DEPRECIATION WITHIN ODRC VALUATIONS

A Report for the ACCC

Prepared by NERA

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Purpose and Key Messages

This report assesses various approaches to determining the level of depreciation for the purpose of arriving at a Depreciated Optimised Replacement Cost (DORC) from an Optimised Replacement Cost (ORC) when setting an Initial Capital Base (ICB). The objective of this report is to further a debate between the Australian Competition and Consumer Commission (the Commission) and Agility Management Ltd Pty (Agility) as to the most appropriate methodology for estimating depreciation.

There are three key messages in our report. The first is that DORC is a cost-based approach to establishing an asset valuation. DORC was created to avoid the problem of circularity that arises when trying to value a regulated asset on the basis of associated (regulated) prices. DORC is independent of any past or future profile of tariffs or revenues. Therefore, any DORC estimation that depends on assumptions about ***revenue*** is inconsistent with the underlying premise of the valuation approach.

The second is that, if it is accepted that the objective of DORC is to replicate the maximum price an efficient new entrant would pay for existing assets in preference to replicating them, then the level of depreciation appropriate for deriving a DORC from an ORC will depend on the ***future costs*** associated with using an existing asset relative to the ***future costs*** that would be associated with purchasing a new asset. These costs will include future operating and maintenance costs as well as future capital expenditure. Estimating these relative costs will be as much an ***empirical*** issue as an ***analytical*** one.

The third key message is that the DORC should be determined exclusively by reference to the economic principles that underpin it. Section 8.10 of the gas code sets out a number of issues that should be considered when establishing the ICB, which include the DORC ***and*** a number of other valuation approaches and related issues. A "DORC" that is intended to reflect these other, sometimes conflicting, valuation approaches is difficult to interpret and may reduce the transparency of the ICB setting process. We therefore believe there is a strong case for divorcing the link between the DORC and ICB.

What is the Depreciation Adjustment Intended to Reflect?

DORC is intended to reflect the economic cost of replacing a specified service capability by reference to an existing asset. The ACCC have written that this can be thought of as:[1]

> ***"…the price that a firm with a certain service requirement would pay for existing assets in preference to replicating the assets."***

[1] ACCC (1999) page 39

The maximum price a firm will be willing to pay for an existing asset, given the cost of replacing it with a new (optimally configured) asset will depend on such factors as the remaining life of the existing asset, any differences in ongoing operating and maintenance costs, any differences in operating risks, the likely costs of asset replacement at the end of its useful life, etc. Accordingly, the DORC valuation should balance the net present value (NPV) of the expected future costs associated with a decision to purchase a new asset and those associated with using the existing asset. Under this definition, the depreciation adjustment should reflect the differences in ***future*** costs associated with new and existing assets.

The appropriate period of calculation will be the period over which the firm's cash flows are expected to be affected by its decision. Whether the firm chooses to purchase existing or new assets, it will not expect to face any associated cashflows beyond the economic life of the market served by these assets, therefore the period of analysis should be the economic life of the market under consideration.

The Agility/Professor King Approach

Agility's proposal

Agility has proposed an approach whereby the DORC of an asset is estimated on the basis of the future revenues it can be expected to generate. In its analysis Agility has used a constant revenue stream, which it believes to be consistent with a competitive market outcome.

The fundamental intention behind DORC is to divorce the asset valuation from revenue streams. DORC is a ***cost based*** valuation precisely because there is a degree of arbitrariness about the assumed future level and profile of revenues that an asset may be able to generate, making revenues an unsuitable basis for economic valuation.

Although Agility has attempted to reduce this arbitrariness by setting the NPV of future cash flows on the basis of the ORC, this still leaves open the issue of the time profile of those revenues. There is an infinite range of revenue paths that will yield an NPV equal to the ORC. Agility has chosen one possible time profile, based on a constant profile of real revenues, arguing that this is the profile consistent with competitive markets. Whether this is the case is open to debate and other revenue profiles would yield different DORC valuations. For example, a front-loaded profile would result in a higher DORC valuation whereas an escalating profile would result in a lower DORC valuation.

Professor King's supporting analysis

Professor King recognises that the fundamental rationale of the DORC approach is to ensure comparability between the value placed on new and existing assets. He states:[2]

> ***As an alternative to purchasing new capital equipment, the new firm could purchase the assets of the existing firm. DORC may be interpreted as the maximum price that a new entrant would be willing to pay for these existing assets rather than purchase new assets. The transformation of ORC to DORC must then leave the new firm indifferent between buying the existing assets and purchasing the new assets.***

Professor King has estimated this difference on the basis of the future revenues associated with existing and new assets. His mathematical representation of the DORC starts from the point of revenues and can then be expressed in terms of cost due to the assumption that real revenues are constant in each year.

Professor King's analysis states that the value of the existing asset to an entrant is the amount it would save as a result of delaying the purchase of a new asset. His analysis states that the DORC is the difference in the NPVs between purchasing the ORC now and purchasing it at the end of the life of the existing asset. The validity of this result is dependent of several assumptions, ie:

- real revenue is constant each year;
- once the new asset is purchased it is never replaced – there are no subsequent capital expenditures;
- there is no technological progress that would change the ORC over time or the operating and maintenance costs associated with a new asset (Professor King acknowledges that changes in these assumptions will alter the conclusions of his analysis but notes that this is consistent with assumptions made by Australian regulators and proceeds to extend his analysis in later sections); and
- the cost of operating and maintaining the two assets is identical – there is no cost advantage to having newer assets.

Expanding Professor King's approach to account for a more complete range of assumptions can have a significant impact on the DORC estimation. However, the key distinction between Professor King's approach and that presented in this paper is that whereas the Professor's approach is based on revenues (which may then be defined according to costs) ours is based directly on underlying future costs.

[2] Professor King (2001), page 6

Consideration of the Empirics

Under the approach presented in this paper, the "depreciation" element of DORC is the value that equates the costs a new entrant faces when it chooses to purchase the existing asset as distinct from choosing a new asset that is optimally configured for the relevant service capability. It is the value that balances the NPV of future costs associated with new and existing assets. Estimating this will ultimately be an empirical issue, since the DORC valuation (defined according to the new entrant test) reflects the underlying cost characteristics of the asset under consideration.

In this paper we provide a simple empirical model to illustrate the depreciation schedule associated with a range of assumptions about the costs associated with new versus existing assets. A preliminary conclusion from this model is that the Commission's straight-line depreciation approach may be more consistent with the characteristics of gas pipelines than Agility's proposed methodology.

Comment on Sinclair Knight Merz's Recommendation

SKM has recommended that straight-line depreciation approach be proscribed, as this would produce a degree of stability and confidence within the industry.

While this is a valid point, NERA has been asked to consider the economic rationale underlying DORC and to consider the appropriate depreciation calculation in line with this. We have therefore based our discussion on the underlying premise that the objective of the DORC calculation is to estimate the maximum price a new entrant would pay for existing, second hand assets in preference to purchasing new assets.

The Case for Divorcing the ICB from the DORC

Section 8.10 of the gas code states that the regulator should consider a number of valuations and associated issues when setting the ICB. It is our view that in this (or any other) context DORC should be determined exclusively by reference to the economic principles underpinning it. This is consistent with our understanding of section 8.10, which states the regulator should consider DORC ***plus*** other issues, rather than stating it should consider an amalgam measure. There is a need to be wary about trying to reflect too many issues within a single instrument, as this may reduce transparency in the ICB setting process (including the implicit tradeoffs the regulator is asked to consider). Such a measure will also become difficult to interpret on economic grounds. Because section 8.10 requires consideration of other issues, this argues for divorcing the strong link between the DORC and the ICB.

1. INTRODUCTION

1.1. Background and Purpose

When setting the Initial Capital Base (ICB) for the purpose of regulating gas pipelines, the Australian Competition and Consumer Commission (the Commission) has tended to rely on a straight-line approach to assessing depreciation for deriving an estimate of Depreciated Optimised Replacement Cost (DORC) from Optimised Replacement Cost (ORC). Under this approach, DORC is estimated as ORC multiplied by the ratio of the asset's remaining useful life over the useful life of a new asset.

Agility Management Pty Ltd (Agility) has proposed an alternative approach to estimating DORC from a given ORC for the purpose of establishing the access arrangements for the Moomba to Sydney Pipeline and the Amadeus Basin to Darwin Pipeline. Agility has proposed that DORC be set on the basis of the NPV of the future revenues that could be generated by existing assets over their remaining life with those revenues determined by reference to a hypothetical new entrant in a contestable market. Agility has assumed that constant real revenues with an NPV equal to the ORC would be consistent with contestable market revenues.

In its draft decision, the Commission rejected Agility's approach in favour of a straight-line methodology. Agility subsequently submitted that the Commission is in error and provided supporting analysis from Professor King. In response, the Commission engaged Sinclair Knight Merz (SKM) to provide independent advice on the validity of Agility's approach. SKM recommended that straight-line depreciation continue to be used.

The Commission now wishes to resolve this debate and has engaged NERA to assess the economic merits of the two approaches and provide a clear set of economic logic as to why one approach should be preferred over the other.

1.2. Report Structure

This report is structured as follows. Part two provides an overview of the objectives underlying DORC. The section focuses on the purpose of depreciation in the derivation of DORC from ORC and establishes a quasi-mathematical formula for considering an economically meaningful depreciation schedule. It also considers the implications of stranding risk for the DORC calculation.

Part three evaluates the arguments put forward by Agility and Professor King to support their proposed methodology. We conclude that their approach is critically dependent upon prior assumptions about the profile of revenue streams and is therefore flawed. We also show (in appendix A) that reasonable adjustments to the assumptions underlying their analysis significantly alter the assumed depreciation schedule.

Part four considers the relative merits of the approaches to assessing depreciation and DORC used by the Commission and proposed by Agility. One of the main conclusions from parts three and four is that the appropriate depreciation schedule will depend on the cost characteristics of assets under consideration and that this is an issue for ***empirical*** as much as ***analytical*** analysis. This section uses a simple model to illustrate the effect on the depreciation profile of varying the underlying economic assumptions. One of the conclusions that can be drawn from this analysis is that the Commission's straight-line depreciation schedule may be more consistent with the general characteristics of pipelines than the schedule suggested by Agility.

Part five discusses the merits of separating the estimation of the DORC from the wider range of factors specified in section 8.10(g) of the Code. We conclude that there is a compelling case for divorcing the DORC valuation from the ICB and determining DORC exclusively on the economic principles underpinning it. This section also addresses the Commission's question regarding the relationship between the depreciation schedule used to estimate DORC from ORC and the depreciation profile moving forward. This section concludes that the depreciation profile looking forward should be transparent, practical and flexible and should ideally maintain the asset value at or below the DORC at each point in time to avoid the risk of by-pass.

Part six evaluates the arguments put forward by SKM in its response to Agility's proposal and Professor King's supporting analysis.

Part seven briefly summarises the key findings and recommendations of the report.

This report also contains the following appendices:

- appendix A provides additional discussion of Agility's approach and considers the implications of a range of revenue paths on the DORC estimate;
- appendix B provides the mathematical formulas used in our illustrative model;
- appendix C summarises the supporting data used as the basis for the assumptions in our illustrative model; and
- appendix D reproduces section 8.10 of the gas code.

2. DEPRECIATION – AN ECONOMIC INTERPRETATION

The ACCC has previously stated that there are two definitions of the valuation DORC attempts to measure:[3]

- ***"One interpretation of DORC is that it is the valuation methodology that would be consistent with the price charged by an efficient new entrant into an industry, and so it is consistent with the price that would prevail in the industry in the long run equilibrium; and***
- ***The second interpretation is that it is the price that a firm with a certain service requirement would pay for existing assets in preference to replicating the assets."***

These definitions are mutually reinforcing. If the value of the asset is not that which a firm would be willing to pay for it in preference to replicating it, the resultant prices will be inconsistent with those an efficient new entrant would charge. It should be noted, that the economic principles underlying DORC preclude an interpretation that it should be derived from an assumption about revenues. Rather the appropriate DORC ***ensures*** consistency by being based on a comparison of the ***future costs*** that would arise with a new or an existing asset.

If the premise behind DORC is that it is the price an entrant with a certain service requirement would pay for existing assets in preference to replicating them (and therefore the value above which the asset faces the risk of by-pass), then it must be that valuation which balances the future costs associated with a new asset versus the existing asset. This will be equivalent to the value of deferred capital expenditure less any additional non-capital costs associated with using more aged assets. Given this, the ***depreciation*** element of the DORC calculation should reflect the difference in costs a new entrant faces when it chooses to purchase the existing asset rather than a new asset that is optimally configured for the relevant service capability. The DORC estimate consistent with this can be represented in the following equation:

$$DORC + NPV[Costs\_existing\_asset] = NPV[Costs\_new\_asset]$$

$$DORC + NPV(Capex_{old}) + NPV(Noncapital\_Costs_{old}) = NPV(Capex_{new}) + NPV(Noncapital\_Costs_{new})$$

This can be rearranged to produce the following:

$$DORC = NPV[(Capex_{new} - Capex_{old}) + (Noncapital\_Costs_{new} - Noncapital\_Costs_{old})] \quad (1)$$

[3] see ACCC (1999) page 39

Where:

Capex$_{new}$ is the ongoing capital expenditure stream associated with the decision to purchase a new asset now - this includes the upfront cost of purchasing the asset immediately as well as the cost of (repeatedly) replacing the asset at the end of its useful life;

Capex$_{old}$ is the ongoing capital expenditure stream associated with the decision to continue using the existing asset– this will include the cost of (repeatedly) replacing the asset at the end of its useful life;

Noncapital Costs$_{new}$ is the stream of future non-capital costs (excluding interest) associated with the decision to purchase a new asset – this includes operating and maintenance costs; and

Noncapital Costs$_{old}$ is the stream of future non-capital costs (excluding interest) associated with the decision to purchase an existing asset now.

The value of DORC (and therefore the correspondingly appropriate level of depreciation) that is consistent with the maximum value of the asset to an efficient new entrant reflects the ***difference between the costs associated with existing and new assets***. This is because the amount a new entrant is willing to pay for existing assets will depend on the ***incremental impact*** on future costs of such a decision. This will reflect differences in, for example:

- ***remaining asset lives*** – the closer is the remaining life of the existing asset relative to that of the replacement asset, the closer will be DORC and ORC and the lower the depreciation adjustment;
- ***on-going operating and maintenance costs*** – existing assets will likely have higher operating and maintenance costs than their modern equivalent. The greater the difference in costs the more DORC will deviate from ORC, implying a greater depreciation adjustment;
- ***operating risks, such as that of break-down*** – the risks associated with existing assets are most likely higher than those associated with modern assets, implying a correspondingly lower valuation (these risks can be treated as a component of the ongoing costs); and
- ***the rate of technological change*** – if the rate of technological change is very high and the price of new assets is declining, there is benefit in delaying the purchase of a new asset to take advantage of lower future prices.

The difference between the ORC and DORC will also depend on the ***economic life*** of the market the assets service. The cash flows included in the NPV equation reflect the costs that the firm expects to incur as a result of making the decision to purchase existing rather than new assets. Under either of these decisions, the firm will expect to exit the market once it is

no longer economically viable and its cash flows will not be affected beyond this date. This is discussed further in the following section.

It should be noted that this analysis assumes that the ORC is based on an asset that has a service capability consistent with the existing asset (optimised) and there are no quality differences or additional services supplied by the new asset.

2.1. DORC Under Stranding Risk

The DORC that reflects the maximum value of existing assets to a new entrant can be estimated using the expected cash flows over the period the firm anticipates remaining in the market. Beyond this point, no cash flows are expected to be incurred that would be affected by the decision to purchase new or existing assets at the present time.

An economic life that is shorter than the technical life of existing assets will, to an extent, result in DORC tending towards ORC, as the difference in value to the owner would reflect only differences in non-capital costs expected under new and existing assets. For example, we understand that there is a risk that the Amadeus Basin reserves may be depleted some time between 2025 and 2039 and that the expiration of contracts may result in asset stranding by 2011.

Under such circumstances, the DORC may not be the best estimate of the maximum value of existing assets to a new entrant firm. This would be the case if prices based on the DORC estimate were higher than the market was willing to pay for the services being provided by the asset. In this situation, the Optimised Deprival Value (ODV) may be a better indication of the value to a new entrant. The objective behind the ODV is to measure the compensation a firm would require to fully offset the loss of the asset.

The New Zealand Ministry of Economic Development defines the ODV as:[4]

> ***"…the minimum of Optimised Depreciated Replacement Cost (ODRC) and Economic Value (EV)… In some cases because of constraints on tariffs it may not be possible to make a normal rate of return on segments of the network when the segment assets are valued at ODRC. That is, the segment is not self-sustainable in the long term. In such cases the EV value, a value lower than the ODRC, is applicable to the segments."***

According to the Ministry, it is appropriate to use the EV when it would not be possible for the assets to earn sufficient long-run profits to provide an appropriate return on the ODRC. The EV is defined by the Ministry as the maximum of the net realisable value (scrap value)

[4] Ministry of Economic Development (2000), page 13

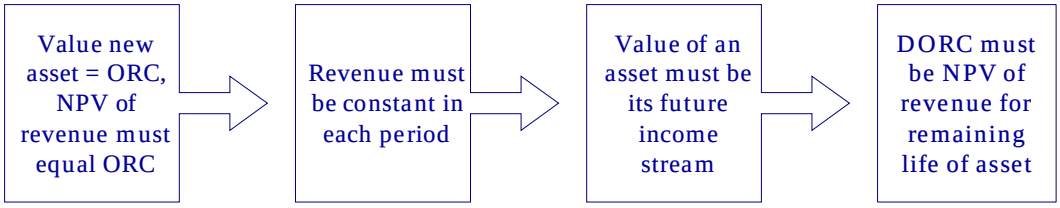
and the present value of the after-tax cash flows attributable to that segment, less any initial investment in non-system fixed assets and working capital associated with the asset.

Because the ODV takes account of situations where a firm may not be able to fully recover the DORC value, it may be a better measure of the ***maximum*** value of the asset to a firm when there is a risk of stranding.

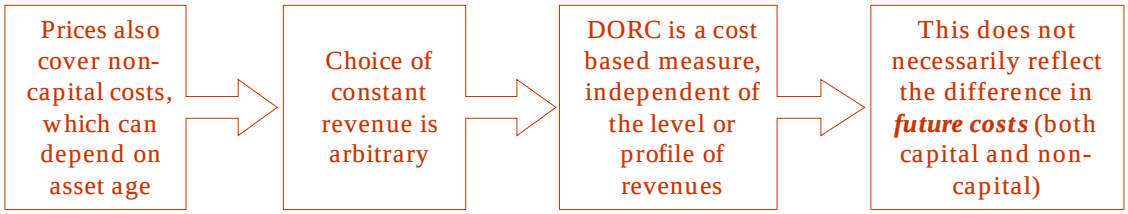
3. AGILITY'S PROPOSED DEPRECIATION APPROACH

3.1. Assessment of Agility's Approach

Agility has based its DORC construction on the following logic:



However, there are problems with each of these steps:



Agility has stated that "having determined the income stream for the new entrant assets, the DORC for the existing assets is determined as the NPV of the first L years of that stream"[5], where L is the remaining life of the existing asset.

The fundamental intention behind DORC is to divorce the asset valuation from revenue streams for the purposes of obtaining valuations in situations where revenue is not determined in a competitive market. DORC is intended to be a ***cost based*** valuation because of the circularity involved when the valuation of a regulated asset is dependent on the size or shape of its anticipated revenue stream. The objective of DORC is to arrive at a valuation reflective of the price an entrant would be willing to pay for second-hand assets given the alternative of replicating them with new optimised assets that provide a certain service capability. Such a valuation will reflect the difference in the NPV of capital and non-capital costs associated with existing versus new assets.

Agility has attempted to avoid the circularity by setting the NPV of the future revenues generated by the asset equal to ORC (as would be consistent with a theoretical competitive market). However, this still leaves open the issue of the time profile of those revenues. There is an infinite range of revenue paths that will yield an NPV equal to ORC. Agility has chosen a constant revenue stream, but it could alternatively have chosen one that was front-loaded (resulting in a much higher DORC valuation) or that escalates from low initial prices (resulting in a much lower DORC valuation). The implications of different revenue profiles

[5] Agility (2000), page 6

on DORC are discussed further in appendix A, where we illustrate this relationship graphically.

Agility has argued that its chosen revenue profile is consistent with that which would apply in a competitive market. Whether this is the case is an issue for debate. Under a theoretical competitive market prices tend towards the marginal cost. In the market for pipeline services, most costs will be fixed rather than marginal. Under these circumstances, a firm may chose to recover its total costs in a non-linear manner, depending on its expectations with regard to such factors as technical change, demand changes over time, developments in other (related) markets, etc. There is ample scope for debate on the revenue or price profile that is consistent with a competitive market. The point is that dependence on revenue streams is inconsistent with the premise that DORC is a cost based approach.

3.2. Assessment of Professor King's Approach

Professor King recognises that the fundamental rationale of the DORC approach is to ensure comparability between the value placed on new and existing assets. He states:[6]

> ***As an alternative to purchasing new capital equipment, the new firm could purchase the assets of the existing firm. DORC may be interpreted as the maximum price that a new entrant would be willing to pay for these existing assets rather than purchase new assets. The transformation of ORC to DORC must then leave the new firm indifferent between buying the existing assets and purchasing the new assets.***

This is precisely the basis of our equation (1) presented in section 2 above.

Professor King's analysis is useful in illustrating and defining the difference between Agility's approach and that outlined in section 2 of this paper. Professor King's mathematical construction results in a value of DORC (P*) as follows:

$$P^* = \frac{v_n}{r}\left(1 - \frac{1}{(1+r)^{T_0}}\right) \qquad (2)$$

Where: P^* is the DORC valuation;
v_n is the constant dollar amount per year over the life-time of the new assets that has an NPV equal to the ORC valuation;
r is the real interest rate; and
T_0 is the remaining life of the existing assets.

Using the equality of the revenue perpetuity (at a level of v_n) and the ORC asset valuation (V_n) in Professor King's analysis, this formula for P* can be rewritten as follows:[7]

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[6] Professor King (2001), page 6

$$P^* = V_n - \frac{V_n}{(1+r)^{T_0}} \quad (3)$$

Where: $\boldsymbol{V_n}$ is the ORC valuation.

This states that DORC will be equal to the amount the entrant would save by delaying the purchase of the asset for T_0 years (the remaining life of the asset), - V_n is the NPV of purchasing the asset now and the second term is the NPV of purchasing the asset in T_0 years.

It can be seen that Professor King's definition of DORC is a simplification of equation (1), which was presented in section 2, ie:

$$DORC = NPV[(Capex_{new} - Capex_{old}) + (Noncapital\_Costs_{new} - Noncapital\_Costs_{old})] \quad (1)$$

Where there are no non-capital cost differences and:

$$Capex_{new} = V_n$$

and

$$Capex_{old} = \frac{V_n}{(1+r)^{T_0}}$$

Underlying this analysis are the following implicit assumptions:

- the price is constant over time (this is required for Professor King's mathematical representation of Agility's approach to simplify to equation (3) above);
- once the new asset is purchased it lasts forever – there are no subsequent capital expenditures;
- there is no technological progress that would change the ORC over time; and
- the cost of operating and maintaining the two assets is identical.

Relaxing these assumptions can have a significant impact on the resulting DORC estimate, as is illustrated in section 5 and discussed in Professor King's paper.

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[7] We note that there is a relatively minor inconsistency in Professor King's analysis in that he starts with a finite period annuity to define v_n but then redefines this to be based on a perpetuity (an annuity that goes forever). Using the annuity formula would result in a slightly different expression for P*. However, in either case the correspondingly appropriate adjustments will lead to equation (2) above.

Professor King provides a second justification for his DORC calculation – that it mimics a perfectly contestable market by equating to the stream of revenue a new entrant could expect to earn over the remainder of the asset's life. This argument suffers from the same flaw as discussed above in relation to Agility's submission. Rather than attempting to construct a valuation based on the ***costs*** associated with existing and new assets, DORC has been constructed on the basis of an NPV of the ***share*** of assumed constant cash flows that the use of the existing assets would yield.

3.3. Distinction Between Approaches

In the above section, we have outlined how, under certain specific assumptions, the mathematical equations specified by King conform to equation (1) outlined in section 2 above. This may therefore give rise to the question "what then, distinguishes the two approaches – is the approach represented in equation (1) merely a refinement of the approach suggested by Agility and King?".

The distinction between the two approaches lies in the theoretical underpinnings that lead to the mathematical representations. Whereas the Agility and Professor King approaches are based on ***revenues***, equation (1) is specified on the basis of ***future costs***.

It will always be possible to make assumptions about revenues that are founded in the costs the company faces and which will therefore result in the mathematical representation of the two models coinciding. In other words, if the revenues are assumed to reflect cost differences, then, yes, the two models will provide the same answer.

However, in a revenue-based approach, there is no in-built mechanism to ensure that the estimation conforms to the premise that the DORC represents the value to a new entrant; rather the approach relies on making specific assumptions about the revenue stream.

4. ILLUSTRATIVE EMPIRICAL MODEL

The discussion in section 2 indicates that the appropriate derivation of the DORC from the ORC will depend on the characteristics of the assets under consideration. If DORC is intended to reflect the value to a new entrant, then it should reflect the difference between the costs (both capital and non-capital related) arising from the purchase of a new asset in comparison to the on-going use of an existing asset. In practice, estimating this is likely to be a relatively complex undertaking.

That said, it is possible to make some high level observations on the basis of what might be an appropriate range of DORC valuations, given a reasonable set of assumptions. This section sets out the results from a simple model of the NPV DORC approach in comparison to the Commission and Agility / Professor King approaches and considers the implications of a range of underlying assumptions regarding the nature of pipeline assets.

4.1. The Basic Model

We have developed this simple model for illustrative purposes. This is not intended to replicate fully the type of analysis that may be expected in the context of a regulatory review process. In particular, a more complete analysis could model the annual cash flows rather than relying on proxy measures which are assumed to remain constant throughout the life of the asset. Furthermore, several of the underlying assumptions require considerable empirical analysis to develop credible estimates.

However, this model can be used to illustrate the types of relationships that could be anticipated between the various approaches and how changes in the underlying assumptions could be expected to impact the DORC valuation.

The model is based on the equation presented in section 2 (the equations in the model are provided in appendix B and source data is provided in appendix C):

$$DORC = NPV\left[\left(Capex_{new} - Capex_{old}\right) + \left(Noncapital\_Costs_{new} - Noncapital\_Costs_{old}\right)\right] \quad (1)$$

We make the following assumptions about the market and the life of the assets:

- the market has a life of 150 years - we recognise that a much shorter timeframe may be appropriate under some circumstances and have illustrated such a situation separately in figure 5.2; and

- the asset has a life of 75 years – this is broadly consistent with the asset life estimates provided in various regulatory submissions, which suggest the life of a pipeline is around 80 years but that other associated assets will have somewhat shorter lives.[8]

The assumptions that affect the ORC to DORC schedule are:

- r (the discount rate, which may be the rate of return or WACC) – the regulatory decisions we considered indicated a real, pre-tax WACC of 7.75%;
- tech (the reduction in the cost of replacement assets per annum) – consideration of the change in the (real) cost of replacing the Moomba to Sydney Pipeline indicated that a value between 0.1 and 0.5 per cent per annum may be appropriate – we have used a value of 0.5 in our analysis;
- prod (the reduction in the operating costs of new assets per annum due to technological advances) – we have not undertaken any empirical estimation of this variable but have used figures ranging from 0.5 to 1 per cent of costs;
- opex (the assumed ratio of operating and maintenance costs to the cost of a new asset using existing assets) – the regulatory decisions we considered indicated a ratio of between 1.2 and 2.5 per cent, however, it is important to recognise that under our illustrative model this ratio is being used as a proxy basis for costs for all future cash flows. Thus, if existing costs are low due to under utilisation, current figures will result in an underestimation of future costs. A more rigorous analysis would use expected costs (cash flows) in each year rather than a combination of various proxies; and
- age costs (the rate at which operating and maintenance costs can be expected to rise as the asset ages) – we have not undertaken any empirical estimation of this variable but have used figures ranging from 0.5 to1 per cent of costs (again, a more comprehensive model could be expected to estimate actual costs associated with the existing and new assets into the future rather than relying on such proxy measures).

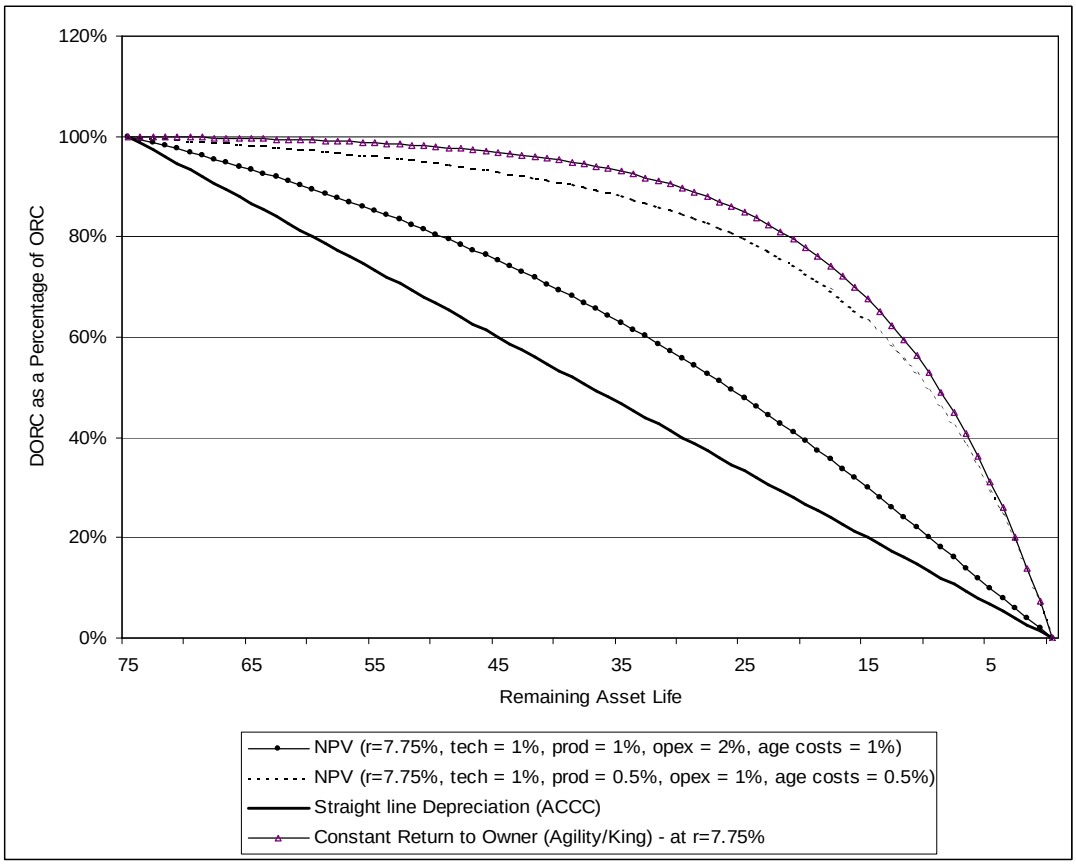
A rigorous analysis of the ORC to DORC estimation for the pipeline industry would require considerable further analysis as to the validity of these assumptions. Such analysis was beyond the scope of our terms of reference; instead this model is intended to be illustrative of the types of relationships that might emerge under varying assumptions.

The following chart (figure 5.1) illustrates the implications of a range of assumptions on the ratio of DORC to ORC given the asset's remaining useful life. This indicates the types of values that would be broadly consistent with the ACCC's straight-line depreciation schedule and Agility/Professor King's annuity schedule. Note that if it were assumed there is no

[8] An average is unlikely to produce as precise a result as using the lives of different classes of assets, however, for the purposes of our illustrative model the implications are unlikely to be significant.

technical, productive or age related costs, this approach converges to Agility's estimated DORC/ORC relationship (in mathematics ***not*** in terms of the underlying approach, the distinction between Professor King's mathematical representation and that presented in our illustrative model is discussed in section 3.3 above).

Figure 5.1
Illustration of DORC to ORC Ratio at a Fixed Point in Time[9]
(assuming market life of 150 years and asset life of 75 years)



It is useful to note the following implications of the assumptions.

The higher the discount rate, the higher will be DORC value relative to ORC. This is due to two factors. First, a higher rate of return will reduce the difference in the NPVs of the on-going costs by giving less weight to future cost discrepancies. Second, a higher rate of return will reduce the NPV of future capital expenditure. The use of existing assets will imply a need to replace these assets at an earlier point than if new assets are purchased

[9] Note that this model does not estimate the change in the DORC over time – it estimates the DORC to ORC ratio at a point in time depending on the assumed age of the asset. Estimating the DORC over time would require modifying the model to appropriately incorporate changes in variables (such as the ORC) between years.

immediately. A higher rate of return therefore has a greater impact on the NPV of future capital expenditure associated with old assets than that associated with new assets.

The greater the rate of decline in the price of new assets, the higher will be the DORC value relative to ORC. When the price of replacing the asset is declining there is greater value in being able to delay a purchase than when the price is not declining. The more the price of a new asset declines between now and the end of the existing asset's life, the lower is the future cost of capex and, therefore, the higher is the DORC valuation.

The higher the rate of productivity improvement associated with new assets, the lower will be DORC relative to ORC. An asset purchased at some point in the past, and therefore with less efficient technology, will have a consistently higher cost base than a new asset. The greater the rate of (past) productivity improvement, the higher this differential will be.

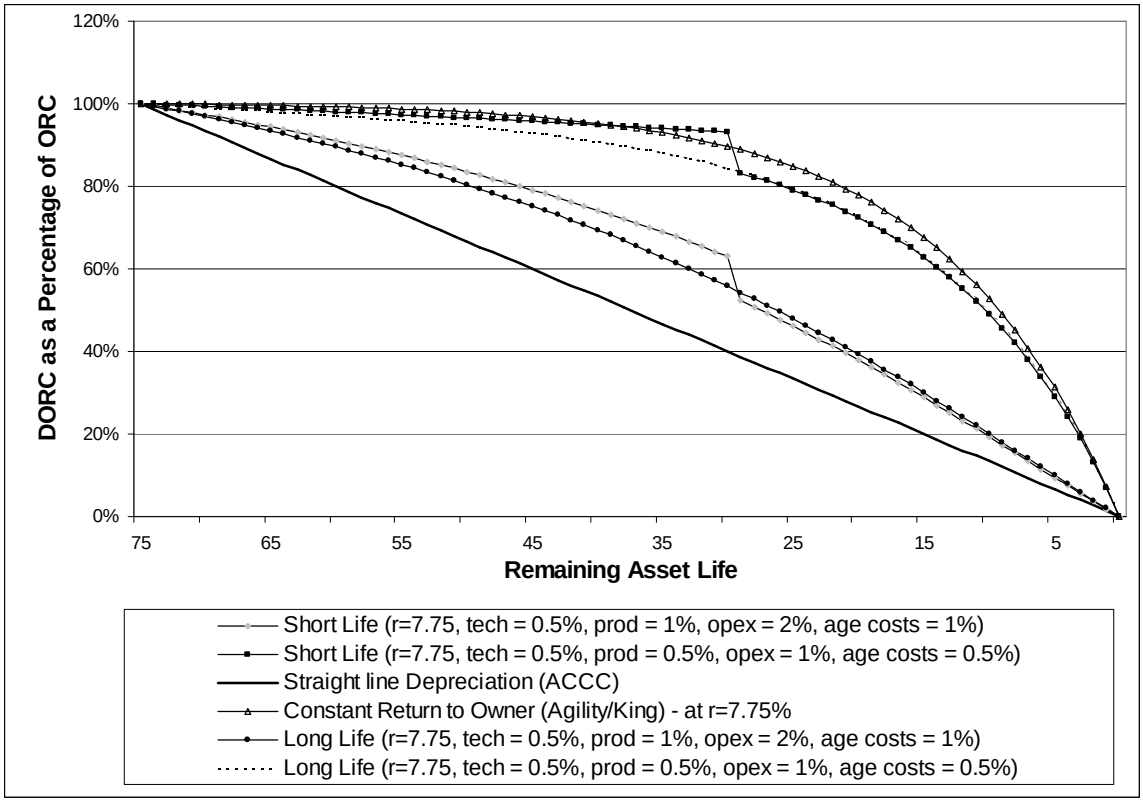
The greater the assumed growth in costs as the asset ages, the lower DORC will be relative to ORC. The higher are the costs associated with continuing to use an aged asset the lower will be the value of that asset to an entrant.

The higher the ratio of initial operating costs to replacement cost, the lower the DORC to ORC ratio (for positive values of "prod" and "age" costs). A higher operating cost relative to the capital cost has the effect of amplifying the impact of changes to the productivity proxy and the assumed increase in costs due to the age of the asset. If "prod" and "age costs" are set to zero, changes in the operating costs have no impact on the DORC to ORC ratio.

The impact of a shorter economic life depends on the remaining useful life of the asset. As noted above, it may be the case that the economic life of the asset is much shorted than the technical life. The model would then need to be adjusted to consider the cash flows only over this shorter timeframe. Revised equations reflecting an economic life of 30 years are provided in appendix B. The impact on the DORC as a percentage of the ORC is represented in the following chart.

This illustrates that although a shortened economic life will have an impact on the DORC to ORC ratio, it does not cause a breakdown in the approach. The implications of discounting mean that (under the assumptions we have incorporated) the difference in incurred on-going costs outweighs the effects of future capital expenditure except for when the assets remaining technical life is relatively short.

Figure 5.2
Illustration of DORC to ORC Ratio at a Fixed Point in Time
("Short life" assumes market life of 30 years and asset life of 75 years)



4.2. Summary

This section builds on the conclusions of the preceding sections, that DORC is a cost-based valuation concept and that the appropriate depreciation value is an issue for empirical analysis. While developing a comprehensive model was beyond the scope of this paper, our preliminary conclusion from the basic model is that the Commission's straight-line depreciation framework may be more consistent with the economic characteristics of the gas pipeline industry than Agility / Professor King's proposed approach.

5. OTHER ISSUES

5.1. Factors In Addition to Future Costs

The Commission has also asked NERA to consider the following in relation to their implications for the DORC calculation:

- past depreciation and tariff-setting frameworks for establishing the value of DORC (as opposed to the ICB);
- the concepts of "wealth neutrality" and "equitable interests of users" in determining the value of DORC and the ICB under the code;
- other factors described in section 8.10 of the Code in determining the value of DORC (as opposed to the value of the ICB); and
- whether there is a strong case for divorcing the strong link between the ICB and DORC and instead treating DORC as a "technical" valuation separate from other section 8.10 criteria.

Section 8.10 sets out a number of factors the regulator should consider when establishing the ICB for a covered pipeline that was in existence at the commencement of the Code. These are set out in appendix C and incorporate most of the issues the Commission mentions, for instance 8.10 (a) requires the Commission to have regard to:

> ***"the value that would result from taking the actual capital cost of the Covered Pipeline and subtracting the accumulated depreciation for those assets charged to Users (or thought to have been charged to Users) prior to the commencement of the Code"***

Section 8.10 does not require the ICB to be set equal to DORC. If this were so, then there may be a case for modifying DORC to reflect issues other than the valuation a new entrant would place on existing assets. However, the wording of 8.10 does not imply a ***requirement*** to develop DORC in this way. Therefore, there is no requirement that the DORC reflect each of the other factors specified in section 8.10.

Furthermore, we believe there are strong arguments for ***preferring*** that DORC be set on economic grounds rather than being set as a "catch-all" measure. Establishing an economically sound DORC arguably provides a better basis for taking account of a range of, sometimes conflicting, issues. Incorporating a number of factors into the one measure reduces the transparency of the tradeoffs between the various factors that the regulator is asked to consider. It may also reduce the regulator's flexibility to make such tradeoffs.

If the DORC is intended to reflect the value a new entrant with a certain service requirement would be willing to pay for second-hand assets in preference to replicating these assets. It should reflect the difference in costs associated with existing versus new assets. Any

valuation that moves away from this definition to incorporate other issues can no longer be said to be a DORC estimate. Our view is that, in this (or any other) context, DORC should be established exclusively on the basis of the economic principles underlying the concept and not by reference to factors that are addressed separately and specifically elsewhere in section 8.10 of the gas code.

In our view, this approach is consistent with the wording of section 8.10, which states the regulator should consider DORC ***and*** a range of other issues when setting the ICB. There does not appear to be any implication within section 8.10 that the DORC under the gas code should differ from DORC as it is generally understood, and we can see no reason DORC should be estimated on the basis of anything other than the economic principles underpinning this valuation concept.

Therefore, while the issues raised in the first three bullet points above may be useful in developing the ICB, they should not be incorporated into the DORC estimate. NERA's view is that there is a case for divorcing the strong link between the DORC and the ICB.

5.2. On-going Depreciation

The purpose of depreciation in the context of the price regulation of infrastructure is to allow the service provider to recover the cost of its investment over time, thus depreciation is often referred to as "the return ***of*** capital". There is an infinite range of depreciation profiles that will be consistent with this objective. In setting a forward-looking depreciation profile, the regulator may wish to take account of a range of the following desirable characteristics, such as:

- ***transparency*** – to ensure the asset is not over- or under- depreciated, there is a need to track the level of depreciation to date at any point in time;
- ***simplicity or practicality***; - the fact that the appropriate depreciation at any future point in time will depend upon the extent of depreciation to date argues for simplicity and practicality in the approach; and
- ***flexibility*** – a depreciation methodology should be flexible enough to anticipate and manage the risks that may be associated with events such as sudden changes in technological advances.

The regulatory approach to depreciation may also want to take into account that if an asset value rises above DORC at some point in the future, this places the service provider at some risk of its facility being by-passed. Although by-pass risk will also depend on a range of other issues, if the asset value rises above DORC, an entrant can, in principle, provide the service at a lower cost than the incumbent firm.

6. COMMENT ON SKM'S RECOMMENDED APPROACH

SKM, in its paper ***NT Gas: Depreciation within DORC***[10] has recommended that the DORC be calculated from the ORC on the basis of straight-line depreciation. SKM's rationale is that this is consistent with previous gas and electricity DORC assessments and that using the straight-line approach consistently will produce a degree of stability and confidence within the industry.

SKM has stated that, in its view, the DORC should not be a "slavish" implementation of a new entrant bypass costing analysis but rather that the new entrant test can be used to provide guidance in the event of procedural uncertainties in the DORC method. SKM also observes that the DORC is a valuation method which is called up in the Code without identification of how the details o the DORC are to be calculated, but appears to be intended to be some form of transparent, reproducible value that stands at one end of the normal range of values that might be accepted for the ICB.

The points made by SKM are valid. In particular, a prescribed approach, such as straight-line depreciation, would increase certainty within the valuation process and may therefore have merit.

However, NERA has been asked to consider the economic underpinnings of the DORC analysis and we have therefore based our interpretation of the depreciation element on the premise that the purpose of DORC is to measure the maximum amount a new entrant would be willing to pay for existing assets in preference to procuring new assets with an equivalent service potential. It is by taking this approach that the DORC remains consistent with the assertion that under most circumstances it should represent the maximum value of the ICB, as any valuations in excess of this will leave the asset vulnerable to by-pass.

Furthermore, we have not attempted to interpret what the writers of the Code may have intended when they wrote section 8.10. While it may well be the case that the authors intended the DORC to be calculated in the way suggested by SKM, NERA is not in a position to make such judgments.

[10] A report for the Australian Competition and Consumer Commission, Version 3, March 2002

7. CONCLUSIONS

This report has evaluated the approach proposed by Agility for estimating DORC from ORC. We conclude that any valuation that depends upon assumptions regarding future revenues is inconsistent with the economic underpinnings of the DORC methodology, which was specifically designed to avoid the circularity otherwise associated with the valuation of regulated assets. If it is agreed that the economic rationale underpinning DORC is that it reflects the value a new entrant would place on existing assets in preference to replicating them, it should reflect the net present value of the future costs associated with the decision to continue using the existing asset versus replacing it with a new asset.

Under this premise, the relationship between ORC and DORC at a given point in time will depend on the characteristics of the asset being considered and is an issue that requires empirical analysis to resolve. On the basis of a simple empirical model we have demonstrated that both the Commission's preferred approach and Agility's proposed approach can be broadly consistent with a particular set of assumptions. The limited data set we have considered suggests that the Commission's straight-line schedule may be more consistent with the likely characteristics of gas pipelines.

Our view is that DORC should be established on the basis of the economic principles underlying the concept and not by reference to factors that are addressed separately and specifically elsewhere in section 8.10 of the gas code. Given that the regulator is required to consider a number of issues under section 8.10, we therefore believe there is a case for divorcing the strong link between the DORC and the ICB for regulatory purposes.

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Independent Pricing and Regulatory Tribunal (1999) ***Draft Decision Access Arrangements for AGL Gas Networks Limited Natural Gas System in NSW***; and

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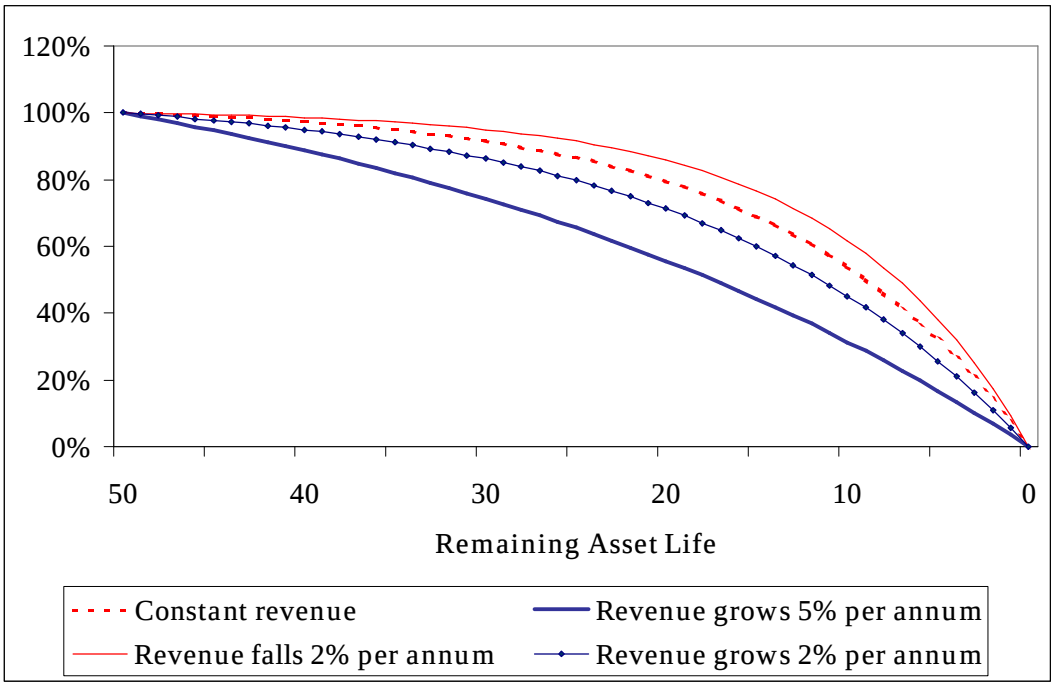
APPENDIX A. IMPLICATIONS OF CHANGES IN THE REVENUE PATH UNDER AGILITY'S APPROACH

As discussed in section 3 above, Agility has attempted to avoid the circularity problem associated with valuing regulated assets according to the revenue they generate by setting the NPV of the future revenues generated by the asset equal to ORC (as would be consistent with a theoretical competitive market). However, as discussed above, this still leaves open the issue of the time profile of those revenues. There is an infinite range of revenue paths that will yield an NPV equal to ORC. Agility has chosen a constant revenue stream but it could easily have chosen one that was front-loaded (resulting in a much higher DORC valuation) or escalating from low initial prices (resulting in a much lower DORC valuation).

The impact on the DORC estimate of different assumptions regarding the profile of future revenue is illustrated in the following diagram, which shows DORC as a percentage of ORC at a given point in time, depending on its remaining asset life.

Figure A.1
Illustration of DORC to ORC Estimate Under Agility's Approach

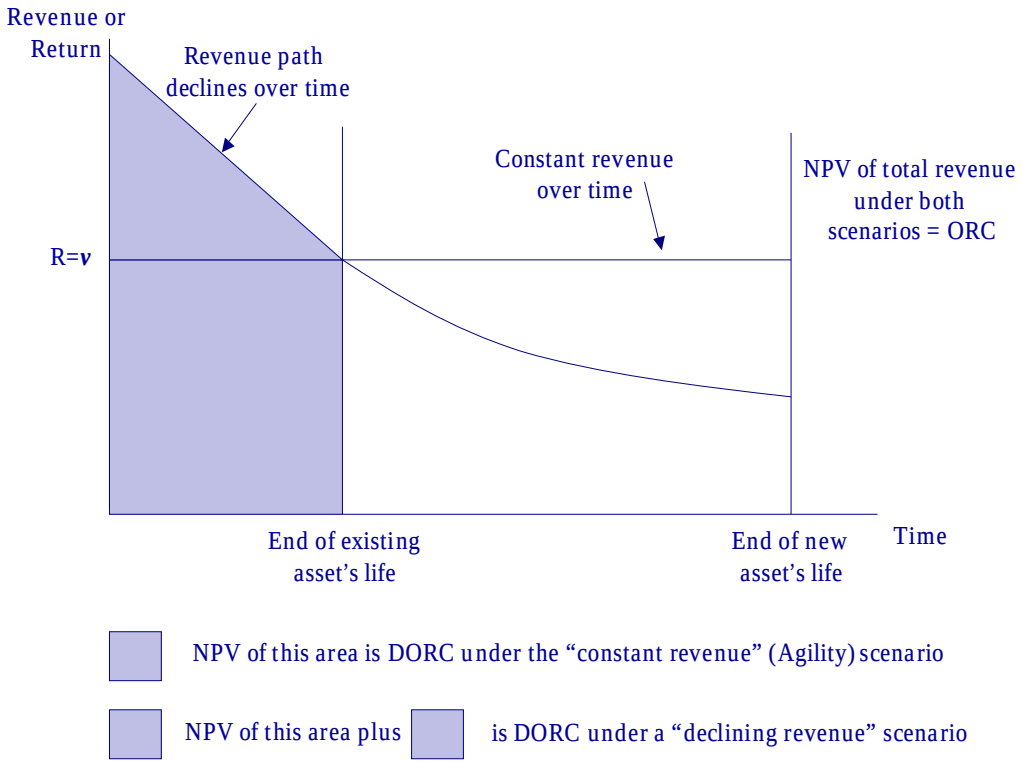


That different price paths alter DORC under Agility's approach demonstrates an internal inconsistency in the logic. Under this approach, relaxing the assumption that revenue is constant in each year implicitly implies that if the entrant chooses to use the existing asset, it either exits the market at the end of this asset's life or that the price of new and existing assets diverges in the future, allowing the future price path to be reset to allow the firm to exactly recover the cost of replacement assets in the future. In either case, this is not consistent with the assumptions associated with the choice to purchase a new asset now,

which involve staying in the market for the life of that asset and remaining consistent with the particular price path assumed now. Under any assumed revenue path other than a constant revenue path, Agility's approach fails to compare like with like when considering the choice of purchasing new versus existing assets.

This is illustrated in figure 3.1. Under a declining price path (and if the price path is maintained into the future), at the end of the existing asset's life there would be no incentive to purchase a replacement asset as prices from that point would not provide the required return on and of investment. This issue is ignored in Agility's approach, which effectively assumes that at that point the entrant either exists the market or prices are reset according to a new price path (that will therefore necessarily differ to the one that is assumed to prevail if the entrant chooses to buy a new asset immediately).

Figure A.2
Illustration of Agility's Methodology



APPENDIX B. MODEL FORMULAE

The underlying basis of the model is the following:

$$DORC = NPV[(Capex_{new} - Capex_{old}) + (Costs_{new} - Costs_{old})]$$

Which can be rewritten as

$$DORC = NPV[Capex_{new}] - NPV[Capex_{old}] + NPV[Costs_{new}] - NPV[Costs_{old}]$$

Table B.1
Model Formulae (150 year market life, 75 year asset life)

	New Asset	Existing Asset
NPV of capital expenditure	$ORC + \frac{ORC(1-tech)^{75}}{(1+r)^{75}}$	$\frac{ORC(1-tech)^{T}}{(1+r)^{T}} + \frac{ORC(1-tech)^{T+75}}{(1+r)^{T+75}}$ (second term omitted when T=75)
NPV of costs (operating and maintenance)	$\frac{C}{(r-g)}\left[1-\left(\frac{1+g}{1+r}\right)^{75}\right]$ $+\frac{C(1-prod)^{75}}{(r-g)(1+r)^{75}}\left[1-\left(\frac{1+g}{1+r}\right)^{75}\right]$	$\frac{C(1+g)^{(75-T)}(1-prod)^{(T-75)}}{(r-g)}\left[1-\left(\frac{1+g}{1+r}\right)^{T}\right]$ $+\frac{C(1-prod)^{T}}{(r-g)(1+r)^{T}}\left[1-\left(\frac{1+g}{1+r}\right)^{75}\right]$ $+\frac{C(1-prod)^{(T+75)}}{(r-g)(1+r)^{(T+75)}}\left[1-\left(\frac{1+g}{1+r}\right)^{75-T}\right]$

Where:

ORC	current cost of replacing the asset
tech	rate of decline in the cost of replacing the asset
r	discount rate (WACC)
T	remaining life of the existing asset
C	maintenance and operating costs associated with new assets purchased today
g	rate of growth in costs as the asset ages
prod	rate of decline in costs associated with new assets due to technological advances

Table B.2
Model Formulae (150 year market life, 30 year asset life)

	New Asset	Existing Asset
NPV of capital expenditure	$= ORC$	=0 (when T ≥ 30) $= \frac{ORC(1-tech)^T}{(1+r)^T}$ (when T < 30)
NPV of costs (operating and maintenance)	$= \frac{C}{(r-g)}\left[1-\left(\frac{1+g}{1+r}\right)^{30}\right]$	$= \frac{C(1+g)^{(75-T)}(1-prod)^{(T-75)}}{(r-g)}\left[1-\left(\frac{1+g}{1+r}\right)^{30}\right]$ (when T ≥ 30) $\frac{C(1+g)^{(75-T)}(1-prod)^{(T-75)}}{(r-g)}\left[1-\left(\frac{1+g}{1+r}\right)^{T}\right]$ $+\frac{C(1-prod)^T}{(r-g)(1+r)^T}\left[1-\left(\frac{1+g}{1+r}\right)^{30-T}\right]$ (when T < 30)

APPENDIX C. COMPARABLE SOURCE DATA

In section 5 above, we outlined the results from an illustrative model that depicted various DORC/ORC ratios given a number of underlying assumptions. Although this is intended as a rudimentary "back of the envelop" analysis, it is useful to compare the assumptions underlying the various scenarios with that arrived at under a number of regulatory decisions.

The following data is sourced from:

- ***Epic Moomba to Adelaide*** – ACCC (2001) ***Final Decision Access Arrangement proposed by Epic Energy South Australia Pty Ltd for the Moomba to Adelaide Pipeline System;***
- ***AGL Central West Pipeline*** – ACCC (2000) ***Final Decision Access Arrangement by AGL Pipelines (NSW) Pty Ltd for the Central West Pipeline***;
- ***AGL Gas Networks*** - IPART (1999) ***Draft Decision Access Arrangements for AGL Gas Networks Limited Natural Gas System in NSW***; and
- ***Multinet, Westar and Stratus*** – Office of the Regulator- General (1998) ***Access Arrangements – Multinet Energy Pty Ltd & Multinet (Assets) Pty Ltd; Westar (gas) Pty Ltd & Westar (Assets) Pty Ltd; Stratus (gas) Pty Ltd & Stratus (Assets) Pty***.

	Asset Lives (years)	Operating costs to ORC value[11]	Real pre-tax WACC
Epic Moomba to Adelaide[12]	• pipelines, 80; • depot/office, 50; • compressors, 30; • spares ,20; and • meter stations & SCADA, 15.	= 15m/625m = 2.4%	7.14%
AGL Central West Pipeline[13]	• pipelines, 80; • regulation and metering stations, 50; • odorising, 35; • SCADA, 10.	= 0.7m/27.9m = 2.6%	7.78%

[11] The Multinet, Westar and Stratus figures provide operating costs to DORC, as the ORC was not provided in the ***Final Decision***.

[12] Asset lives, page 20; operating costs, page 56; ORC, page 19; WACC, page 54.

[13] Asset lives, page 70; operating costs, page 74; ORC, page 62; WACC page 48.

	Asset Lives (years)	Operating costs to ORC value[14]	Real pre-tax WACC
AGL Gas Networks[15]	• trunk and HP mains, 80; • HP services, MP mains and services, 50; and • meters, 15. meter stations & SCADA – 15.	= 108m / 2,009m = 5.4%	7.75%
Multinet, Westar and Stratus[16]		= 125.9m / 1,866m =6.7%	7.75%

The analysis in section 5 also required an assumption regarding the rate of technological improvement in the industry. NERA has undertaken empirical analysis of the rate of change in the price of replacing assets in a separate report.[17] An historical estimate of the rate of technological change on the Moomba to Sydney Pipeline (MSP) was calculated as the rate that equated the historical capital expenditure on the MSP (in current prices) with the current estimates of the ORC. This calculation involved the following three steps:

- estimating the historical capital expenditure in current prices;
- adjusting ORC values to match up with historical data; and
- calculating the rate of technological change that equates the above two values.

The value adopted in that report was 0.5 percent based on the average historical rate of technological change for the entire pipeline system. The same value has been used in this report.

[14] The Multinet, Westar and Stratus figures provide operating costs to DORC, as the ORC was not provided in the ***Final Decision***.

[15] Asset lives, page 134; operating costs, page 180; ORC, page 92; WACC page 79.

[16] Operating costs, page 99; DORC, page 52; WACC page 79.

[17] NERA (2002) ***The Hypothetical New Entrant test in the context of Assessing the Moomba to Sydney Pipeline prices***, A Report for the ACCC

Section 8.10 Requirements

8.10 When a Reference Tariff is first proposed for a Reference Service provided by a Covered Pipeline that was in existence at the commencement of the Code, the following factors should be considered in establishing the initial Capital Base for that Pipeline:

(a) the value that would result from taking the actual capital cost of the Covered Pipeline and subtracting the accumulated depreciation for those assets charged to Users (or thought to have been charged to Users) prior to the commencement of the Code;

(b) the value that would result from applying the "depreciated optimised replacement cost" methodology in valuing the Covered Pipeline;

(c) the value that would result from applying other well recognised asset valuation methodologies in valuing the Covered Pipeline;

(d) the advantages and disadvantages of each valuation methodology applied under paragraphs (a), (b) and (c);

(e) international best practice of Pipelines in comparable situations and the impact on the international competitiveness of energy consuming industries;

(f) the basis on which Tariffs have been (or appear to have been) set in the past, the economic depreciation of the Covered Pipeline, and the historic returns to the Service Provider from the Covered Pipeline;

(g) the reasonable expectations of persons under the regulatory regime that applied to the Pipeline prior to the commencement of the Code;

(h) the impact on the economically efficient utilisation of gas resources;

(i) the comparability with the cost structure of new Pipelines that may compete with the Pipeline in question (for example, a pipeline that may bypass some or all of the Pipeline in question);

(j) the price paid for any asset recently purchased by the Service Provider and the circumstances of that purchase; and

(k) any other factors the Relevant Regulator considers relevant.