas flow of 353 TJ/d from Iona and a gas pressure at Iona of 9.5 MPa. This is illustrated in Figure 1.

[1] Page 3 of Business Case BC175 - Gas to Culcairn Project, APA GasNet Australia (Operations) Pty Limited, 3 March 2012
[2] AGL Energy Limited, letter dated 18 June 2012
[3] This is the gas pressure that AEMO has committed to maintain.

Figure 1: Pressure Profile of SWP with 353 TJ/d Inlet Gas Flow



To transport gas northward from Iona at a continuous rate in excess of 353 TJ/d will require expansion of the capacity of the SWP.

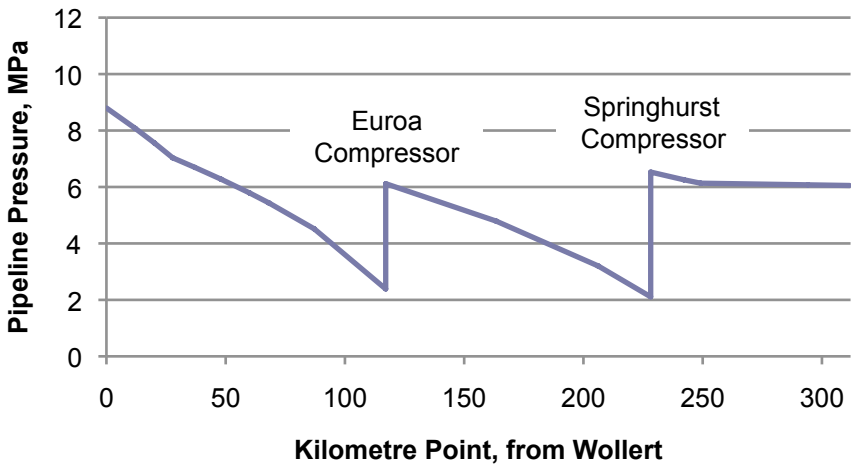
b) Delivery of gas to Culcairn

The present capacity for delivery of gas northward from Wollert to Culcairn (after commissioning of the Euroa Compressor) is 48 TJ/d[4]. This has been confirmed through modelling[5] undertaken by Sleeman Consulting that indicates, after commissioning of the Euroa Compressor, Pipeline Vic:101 will be fully loaded during peak demand periods with delivery of gas to Culcairn at a rate of 48 TJ/d and a pressure not less than 6.0 MPa. This is illustrated in Figure 2.

It is noteworthy that the pipeline section from Wollert to Wandong (where the Wollert to Bendigo system connects in) then on to Euroa (where the Euroa to Shepparton/Echuca lateral connects in) is particularly heavily loaded. Small changes to the throughput of this section of pipeline will have a marked impact upon gas pressure at the inlet to the Euroa Compressor.

[4] Page 2 of Business Case BC175 - Gas to Culcairn Project, APA GasNet, 3 March 2012.
[5] Sleeman Consulting utilised a steady state model of the pipeline system north of Wollert, including laterals to Shepparton and Bendigo. Modelling was based upon 1 in 20 peak day gas demands.

Figure 2: Pressure Profile Wollert to Culcairn
(With 48 TJ/d Delivery to Culcairn)



Of the 48 TJ/d capacity to Culcairn, 36 TJ/d is contracted on a firm basis, leaving 12 TJ/d available for contract. To meet the requirement for export of an additional [C-I-C] TJ/d the capacity for delivery of gas to Culcairn will need to be increased by [C-I-C] TJ/d (ie, [C-I-C] TJ/d required less 12 TJ/d available) to a new total of [C-I-C] TJ/d.

It is important to note that the requirement for expansion of the capacity of either the SWP or Pipeline Vic:101 in order to transport additional gas does not in and of itself mean APA Gasnet's proposed expansion, or any other expansion, is necessarily justified. For the expenditure to be justified and therefore taken into account in determining tariffs it must comply with engineering or economic criteria set out in the National Gas Rules, specifically Rule 79(2). The AER will determine compliance, in this case on the basis of economic criteria.

4.2 Project Alternatives and Costs

The principal means by which the gas transportation capacity of an existing gas pipeline system may be expanded are:

- pipeline looping, to increase the effective diameter of a pipeline, allowing more gas to be transported without excessive loss of gas pressure; and

- addition of pipeline compression, to increase the average operating pressure and, in turn, efficiency of a gas pipeline, allowing more gas to be transported.

Other options for expanding the capacity of a gas pipeline, such as:

- the application of internal coatings to reduce friction; or
- increasing the maximum allowable operating pressure,

might be available in some circumstances but are typically only available prior to construction of a pipeline.

Options for expansion of the SWP or Pipeline Vic:101 (north of Wollert) are investigated below.

4.2.1 South West Pipeline

Key options for expanding the capacity of the SWP to allow transport of, at least, an additional [C-I-C] TJ/d of gas north from Iona are reviewed below.

a) Compression

The optimal location(s) for gas compression facility(s) and the compression power that will be required (or is available) are both inter-related and dependent upon the duty of the facility (north, south or bi-directional compression). For northward compression of gas with a single compressor station, analyses undertaken by Sleeman Consulting[6] suggest compressor locations as set out in Table 2 would be efficient.

Table 2: Compressor Station Location and Performance
(Figures are Indicative from Steady-state Model)

SWP Inlet Pressure	Compressor Size	Location (from Iona)	Capacity Increment
9.5 MPa	Centaur	42 km	96 TJ/d
	Taurus	48 km	106 TJ/d
10.5 MPa	Centaur	54 km	120 TJ/d
	Taurus	59 km	130 TJ/d

If two compressors are installed, efficient[7] locations for Centaur or Taurus sized units would be around 40-45 km and 80-85 km from Iona, giving pipeline capacity increments of around 175 to 190 TJ/d respectively.

[6] Sleeman Consulting used a steady state model of pipeline infrastructure between Iona and Brooklyn to investigate the impact upon northward gas transportation capacity of adding compression to the SWP. Combinations of compressor size and location were investigated to estimate the most efficient location for each size of compressor. The impact of using two compressors was also investigated.

[7] These figures are based upon a gas pressure at Iona of 10.2 MPa. The optimal configuration will vary as performance requirements and/or the Iona gas pressure vary.

APA GasNet has two compressor sites available, one at Winchelsea (about 82 km from Iona) and one at Stonehaven (about 118 km from Iona). While APA GasNet's sites are not optimal for purely northward transportation of gas, they will offer better performance if/when compressing gas to the south for recharge of underground gas storage. This is because, when compressing gas for southerly transport, compressor stations locations to the north (like Stonehaven) will be more efficient and allow better use of pipeline potential.

For northerly transport of gas the Winchelsea site is considerably more attractive than Stonehaven as a site for an initial, single compressor pumping northward. This is illustrated in Table 3.

Table 3: Comparison of Single Compressor Potential
(Figures are Indicative from Steady-state Model)

Compressor Scenario		Capacity Increment		
Location	Size	APA GasNet	Sleeman Consulting	
Iona gas pressure		*9.5 MPa*	*9.5 MPa*	*10.2 MPa*
Stonehaven	Centaur	49 TJ/d	41 TJ/d	72 TJ/d
	Taurus	59 TJ/d	47 TJ/d	78 TJ/d
Winchelsea	Centaur	69 TJ/d	65 TJ/d	98 TJ/d
	Taurus	81 TJ/d	75 TJ/d	108 TJ/d
'Optimised'	Centaur	-	96 TJ/d	120 TJ/d
	Taurus	-	106 TJ/d	130 TJ/d

The modelling results presented in Tables 2 and 3 indicate:

- Considerable efficiency, and hence pipeline capacity, benefits are realisable by operating the SWP at its rated pressure (10.2 MPa). With a gas pressure at Iona of 10.2 MPa, around 30 TJ/d of additional northward pipeline capacity will be available. The 9.5 MPa pressure limitation at Iona is sub-optimal and, as set out in Section 4.2.1(c) below, should be reviewed.

- Sleeman Consulting's modelling confirms the capacity benefits associated with installation of a compressor at Winchelsea rather than Stonehaven or, preferably, at an optimised location are significant.

The figures presented in the third and fourth columns of Table 3 (ie, relating to capacity increments based upon a 9.5 MPa gas pressure at Iona) serve to confirm APA GasNet's estimates. It is likely that Sleeman Consulting's figures are lower as a result of differences in assumptions and modelling approach[8].

- Taurus sized compressors appear to be oversized for use on the 500 mm diameter SWP. By making full use of pipeline pressure capability at Iona, Taurus compressors offer little net benefit over Centaur compressors.

APA GasNet proposes to install a Taurus sized gas compressor at Stonehaven, an existing site, in order to expedite expansion of the SWP. This would appear to be sub-optimal, particularly since the incremental capacity is not required until the [C-I-C], and therefore neither efficient nor prudent.

The preferred approach is to use available time to secure a site and approvals for installation of a Centaur 50 compressor either at Winchelsea or, preferably, at a site closer to Iona. A site closer to Iona offers the following advantages:

- It affords a greater increase in pipeline capacity, the value of which may be important in the event the SWP must continue to be operated with an inlet gas pressure of 9.5 MPa.

- It will be well suited for a further, future capacity expansion by installation of a compressor at Winchelsea.

The estimated cost to install bi-directional compression at a greenfields site is of the order of $35m for a Solar Centaur[9] sized compressor. This figure will vary depending upon specialised site or access works that may be required, or any need for fly in / fly out of construction crews and equipment. Ongoing operations, maintenance and fuel costs will also be incurred.

Operations and maintenance costs are likely to be of the order of 6% to 8% of the capital cost of the unit and will vary depending upon the operating hours of the unit. This estimate is based upon Sleeman Consulting experience, and

[8] Sleeman Consulting's approach to modelling of compressor power requirements is generic, rather than specific to make/model of compressor, and therefore tends to be conservative.
[9] Sleeman Consulting has carried out check pricing with a major industry service provider.

is considered sufficiently accurate for a first pass comparison of development options as is presented in Section 4.2.1(d).

Fuel usage will be around 430 TJ/a for a Solar Centaur unit operating at 100% capacity factor. Sleeman Consulting has prepared this fuel consumption estimate on the basis of a generic fuel efficiency of 36%. Actual fuel usage will vary depending upon operating hours and load.

b) Pipeline Looping

As an alternative to installation of gas compression facilities, the SWP could be looped. For northward transportation of gas the most efficient location for looping would be immediately to the north of Iona. To transport an additional [C-I-C] TJ/d of gas in a northerly direction would require installation of pipeline looping to the north of Iona with lengths of the order set out in Table 4.

Table 4: SWP Looping Requirement
(for [C-I-C] *TJ/d extra northward capacity)*

Loop Diameter, mm	400	450	500
Length Required, km	40	35	32
OoM[10] Cost	$45m	$44m	$45m

The order of magnitude cost[11] of installing looping to increase the capacity of the SWP is estimated to be of the order of $45m, regardless of the pipeline diameter selected for looping.

c) Improved Utilisation of Existing Infrastructure

While APA GasNet's augmentation planning must take system operational constraints into account, for the SWP the 9.5 MPa inlet pressure constraint means the full potential of the SWP is not being utilised.

AEMO cites[12] operational issues (such as demand uncertainty) as necessitating routine operations at below the

[10] Order of Magnitude ('OoM') Cost.
[11] Based upon an industry indicative $60,000 per inch-km of pipeline looping installed, plus a further $10,000 per inch-km provision for tough/rocky conditions anticipated along the route of the SWP. Further details of this cost index are provided in Section 4.2.3(b) of this Report. The cost index reflects guidance provided to Sleeman Consulting by pipeline industry construction service providers. The 60,000 per inch-km figure allows for additional costs associated with construction work alongside an operating high-pressure gas pipeline.
[12] See Section C.2.2 of Appendix C to 2011 Victorian Annual Planning Report, AEMO.

SWP's rated pressure. Sleeman Consulting understands the crux of the operational issues may be as follows:

- if gas that has been nominated for receipt on a particular day cannot be received into the VTS then penalties will be payable to the gas supplier in question; but

- operating the VTS (in this case at Iona) below its maximum allowable pressure ensures space is available in the system (in this case the SWP) to ensure gas quantities nominated for receipt at Iona can actually be received, and penalties avoided.

In contrast, long distance gas pipelines in other states are routinely operated with an inlet pressure equivalent to the maximum allowable for the pipeline in question.

A consequence of the Victorian operating regime is that the full potential of the VTS cannot be reliably realised. Capital investments, to expand system capacity, may as a consequence be required but not, technically, necessary. It may be more efficient in the interests of users of the VTS to incur an occasional penalty than to incur significant expense expanding system capacity to meet occasional, peak requirements.

If the Victorian gas market regime is constraining system operations and causing suboptimal investments and outcomes, then structural change could be considered in the interest of system users.

By operating the SWP with an inlet (Iona) gas pressure of 10.2 MPa, the capacity of the pipeline will be increased by around 30 TJ/d[13]. This has important implications in terms of the nature and timing of capacity expansion work to be undertaken, especially given that the incremental loads are at this stage forecast, not committed.

d) Comparison of Options

When comparing options for expansion of a pipeline it is important that both capital costs and future operating, maintenance and compressor fuel costs be taken into account using discounted cash flow analyses and having regard for the way in which the infrastructure will be

[13] In contrast AEMO estimates a capacity increase of only 20 TJ/d is available. Refer to Section C.2.2 of Appendix C to the 2011 Victorian Annual Planning Report, prepared by AEMO.

operated. While recurring costs associated with use of compression are significantly higher than the ongoing costs associated with installation of pipeline looping, use of compression may be preferable if it will require only intermittent operation or when overall operating efficiency improvements mean significant pipeline related capital expenditure is avoided.

A present value[14] comparison of the costs of expanding the capacity of the SWP is presented in Table 5. The looping and compression scenarios presented in Table 5 are based upon the inlet pressure of the SWP remaining at 9.5 MPa. To illustrate the impact of variations in utilisation of infrastructure, Table 5 includes information for both 100% capacity factor (ie, continuous use) and 55% capacity factor.

Table 5: Comparison of OoM Present Value Costs

Scenario	Looping	Compression (Winchelsea Centaur)	Iona @ MAOP
100% capacity	$51.7m	$82.6m	-
55% capacity	$51.7m	$54.4m	-
Capacity increment	[C-I-C]	69 TJ/d	30TJ/d
Cost per TJ/d of additional capacity	$1.72m	$1.20m (@100%) $0.79m (@ 55%)	0

Clearly, the best development option is to operate the SWP with an inlet gas pressure (at Iona) of 10.2 MPa, even if only on an interim basis. It would appear that a changed operation regime will allow the incremental, but as yet uncommitted, capacity requirement to be met without need for capital investment.

If pipeline expansion is required then the best development option will be significantly dependent upon market outlook. The following observations are relevant:

- Capacity expansion by installation of compression is 'lumpy' in nature, whereas looping can be installed on a sectional basis to meet market requirements. Notwithstanding this, compression is typically the most efficient means for achieving initial expansions of a

[14] Discounted cash flow modelling was carried out using nominal cash flows over a 20 year period, on the basis of a 2.5% rate of increase in CPI, and at a nominal pre-tax discount rate of 10.55%. Compressor maintenance costs have been assumed at 8% of a $35m capital cost, and a compressor fuel cost of $5.00/GJ has been adopted.

pipeline's capacity. This is illustrated by the cost per TJ/d of capacity figures presented in Table 5.

- If the requirement for expanded capacity had been 53 TJ/d (as proposed by APA GasNet) then the choice of compression over looping is clearly appropriate. To achieve the same capacity increment from looping as is achievable through installation of a Centaur 50 compressor at Winchelsea, the length and cost of looping required would be approximately doubled.

- To service the potential, incremental [C-I-C] TJ/d capacity requirement[15], compression is considered preferable to looping for the following reasons.
  - Despite the higher present value of costs set out in Table 5, the up-front capital cost of installing compression is considerably lower than the cost of looping. Further, the tabulated compression costs will fall as the capacity factor of the Winchelsea Compressor falls.
  - Installation of the Winchelsea Compressor gives a substantial uplift in gas deliverability to Melbourne, with associated security of supply benefits in the event of gas supply interruptions elsewhere.
  - Use of compression is the logical first stage of an expansion programme that could be implemented should gas transportation demand continue to grow.

4.2.2 Pipeline Vic:101, Wollert to Barnawartha

As a general observation, to increase the northward transportation capacity of Pipeline Vic:101 will require modification of:

- the heavily loaded Wollert to Euroa leg, which has a maximum allowable operating pressure ('MAOP') of 8.8 MPa: and potentially

- the Euroa to Springhurst leg, which has a MAOP of 7.39 MPa.

Provided gas pressures are high enough at the inlet to the Springhurst compressor, the Springhurst compressor and the pipeline leg from Springhurst to Barnawartha then on to Culcairn can handle the required gas flow rate and Culcairn gas delivery pressure requirements. Sleeman Consulting estimates

[15] Should a change in operating regime not be possible, and a capacity expansion determined to be justified.

a gas pressure of around 2.8 MPa at the inlet to the Springhurst Compressor will satisfy this requirement.

Key options for increasing the Culcairn gas 'export' capacity to [C-I-C] TJ/d are reviewed below.

a) Compression

Compression facilities are presently installed at Wollert, Euroa (about 117 km north of Wollert) and Springhurst (about 228 km north of Wollert). The capacity of Pipeline Vic:101 could conceivably be increased by installation of additional compression, with recommended locations being:

- just south of Broadford, to increase the capacity of the Wollert to Euroa leg; and

- just north of Benalla, to increase the capacity of the Euroa to Springhurst leg.

Installation of Centaur 50 sized compressors at these two locations would be just sufficient to increase total gas export capability to 81 TJ/d (after allowing also for transport of gas used to fuel the compressors). Use of a Taurus size compressor at Broadford, adding a further 1 MW of compression power, would see export capacity increased by only a further 3 TJ/d. A Taurus sized compressor unit is not well matched for the relatively small (300 mm) diameter of Pipeline Vic:101, with very high compression ratios being required. It would be preferable to use multiple, smaller compressor units although, to accommodate continued growth of gas exports, pipeline looping will eventually be both necessary and more efficient.

Installation of a single Centaur 50 compressor at the Broadford location will increase Culcairn export capacity to just over 66 TJ/d, or to around 80 TJ/d if the MAOP of Pipeline Vic:101 is re-rated[16] to 8.8 MPa north of Euroa.

Sleeman Consulting has received industry specific advice[17] on the order of magnitude cost of developing a Centaur 50 sized compressor station. The indicative cost, based upon good conditions but remote access, is $35m to $40m. Operating and maintenance costs are estimated on the basis of Sleeman Consulting experience to be of the order of 6% to 8% of capital cost. Fuel gas consumption will be

[16] See Section 4.2.2(c) of this Report.
[17] [C-I-C]

around 430 TJ/a at 100% capacity factor[18], but will vary depending upon operating hours and load.

b) Looping

APA GasNet has proposed installation of 104.1 km of looping, as follows, to achieve a northward gas transportation capacity of 81 TJ/d:

- 27.8 km of 450 mm nominal diameter looping immediately north of Wollert;
- 30.0 km of 450 mm nominal diameter looping immediately south of the Euroa Compressor; and
- 46.3 km of 450 mm nominal diameter looping immediately north of the Euroa Compressor.

Modelling undertaken by Sleeman Consulting confirms APA GasNet's proposed augmentation will increase the deliverability of gas to Culcairn by 33 TJ/d to 81 TJ/d. While it is generally preferable to carry out looping on the downstream side of compressor stations[19], the reduction in looping that would be achievable by revising APA GasNet's proposed programme is less than 1 km. APA GasNet has advised, and on the basis of desktop review work Sleeman Consulting agrees, that APA GasNet's approach is appropriate since:

- from Wollert, north via Wallan to Wandong, is reasonably flat, open country well suited for pipeline construction;

- from Wandong via Broadford to Seymour the route of Pipeline Vic:101 passes through the Great Dividing Range. Hilly, rocky and, in places, tight conditions will add significantly to the cost of pipeline looping work;

- north from Seymour the terrain is once again open and relatively flat, and pipeline construction conditions improved.

Of greater significance is that the possible requirement for an increase in the capacity to deliver gas to Culcairn[20] is only [C-I-C] TJ/d, not 33 TJ/d.

To achieve a northward capacity increase of [C-I-C] TJ/d, to [C-I-C] TJ/d total, will require only the first section of looping, that is, 27.2 km of 450 mm nominal diameter

[18] Estimated by Sleeman Consulting on the basis of a 36% fuel efficiency.
[19] That is, installation of additional looping north of Wandong would be more efficient that installation of 30.0 km of looping to the south of Euroa.
[20] See Section 4.1 hereof.

looping immediately north of Wollert. This heavily loaded section of pipeline is the first and foremost constraint upon northward gas deliverability.

Sleeman Consulting estimates it may be possible to achieve an [C-I-C] TJ/d increase in Culcairn export capacity with a looping programme that ends between Wallan and Wandong, but considers it would be prudent to loop all the way to Mt Franklin / Bendigo offtake at Wandong. The estimated cost[21] for 27.2 km of 450 mm diameter looping is $30.8m.

c) Pressure Re-rating

APA GasNet has achieved re-rating of the maximum allowable operating pressure of Pipeline Vic:01 between Wollert and Euroa.

Re-rating of the pipeline between Euroa and Springhurst, as well as to the north of Springhurst, should be achievable since the technical specification for the pipeline north of Euroa is understood to be identical to that of the section already re-rated.

Re-rating of the pipeline north of Euroa, in conjunction with suitable expansion of pipeline capacity south of Euroa, will allow a Culcairn export capacity increase well in excess of 33 TJ/d to be realised.

Although an export capacity increase of just [C-I-C] TJ/d is achievable without enhancement of the capacity of Pipeline Vic:101 to the north of Euroa, Sleeman Consulting considers there could for the following reasons be merit in pursuing re-rating of this pipeline section:

- re-rating will allow the pipeline to be operated more efficiently, reducing compressor fuel costs and allowing future capacity expansion with no, or reduced, need for compression or looping north of Euroa;
- operating infrastructure to achieve best efficiency and asset utilisation is both prudent and consistent with good industry practice.

[21] Pro-rated from APA GasNet's looping cost estimate, which is considered reasonable as discussed in Section 4.2.3 of this Report.

d) Comparison of Options

Towards identifying the optimal approach to increase Culcairn gas export capacity to [C-I-C] TJ/d, Table 6 summarises possible expansion options, showing also the impact upon costs of varying asset utilisation (ie, capacity factor[22]).

Table 6: Comparison of Costs of Development Options[23]

Option		Augmentation		PV of Costs (100% / 55% capacity factor)
		Wollert -Euroa	Euroa - Springhurst	
1a	Looping	27.2 km loop	none	$45m / $41m
1b		27.2 km loop	Re-rate	$41m / $41m
2a	Broadford Compression	Install C50	none	$100m / $71m
2b		Install C50	Re-rate	$88m / $67m

The following observations can be made:

- Installation of looping is the lowest cost way to increase Culcairn export capacity by [C-I-C] TJ/d.

- Re-rating of the operating pressure of Pipeline Vic:101 to the north of Euroa is considered desirable and worthy of pursuit. Re-rating of pipeline operating pressure north of Euroa allows that section of pipeline to be operated more efficiently (at higher pressure), thereby reducing overall fuel use. This is evident in Table 6 in that the present value costs of options 1b and 2b are, for 100% capacity factor, lower than the costs of options 1a and 2a respectively. A 10% increase in assumed compressor fuel cost would render option 1b more attractive than option 1a for both 100% and 55% capacity factors.

- Installation of a compressor at Broadford, in conjunction with re-rating of pipeline operating pressure to the north of Euroa, would afford a Culcairn export capacity

[22] A capacity factor of 55% has been selected for comparative purposes. This corresponds to information presented by APA GasNet at page 62 of 'Access Arrangement Submission', APA GasNet Australia (Operations) Pty Ltd, March 2012.

[23] In preparing Table 6 compressor fuel usage has been evaluated on a comparative basis, that is, by comparing and valuing differences in fuel usage between alternative options. A compressor fuel price of $5.00/GJ has been adopted. Higher compressor fuel prices will increase the attractiveness of the recommended option (looping with re-rating). The Table takes O&M costs of new compressors into account on the basis of 8% of capital cost, but does not consider O&M costs of existing compressors (namely Wollert, Euroa and Springhurst). An allowance of $5m, as outlined in Section 4.2.3(c) of this Report, has been made for the cost of re-rating of pipeline operating pressure.

increase of around 80 TJ/d. In present value terms the cost of capacity expansion using compression is equivalent to $1.1m per TJ/d of expanded capacity (for 100% load factor scenario). This compares favourably with a present value cost of the order of $2.3m per TJ/d for expansion by looping.

If there is firm expectation of further growth in demand for export of gas, consideration should be given to use of compression. The attractiveness of using compression to expand capacity is enhanced if the additional compressors will be operated on an intermittent[24] basis only (as indicated by the cost data for 55% capacity factor).

In regard to demand for Culcairn export capacity, it is noted that AEMO[25] projects a reduction in exports from Victoria over the long term.

The recommended approach to increase by [C-I-C] TJ/d the northward gas transportation capacity of Pipeline Vic:101 is to:

- install 450 mm diameter looping between Wollert and Wandong; and, to complement this
- undertake re-rating (to 8.8 MPa) of the maximum allowable operating pressure of Pipeline Vic:101 from Euroa north to at least Springhurst.

4.2.3 Costs

Costs associated with carrying out the proposed or alternative capacity expansion programmes are reviewed below.

a) Compression

APA GasNet's estimates of the cost of a new bi-directional compressor station are set out in Table 7. The higher figure for each class of compressor is for development on a greenfields site (Winchelsea), not yet owned or permitted. The lower figure is for a site already owned and previously permitted (Stonehaven).

Although the Stonehaven site is already owned and permitted, it is subject to significant civil costs associated with siteworks and site access[26].

[24] That is, operation of the compressors will only be required during periods of high system demand and/or the requirement for export of the full 81 TJ/d is itself intermittent.
[25] See 2011 Gas Statement of Opportunities, Chapter 7 and Section A1.4.6 of Attachment A1.
[26] The Stonehaven site is basalt, and requires construction of a long access road to Hamilton Highway.

Table 7: Compressor Station Costs per APA GasNet[27]

Centaur compressor	$34.9m - $37.0m
Taurus compressor	$38.3m - $40.5m

Sleeman Consulting has received industry specific advice[28] on the likely cost for greenfields development of a Centaur 50 compressor. The indicative cost, based upon good conditions but remote access, is $35m to $40m. Pro-rating this figure on the basis of installed power gives in excess of $40m for a Taurus sized compressor station. APA GasNet's compressor cost estimates are therefore considered reasonable.

b) Looping

APA GasNet's pipeline looping cost estimates are summarised in Table 8.

Table 8: Pipeline Looping Costs per APA GasNet[29]

Looping Size / Length	Capital	Cost Index ($ per inch-km)
400 mm / 114.3 km	$122.5m	66,984
450 mm / 104.1 km	$122.2m	65,215
500 mm / 96.7 km	$120.4m	62,254

APA GasNet's looping cost estimates are considered reasonable on the following basis:

- An industry indicative cost index for pipeline construction in open country is considered to be around $50,000 per inch-km. This takes account of current and anticipated market conditions (lack of contractor availability and high labour costs).

- For pipeline looping, the cost index should be increased by up to 20% to provide for considerable additional work associated with pipe-laying alongside an operational high-pressure gas pipeline[30].

[27] From Business Case BC175 - Gas to Culcairn Project, APA GasNet, 3 March 2012.
[28] [C-I-C]
[29] From Business Case BC175 - Gas to Culcairn Project, APA GasNet, 3 March 2012. The forecast cost for the 450 mm size looping was subsequently marginally reduced (in the 'VTS AA Capex Forecast Final', dated 6 July 2012. For comparative purposes the original estimates have been used in Table 8.
[30] While there may be some benefits associated with looping (for example, use of an existing easement may reduce project lead-time) such benefits are outweighed by costs for activities

- There may also be some cost index uplift to cover amortisation of mobilisation costs in circumstances where pipeline sections to be developed are relatively short.

- Combining the abovementioned factors gives a pipeline looping cost index in excess of $60,000 per inch-km.

APA GasNet's pipeline looping cost estimates are considered reasonable.

c) Pipeline Re-rating

Australian Standard AS2885.1, which governs design and construction of gas pipelines, incorporates provisions for upgrading of the maximum allowable operating pressure ('MAOP') of a pipeline in certain circumstances. In accordance with the Standard, APA GasNet secured approval to increase the operating pressure of Pipeline Vic:101, between Wollert and Euroa, to 8.8 MPa.

To seek approval for re-rating of the pipeline north of Euroa will require a programme of work involving, but not limited to:
- intelligent pigging of sections of the pipeline;
- uncovering and inspection of sections of the pipeline;
- rectification or replacement of unsatisfactory equipment; and
- documentation, including pipeline operational history.

The cost incurred by APA GasNet for work to re-rate the Wollert to Euroa pipeline section was $7.3m, although this included modifications to the Springhurst Compressor (to make the station bi-directional). A provision of the order of $5.0m is suggested for work to gain approval for re-rating of Pipeline Vic:101 north of Euroa on the following basis:

- after allowing for the costs of Springhurst Compressor work (details of which are not available to Sleeman Consulting) the cost of the previous pressure re-rating exercise was less than $7.3m;

- the previous re-rating work was for 117 km of pipeline, which is comparable to the 132 km distance from Euroa to Barnawartha; and

- experience, including research and documentation completed, with re-rating of the Wollert to Euroa

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such as dig-ups, to confirm location of existing pipeline, and right-of-way constrictions including inability to operate heavy equipment above the existing pipeline

pipeline section should have application for a future re-rating exercise, thereby helping to control the costs of the future exercise.

4.3 Project Timing

The requirement for system augmentation to allow increased delivery of gas to Culcairn is driven by forecasts rather than firm commitments. With regard for the advice of AGL[31], the forecast requirement is for a [C-I-C] TJ/d increase in the capacity to receive gas at Iona and an [C-I-C] TJ/d increase in capacity to export gas at Culcairn, both commencing [C-I-C].

4.3.1 APA GasNet Proposal

APA GasNet has proposed immediate development of the Stonehaven Compressor. The Stonehaven site is already owned and has previously been permitted for development of the compressor station.

APA GasNet also proposes to undertake looping of 104.1 km of Pipeline Vic:101, to be complete by January 2015.

APA GasNet's proposed works are to increase Iona gas receipt capacity by at least 53 TJ/d and Culcairn gas export capacity to 81 TJ/d. The works are in excess of what is required to meet forecast requirements.

4.3.2 Alternative Approach

The forecast requirement for receipt of an additional [C-I-C] TJ/d of gas at Iona can be satisfied by changing the operating regime of the SWP. The pipeline should be operated with an inlet pressure, at Iona, of 10.2 MPa.

Should a change in the operating regime for the SWP not be possible then a Centaur 50 sized compressor station should be developed at Winchelsea or, preferably, at a site (to be procured and permitted) between Winchelsea and Iona. Time is available to achieve this as the forecast requirement for additional SWP capacity does not arise until [C-I-C]. There is no need for rushed, and sub optimal, expenditure on development of the Stonehaven Compressor.

In parallel with the above, 450 mm diameter looping of Pipeline Vic:101, should be carried out between Wollert and Wandong, to be operational by January 2015.

[31] AGL Energy Limited, letter dated 18 June 2012

Re-rating of Pipeline Vic:101, from Euroa to at least Springhurst, to allow operation at up to 8.8 MPa should be investigated in view of efficiency and capacity benefits realisable.

4.4 Observations

Key observations in relation to the proposed Gas to Culcairn Project are summarised below.

a) The need for an increase in capacity to receive gas at Iona and to export gas at Culcairn is driven by forecasts rather than commitments. The forecasts are overstated. The corrected forecast requirement is for a [C-I-C] TJ/d increase in capacity to receive gas at Iona and an [C-I-C] TJ/d increase in capacity to export gas at Culcairn, both from [C-I-C].

b) If the expansion project is to proceed then it will be necessary to expand both the capacity of the SWP and the capacity of Pipeline Vic:101 between Wollert and Euroa.

c) APA GasNet proposes installation of a Taurus 60 compressor at Stonehaven on the SWP be expedited. At a cost of $38.3m this will increase capacity to receive gas at Iona by 59 TJ/d, but will be a sub-optimal (and therefore not prudent) arrangement.

d) It is preferable that:

- operating arrangements for the SWP be revised so as to operate the pipeline at its full rated pressure (10.2 MPa), thereby improving its efficiency and increasing its capacity by an estimated 30 TJ/d; or

- a new Centaur 50 based compressor station be developed at Winchelsea or, preferably, midway between Winchelsea and Iona, giving a capacity increase of the order of 70 TJ/d to 90 TJ/d respectively. If operating arrangements for the SWP are revised the capacity increase will be 98 TJ/d to 120 TJ/d respectively.

  Relative to making use of the Stonehaven site, which is already owned by PAA GasNet, it will take additional time to procure both a new compressor site and development approvals. Time is however available to implement the more efficient compressor station development since the increase in gas receipt capacity at Iona is not required until [C-I-C].

  The preferred approach is efficient and consistent with good industry practice.

e) APA GasNet proposes the installation of 57.8 km of 450 mm diameter looping between Wollert and Euroa and 46.3 km of looping to the north of Euroa. At a cost of $118.0m this will give a gas export capacity increase of 33 TJ/d.

f) To achieve the required [C-I-C] TJ/d capacity increase it is only necessary to install 27.2 km of 450 mm diameter looping between Wollert and Wandong at an estimated cost of $30.8m.

   The looping does not need to be installed and operational until [C-I-C].

g) Although not requested by APA GasNet, and not required to meet the corrected forecast increase in Culcairn gas export, Sleeman Consulting suggests consideration be given to re-rating of the maximum allowable operating pressure of Pipeline Vic:101 to the north of Euroa. This will improve the operating efficiency of the pipeline and reduce compression fuel costs.

5 Western Outer Ring Main Project

5.1 Need for Project

The primary purpose[32] of the Western Outer Ring Main ('WORM') Project is to mitigate the effects of a major interruption to gas supply from Longford, particularly in terms of the need for curtailment of gas supply to domestic customers.

As the VTS is presently configured, in the event of a Longford outage the ability to supply gas (that has been received at Iona) to domestic customers to the north and east of Melbourne is potentially constrained by the lack of pipeline capacity across Melbourne from west to east. The WORM will allow gas that is received at Iona to be transferred efficiently to Wollert and, from there, to east Melbourne and Gippsland via Pakenham.

APA GasNet contends other benefits will also flow from development of the WORM, including:

- improved flexibility and efficiency of operations of the VTS, increased capability for transfer of gas to Iona for injection to underground storage, and better management of linepack within the VTS;
- ability to meet predicted gas demand growth to the north and west of Melbourne, and further growth in export of gas to NSW;
- overcoming the need for further upgrade of the Brooklyn Compressor Station; and
- enhanced gas on gas competition.

This document overviews the role of, and alternatives to, development of the WORM and provides comments to assist the AER in determining whether the proposed WORM Project is justified in accordance with the National Gas Rules.

5.2 Project Alternatives and Costs

5.2.1 APA GasNet Proposal

APA GasNet's WORM proposal incorporates the following:

- 8.3 km of 500 mm nominal diameter class 600 (10.2 MPa) pipeline from Rockbank to Plumpton, construction of which is already proceeding;

[32] Business Case BC083 – Western Outer Ring Main (WORM), APA GasNet Australia (Operations) Pty Limited, 3 March 2012.

- 49.3 km of 500 mm nominal diameter class 600 pipeline to be constructed from Plumpton to Wollert;
- Solar Centaur C50 compressor to be installed at Wollert to compress gas westward into the WORM; and
- pressure reduction facilities to allow gas to be delivered from the WORM into the lower rated (6.89 MPa) Pakenham to Wollert Pipeline.

APA GasNet's proposed pipeline size (ie, 500 mm) is reasonable. It is logical for the WORM, as an effective bi-directional extension of the SWP to have the same diameter and pressure rating as the SWP.

The direct capital cost of the WORM Project as proposed by APA GasNet is $92.4m, comprising:
- $72.9m for pipeline, including pressure reduction facilities at Wollert; and
- $19.5m for the additional compressor at Wollert.

The pipeline construction cost set out above, equivalent to $72,617 per inch-km, is high but not unreasonable. The relatively high cost per inch-km reflects significant costs associated with securing land access and approvals for construction of the pipeline in proximity to Melbourne, through areas of future development. This has been confirmed through inspection of cost break-up information provided by APA GasNet.

5.2.2 Alternative Approach

The only practical alternative to the WORM, as a means of enhancing scope for transfer of gas from the west to the east of Melbourne, is to construct a new gas pipeline between Brooklyn and Dandenong. By interconnecting the relatively high-pressure pipeline infrastructure that terminates at those locations, the potential cross-city gas transfer constraint of the low-pressure (2.76 MPa) system may be overcome.

APA GasNet has identified a possible Brooklyn to Dandenong pipeline corridor some 48 km in length that would involve a crossing of Port Philip Bay. To avoid the Bay crossing would require additional pipeline construction in highly built up areas. Either way, Sleeman Consulting agrees that construction of a high pressure Brooklyn to Dandenong Pipeline would be fraught with difficulty, and more expensive than the proposed Plumpton to Wollert component of the WORM.

Sleeman Consulting also agrees that the proposed WORM may offer advantages in terms of servicing both:

- gas demand growth in the areas north and west of Melbourne, for example the Kalkallo development; and
- growth if any in the requirement for export of gas via Culcairn.

5.3 Project Timing

There is no specific timing imperative for development of the WORM. Rather, if the project is determined to be justified then it would be logical that it be developed in a timely manner in order to take advantage of any operational or security of supply benefits the project will deliver.

5.4 Technical and Commercial Considerations

5.4.1 Matters to be Considered

APA GasNet has provided[33] documents to justify development of the WORM. Matters for consideration in relation to justification of the WORM Project are set out below.

a) Security of Supply Benefits

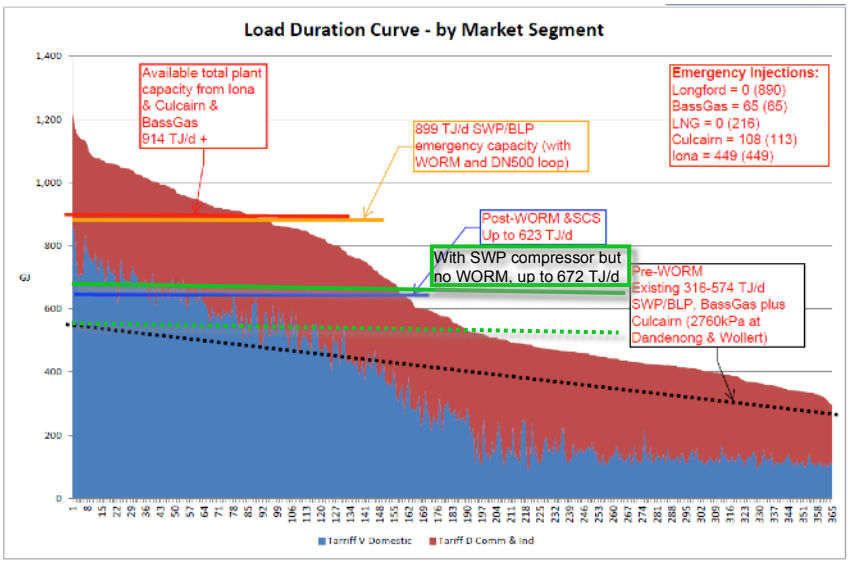
APA GasNet's primary project justification is based upon a reduction in the potential for disruption of gas supply to domestic customers and, hence, potential avoidance of costs. This concept is illustrated in Figure 3[34], in which:

- The blue shaded area represents the daily gas requirement of domestic gas users in Victoria;
- The black dotted line represents the present deliverability of gas from sources excluding Longford;
- The blue solid line represents the deliverability of gas from sources excluding Longford after development of the WORM; and
- Sleeman Consulting has added the green solid and dashed lines, explained below.

[33] a) Business Case BC083 – Western Outer Ring Main, APA GasNet Australia (Operations) Pty Limited, 3 March 2012; and
b) r2a Due Diligence Engineers Report: Effectiveness of the Western Outer Ring Main (WORM) Project on Security of Supply of the Victorian Transmission System (VTS), March 2012

[34] Page 5 of Business Case BC083 – Western Outer Ring Main, APA GasNet Australia (Operations) Pty Limited, 3 March 2012.

Figure 3: Illustrative Benefit of WORM



The present gas deliverability (black dotted line in Figure 3) as referenced by r2a Due Diligence Engineers represents the deliverability of gas during normal circumstances, that is, when gas is also being delivered from Longford. In emergency circumstances the deliverability of gas is higher, as set out in Table 9 and illustrated by the green dotted line in Figure 3.

In evaluating exposure in an emergency situation, consideration should be given to emergency deliverability (ie the green dotted line not the black dotted line). In the event of a Longford gas supply failure, the number of days of potential risk for domestic customers is less than 100 (after allowing for curtailment of larger users), rather than 148 as indicated by APA GasNet.

Table 9: Gas Deliverability in Emergency (No Longford)

Source	Winter	Shoulder	Summer
Iona[35]	374	374	374
Culcairn[36]	113	110	108
Yolla[37]	65	65	65
Total	552	549	547

[35] This includes delivery of gas to the Western Transmission System. Source: r2a Report
[36] Source: r2a Report
[37] Source: r2a Report, verified by reference to page 30 of '2010 Victorian Annual Planning Report Update', AEMO.

The blue solid line in Figure 3 represents APA GasNet's estimate of gas deliverability into the Victorian market after development of the Stonehaven Compressor Station and the WORM, and assuming no gas is received at Longford.

The green solid line in Figure 3 represents Sleeman Consulting's estimate of gas deliverability into the Victorian market assuming the capacity of the SWP is upgraded, but without development of the WORM. The gas deliverability represented by the green solid line is the aggregate of gas receivable from the following sources (on the basis that no gas is received at Longford[38]):

- In an emergency, gas availability from Yolla, delivered at high pressure into the Gippsland Zone (shown in Figure 4), is 65 TJ/d. In contrast, the forecast 1 in 20 peak day demand for Gippsland, prior to curtailment of gas supply to large users, is only 69 to 70 TJ/d. After curtailment of large users a considerable surplus of gas will be available for delivery into the Melbourne Zone.

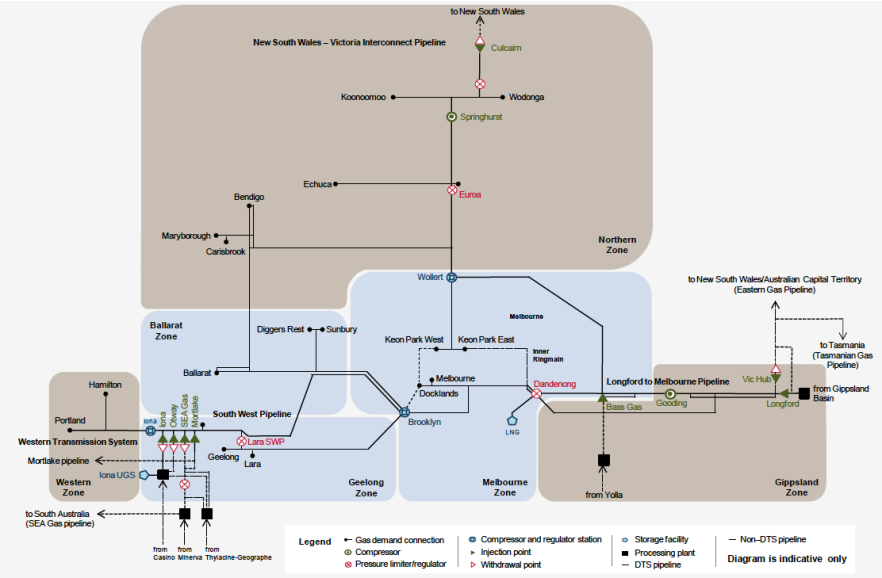
- Gas availability from Culcairn is 113 TJ/d during the critical winter period. This is about equivalent to the 1 in 20 peak day demand of the Northern Zone (shown in Figure 4), again before curtailment of gas supply to large users. Surplus gas will be available for the Melbourne Zone via Wollert.

- Gas will be available from Iona[39] at a rate of 374 TJ/d or:
  - with rationalised operation of the SWP, 404 TJ/d; or
  - with rationalised operation and installation of a gas compressor, as discussed in Section 4.2.1(a), up to 472 TJ/d (for Winchelsea) or 494 TJ/d (for an optimised location).

  These rates of deliverability are well in excess of the combined 1 in 20 peak day demands of the Ballarat, Geelong and Western Zones (shown in Figure 4), prior to curtailment of gas supply larger users. Surplus gas will be available for supply into the Melbourne Zone via Brooklyn.

[38] The scenario adopted by APA GasNet has been adopted for comparative purposes. This does not imply the scenario is, or is not, appropriate for assessing security of gas supply related matters.
[39] Note, the maximum availability of gas from Iona is 500 TJ/d. See page 30 of 2010 Victorian Annual Planning Report Update, AEMO.

Figure 4: Victorian Transmission System[40]
(Showing System Withdrawal Zones)



The WORM is not required to deliver gas from Iona/Brooklyn into the Melbourne Zone in the circumstances outlined above. With reduced supplies of gas from the east (ie, no deliveries of gas from Longford) and curtailment of gas supply to larger users, the 750 mm diameter Melbourne section of the VTS can accommodate these flows, despite its lower operating pressure. Indeed, in the absence of the WORM this is the very mechanism by which gas received at Iona may be exported at Culcairn as part of the Gas to Culcairn Project[41].

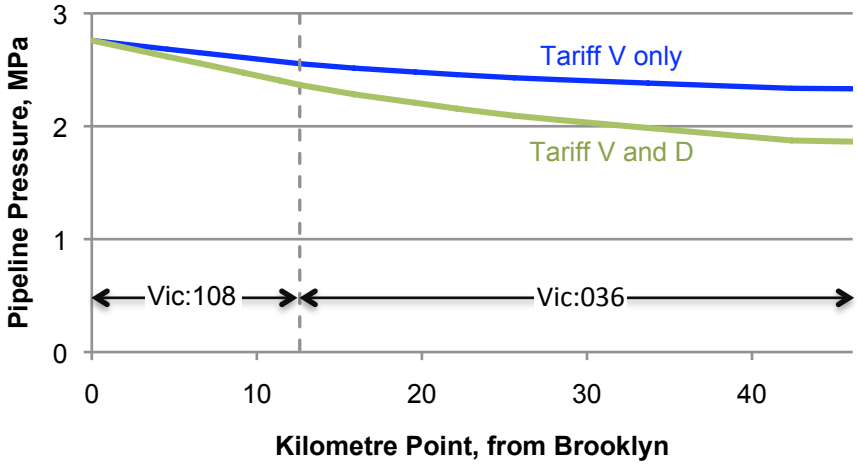
The ability of the Melbourne section of the VTS to handle gas quantities from Iona via Brooklyn has been confirmed through modelling undertaken by Sleeman Consulting, results of which are depicted in Figure 5.

The blue line in Figure 5 is based upon 434 TJ/d of gas being supplied into the Melbourne section of the VTS at Brooklyn[42]. This quantity of gas is sufficient to meet the forecast 2013 peak day demand of all offtakes of gas from the VTS

[40] Figure from page A1-4 of the 2011 Gas Statement of Opportunities, prepared by the Australian Energy Market Operator.
[41] Conceptually, gas received at Iona will be transported to Brooklyn and delivered into the Melbourne zone, thereby freeing up gas from the east for diversion via Pakenham to Wollert, and then on to Culcairn for export.
[42] This gas flow rate was selected for modeling purposes as it represents an extreme scenario where all gas for the Melbourne Zone is supplied via Brooklyn. It is not represented that gas will be available at Brooklyn at this rate. Some curtailment of gas supply may be necessary on peak days as outlined with reference to Figure 3.

between Brooklyn and Dandenong, including offtakes at Dandenong[43].

Figure 5: Pressure Profile Brooklyn to Dandenong



Given the capacity of the Melbourne section of the VTS it is not necessary to develop the WORM to be able to utilise gas from Iona in the event of an interruption to supply of gas from Longford. The key requirement for mitigating a loss of Longford gas supply is to maximise capacity for transport of gas from Iona through expansion of the north-haul capacity of the SWP.

In view of the above, Sleeman Consulting has not been able to replicate the security of supply component of the business case presented by APA GasNet. It appears the security of supply related benefits should be available even without the WORM.

b) Related Projects

APA GasNet has identified a range of related projects that may or may not be required, depending upon whether or not the WORM is developed. The most significant of these are considered below.

i) Sunbury Loop

The decision to develop the Sunbury Loop, from Rockbank to Plumpton, was integral to APA GasNet's decision not to proceed with previously approved redevelopment of the Brooklyn Compressor Station

[43] Based upon information from VTS Tariff Model. The gas flow rate for the green line in Figure 5 is 589 TJ/d.

(which would have increased the gas pressure available at the inlet to the existing Sunbury lateral).

Notwithstanding that the Sunbury Loop was upsized as a precursor to development of the WORM, the costs are sunk and arguably not relevant to a decision regarding justification for development of the WORM.

ii) Rockbank PRS

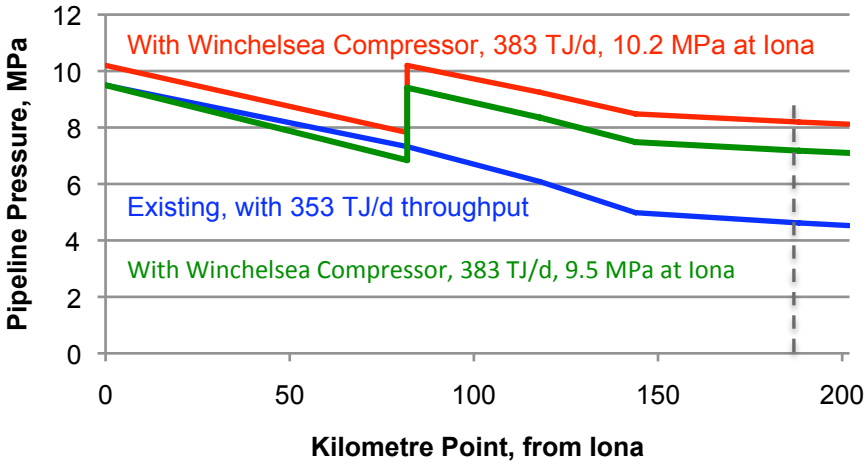
Installation of a new Pressure Reduction Station ('PRS') at Rockbank is proposed. The PRS will utilise gas pressures available in the Brooklyn to Lara Pipeline in support of gas supply to Ballarat, thereby overcoming the requirement for compression at Brooklyn of gas into the Brooklyn to Ballan Pipeline.

In the event gas compression is installed on the SWP then, subject to arrangements for scheduling receipt of gas at Iona, the new PRS at Rockbank might in any case be developed. With a compressor installed on the SWP, gas pressures in the Brooklyn to Lara Pipeline will be maintained at levels high enough for operation of the new PRS. This is illustrated in Figure 6, which shows present and potential pressure profiles of the SWP. The potential profiles are based upon development of the Winchelsea Compressor, operation of the SWP with an inlet gas pressure, at Iona, of either 9.5 or 10.2 MPa, and with gas receipt at Iona of [C-I-C] TJ/d.

Figure 6 shows the gas pressure available at Rockbank will in either of the potential cases be sufficient to support gas deliveries to Ballarat. Sleeman Consulting estimates (through modelling of the Brooklyn to Ballarat Pipeline) a gas pressure around 6 MPa at Rockbank will meet this requirement.

With lower flows in the SWP, higher gas pressure will be available at Rockbank.

Figure 6: SWP Pressure Profiles



During peak demand periods, when the gas pipeline to Ballarat is most heavily loaded, it is most likely that gas will be scheduled for receipt at Iona. However, if operating arrangements for the Victorian Declared Wholesale Gas Market prevent scheduling of Iona gas receipts to support operations in the manner outlined above then:

- it will be necessary to retain back-up compression at Brooklyn; and
- installation of the proposed new PRS will not be necessary (since Brooklyn must continue in operation to meet peak requirements).

In the above eventuality, gas compression facilities at Brooklyn[44] are already sufficient[45] to compress gas to Ballarat to meet peak day requirements.

iii) Brooklyn Compressor Station

APA Gas Net proposes to downgrade the Brooklyn Compressor Station, eventually to a single unit (BCS12) compressing gas to Laverton for Gas Powered Generation.

Reflecting the observations set out immediately above, if the WORM is not developed and the SWP (with compression installed) can be used to support gas

[44] Brooklyn compressor BCS12 is preferred for this service. If not available units BCS8 and BCS9 can meet the requirement.
[45] Section 5.1.9 of Victorian Annual Planning Report 2012, Australian Energy Market Operator. concludes that, without the WORM, no Ballarat gas supply constraints have been identified for a 10 year outlook period on the basis of current demand forecasts.

delivery to Ballarat through the proposed new PRS then the Brooklyn Compressor Station can be rationalised as proposed by APA GasNet and operating savings realised. Recharge of underground storage can take place during offpeak, summer periods when BCS12 is not required for compression to Laverton. As noted by APA GasNet[46], compression of gas for recharge of underground storage will be more effectively achieved using one compressor at Brooklyn together with compression on the SWP.

If gas compression is not installed on the SWP then at least two Centaur compressors will need to be retained at Brooklyn to meet possible requirements for:

- compression of gas to Geelong and Laverton;
- compression of gas for recharge of underground storage (2 units operating during off peak periods);
- compression of gas to Ballarat.

Some downgrading of the station may still be possible, but this has not been specifically investigated herein.

iv) Kalkallo Lateral

If the WORM is not developed, the proposed Kalkallo Lateral will be of longer length with an incremental cost of $6.2m[47].

Overall, if the WORM is not developed it would appear that costs may need to be incurred, or alternative actions implemented, as summarised in Table 10.

[46] Page 27 of APA GasNet Compressor Strategy
[47] Business Case BC083 – Western Outer Ring Main, APA GasNet Australia (Operations) Pty Limited, 3 March 2012

Table 10: Capital Cost Consequences of Not Developing, and Alternative to, WORM

Requirement	With WORM[48]	Without WORM[35]	Alternative	
			With compression on the SWP	Without compression on the SWP
WORM	$72.9m	-	-	-
Wollert Pressure Regulator		-	-	-
Wollert Compression	$19.5m	-	-	-
Sunbury lateral / WORM stage 1	already committed			
Rockbank PRS	$2.2m	-	$2.2m	-
Brooklyn Compressor Station	$0.2m	$55.0m	$0.6m[49]	$2.2m[50]
Iona Compressor Station	-	$0.7m	-	$0.7m
Wollert Compressor Station	-	$0.5m	$0.5	$0.5m
Kalkallo Lateral extension	-	$6.2m	$6.2m	$6.2m
Subtotal Costs	**$94.8m**	**$62.4m**	**$9.5m**	**$9.6m**
SWP Capacity (Iona 9.5 MPa)	*353 TJ/d*		*418 TJ/d*	*353 TJ/d*
Compressor on SWP[51]	$38.3m (Stonehaven T60)		$35.0m	n/a
Total Costs	**$133.1m**	**$100.7m**	**$44.5m**	**$9.6m**
SWP Capacity (Iona 9.5 MPa)	*412 TJ/d*		*418 TJ/d*	*353 TJ/d*

[48] Information sourced from Business Case BC083 – Western Outer Ring Main, APA GasNet Australia (Operations) Pty Limited. Stonehaven Taurus 60 Compressor cost is sourced from Business Case BC175 – Gas to Culcairn Project, APA GasNet Australia (Operations) Pty Limited.
[49] It has been assumed that the Brooklyn CS Ballarat Filter and the smaller GEA upgrade work, as per APA GasNet Business Case BC083, will be required to maintain operability in advance of start up of new compression on the SWP.
[50] Allows for station isolation and loading valves, larger GEA upgrade and Ballarat filter (as per APA GasNet Business Case BC083).
[51] While this item is part of the Gas to Culcairn Project, it is necessary to realise increased capacity in the SWP.

c) Other Benefits

From a technical perspective development of the WORM, a high-pressure east - west gas pipeline link around Melbourne, has appeal. Development of the WORM will deliver the following operational benefits:

- increase the rate at which gas can be transferred to Iona for injection to underground storage. This is because present constraints associated with transfer of gas through the 7.39 MPa Brooklyn to Geelong Pipeline will be removed. Gas will instead be delivered at high pressure from Wollert via Stonehaven to Iona.

- system and linepack management should be improved, particularly in the event of an interruption to normal gas supplies.

These may be desirable outcomes in their own right, but are not immediately quantifiable.

5.4.2 Observations

In consideration of the matters outlined in Section 5.4.1 the following observations are made:

- The WORM and related projects have a cost of $94.8m. This does not include the cost of compression if installed on the SWP.

- If developed, APA GasNet considers the WORM will deliver benefits including:
  - improved system operability and linepack management, (factors that are not immediately quantifiable);
  - avoidance of $64.6m of capital expenditure elsewhere, in particular at Brooklyn Compressor Station and for supply of gas to Kalkallo; and
  - mitigation of the effects of a loss of gas supply from Longford.

- The net cost of developing the WORM is then $30.2m (ie, $94.8m - $64.6m), to be justified on the basis of the security of gas supply related benefits.

- However, it does not appear that development of the WORM is necessary to realise security of supply benefits associated with receipt of gas at Iona. Accordingly, there is doubt regarding justification of the net expenditure to develop the WORM.

- With or without the WORM, security of gas supply benefits associated with receipt of gas at Iona will be maximised to the extent the ability to receive gas at Iona for northward transport is maximised. Expansion of the capacity of the SWP, though installation of compression, will deliver this outcome.

- If a gas compressor is not installed on the SWP (or a compressor is installed but gas cannot be reliably scheduled for receipt at Iona) then:
  - the proposed new Rockbank PRS will not be required; and
  - the Brooklyn Compressor Station will need to remain in service, but the major upgrades proposed by APA GasNet do not appear to be required. On the contrary, some rationalisation may still be possible.

  With the Sunbury lateral in place the compression power requirement (for compression to Ballarat) is reduced[52], and the Victorian Annual Planning Report 2012 does not identify constraints on supply of gas to Ballarat (based upon present demand forecasts for a 10 year period without the WORM). The three existing Centaur compressors at Brooklyn should be capable of satisfying compression requirements, with BCS10 used as back-up or for compression to Ballarat if the other units are required for other duty.

- If a gas compressor is installed on the SWP and gas can be reliably scheduled for receipt at Iona in quantities to meet the requirements of the Ballarat and Geelong Zones then the proposed new Rockbank PRS should be developed. This should allow further downgrading of the Brooklyn Compressor Station (as proposed by APA GasNet) and realise operating benefits comparable to those achievable with the WORM. Capital costs of around $9.5m would be incurred.

In summary, while the WORM will afford some benefits in terms of system and linepack management and transfer rate of gas for recharge of underground storage, its development is not necessary for security of supply benefits to be realised. Further, it is not apparent that major redevelopment of the Brooklyn Compressor Station is required, or would be justified, if the WORM is not developed.

[52] Page 22 of APA GasNet Compressor Strategy 2012.

Development of the WORM is not considered to be prudent since developing it will not be consistent with achieving the lowest sustainable cost of providing services.

6 South West Pipeline Compression

Regardless of whether or not the WORM is developed, to realise maximum strategic benefits in the event of a Longford outage it is important gas be deliverable from Iona at the highest possible rate. Accordingly, installation of gas compression on the SWP warrants consideration in its own right. Although outside the immediate scope of this Report, the following potential benefits of installing compression on the SWP (at Winchelsea Compressor or, preferably, closer to Iona) are noted:

- a material increase in deliverability of gas to Brooklyn and, in turn, Melbourne, with associated security of supply benefits in the event of a Longford outage;

- use of the compressor, in conjunction with one compressor at Brooklyn, to improved capacity for transfer of Longford gas to Iona for recharge of underground storage; and

- subject to being able to schedule requisite quantities of gas for receipt at Iona, gas pressure will be available in the SWP to support delivery of gas to Ballarat through the proposed new Rockbank Pressure Reduction Station, thereby reducing the need for operation of the Brooklyn Compressor Station and allowing operating benefits to be realised.

7 Conclusions

7.1 Gas to Culcairn Project

The Gas to Culcairn Project is proposed to meet a forecast requirement for receipt of an additional 53 TJ/d of gas at Iona and firm export of an additional 33 TJ/d of gas at Culcairn. The forecast requirements are overstated. A corrected forecast is for receipt of an additional [C-I-C] TJ/d of gas at Iona and export of an additional [C-I-C] TJ/d of gas at Culcairn.

It is accepted that:

- installation of compression is the best means of expanding capacity to meet the corrected forecast of requirements for receipt of additional gas at Iona: and

- installation of looping is the best means of expanding capacity to meet the corrected forecast of requirements for delivery of additional gas to Culcairn.

However, the capacity augmentation programme proposed by APA GasNet is, in the case of the SWP, suboptimal and in the case of Pipeline Vic:101, excessive.

APA GasNet proposes installation of a Taurus 60 compressor at Stonehaven on the SWP to increase capacity to receive gas at Iona by 59 TJ/d. Sleeman Consulting considers the proposed development is not efficient.

It is preferable that operating arrangements for the SWP be revised so as to operate the pipeline at its full rated pressure (10.2 MPa) and increase capacity to receive gas at Iona by an estimated 30 TJ/d.

Alternatively, a new Centaur 50 based compressor station should be developed at Winchelsea or, preferably, midway between Winchelsea and Iona, giving a capacity increase of the order of 70 TJ/d to 90 TJ/d respectively, rising to 98 TJ/d to 120 TJ/d if operating arrangements for the SWP are revised (as suggested above).

APA GasNet proposes installation of a total of 104.1 km of 450 mm diameter looping of sections of pipeline to the north Wollert to give a gas export capacity increase of 33 TJ/d. To achieve the required [C-I-C] TJ/d capacity increase it is only necessary to install 27.2 km of 450 mm diameter looping between Wollert and Wandong.

Sleeman Consulting suggests consideration be given to re-rating of the maximum allowable operating pressure of Pipeline Vic:101 to the north of Euroa. This will improve the operating efficiency of the pipeline and reduce compression fuel costs. This is not an option presently proposed by APA GasNet or required to meet forecast market requirements.

The basis of APA GasNet's cost estimates for installation of compression and looping is considered reasonable. On the basis of the revised augmentation programme set out above, the cost of expanding Iona gas receipt and Culcairn gas export capacities to meet corrected requirements is:

- $35m for installation of bi-directional Centaur 50 compressor on the SWP; and

- $30.8m for installation of looping between Wollert and Wandong.

The estimated cost to achieve re-rating of the maximum allowable operating pressure of Pipeline Vic:101 to the north of Euroa is $5m.

7.2 WORM

The WORM Project is proposed to mitigate the effects of a major interruption to gas supply from Longford, particularly in terms of the need for curtailment of gas supply to domestic customers. Other benefits may also flow from the project, notably in terms of downgrading of the Brooklyn Compressor Station, and flexibility and efficiency of system operations.

APA GasNet has proposed the installation of 49.3 km of new 500 mm gas pipeline to complete a link between the Brooklyn Lara Pipeline and Wollert. In addition, a new Centaur 50 compressor will be required at Wollert to deliver gas into the WORM, along with a pressure reduction facility to receive gas from the WORM. The capital cost of these facilities totals $94.8m and is considered reasonable for the works concerned.

However, the security of supply related benefits that may accrue from development of the WORM are intangible and, in any case, realisable without need for its development. In the event of a loss of gas supply from Longford capacity exists for injection at Brooklyn of gas into the large diameter low-pressure system that services Melbourne – in effect a reversal of normal operations that involve gas being supplied from Dandenong.

In addition, it is not evident that substantial redevelopment of the Brooklyn Compressor Station (as referenced by APA GasNet) will be required in the event the WORM is not developed. With the Sunbury lateral in place the requirement for compression of gas to Ballarat is reduced and potential may in any case exist for some downgrading of Brooklyn Compressor Station.

Development of the WORM is not considered to be prudent since developing it will not be consistent with achieving the lowest sustainable cost of providing services.