FINAL REPORT

Quantification of asymmetric demand risk on the Goldfields Gas Pipeline

PREPARED FOR THE GOLDFIELDS GAS TRANSMISSION JOINT VENTURE

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Contents

Boxes, tables and charts

1 Introduction

This paper sets out a quantitative analysis of the asymmetric demand risks faced by the Goldfields Gas Pipeline (GGP).

The returns to a pipeline are asymmetric when the upside potential is constrained by various factors, whereas the downside potential is far less constrained. Under these conditions the expected balance of upside and downside tends to be adverse for the pipeline's owner, in this case the Goldfields Gas Transmission Joint Venture (GGTJV). This makes the expected value of returns lower than that permitted by the regulator, the Western Australian Economic Regulation Authority (ERA), in its Amended Draft Decision.[1]

This difference in expected value arises from uncertain factors, which are outside the control of the GGTJV. If insurance coverage were available to compensate for asymmetric risk, then the premiums associated with that insurance would be a cost of doing business that would be incurred by a prudent owner. As such, this insurance premium should be a cost, which is included in the regulatory cost base.

The specific asymmetric risk considered here, demand risk, is uninsurable. That does not mean that the GGTJV avoids this cost, only that the GGTJV bears it in the form of self-insurance costs. We present here a calculation of an actuarially fair annual payment representing the accrued cost of self-insurance.

Intuitively, the demand risks on the GGP are not symmetric. GGP is unlike many gas transmission pipelines as it almost exclusively serves industrial demand, most of which is mining-related. Mining-related demand tends to be more volatile than residential demand. While some of this impact will be picked up in the systematic risk (beta) of the pipeline, there will also be an asymmetric impact because the potential for demand to fall below expected levels is greater than the potential for demand to be above expected levels.

On the downside, the GGTJV is exposed to the risk that any particular customer will exit the market served by the GGP, either when the contract for gas supply expires or due to industrial closure. For example, if the largest customer were to stop or scale back production due to a particular incident, the volume of gas supplied could drop dramatically. Furthermore, take or pay contractual provisions are of limited benefit when the demand reduction arises from closure or financial stress of a major customer.

[1] Economic Regulation Authority 2004, Amended Draft Decision on the Proposed Access Arrangement for the Goldfields Gas Pipeline Submitted by Goldfields Gas Transmission Pty Ltd, 29 July.

On the upside, while there is some scope for new customers to seek access, there may be long lead times before these customers are able to accept gas supplies, owing to the time required to develop mining operations to exploit new deposits. In addition to lead-time constraints, there are capacity constraints on the GGP. In 2004, the GGP's average annual throughput was approximately 80% of the current capacity limit of 110 TJ/day. A modest increase in demand would bring the pipeline near its current capacity limit. While further capacity can be added by increasing the number of compressor stations, capacity addition displays diminishing returns to investment. Ignoring regulation, the constraint on the upside is not so much the hard capacity limit of the pipeline, but the diminishing commercial attractiveness of expanding capacity to meet higher demand levels.

Of course, regulation is impossible to ignore. When demand for gas supplied by the GGP is strong, the Code requires the revision of forecasts at each regulatory review and therefore a pass through (reduction in price) to customers. The Code also permits revisions in forecasts when demand is weak. However, the ability to fully pass on any price increases to customers is constrained by competition between gas and alternative fuel sources. If demand has fallen due to competition with alternative fuel sources, increases in price will only exacerbate the business impact.

The fact that the ERA adopted the demand forecast submitted by the GGTJV in its Amended Draft Decision does not mean that the asymmetric demand impact has been factored away. Even under the most likely demand estimate there may be greater scope for demand to fall significantly below this estimate than to rise above it.

The following sections elaborate on these points. First we discuss the nature of asymmetric risk, and the most appropriate manner of incorporating it in regulated returns. Second we present the analytical work, which involves Monte Carlo simulation of a range of possible demand scenarios. Finally we present the conclusions.

2 Background to the asymmetric risk issue

The ERA's Amended Draft Decision on the GGP access arrangement included no allowance for asymmetric risk. Regulatory precedent on asymmetric risk is evolving, as seen in recent decisions by the ACCC, most notably in its GasNet and SPI Powernet decisions, but also in subsequent electricity transmission decisions. It is well known that the CAPM approach used by Australian regulators to determine a rate of return assumes the diversifiability of some unavoidable risks. If these are risks that investors in a security cannot avoid by diversification, investors can be expected to require a return for bearing that risk.

2.1 Defining Asymmetric Risk

The assumptions of the CAPM imply that the returns are normally distributed. However, there are many risks, and hence returns, that are asymmetric. Risks are asymmetric when the possible outcomes in one direction are different than the possible outcomes in the opposite direction. Asymmetric risks are very common but are not necessarily a problem when using the CAPM to estimate the cost of equity capital if the risks can be insured against or diversified.

Regulated infrastructure firms such as the GGTJV, the owner of the GGP, face a range of risks that are asymmetric. These include:

- assets becoming stranded as customers change consumption patterns or competitors change strategies;
- regulatory bodies adjusting policies or regulatory frameworks; and
- the occurrence of extreme events, with the firm bearing the adverse consequences but, thanks to regulatory controls, not benefiting commensurately when the consequences are positive.

These risks can have a number of characteristics that differentiate them from other risks faced by the company. First, the risks are asymmetrical and beyond the firm's control. Therefore they cannot be diversified away by the company. Second, insurance against these risks is not commercially available. Third, these risks are not accommodated in the CAPM.

Because risks of this type are assumed in the CAPM not to require compensation, estimations of the cost of equity capital using the CAPM will not include any compensation for facing these risks. Yet it is clear that investors will require such compensation if they are to invest in infrastructure companies. The question becomes how compensation for the risks should be achieved in the regulatory process. The CAPM is not amenable to modifications for these risks, so either regulatory cashflows must be supplemented, or the CAPM-determined cost of capital must be adjusted upward.

2.2 How best to incorporate a Return for Asymmetric Risk

Since it has no alternative but to bear the risk of losses, the regulated firm should be permitted a cash flow or cost component that explicitly includes the actuarially-fair premium for insuring against this risk. If insurance were available, the owners of the regulated firm could take out insurance coverage. Of course, if it did so, the expense of the insurance should be fully acceptable to a regulator and recognised in the cost base. On this basis the company could cover the risk with no adverse impact on its profit.

Since insurance coverage is generally not available, the company is forced to self-insure. Companies could still deal with the issue if they were allowed to use accrual accounting for the self-insurance premia in determining their costs. A firm would record an expense for the actuarially-fair self-insurance premium. Again, if this approach were permitted, the premium would be an expense that regulators should accept as a legitimate part of doing business and be recoverable through revenue.

The approach taken here is to estimate an actuarially-fair self-insurance premium for the principal asymmetric risks faced by the company. The ACCC has stated that to adequately assess a proposal for self-insurance, it would "need to consider such matters as: a report from an appropriately qualified insurance consultant that verifies the calculation of risks and corresponding insurance premiums; confirmation of the board resolution to self-insure; and the relevant self-insurance details that unequivocally set out the categories of risk the company has resolved to assume self-insurance for." [2] Once the estimation has been made and approved, the amount would be imputed to the costs of the company.

We note that many asymmetric risks are uninsurable. For uninsurable risks, the ACCC's requirements are problematic. The board of a firm may resolve to self-insure when external insurance coverage is available but expensive. However, when external insurance coverage is unavailable at any price, the board has no option but to self-insure. As there would be no alternative, there is no decision involved, so there would be no board resolution.

While regulatory precedent has developed, the amounts provided in regulatory decisions to date have been small, almost trivially so in comparison to the regulatory asset base. Table 1 sets out the ACCC's allowances in its GasNet and SPI Powernet decisions. In both cases the cash flow amount for asymmetric risk is less than 0.04% of the regulated asset base.

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2 ACCC 2002, "*Draft greenfields guideline for natural gas transmission pipelines*," June, p.16.

Table 1 **ACCC asymmetric risk allowances: GasNet and SPI Powernet decisions**

Decision/proposal	Annual cash flow amount (year 1, $'000)	Opening asset value ($m)	Cash flow amount as % of asset value
GasNet	182	494.2	0.034%
SPI Powernet	710	1,835.6	0.039%

Source: Australian Competition and Consumer Commission, Final Decision: GasNet Australia access arrangement revisions for the Principal Transmission System, November 2002. Australian Competition and Consumer Commission, Decision: Victorian Transmission Network Revenue Caps 2003-2008, December 2002.

3 Quantifying an actuarially fair self-insurance premium

This paper describes a calculation of the actuarially fair self-insurance premium that the GGTJV requires to compensate it for the asymmetric demand risk it faces on the GGP. Note that this section does not aim to quantify other asymmetric risks faced by the GGTJV including: regulatory risk, credit risk, or deductible amounts in insurance policies.

Many business risks, especially those relating to uncertain future demand, involve an upside and a downside. If the upside and downside tend to equalise each other in an expected value sense, then the demand risk is symmetric. It is often the case with regulated assets, however, that the upside is truncated by the regulator's requirement to share the demand and efficiency gains with consumers. Other factors tending to truncate upside returns may be capacity limits or high costs in expanding capacity to meet buoyant demand.

In order to quantify the asymmetric effect for the GGP using explicit cashflow modelling, two tools are required:

1. a spreadsheet which calculates the net present value of returns for any given demand profile over time; and
2. a method of generating and assigning probabilities to a range of possible future demand profiles.

With these tools, it is possible to calculate an expected net present value of GGP returns and compare that with the net present value implicit in the ERA's Amended Draft Decision. The difference between these returns, expressed as an annuity, is the actuarially fair insurance premium needed to compensate for the asymmetric risks implicit in demand uncertainty.

In the next three subsections, we set out an explanation of the financial evaluation of each demand scenario, the method of generating and assigning probabilities to specific demand scenarios, and the results of this analysis.

3.1 Financial evaluation of any given demand scenario

In order to evaluate the impact of different demand scenarios on the business value of the GGP, we have adapted a financial model of the pipeline provided to us by the GGTJV. The focus of that model was to replicate the ERA's recommended tariffs based upon the ERA's decisions on key cost of service parameters. It was necessary to extrapolate from the final year of that model, 2009, to the assumed end of the pipeline's economic life. In this case we adopted the date initially proposed by the GGTJV and used by ERA, namely 2036.

The following assumptions formed the basis of that extrapolation:

- The 2009 ERA-recommended tariff applying to contract durations of 20 years was used in all years from 2010 to 2036, adjusting for inflation at 2.61% per annum.
- Opex was assumed to increase at 1% per annum real in each year after 2009.
- In each year between 2009 and 2031 (five years before the end of the pipeline's economic life) capex was assumed to be equal in real terms to the average annual capex from 2000 to 2009.
- Net present values employed the ERA-recommended WACC of 10.79% pre-tax nominal as the discount rate.

These assumptions were applied to the high, medium, and low demand scenarios. In the medium scenario, we assumed that demand continues at the 2009 level for the rest of the modelling period (to 2036). Under this demand scenario, the net present value of revenues (at the ERA 20 year contract tariffs) exceeded the net present value of capital and operating costs (including the 2004 ERA DORC value of the pipeline) by only $4.8m, which is less than 1% of the DORC value. This result suggests that the extrapolation assumptions yielded a medium demand case result that is consistent with the regulatory goal of zero economic profit: the present value of net revenue is approximately equal to the regulatory asset valuation.

3.2 Generation of probability-weighted demand scenarios

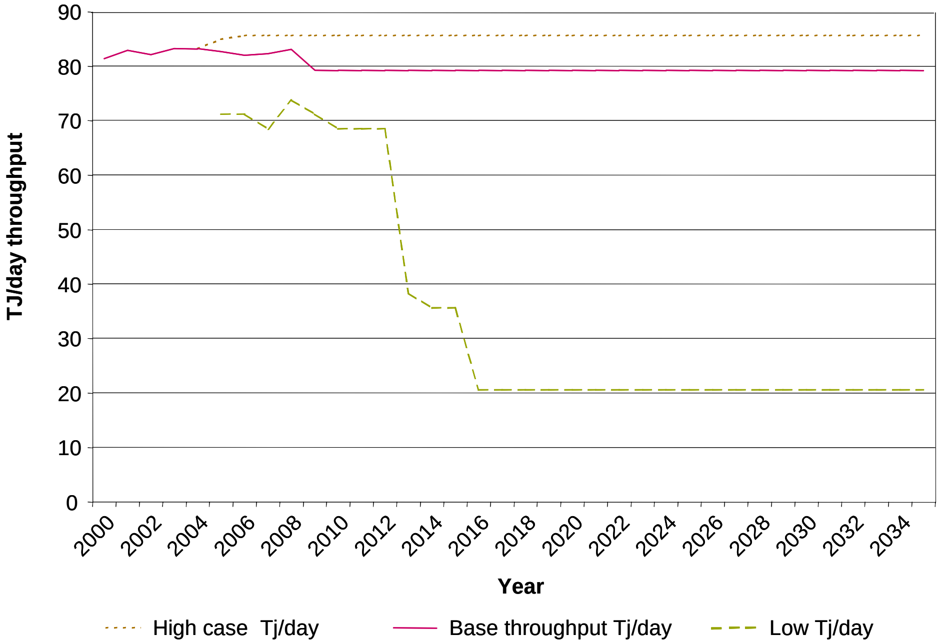
As noted above, the medium demand scenario, which is the GGTJV's current Access Arrangement forecast (2004), assumes that 2009 throughput continues each year of the modelling period. That scenario yields a result close to zero economic profit for the pipeline's economic life.

The low demand scenario is based on the long-term forecast provided by GGTJV to the ERA on 15 December 1999. That scenario is published in the Amended Draft Decision at page 86. It assumes that no gas throughput beyond what is currently contracted will be transported on the GGP.

The high demand scenario is based on the throughput consistent with the GGP's current capacity (assuming a 78% load factor, as applied in 2009).

The three demand scenarios are compared in the figure below.

Chart 1 **Demand scenarios**



The various forecasts can be seen to represent the demand on the GGP assuming certain states of the world take place. In this analysis we treat the pessimistic GGTJV and optimistic forecasts, for each year, as points in a distribution of sales. In particular:

- The GGTJV Pessimistic scenario was taken as an estimate of the minimum demand that could be expected in any year;
- The (capacity-capped) Optimistic scenario was taken as the maximum demand in any year; and
- The constant 2009 forecast was taken as an estimate of the most likely demand in any one year.

Given these assumptions it is possible to define a distribution of sales. In this analysis Pert distributions were assumed to apply. Thus, a Pert distribution of sales was constructed for each year of the modelling period 2010 to 2036.

An overview of the Pert distribution is given in Box 1.

Box 1 **The Pert Distribution**

The Pert distribution is constructed using data on minimum demand, most likely demand and maximum demand. The formulas required to calculate selected moments of the Pert distribution are detailed below.

Definitions:

$$\mu \equiv \frac{\text{min} + 4 \cdot m.likely + \text{max}}{6} \quad \alpha 1 \equiv 6\left[\frac{\mu - \text{min}}{\text{max} - \text{min}}\right] \quad \alpha 2 \equiv 6\left[\frac{\text{max} - \mu}{\text{max} - \text{min}}\right]$$

Mean:

$$\mu \equiv \frac{\text{min} + 4 \cdot m.likely + \text{max}}{6}$$

Variance:

$$\equiv \frac{(\mu - \text{min})(\text{max} - \mu)}{6}$$

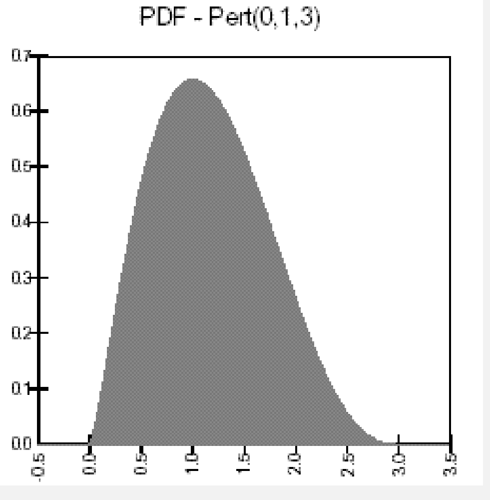
Skewness:

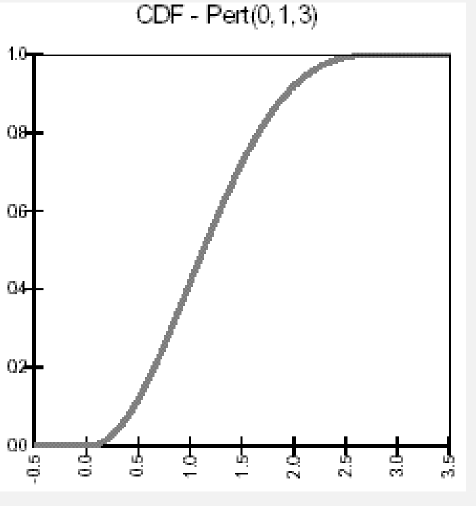
$$\frac{\text{min} + \text{max} - 2\mu}{4}\sqrt{\frac{7}{(\mu - \text{min})(\text{max} - \mu)}}$$

Kurtosis:

$$3\frac{(\alpha_1 + \alpha 2 + 1)\left(2(\alpha_1 + \alpha_2)^2 + \alpha_1\alpha_2(\alpha_1 + \alpha_2 - 6)\right)}{\alpha_1\alpha_2(\alpha_1 + \alpha_2 + 2)(\alpha_1 + \alpha_2 + 3)}$$

An example of the probability distribution function and cumulative density function of a Pert Distribution with minimum demand 0, most likely demand 1, and maximum demand 3 are given below.





Source: Palisade Corporation, Distribution Function.

3.3 Results of expected net present value calculation

The net revenue from the GGP was then specified as revenue minus estimated operating costs and the costs of any additions to capacity required to meet demand in a particular year. The net return was then discounted by ERA's real pre-tax WACC to derive the Present Value of net revenue.

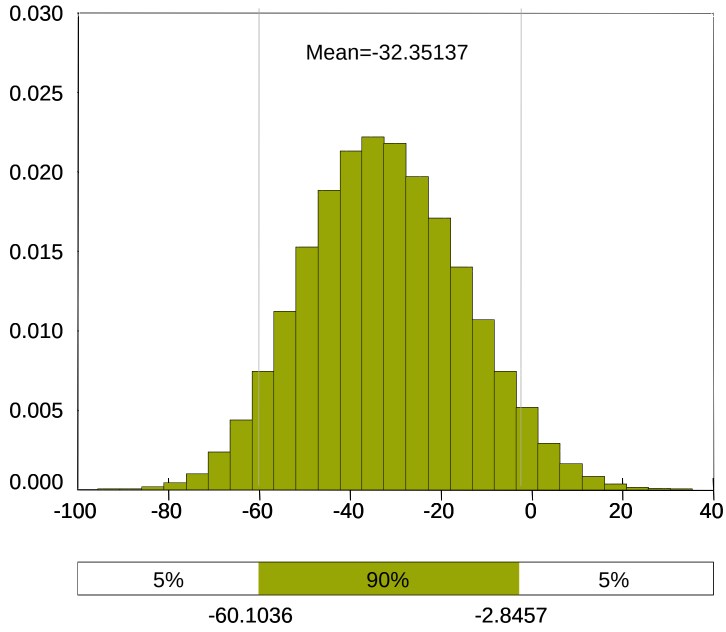
To calculate the expected value of GGP's net return a "Monte Carlo" simulation was undertaken in which the quantity of sales in each and every year over the period 2010 to 2036 was derived by sampling the Pert distributions. The present value of GGP's net revenue was then calculated. This procedure was repeated 100,000 times and the results from these simulations were used to generate a probability distribution for the present value of GGP's net returns (Chart 2).

GGP's expected return, incorporating the possibility of asymmetric risk factors is calculated to be ($-32.4) million. This is approximately $37 million less than the expected return of $4.8m based on ERA's methodology, which implicitly assumes there are no asymmetric effects.

The GGTJV would be indifferent between insuring against the net effect on its returns of asymmetric factors and accepting a return which incorporated these factors. An annual "insurance" amount can thus be estimated as the annuity that, when discounted over the remaining life of the GGP at the ERA-determined WACC, gives a value equal to $37 million — the difference between the net present value of expected returns calculated here and the net present value of returns expected by ERA.

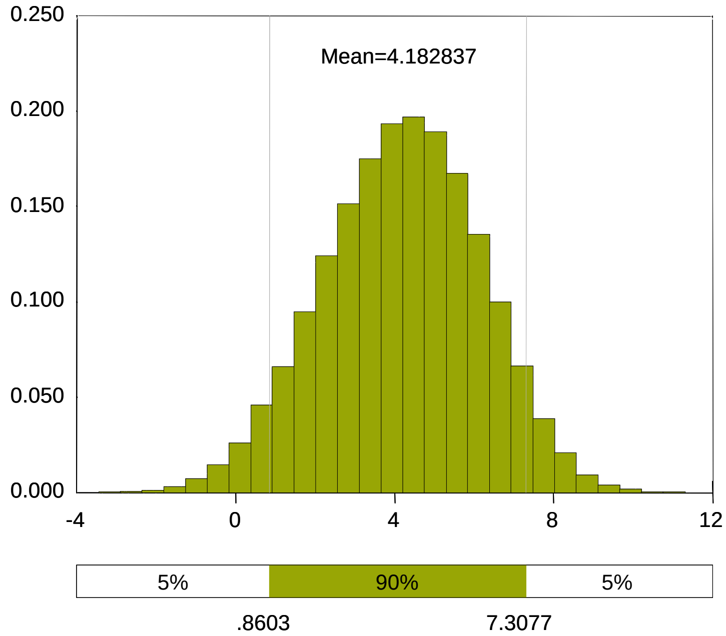
A distribution of these real annuities can be calculated (Chart 3). An expected annuity of $4.18 million is indicated. That is, given the regulated returns suggested by ERA, the GGTJV would require an additional $4.18 million per year to compensate it for the possibility that it may be disadvantaged by the occurrence of asymmetric effects.

Chart 2 Net present value of the GGTJV's net returns incorporating asymmetric effects ($m) Mean value of net cashflows = ($-32.4m)



Data source: Monte Carlo simulation with Pert distribution.

Chart 3 Real annuity required to compensate the GGTJV for the impact of asymmetric factors on its returns ($m 2004) Mean value of annuity = $4.18m



Data source: Monte Carlo simulation with Pert distribution.

3.4 Sensitivity testing

As a sensitivity case, to explore the possible consequences of our selection of a Pert distribution, we have used a triangular distribution as an alternative distribution. In the triangular distribution case, the expected value of returns to GGP is even more negative than in the Pert distribution, at ($70.2m). The actuarially fair self-insurance premium is $8.44m per annum, representing the mean of the distribution of annuities. The probability that the appropriate annuity is greater than $4.58m is 95% for the triangular distribution.

We have also modelled the impact of increasing the asset life to 70 years. In this case there is an increase in the required annual annuity under a Pert distribution to $5.7 million.

4 Conclusions

This report has presented a calculation of a mean estimate of the premium needed to insure against demand risk. The estimate of the value of this risk is $4.18m per annum, assuming a Pert distribution is used to model the asymmetric effects. If instead a triangular distribution is employed, the self-insurance premium is estimated to be significantly higher: $8.44m per annum. While the various demand scenarios are subject to considerable uncertainty, it is clear that the demand risks discussed here are fundamentally asymmetric in character.

The source of the asymmetry is the fact that GGP throughput and revenue is almost completely reliant on demand from mining companies along its route. Unlike the urban residential demand that characterises most long-distance pipelines in Australia, the GGP's demand base is subject to sudden downward movements as mineral resources are exhausted or world commodity prices change. The upside is likely to be less extreme and positive changes are likely to be much less sudden.

The intuition behind the results reported here is that the owner's ability to recoup its residual investment value post 2009 is dependent upon future gas throughput being sufficiently high to permit recovery of capital costs without significant increases in tariffs. The difficulty with this approach is that the potential downside is significantly further below the most likely scenario than the potential upside is above it. The demonstrated asymmetry of potential best and worst case scenarios leads to the conclusion that the expected value of throughput (and therefore net pipeline revenue) lies well below the most likely value employed by the regulator. In effect, the regulator is using a most likely outcome when it should be using an expected value outcome. We have quantified the net present value of the difference between most likely and expected values, and estimated an annual charge that would equalise the two values. That annual charge must be included in the revenue requirement if the expected value of the pipeline owner's returns is to be equal to the regulatory asset base. Refusal to permit the annual charge to be included in the revenue requirement would be contrary to the pipeline owner's legitimate business interests because it would prevent the owner from recovering the regulatory initial capital base from tariffs.

This calculation is inherently conservative in that it has not included any allowance for regulatory risks introduced at future price resets. We have not attempted to quantify this effect, but its direction is unambiguous. ERA will revisit GGP pricing every five years. When it does so, ERA will consider, *inter alia*, changes in demand patterns, which have emerged since the prior reset. If demand on the GGP has reduced, it is unlikely to translate to prices which are sufficiently high to ensure recovery of the GGTJV's revenue requirement because:

- even if ERA approved price increases, price increases would be commercially unviable because they would only accelerate the market share loss to other fuel sources, and
- the regulator may strand redundant capital.

To put these conservative results into perspective, the self-insurance premium of $4.18m per annum for asymmetric risk is approximately equivalent to an increase in the regulatory WACC of 0.94% (from 10.79% to 11.73% pre-tax nominal). Acceptance of this self-insurance premium would lead to an increase of less than 6% in the revenue requirement. An increase of this magnitude would still leave the regulated revenue below the level that prevailed prior to the ERA's Amended Draft Decision.

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