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Report to the ACCC

Working Capital

Relevance for the Assessment of Reference Tariffs

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Chapter 1

Overview

1.1 Brief

The Australian Competition and Consumer Commission (the Commission) has engaged The Allen Consulting Group to advise whether it would be appropriate for the Commission to include an explicit (additional) allowance in respect of working capital in the cash flow assumptions that guide its assessment of reference tariffs. In addition to this written report, the Commission has asked that an excel model be produced to demonstrate the methodology employed for assessing whether such an allowance is appropriate, and apply the methodology to a real-world example (namely, the Epic Energy Moomba-Adelaide pipeline).

The National Third Party Access Code for Natural Gas Pipeline Systems (the Gas Code), as well as the legislation that gives the Gas Code its legal effect, provides the legal framework against which this issue is considered. In addition, as will be elaborated upon below, the particular assumptions that are made about the timing of cash flows will affect the assessment of whether an allowance in respect of working capital is appropriate. The timing assumptions analysed in this report derive from those implied by the Commission's approach to cash flow modelling, as reflected in its Post Tax Revenue Model (PTRM),[1] although the implications of the other timing assumptions that commonly are adopted by regulators are also presented.

1.2 Summary of Findings

The purpose of this paper is to assess from first principles whether an additional allowance for working capital is appropriate, having regard to the relevant statutory guidance. Accordingly, Chapter 2 begins with a discussion of the guidance provided by the relevant provisions in the Gas Code, and their implications for the question of whether an allowance in respect of working capital is appropriate.

It is noted that the concern that an additional allowance in respect of working capital is required, can be interpreted as a concern that the simple formula adopted by the Commission when calculating the target revenue to be factored into reference tariffs is inappropriate. In particular, it implies that the implicit assumptions in that formula about the timing of cash flow *in respect of operating activities* may not accurately reflect the true timing of cash flow within a given year, and so understate the opportunity cost associated with investors' funds. Focussing on working capital alone implies that only part of the problem is being considered, however. A difference between the assumed and actual timing of cash flow within each year is a more general concern – the relevant question, in light of the guidance provided by the Gas Code, is whether the implicit timing assumptions for *all of the forecast cash flow* within any year provide a reasonable proxy for the true timing of that cash flow.

[1] The implications of the Commission's approach have been drawn from its publication, Australian Competition and Consumer Commission, Post-Tax Revenue Handbook, October 2001, and the illustrative excel model available on the Commission's website.

Chapter 3 then discusses the implicit assumptions about the within-year timing of cash flows for the target revenue formula employed by the Commission in the PTRM, as well as three other potential target revenue formulae. It is noted that the formula adopted by the Commission assumes that the service provider receives the share of revenue in respect of capital costs *on the last day of the year*. As revenue is received over the course of each year, it would be expected that target revenue would overstate the opportunity cost associated with investors' funds, and so would offset any shortfall in the cost of financing operating expenditure (ie, the required return on working capital). It is noted, however, that which of these effects dominate is an empirical issue.

Chapter 4 then demonstrates how the extent of bias, if any, in the various simple target revenue formulae may be tested, and applies that methodology to the case of the Epic Energy Moomba to Adelaide pipeline.

The model permits assumptions to be entered about the actual timing of a service provider's cash flow over a test year, and then uses these assumptions to allocate the expenditure and revenue over that year against particular days in the year (with some of the revenue and expenditure in respect of a year typically falling into the next year). Once a proxy for 'daily' cash flow is derived, it is possible to calculate the *precise* target revenue (corresponding to the timing assumptions) by conducting a discounted cash flow calculation on a daily basis. Thus, to the extent that there is a difference between the timing of expenditure and the receipt of revenue, the opportunity cost associated with that delay implicitly is included in the precise target revenue, irrespective of whether that expenditure would be classified as operating or capital expenditure for financial accounting purposes. The precise target revenue calculation can then be compared to the target revenue derived from the simple formula – and the bias (if any) determined.

A number of plausible assumptions were adopted for the within-year timing of the cash flows for the Moomba to Adelaide pipeline, and it was found that the simple target revenue formula used in the PTRM overstates the revenue required by about 1.8 per cent (which can be interpreted as the extent to which average prices are higher under the PTRM approach than required). While the results showed that there would be a financing cost associated with operating activities, it is swamped by the favourable timing assumptions with respect to the share of revenue associated with capital costs.

In addition, it was found that the existence of the bias continues even if extreme assumptions are made about the timing of expenditure and revenue receipts. For example, if it is assumed that the service provider pays for inputs on a daily basis as they are provided, and receives revenue 90 days after the end of each month (rather than 19 as at present), a favourable bias of 0.3 per cent would remain. Again, while these assumptions imply an increase in the financing cost associated with operating activities, any shortfall in respect of these activities is swamped by the favourable timing assumptions with respect to the share of revenue associated with capital costs.

These results provide no rationale for including an additional allowance in target revenue to provide a return on working capital. Rather, the results suggest that, were further precision to be sought in relation to the within-year timing of cash-flow – which underpins the arguments for a return on working capital – then the likely outcome is that the more precise target revenue would be *lower* than that derived using the PTRM.

A wider issue for the Commission – and one beyond the scope of this report – is whether the target revenue formula in the PTRM should be changed to reduce the potential for bias (in favour of the service provider) that has been identified.

Several alternative target revenue formulae are presented in the report, and the option exists for the Commission to model the within-year timing of revenue and costs for a regulated entity for a 'test year' (using the approach described in this report), and to make an explicit adjustment to target revenue to remove whatever bias is found to exist. Against this, however, simplicity has a number of advantages – including that it adds to the transparency of regulation, and reduces administrative and compliance costs. The level of imprecision with respect to the other factors that affect the assessment of reference tariffs is also relevant when considering the degree of precision warranted with respect to the within year timing of cash flow. Ultimately, these are trade-offs the Commission is best placed to resolve.[2]

[2] A related area where the Commission should consider change to the PTRM is with respect to the method that is used to adjust prices for inflation. This matter is discussed in footnote 27.

Chapter 2

Guidance Provided by the Gas Code

Neither the Gas Code itself, nor the legislation that provides it with legal effect, makes any explicit references to working capital.[3] Section 8.1 lists a number of objectives to be achieved when assessing reference tariffs and reference tariff policies. The meaning of these objectives, and their implications for assessing whether or not an allowance for working capital should be provided, is discussed first.

The discussion of the section 8.1 objectives concludes that the issue of whether or not an allowance for working capital is appropriate requires consideration of whether the timing assumptions implicit in the simple 'target revenue' formulae that regulators typically adopt, approximately reflect the actual timing of costs and revenue within a particular year. If the simple timing assumptions approximate the actual timing of costs and revenue, then the target revenue should provide an unbiased estimate of the opportunity cost associated with investors' funds being tied up in the regulated activity. Section 8.4 of the Gas Code provides guidance on the calculation of target revenue, and so these provisions are also discussed to assess whether the guidance provided would vary the guidance provided by section 8.1.

2.1 Guidance Provided by Section 8.1 of the Code

The objectives specified in section 8.1 of the Code are as follows.

> 8.1 A Reference Tariff and Reference Tariff Policy should be designed with a view to achieving the following objectives:
>
> (a) providing the Service Provider with the opportunity to earn a stream of revenue that recovers the efficient costs of delivering the Reference Service over the expected life of the assets used in delivering that Service;
>
> (b) replicating the outcome of a competitive market;
>
> (c) ensuring the safe and reliable operation of the Pipeline;
>
> (d) not distorting investment decisions in Pipeline transportation systems or in upstream and downstream industries;
>
> (e) efficiency in the level and structure of the Reference Tariff; and
>
> (f) providing an incentive to the Service Provider to reduce costs and to develop the market for Reference and other Services.

A common thread to most of objectives is the concept of *economic efficiency*, being mentioned expressly in two of them (objective (a) and (e)), and being implied by three others ((b), (d) and (f)).[4] Accordingly, the general concept of economic efficiency, and how economic efficiency concerns influence economic regulation, is considered prior to discussing the meaning of the particular objectives in section 8.1. The implications for the assessment of a request for an additional allowance in respect of working capital are drawn thereafter.

[3] Interestingly, even Attachment A to the Gas Code, which is a detailed list of the cost items that may be taken into account when assessing reference tariffs, makes no reference to working capital.

[4] While objective 8.1 (c) does not direct attention towards an aspect of economic efficiency, safety and reliability (or, more particularly, the efficient level of reliability) are consistent with economic efficiency.

Defining Economic Efficiency

Economic efficiency, in general terms, refers to a condition under which society's limited resources are used such that the net benefit to society is maximised, for a given distribution of wealth. An efficient use of society's resources is generally accepted as one in which:

- the mix of goods and services that an economy produces reflects the relative value that society places on those goods and services given the extent of society's resources required to produce the respective goods and services (*allocative efficiency*);[5]
- firms produce the goods and services for the minimum cost, which implies that the lowest-cost combination of society's resources (typically defined generically as land, labour and capital) is used, and the best technology is employed (*productive* or *technical efficiency*); and
- the mix of goods and services produced, and the production processes employed by firms, change over time in response to changes in tastes, technology and other like factors – that is, so that *allocative* and *productive efficiency* is maintained at each point in time (*dynamic efficiency*).

Competition is widely regarded as the most effective means of delivering economic efficiency, and in such an environment, *prices* play an important role in coordinating decentralised agents towards delivering efficient outcomes. For example:

- In competitive product markets, sellers are forced to reduce the price of their product to the marginal cost of production, as rivals will be able to undercut and take customers if they price above this level. Customers buy the bundle of goods and services that provide them with the most benefit, given the relative prices and their incomes. As the prices reflect the cost to society of producing the goods and services, it would be impossible to re-configure the mix of production and provide this customer with a more valuable bundle without harming another.[6]
- Competitive product markets also force sellers to produce the goods and services for the lowest cost, as rivals would be able to undercut were this not the case. Competitive input markets ensure that the prices that firms pay for their inputs (land, labour and capital) reflects the marginal cost of using the input to produce the particular good or service – the cost reflecting the value to society of the other goods and services that could have been produced with these inputs. Thus, the prices produced by competitive markets induce firms to select the combination of factors that implies that its goods and services are produced for the minimum foregone production of other goods and services.

[5] A further requirement for allocative efficiency is that the allocation of factors between producing current consumption, and investment in order to permit higher levels of future consumption, reflects households' preferences for current versus future consumption, given the rate at which current consumption can be converted into future consumption.

[6] It is important to distinguish between what firms may be seeking to achieve in a competitive market, and the outcome of a competitive market. In economics, it is typically assumed that firms strive to maximise profits, which would almost universally imply a preference for setting prices well above marginal cost, if all or most of their customers could be retained at those prices. The process of competition, however, implies that such pricing policies are not sustainable, as customers would be lost to rivals. Thus, the outcome of a competitive market to an economist refers to the implications of the environment of rivalry on the agents operating within the market, and not to what may be the subjective intentions of those agents.

- The processes referred to above also result in an efficient mix of goods and services being produced by the economy at any point in time. Customers would only be willing to pay an amount up to the value they place upon any good or service for that item, and firms pay the cost to society for the inputs required to produce any good or service. These pressures imply that firms will find it profitable to produce the goods and services that customers want – and so that production will result – but find it unprofitable to produce goods and services whose cost of production to society exceeds the benefit – and these activities will not be undertaken.

Where, however, competition is weak or absent – as may be the case in industries characterised by natural monopoly technologies (such as gas transmission pipelines and distribution systems) – the limited nature or absence of the process of rivalry may imply that the forces identified above no longer operate (that is, firms have *market power*), and departures from economic efficiency may result.

A particular concern is that, where firms have market power, they will set prices above marginal cost in order to make higher returns, which in turn leads to customers and firms switching away from the use of the particular product where this is socially desirable (allocative inefficiency).[7] A further concern is that, while market power imposes no barrier to firms achieving productive efficiency, the absence of rivalry may imply there is less concern about containing costs and implementing the latest technologies. Thus, market power may also lead to a wasting of society's scarce resources.[8]

It is to address these problems arising from market power that may justify economic regulation of such activities. It follows logically that the appropriate objective for economic regulation is that regulators strive to restore economic efficiency. An equivalent means of describing the objective for economic regulation is that regulators strive to generate the outcomes that would have been produced by a competitive market, given the prediction that a competitive market will generate economic efficiency, as discussed above. As Professor Kahn has noted:[9]

> The main body of microeconomic theory can be interpreted as how, under proper conditions – for example, of economic rationality, competition and laissez-faire – an unregulated market will produce optimum results.
>
> …
>
> So that … the single most widely accepted rule for the governance of the regulated industries is regulate them in such a way that would produce the same results as would be produced by effective competition, if it were feasible.

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[7] Indeed, where the technology employed by firms is a natural monopoly technology, a departure from marginal cost pricing is inevitable. This is because such prices would not be expected to recover all of the fixed costs incurred to provide the service, and so capital would not continue to be attracted to the industry over time. In this situation, efficient prices are those that generate a use of the particular good or service that is as close as possible as that which would have occurred had prices been set at marginal cost, which may involve setting prices with fixed and variable components, discrimination between different types of users based upon capacity to pay, or other like strategies.

[8] The potential for firms not to minimise cost is explained in the relevant literature with reference to departures from standard economic assumptions (in particular, the existence of principal/agent problems between owners and staff, and problems of information asymmetry between owners, management and staff). The classic reference is Leibenstein, H., "Allocative Efficiency vs. 'X-Efficiency'". *American Economic Review*, 1966.

[9] Kahn, A, *The Economics of Regulation: Principles and Institutions*, 1988 (Wiley, New York), Vol 1, p. 17.

That said, when considering the objectives for regulators, two caveats should be borne in mind. First, as is clear from the quote from Kahn above, the competitive market outcome for which regulators should strive is the outcome of a *notional* market – that is, the market that would produce economic efficiency. Secondly, there are a number of constraints to the process of regulation, which may imply that the efficient outcome – in the presence of regulation – may differ from the outcome that would have occurred in the absence of the market power.[10]

Applying Efficiency Concerns to Economic Regulation

The process under which regulated charges are determined normally follows a number of steps, which are as follows.

- First, a target amount of revenue is derived ('target revenue'), which is the amount of revenue that the regulated charges will be designed to recover.
- Secondly, either individual tariffs or a control over the basket of tariffs is established consistent with the target revenue (for example, the control may apply over the weighted average tariff, and the regulated entity may have flexibility over the design of individual tariffs under this cap).

In price cap or incentive based regulatory regimes – which includes most of the regulatory regimes in Australia – there is also a third step, which is to commit not to review charges for a pre-defined period of time, and to define a formula under which individual tariffs or the cap on the basket of tariffs may move over time. It is also common under price cap regimes also to implement measures designed to provide the regulated entity with an incentive to deliver the efficient level of service, and to put in place other measures to enhance the incentives on the entity to reduce cost over the period.

The question of whether an additional allowance should be included in target revenue in respect working capital concerns only the first of the steps identified above. From the discussion of efficiency above, it follows that there are two competing objectives that a regulator must consider when calculating target revenue.

- First, the target revenue must be sufficient to ensure that the provision of the relevant good or service continues (at least to the extent that the activity, or any additional activity, continues to deliver net benefits to society). Thus, revenue must be sufficient to ensure that existing factors continue to be devoted to the regulated activity, and that investment continues to be attracted to the industry over time.
- Secondly, the target revenue should minimise the extent to which prices are required to depart from marginal cost. Given the tendency for marginal cost pricing to fail to recover all of the fixed costs associated with a regulated activity (that is, where the activity is characterised by a natural monopoly technology), this typically implies that a reduction in target revenue (at least against the prices that would be set by a firm with market power) would be preferred.

The means by which these objectives may be reconciled is to set target revenue at a level that is sufficient to ensure continued service provision, but no more.

[10] As an example of the second caveat, one of these constraints is the asymmetry of information about such matters as the cost of undertaking the regulated activity and the price sensitivity of customers between the regulator and regulated entity. In the presence of such constraints, it may be optimal to implement strategies that imply a trade-off with objectives (such as allocative efficiency) in order to alleviate information asymmetry problems.

Investment will continue to be attracted to an industry over time if the value of the additional revenue (net of additional costs) associated with any new project is equal to the cost of undertaking the project. An equivalent statement is that the investors in the new project should expect to receive a return on their investment (net of additional costs) equal to the opportunity cost of those funds,[11] and the return of those funds over time. More formally, if PC refers to the project cost, R_i the revenue expected at the end of period i, C_i refers to the expected ongoing costs associated with the project at the end of period i (which would be a combination of operating and capital costs), T is the expected life of the project (after which it is worthless), and r is the (effective) per period discount rate (which is set equal to the opportunity cost of the funds), then target revenue should be determined such that:

$$PC = \sum_{i=1}^{T} \frac{R_i - C_i}{(1+r)^i} \quad (1)$$

which is a familiar present value calculation. If the market value of the future cash flows associated with this asset at the end of period n is given by MV_n, then this relationship can be re-expressed as:

$$PC = \sum_{i=1}^{n} \frac{R_i - C_i}{(1+r)^i} + \frac{MV_n}{(1+r)^n} \quad (2)$$

Accordingly, these equations imply the target revenue the regulator determines (which takes account of *all* of the assets required to perform the regulated activities) should provide a stream of revenue, R_i such that:

$$RAV_0 = \sum_{i=1}^{n} \frac{R_i - C_i}{(1+r)^i} + \frac{RAV_n}{(1+r)^n} \quad (3)$$

where RAV_0 comprises the regulator's view of the 'market value' of assets at the commencement of the period – which includes the residual value associated with investments made in previous periods – and RAV_n is the regulator's view of the market value of the assets at the end of period n,[12] and R_i and C_i refer to all revenue and cost (including the cost of undertaking new projects) at time i within the period.

[11] The opportunity cost associated with investing in any activity is the return foregone by not investing in alternative activities (adjusted for the relative risk of the investments). Thus, the opportunity cost should reflect the return that could have been earned in alternative investments, adjusted for the relative risk of the project in question.

[12] RAV_n implicitly includes the residual value associated with new projects undertaken over the period.

In practice, regulators often express the 'target revenue' calculation in an accrual accounting version – that is, as the sum of a return on the regulatory value of assets (including new investment forecast to occur over the period), a return of capital (depreciation), and a forecast of operating expenses over the period. However, this form of expressing the target revenue calculation can be demonstrated merely to be a rearrangement of a present value calculation,[13] and so will deliver the same results for a common set of assumptions.[14] More importantly, to the extent that the use of an accrual accounting version of the target revenue formula delivered a materially different level of target revenue, then that approach would not be consistent with the achievement of economic efficiency – the relevant objective is to provide a stream of revenue and a commitment to a regulatory asset value at the end of the period that has a market value equal to the regulatory value of the assets at the start of the period.

Meaning of the Objectives in Section 8.1

With the exception of section 8.1(c), all of the objectives set out in section 8.1 of the Gas Code draw attention to factors that need to be considered when assessing whether the reference tariff and reference tariff policy are consistent with economic efficiency. The most relevant of the objectives for the matter at hand, and their interpretation in light of the discussion above, are as follows.

- *Provide the opportunity to recover efficient cost (8.1(a))* – this draws attention to the requirement for the process by which target revenue is determined to put in place the conditions under which capital will continue to be attracted to the industry.[15]

- *Replicate the outcome of an efficient market (8.1(b))* – as explained above, this should be interpreted as an alternative reference to the pursuit of economic efficiency, given that the rationale behind the support of economists for competition is that it will produce efficient outcomes.

- *Not distorting investment incentives in pipelines or in related industries (8.1(d))* – avoiding a distortion should be interpreted as an alternative reference to promoting an efficient outcome. The requirement to consider efficiency in the provision of the regulated infrastructure, amongst other things, draws attention to requirement for the determination of target revenue to be such that investment continues to be attracted while society values the relevant service, which is the same factor contemplated by section 8.1(a). The requirement to consider the efficiency in the investment in upstream and downstream activities draws attention to the need to restrict prices for the regulated service to the minimum level required – that is, to the level just sufficient to ensure continued investment.

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[13] This is demonstrated in Appendix A.

[14] The analytical link between accruals and cash flow concepts for both regulatory and accounting purposes, and the relevant academic literature, is discussed in Johnstone, D, *Replacement Cost Asset Valuation and Regulation of Energy Infrastructure Tariffs: The Problems with DORC*, Department of Accounting and Finance, University of Wollongong, 2001, pp. 6-7.

[15] The reference to 'efficient' cost also invites consideration of a number of other issues, such as whether the relevant cost is consistent with productive efficiency, and whether the continued provision of the service (or the provision of additional service) provides net benefits to society (that is, whether its provision is consistent with allocative efficiency).

- *Efficiency in the level and structure of tariffs (8.1(e))* – the reference to an efficient tariff level draws attention to the need for any difference between regulated charges and the marginal cost of service provision across all services or users to be minimised, in turn implying that target revenue provides sufficient revenue to continue to attract investment, but no more (as discussed against 8.1(d)).

It follows that the objectives in section 8.1 of the Gas Code draw attention explicitly to the implications drawn from a consideration of economic efficiency, as discussed above.

2.2 Working Capital – Interpretation of the Problem

In principle, when undertaking the present value calculation implied by equation 3 above, the points in time at which it is assumed that revenue is received or expenses are paid should reflect *precisely* the expected timing of these cash inflows and outflows. Therefore, if revenue is expected to be received monthly in arrears, and costs are expected fortnightly or monthly, then – in principle at least – the present value calculation should take account of this timing. In the limiting case, cash flow over the regulatory period could be forecast and discounted on a *daily basis*, so that the target revenue would reflect precisely (at least in expectation terms) the opportunity cost associated with investors having their capital tied up in the regulated activity. This would imply that target revenue for year t would be found by finding $R_{i,t}$ such that:[16]

$$RAV_{t,open} = \sum_{i=1}^{365+} \frac{R_{i,t} - C_{i,t}}{(1+r)^{i}} + \frac{RAV_{t,close}}{(1+r)^{365}} \qquad (4)$$

where $R_{i,t}$ and $C_{i,t}$ now refer to the forecast of daily revenue and costs for year t, $RAV_{t,open}$ and $RAV_{t,close}$ refer to regulatory value of the assets at the opening and closing of year t, and the other variables are defined as before.[17]

In practice, however, the various formulae regulators typically use to calculate target revenues only make use of annual forecasts of cost and revenue, and make very simple assumptions about the timing of receipt of revenue and payment of expenses within any particular year. The different target revenue formulae, and the precise timing assumptions implied by each, are described in detail in Chapter 3.

The adoption of a simple approach for calculating target revenues, and reliance only on annual forecasts, has significant attractions – it both adds to the transparency of regulatory decision making process, and also reduces the cost of complying with regulatory requirements. An important issue to consider, however, is whether the target revenue derived from one of the simple target revenue formulae – with the simple assumption about the timing of costs and revenue within each year – provides an unbiased forecast of the target revenue that would be derived were regard had to the actual timing of cash flow within the year, or whether a *material bias* is created – either in favour or against the regulated entity.

[16] The summation is over 365+ periods because the some of the revenue receipts or expenditure may fall over into the next year.

[17] If the effective annual discount rate is given by r*, then $r = (1+r^*)^{1/365} - 1$.

In simple terms, a net working capital requirement will arise whenever revenue is received after operating expenses are paid, on average. As there is a period of time for which investors' funds are tied up, a cost is imposed – that cost being the foregone return that could have been earned by investing those funds in another activity and earning a return in the intervening period, or returning the funds to shareholders and permitting them to do the same.[18]

Clearly, if the target revenue calculation reflected the actual timing of revenue receipts and costs incurred within the period (ie, equation 4 were used), then an allowance for the opportunity cost associated with working capital automatically would be reflected in the target revenue as calculated. Therefore, to claim that an additional allowance in respect of working capital is required amounts to stating that the within year timing assumptions for the *share of revenue and costs associated with operating activities* implied by the simple target revenue formula are incorrect, and that the difference creates a material bias against the service provider.

Focussing solely on the share of revenue and costs associated with operating activities implies that only part of the problem is being considered, however. As discussed above, the guidance provided by the objectives in section 8.1 of the Gas Code direct attention to whether target revenue is sufficient – but just sufficient – to continue to attract investment into the industry, which requires consideration of *all revenue* and *all costs*.[19] Therefore, the relevant question is whether the simple assumptions implicit in the target revenue formula about the within year timing of *all revenue* and *all costs* are reasonable, or whether a net material bias is created. Thus, while it may be the case that the implicit timing assumptions with respect to the operating activity's share of revenue and cost understates the opportunity cost associated with investors funds, this may be offset by the opportunity cost associated with capital assets being overstated – and it is the net effect that is relevant.

2.3 Guidance Provided by Section 8.4 of the Code

Section 8.4 describes three approaches that may be used to derive target revenue, which are:

- *Cost of service approach* – target revenue is calculated as the sum of a return (equal to the estimated cost of capital) on the regulatory value of the assets, depreciation and operating and maintenance expenses;
- *NPV approach* – target revenue is calculated by finding the amount of revenue that would deliver a present value of future revenue (and the residual value at the end of the regulatory period) equal to the regulatory value of the assets at the start of the period, where the discount rate is the estimated cost of capital; and
- *IRR approach* – target revenue is calculated by finding the amount of revenue that would deliver an internal rate of return equal to the estimated cost of capital.

[18] The stock of net working capital at the end of a reporting period is typically defined for accounting purposes as the difference between current assets (such as accounts receivables) and liabilities (such as accounts payable). To the extent that the amount of money not yet received exceeds the amount of bills not yet paid, a financing cost arises.

[19] Indeed, the justification for a return on working capital is no different to the requirement for a return on capital assets. In both cases, investors commit funds at a point in time, have their funds returned at some time in the future, and in the meantime require a return on those funds to compensate for the opportunity cost. The only difference between the treatment of working capital and capital costs is the length of time during which the funds are tied up within the regulated entity – whereas for working capital, funds may be tied up for a matter of weeks, for the latter funds may be tied up for upwards of forty years.

The *NPV* and *IRR* approaches correspond precisely to the general target revenue calculation defined in equation 3, the *Cost of Service* is the accrual accounting version of this calculation that was described above and, as noted already, all three approaches will deliver an identical target revenue calculation (for a common set of assumptions). Therefore, the guidance provided by section 8.4 of the Gas Code on the *general approach* for calculating target revenue is identical to that which is implied by a consideration of section 8.1.

A relevant question is whether the way in which these approaches are described in section 8.4 provides any additional constraints as to how they should be applied – in particular, whether guidance is provided as to what timing assumptions should be made, or with respect to the degree of precision to be made with respect to the timing assumption.

The description of the 'NPV' and 'IRR' approaches do not specify the assumption that should be made about the timing of cash flows within each year of the regulatory period, and the 'Cost of Service' approach is only outlined in broad terms. That is, no guidance is provided on whether all revenue should be assumed to be received, and costs incurred, at the end of each year, or whether the timing of both should be assumed to be the mid-point within each year, or whether cash flows should be assumed to occur continuously at a constant rate, or whether explicit assumptions should be made about the timing of cash flows within any particular year.

The one potential constraint on the formula to be adopted when calculating target revenue is the requirement that any of the methodologies be applied 'in accordance with generally accepted industry practice'. A literal interpretation of this clause is difficult, however, as the calculation of target revenues for the purpose of setting regulated charges would not normally be undertaken outside of regulatory authorities or entities interacting with regulators, and so it would be difficult to claim that there is a 'generally accepted industry practice'. That said, present value calculations are widely used for a variety of other purposes in industry.

An assessment of the variety of purposes for which discounted cash flow analysis is used suggests that the requirement to have regard to generally accepted industry practice does not provide much guidance.

At one end of the extreme, when assessing the value of a new project, it would appear common practice to make the simplifying assumption that revenue is received, and costs incurred, only once a year, and then, the common assumption would appear to be that cash flows occur at the end of each year. That said, this implicit timing assumption is not universally advocated, with Brealey and Myers, a leading finance text, suggesting that an assumption of continuous cash flows may be more appropriate:[20]

> There is a particular value to continuous compounding in capital budgeting, where it may often be more reasonable to assume that a cash flow is spread evenly over a year than that it occurs at a year's end.

At the other end of the extreme, very precise assumptions about the timing of cash flows are made when valuing bonds or other interest bearing products, and the implications of the timing of the cash flows for the value of the products well understood. As Damodaran notes:[21]

[20] Brealey, R and S Myers, *Principles of Corporate Finance*, (McGraw-Hill, 5ed,) 1996, p. 44.

[21] Damodaran, A, *Applied Corporate Finance*, (Wiley), 1999, p. 516.

> In the examples [of calculating present values] above, the cash flows were assumed to be discounted and compounded annually … In some cases, however, the interest may be calculated more frequently, such as on a monthly or semiannual basis. In these cases, the present and future values may be very different than those computed on an annual basis.

Similarly, there is evidence that analysts employ (or at least, popular texts recommend) some precision with respect to the assumed timing of within year cash flows when valuing equities based upon the value of future dividends (or, alternatively, calculating the cost of equity that is implied by the current share price and expected dividends, such as with the dividend growth model). As an example, Morin notes:[22]

> It is a rudimentary tenet of security valuation theory … that when determining investor requirements, the cost of equity is the discount rate that equates the present value of future cash receipts to the observed market price. Clearly, given that dividends are paid quarterly and given the observed stock price reflects the quarterly nature of dividend payments, the market required return must recognise quarterly compounding … Since investors are aware of the quarterly timing of dividend payments and since the stock price already fully reflects the quarterly payment of dividends, it is essential that the [discounted cash flow] model used to estimate equity costs also reflect the actual timing of quarterly dividends.

Consistent with this, while the simplest of the versions of the dividend growth model assumes implicitly dividends are paid annually, other versions that take account of semi-annual or quarterly dividend payments and other refinements, such as non-constant dividend growth, are in common use.

Therefore, it would appear that section 8.4 of the Gas Code provides no further guidance relevant to the assessment of whether an allowance for working capital is required to that provided by section 8.1. In particular, the description of the approaches for calculating target revenue do not mandate that particular timing assumptions be adopted, nor preclude more precise modelling of the timing of within-year cash flow.

[22] Morin, R, *Regulatory Finance: Utilities' Cost of Capital*, (Public Utilities Reports, Arlington, Virginia), 1994, p. 183.

Chapter 3

Target Revenue Timing Assumptions

As noted above, all of the formulae that may be used to calculate target revenues for regulatory purposes make implicit assumptions about the timing of revenue receipts and cash outlays *within each year*. This chapter discusses the within year timing assumptions implied by the target revenue formula included in the Commission's PTRM, as well as that implied by other commonly-used (or potential) formulae. Observations are also made as to whether there are any strong a priori reasons for expecting the different formulae to misstate target revenue, and the likely direction of that bias.

3.1 PTRM Timing Assumptions

Leaving aside the impact of inflation and taxation, the formula for target revenue that is reflected in the ACCC's PTRM is:[23]

$$TR_t = r.RAB_{t,open} + Dep_t + O\&M_t \qquad (5)$$

where TR_t refers to the target revenue for year t, r is the opportunity cost of capital, $RAB_{t,open}$ is the value of the regulatory asset base at the commencement of year t (ie the opening value), Dep_t is the regulatory depreciation allowance (or return of capital) for year t, and $O\&M_t$ is the forecast of operating and maintenance costs for year t. The first element in this equation – $r.RAB_{t,open}$ – is referred to below as the 'return on assets' component of target revenue, and the combination of the return on assets and depreciation elements is referred to as the 'capital-related' component or share of target revenue.

As shown in Appendix A, this particular formula makes the following assumptions about the timing of cash flow within a particular year:

- the share of revenue in respect of capital-related costs (that is, both the return on assets and depreciation elements) is received at the end of the year;
- capital expenditure is incurred at the end of each year; and
- the timing of the share of revenue in respect of operating and maintenance costs is aligned with the timing of these costs.

Clearly, these assumptions are unlikely to reflect a service provider's actual timing of cash flow. The differences that may exist between the assumed and actual timing, and the implications, include the following.

- Revenue would be expected to be received over the course of each year. Thus, the assumption that capital-related revenue is received at the end of the year would undervalue the revenue received by the provider, providing a bias in favour of the provider (all else constant).

[23] Australian Competition and Consumer Commission, Post-Tax Revenue Handbook, October 2001, p. 12. While it is noted that the different possible assumptions about taxation may have a significant effect on target revenue (which justifies a rigorous assumption about taxation in that context), changing these assumptions has little effect on the timing of within year cash flows.

- Capital expenditure would also be expected to be incurred over the course of each year. This, the assumption that this cash outflow occurs at the end of the year would understate the cost of providing the regulated services, providing a bias against the service provider (all else constant).

- The timing of revenue over the period is unlikely to be aligned precisely with the timing of operating and maintenance activities. Depending upon the net timing mismatch, there may be a bias for or against the provider (all else constant).

For most regulated utilities, as between 60 and 70 per cent of revenue reflects the capital-related components (and most of which is the 'return on assets' component), intuition would suggest this target revenue formula would be more likely to *overstate* (rather than understate) required revenue. However, whether the combined impact of these possible effects is material, and the direction of any material bias can be estimated empirically, analysis of which is presented in Chapter 4.

3.2 Alternative Target Revenue Formulae

An alternative commonly used formula for target revenue is to provide a return on the *average* asset value over the period (rather than the opening value). That is:

$$TR_t = r.\left(\frac{RAB_{t,open} + RAB_{t,close}}{2}\right) + Dep_t + O\&M \qquad (6)$$

where $RAB_{t,close}$ is the value of the regulatory asset base at the end of year t (ie the closing value), and the other variables are as defined before. This formula has been used by, amongst others, the Office of the Regulator-General and the Queensland Competition Commission.

As shown in Appendix A, this formula is consistent with the following assumptions about the timing of cash flows within a year:

- half of the annual depreciation allowance is received, and half of the annual capital expenditure is undertaken, at the commencement of the year, with the remainder received or spent at the end of the year;

- the remainder of the capital-related component of revenue is received at the end of the year (which includes the share of revenue attributable to the return on the assets in place at the start of the year); and

- the timing of the share of revenue in respect of operating and maintenance expenditure is aligned with the timing of these costs.

This formula differs from the previous one in that it provides a return equal to half of the cost of capital on the net financing of capital expenditure the utility is expected to undertake during year (that is, half of the forecast capital expenditure less depreciation). Similarly, if the utility is 'withdrawing funds' from the regulatory asset base in any year (that is, depreciation exceeds capital expenditure), half of the return on this amount is deducted. The intuition behind providing (or deducting) half of the normal return is that the additional capital would have been invested for approximately half of a year if incurred continuously over the year. Thus, formula (6) provides higher target revenue than formula (5) if forecast capital expenditure exceeds depreciation, and a lower return if forecast capital expenditure is lower than depreciation.

In practice, however, capital expenditure and depreciation are likely to be reasonably close (at least over a reasonable period of time), and so there may not be a material difference between the use of these formulae in practice. In addition, formula (6) retains the implicit assumption that the majority of the revenue attributable to any year is received at the end of that year – and so the observations about the likely bias in formula (5) apply equally.

A third alternative assumption about the timing of within year cash flow is that capital-related revenue is received, and capital costs incurred, at mid-point of each year (with the share of revenue attributable to operating costs aligned with the incidence of these costs, as with the previous formulae). It is understood that a number of UK regulators have adopted this approach when reviewing price controls. This timing assumption is *approximately* equivalent to assuming that the capital-related share of revenue is received, and capital expenditure is undertaken, at a constant rate over any year.

Appendix A demonstrates that the accrual version of the target revenue formula that is consistent with the mid-year timing assumption is as follows:

$$TR_t = r.RAB_{t,open}.\frac{1}{(1+r)^{1/2}} + Dep_t.\frac{1}{(1+r)^{1/2}} + Capex_t.(1-\frac{1}{(1+r)^{1/2}}) + O\&M_t \qquad (7)$$

where $Capex_t$ is the forecast capital expenditure for year t.

Lastly, if it were considered that assuming the capital-related share of revenue is received, and capital expenditure is undertaken, continuously (and at a constant rate) over any year, it is a straightforward exercise to derive the exact expression for the target revenue formula. In Appendix A it is shown that the target revenue formula consistent with continuous cash flows is as follows:

$$TR_t = r.RAB_{t,open}.\frac{\ln(1+r)}{r} + Dep_t.\frac{\ln(1+r)}{r} + Capex_t.\left(1-\frac{\ln(1+r)}{r}\right) + O\&M_t \qquad (8)$$

where *ln* refers to a natural logarithm, and the other terms are as defined above.[24]

The differences between the assumptions implied in the PTRM target revenue formula and the assumptions implied by equations (7) and (8) can be seen by noting that these equations all can be expressed in terms of the following equation:

$$TR_t = r.RAB_{t,open}.CF + Dep_t.CF + Capex_t.(1-CF) + O\&M_t \qquad (9)$$

where CF is a 'correction factor' that reflects the particular timing assumption adopted. For the formulae discussed above:

(1) PTRM Formula: $CF = 1$

(2) Mid-Year Cash Flows: $CF = \frac{1}{(1+r)^{1/2}}$

[24] Note that the discount rate, r, in this formula refers to the effective annual discount rate, and so is directly comparable to the discount rates included in the other formulae. When discounting in continuous time, the applicable discount rate is the continuous time discount rate, which is related to the effective annual rate through the formula: $r_{continuous} = \ln(1+r_{effective})$.

(3) Continuous Cash Flow: $\frac{\ln(1+r)}{r}$

For the second and third of these formulae, CF is greater than zero but less than one (noting that because *r* is an annual rate of return, it will always be greater than zero, but less than 1). Thus, when the 'mid-year' and 'continuous' formulae are compared to the PTRM formula, it is clear that both the return on assets and depreciation elements are discounted to reflect the fact that this revenue is received earlier (and hence the revenue is more valuable than assumed by the PTRM formula). In contrast, however, as capital expenditure is assumed to be undertaken earlier than by the PTRM formula, the target revenue is increased, reflecting the higher cost associated with the earlier financing commitment.

It can also be demonstrated that the correction factor for the continuous cash flow assumption is larger than the correction factor for mid-year timing of cash-flows, implying that receiving revenue continuously is more valuable (and incurring costs is more costly) than receiving revenue or incurring costs in the middle of the year – although the difference is very small.[25]

With respect to the possibility for bias, as the last two formulae no longer assume that the majority of revenue is received at the end of each year, it is far less likely that they would create a bias in favour of the regulated entity than would the use of formula (5) or (6). Indeed, given that regulated utilities tend to receive their revenue with a lag, to the extent that there is a bias, it may go against the utility – although there are no strong *a priori* grounds for believing that any such bias would be material. Again, whether there is a bias, and if so, its direction and size, can only be determined empirically.

[25] For a discount rate of 7 per cent, the correction factor for the mid-point cash flow formula is 0.9667, whereas the correction factor for the continuous time formula is 0.9666 – the difference being immaterial.

Chapter 4

Assessment of Bias in Target Revenue Formulae

In the previous chapters, it has been noted that whether or not a particular target revenue formula may be biased given the actual timing of the cash flow to a regulated entity within a particular year, and the size of any such bias, may be tested empirically. This chapter describes how such a test may be performed, provides the results obtained for a real world example, that being the Epic Energy Moomba to Adelaide pipeline.

4.1 Outline of the Approach

In Chapter 2 it was noted a precise calculation of the target revenue requirement for a particular year (year t) could be found by finding $R_{i,t}$ such that:[26]

$$RAV_{t,open} = \sum_{i=1}^{365+} \frac{R_{i,t} - C_{i,t}}{(1+r)^i} + \frac{RAV_{t,close}}{(1+r)^{365}} \qquad (10)$$

where $R_{i,t}$ and $C_{i,t}$ are the forecast of *daily* revenue and costs for year t, $RAV_{t,open}$ and $RAV_{t,close}$ refer to regulatory value of the assets at the opening and closing of year t, and r is the daily discount rate, which is given by:

$$r^{daily} = \left(1 + r^{annual}\right)^{1/365} - 1 \qquad (11)$$

The (annual) target revenue for year t would then be given by the simple sum of the assumed daily revenue stream for that year, that is:

$$TR_t = \sum_{i=1}^{365+} R_{i,t} \qquad (12)$$

Given a set of assumptions about how the receipt of revenue and payment of expenses are expected to be spread over the course of the year, the *precise* target revenue consistent with those timing assumptions can be calculated using equations (10) and (12). Comparing the *precise* target revenue for a test year to the target revenues calculated by the various formulae will then reveal whether or not the simple formulae create a material bias given the particular assumption about the actual timing of revenue and costs, as well as the size of any bias. In addition, by varying the timing assumptions, the sensitivity of the results to those assumptions may be assessed, in turn providing a check on the reliability of the results.

A similar approach may also be used to test whether there is a requirement for working capital, for a given set of timing assumptions. In particular, the allowance required in target revenue in respect of operating activities for a year can be calculated by finding $R_{i,t}^{O\&M}$ such that:

[26] While, in principle, smaller periods than a day could be used, it is unlikely that the receipt of revenue and payment of expenses could be divided upon into smaller periods on any meaningful basis.

$$\sum_{i=1}^{365+} \frac{R_{i,t}^{O\&M}}{(1+r)^i} = \sum_{i=1}^{365+} \frac{O\&M_{i,t}}{(1+r)^i} \quad (13)$$

The total allowance required in respect of operating activities – which will reflect both the cash spent, and the cost of financing operating activities – is then given by:

$$TR_t^{O\&M} = \sum_{i=1}^{365+} R_{i,t}^{O\&M} \quad (14)$$

The financing cost associated with operating activities – or allowance required in respect of working capital (WC_A) – is just the extent to which the required allowance for operating activities exceeds the forecast cost of operating activities, that is:

$$WC\_A_t = TR_t^{O\&M} - O\&M_t \quad (15)$$

The implied *stock* of working capital, in turn, is given by:

$$WC\_S_t = \frac{WC\_A_t}{r} \quad (16)$$

where r is now the effective annual discount rate (as discussed above). As noted in Chapter 2, however, the existence of a positive working capital requirement, of itself, does not imply that it is appropriate to add an increment to target revenue. Rather, the appropriate question is whether target revenue is adequate, having regard to timing of all revenue and expenditure.

The Allen Consulting Group has produced a model that undertakes such a calculation, and has applied this model to the case of the Moomba to Adelaide pipeline. The next section describes the form of the inputs required for the model, and the basic algorithms performed, and the section thereafter reports the results obtained.

4.2 Empirical Test of Timing Assumptions

The basic structure of the model is as follows.

- The financial information for the test year is entered, that is, the opening regulatory asset value, depreciation allowance, assumed cost of capital and operating and capital expenditure forecasts.
- The forecasts of annual operating and capital expenditure are broken down into a series of payments throughout the year, as determined by the assumed timing of these payments. The form of timing assumptions required is discussed below.
- A 'seed' value for target revenue is assumed, which is then broken down into a series of revenue receipts throughout the year, as determined by the assumed timing of these receipts. The form of timing assumptions required is also discussed below.
- The 'seed' value for target revenue is iterated (via a 'goal seek' algorithm) until equations 10 and 12 are satisfied. The value for target revenue that results is the *precise* target revenue corresponding to the timing assumptions.

The same process is used to estimate the implied working capital allowance, except that all capital related costs are set to zero.

For simplicity, the model uses revenue and costs defined in constant price terms and consistent with this, employs a real discount rate and costs expressed according to current cost accounting conventions.[27] The model also discounts pre tax revenue streams and consistent with this, requires the use of a discount rate defined in pre tax terms for simplicity. As noted above, while the choice of a pre or post tax cost of capital is a significant matter when deriving the *level* of target revenue, it is not expected to have a material effect on the assessment of the timing assumptions implicit in the simple target revenue formulae. Thus, pre tax cash flows are used for simplicity.

Timing of Expenditure and Revenue

For *operating expenditure*, the model assumes that the regulated entity incurs the expenditure at a constant rate over the period, is invoiced at regular intervals for goods or services purchased, and pays the invoice after a specified period of time. Thus, in the model, two inputs are required to define the timing of the payment of a particular class of operating expense – the frequency with which bills are received (referred to in the model as 'frequency'), and the time permitted for the payment to be made (referred to in the model as 'delay'). Up to five different classes of operating expenditure – with unique timing assumptions – are permitted.

As an example, if the 'frequency' for a particular class of operating expenditure were set at 30 days, and assumed that payment is required within 30 days, then it would be assumed that the first cash-outflow would occur at the end of day 60, and the second at the end of day 90, and so forth. If the forecast expenditure for this class were $365 (ie, a dollar a day), then the first payment would be $30, which would continue until day 390 (ie, 25 days into the next year). The remaining five dollars (ie, $365-($30*12)) would be paid with the next invoice – that is, on day 420.

In practice, even if invoices from certain suppliers are received periodically, they are likely to be staggered throughout the month. However, the difference in the discounted cost associated with the simplifying assumption that all invoices are received at the end of each month and the assumption that invoices are received uniformly throughout a month is immaterial. This follows from the fact that if invoices are staggered, then the regulated entity will pay an amount of cash earlier than assumed at the start of the year, but pay an amount of cash later than assumed at the end of the year, and these effects almost cancel each other out.[28]

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[27] The use of constant price inputs is equivalent to assuming that the prices of both outputs and inputs adjust continually with inflation within each year. In practice, however, while this may be a reasonable assumption about the cost of inputs, prices for the output – the regulated services – are often indexed for inflation only once per year (although exceptions to this convention exist).

Accordingly, a related issue is whether the method employed to index output prices for inflation provides an unbiased level of compensation for inflation – which, again, turns largely on the implicit assumptions about the within-year timing of revenue and cost inherent in the indexation method. For example, if revenue is received approximately continuously throughout the year, then setting the regulated prices at the 'middle-of-year' price level will provide an approximately correct level of compensation for inflation – prices will be too high for the first half of the year, and too low for the second, with these effects approximately cancelling each other out. In contrast, if revenue is received approximately continuously throughout the year, but regulated charges are set at the end-of-year price level, then the provider would have been overcompensated for inflation – with prices higher than required, in percentage terms, by about half of the annual rate of inflation. In the PTRM, regulated prices are set in 'end of year' prices. As regulated entities receive revenue over the course of the year, the treatment of inflation in the PTRM would create a bias in the favour of the regulated entity.

[28] The types of timing mismatches that give rise to a financing cost are those that do not reverse within the year, but are maintained over time.

For *capital expenditure*, the model permits a choice of two assumptions. It may be assumed that the expenditure for a given class is spread over the year (referred to as 'evenly spread'), in which case the treatment is precisely the same as for operating expenditure. In addition, the model permits an assumption that there may be a lumpy expense that is expected to be paid on a particular day. In this case, an assumption is just needed about the day on which the 'one off' payment will be made. Again, as with operating expenditure, up to five different classes of capital expenditure – each with unique timing assumptions – are accommodated.

The treatment of *revenue* also mirrors the treatment of operating expenditure. That is, it is assumed that revenue is received at a constant rate over the year, the service provider invoices users at regular intervals, and revenue is received after a defined period. The model permits up to five classes of users to be specified with a unique set of timing assumptions for each.[29]

4.3 Timing Assumptions and Results for the Moomba to Adelaide Pipeline

Year 2001 has been used as the 'test year' for the Moomba to Adelaide pipeline, and the relevant annual financial forecasts have been taken from the Commission's final decision. As discussed earlier, the model developed requires the financial forecasts to be entered in constant prices, and expressed in 'current cost accounting' terms, and so the figures reported by the Commission have been adjusted where required. The annual financial assumptions used (all expressed in beginning 2001 dollars) are shown in Table 4.1.

Table 4.1

FINANCIAL INPUTS ($1/1/2001)

Item	Input
Opening Regulatory Asset Value	$353.0m
Depreciation [30]	$10.7m
Capital Expenditure	$2.5m
Operating Expenditure	$14.7m
Cost of Capital (Pre Tax Real)	7.14%

Source: Australian Competition and Consumer Commission, *Final Decision: Access Arrangement Proposed by Epic Energy South Australia for the Moomba to Adelaide Pipeline System*, pp. 31, 54 and 56.

[29] The timing of the receipt of revenue by *distributors* may be a more complex matter than that for transmission pipelines. One option for the payment arrangements between distributors and retailers is that distributors only bill retailers for the transportation charges associated with customers who have had their meters read within the preceding period. A benefit of this arrangement is that transactions between distributors and retailers would be based upon metered gas volumes; however, it results in a deferral of revenue compared to the case where the distributor bills for all of the gas transported during the preceding period. It is understood that all of the transmission pipelines that are regulated by the Commission charge users for all of the gas transported during the invoicing period (and use some form of estimate where actual meter data is not available). This implies that the simple proxy for the timing for revenue (discussed in the text above) is appropriate.

[30] The depreciation allowance reported by the Commission is the net effect of the return of capital (in real terms) and the inflation revaluation of the asset. The figure reported in the table reflects the first of these factors only. The depreciation allowance reported also excludes the effect of taxation normalisation in order to proxy a 'typical' year for the utility.

With respect to the assumed timing of *operating expenditure*, two different classes are assumed. First, about 43 per cent of Epic Energy's expenditure is accounted for by wages and salaries, which are assumed to be paid fortnightly, directly into employees' bank accounts. For the remainder, it is that Epic Energy is invoiced monthly, and has a further month for payment. With respect to *capital expenditure*, it is also assumed that invoices are received monthly, and a further month is provided for payment. Lastly, for *revenue*, it is assumed that Epic Energy sends out invoices at the end of each month, and that a 19 day period is provided for payment.[31] Implicitly, the first option for the timing of revenue discussed above is selected. These assumptions are summarised in Table 4.2.

Table 4.2

TIMING ASSUMPTIONS

Item	Frequency	Delay
Operating Expenditure – 43%	14 days	0 days
Operating Expenditure – 57%	30 days	30 days
Capital Expenditure	30 days	30 days
Revenue	30 days	19 days

Source: ACG analysis and memorandum titled 'MAP working capital requirement' from Mr John Williams on behalf of Epic Energy, dated 16 August 2001.

Table 4.3 shows the calculation of target revenue for the four methods discussed above, the *precise* target revenue that corresponds to these timing assumptions, and the consequent bias (expressed as a percentage of the simple target revenue formula) associated with the use of each of the simple target revenue formula. The table also shows the implied cost of financing operating activities – that is, the return required on working capital (with the bias expressed as a proportion of the PTRM target revenue).

Table 4.3

RESULTS FOR THE MOOMBA TO ADELAIDE PIPELINE – BASELINE TIMING ASSUMPTIONS

	PTRM	AAV	Mid-Point	Continuous	Working Capital
Target Revenue – Simple Formula	50.5	50.3	49.4	49.4	14.7
Target Revenue – Precise	49.6	49.6	49.6	49.6	14.7
Difference	0.9	0.6	-0.2	-0.2	0.0
Bias (%)	1.8%	1.2%	-0.4%	-0.4%	0.0%

Table Notes: A positive difference between the target revenues and a positive bias are favourable to the service provider, and negatives are detrimental. PTRM refers to equation 5 described in Chapter 3 (as used in the Commission's PTRM), AAV refers to equation 6, Mid-Point to equation 7, and Continuous to equation 8.

These results show that, for the timing assumptions discussed above, the use of the PTRM target revenue formula, or the return on average asset value formula, results in a significant bias in the favour of the service provider. That is, using these formulae would lead to average prices being 1.8 per cent or 1.2 per cent higher than required. For the other formulae, the bias is reversed implying that the target revenue is lower than required, although the extent of the bias is much smaller.

[31] The assumptions about the timing of revenue are taken from the memorandum titled 'MAP working capital requirement' from Mr John Williams on behalf of Epic Energy, dated 16 August 2001.

Lastly, the results show that, for these timing assumptions, the cost of financing operating activities is small – approximately $15,000 for the test year.[32] Clearly, any shortfall to the service provider from ignoring the cost of financing operating activities is swamped by the benefit arising from the overstatement of the cost of financing capital assets.

For the PTRM and the average asset value formulae, the existence of a bias in favour of the service provider remains, even if extreme assumptions are made about the timing of expenditure within the year. By way of example, Table 4.4 shows the results obtained for these formulae (and working capital) if it is assumed that operating and capital expenses are paid daily as the goods or services are provided, and the timing of revenue is held constant.

Table 4.4

RESULTS FOR THE MOOMBA TO ADELAIDE PIPELINE – EXTREME EXPENDITURE TIMING ASSUMPTION

	PTRM	AAV	Working Capital
Target Revenue – Simple Formula	50.5	50.3	14.7
Target Revenue – Precise	49.7	49.7	14.8
Difference	0.8	0.5	-0.1
Bias (%)	1.6%	1.0%	-0.2%

Table Note: A positive difference between the target revenues and a positive bias are favourable to the service provider, and negatives are detrimental. PTRM refers to equation 5 described in Chapter 3 (as used in the Commission's PTRM), and AAV refers to equation 6.

Even under these assumptions, the use of the PTRM or the return on the average asset value target revenue formulae still results in prices being 1.6 per cent and 1.0 per cent higher than required. The required return on working capital rises – to about $94,000 (with an implied working capital of about $1.3 million), but again, any shortfall from not making an explicit allowance for the cost of financing operating activities is swamped by the favourable allowance provided in respect of capital assets.

Lastly, the positive bias associated with the PTRM formula also continues if extreme assumptions are made about the timing of revenue receipts. By way of example, if Epic continues to invoice users monthly, but gives users another 90 days to pay (rather than 19), the positive bias remains at 0.5 per cent, and if combined with the extreme expenditure assumptions discussed above, the positive bias remains at 0.3 per cent.

[32] The corresponding stock of working capital is about $211,000, or about 0.06 per cent of the regulatory asset value.

4.3 Conclusion

The question posed at the start of this report was whether it would be appropriate for the Commission to include an additional allowance in respect of working capital when assessing reference tariffs. The results above imply that such an allowance is unnecessary – while there may be a (small) financing cost associated with operating expenditure, any shortfall from not including an allowance in respect of working capital is likely to be swamped by the favourable allowance provided in respect of capital assets under the PTRM target revenue formula. It follows that if the Commission were to pursue further precision in relation to the assumptions it makes about the within-year timing of cash flow – which underpins the arguments for a return on working capital – then the likely outcome is that the more precise target revenue would be *lower* than that derived using the PTRM.

A wider issue for the Commission – and one beyond the scope of this consultancy – is whether the target revenue formula in the PTRM should be changed to reduce the potential for bias (in favour of the service provider) that has been identified.

Several alternative target revenue formulae have been presented, all of which appear to display a lower level of bias than the PTRM target revenue formula, at least for the baseline timing assumptions adopted for specific case examined in this report (Table 4.3). The option also exists for the Commission to model the within-year timing of revenue and cost for a regulated entity for a 'test year' (using the approach described in this report), and to make an explicit adjustment to target revenue to remove whatever bias is found to exist. Against this, it was noted in Chapter 2 that the use of a simple approach for determining target revenue has significant attractions in terms of adding to the transparency of regulation, and reducing administrative and compliance costs. The level of imprecision with respect to the other factors that affect the assessment of reference tariffs – such as the estimate of the opportunity cost of capital and expenditure benchmarks – also needs to be borne in mind when assessing the degree of precision warranted with respect to the within year timing of cash flow. Ultimately, these are trade-offs that the Commission is best placed to resolve.[33]

[33] A related area where the Commission should consider change to the PTRM is with respect to the method that is used to adjust prices for inflation. This matter is discussed in footnote 27.

Appendix A

A.1 Derivation of the PTRM (End of Year Cash Flows)

Target Revenue Formula

If revenue is received and capital expenditure incurred at the end of each year, then the portion of target revenue associated with capital costs for year t is found by finding TR_t^{Cap} such that:

$$RAB_{t,open} = \frac{TR_t^{Cap} - Capex_t + RAB_{t,close}}{1+r}$$

Noting that:

$$RAB_{t,close} = RAB_{t,open} + Capex_t - Dep_t$$

and substituting this back into the original expression, implies:

$$RAB_{t,open} = \frac{TR_t^{Cap} - Dep_t + RAB_{t,open}}{1+r}$$

which can be rearranged to yield:

$$TR_t^{Cap} = r.RAB_{t,open} + Dep_t$$

With respect to operating activities, the precise formula for deriving this share of target revenue (from equation 3 above) is to find $R_{i,t}$ such that:

$$\sum_{i=1}^{n} \frac{R_{i,t}}{(1+r)^i} = \sum_{i=1}^{n} \frac{O\&M_{i,t}}{(1+r)^i}$$

where year t has been broken into i equal increments (and r is the corresponding per-period discount rate). The share of target revenue associated with operating activities is then given as:

$$TR_t^{O\&M} = \sum_{i=1}^{n} R_{i,t}$$

and the forecast of annual operating expenses is given by:

$$O\&M_t = \sum_{i=1}^{n} O\&M_{i,t}$$

If it is assumed that the timing of revenue within the year is aligned precisely with the timing of the operating expenses, and the present value of the allowance in target revenue for operating expenses and the present value of these expenses are equated, then it must follow that:

$$R_{i,t} = O\&M_{i,t}$$

It then follows that:

$$TR_t^{O\&M} = \sum_{i=1}^{n} R_{i,t} = \sum_{i=1}^{n} O\&M_{i,t} = O\&M_t$$

That is, if the timing of revenue is aligned precisely with the timing of the operating expenses, the appropriate allowance in target revenue in respect of operating activities is just the forecast of annual expenses. Under any other timing assumption, the appropriate allowance in respect of operating expenses will differ from the forecast of the annual expenses – with the direction of the magnitude of the difference dependent upon the timing mismatch.

Therefore, under the timing assumptions for revenue, capital and operating expenses discussed above, target revenue would be given by:

$$TR_t = r.RAB_{t,open} + Dep_t + O\&M_t$$

which is the target revenue formula in the PTRM.

A.2 Derivation of the 'Return on Average Asset Base' Target Revenue Formula

If half of the depreciation share of revenue is received and half of the capital expenditure is incurred at the start of each year, the remainder of revenue is received and capital expenditure incurred at the end, then the portion of target revenue associated with capital costs for year t is found by finding TR_t^{Cap} such that:

$$RAB_{t,open} = \frac{Dep_t - Capex_t}{2} + \frac{\left(TR_t^{Cap} - \frac{Dep_t}{2}\right) - \frac{Capex_t}{2} + RAB_{t,close}}{1+r}$$

Noting that:

$$RAB_{t,close} = RAB_{t,open} + Capex_t - Dep_t$$

and substituting this back into the original expression, implies:

$$RAB_{t,open} = \frac{Dep_t - Capex_t}{2} + \frac{TR_t^{Cap} - \frac{3}{2}Dep_t + \frac{Capex_t}{2} + RAB_{t,open}}{1+r}$$

which can be rearranged to yield:

$$TR_t^{Cap} = r.\left(\frac{RAB_{t,open} + RAB_{t,close}}{2}\right) + Dep_t$$

which, given the same assumption about the timing of the remainder of revenue and operating expenses discussed above, implies a target revenue formula:

$$TR_t = r.\left(\frac{RAB_{t,open} + RAB_{t,close}}{2}\right) + Dep_t + O\&M$$

A.3 Derivation of the 'Mid-Point Timing' Target Revenue Formula

If all of the revenue is received and capital expenditure is incurred at the midpoint of each year, then the portion of target revenue associated with capital costs for year t is found by finding TR_t^{Cap} such that:

$$RAB_{t,open} = \frac{TR_t^{Cap} - Capex_t}{(1+r)^{1/2}} + \frac{RAB_{t,close}}{1+r}$$

Noting that:

$$RAB_{t,close} = RAB_{t,open} + Capex_t - Dep_t$$

and substituting this back into the original expression, implies:

$$RAB_{t,open} = \frac{TR_t^{Cap} - Capex_t}{(1+r)^{1/2}} + \frac{RAB_{t,open} + Capex_t - Dep_t}{1+r}$$

which can be rearranged to yield:

$$TR_t = r.RAB_{t,open}.\frac{1}{(1+r)^{1/2}} + Dep_t.\frac{1}{(1+r)^{1/2}} + Capex_t.(1 - \frac{1}{(1+r)^{1/2}})$$

which, given the same assumption about the timing of the remainder of revenue and operating expenses discussed above, implies a target revenue formula:

$$TR_t = r.RAB_{t,open}.\frac{1}{(1+r)^{1/2}} + Dep_t.\frac{1}{(1+r)^{1/2}} + Capex_t.(1 - \frac{1}{(1+r)^{1/2}}) + O\&M_t$$

A.4 Derivation of the Continuous Time Target Revenue Formula

If all of the revenue is received and capital expenditure is incurred continuously (and at a constant rate) over each year, then the portion of target revenue associated with capital costs for year t is found by finding TR_t^{Cap} such that:

$$RAB_{t,open} = \int_0^1 \left(TR_t^{Cap} - Capex_t\right)e^{-r^c\tau}.d\tau + \frac{RAB_{t,close}}{1+r}$$

where r^c is the continuous time analogue of the (effective annual) discount rate, r. Evaluating the integral implies that:

$$RAB_{t,open} = \left(TR_t^{Cap} - Capex_t\right)\left(\frac{1-e^{-r^c}}{r^c}\right) + \frac{RAB_{t,close}}{1+r}$$

Noting that:

$\ln(1+r) = r^c$, and $r = e^{r^c} - 1$

implies that this can be expressed as:

$$RAB_{t,open} = \left(TR_t^{Cap} - Capex_t\right)\left(\frac{r}{(1+r).\ln(1+r)}\right) + \frac{RAB_{t,close}}{1+r}$$

Noting that:

$$RAB_{t,close} = RAB_{t,open} + Capex_t - Dep_t$$

substituting back into the original expression, and rearranging the terms yields:

$$TR_t = r.RAB_{t,open}.\frac{\ln(1+r)}{r} + Dep_t.\frac{\ln(1+r)}{r} + Capex_t.\left(1 - \frac{\ln(1+r)}{r}\right)$$

which, given the same assumption about the timing of the remainder of revenue and operating expenses discussed above, implies a target revenue formula:

$$TR_t = r.RAB_{t,open}.\frac{\ln(1+r)}{r} + Dep_t.\frac{\ln(1+r)}{r} + Capex_t.\left(1 - \frac{\ln(1+r)}{r}\right) + O\&M_t$$