Smart Water Fund

Final Report

An Economic Framework for Estimating Long Run Marginal Costs in the Victorian Water Industry

Project 8TR8-001

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NERA
ECONOMIC CONSULTING

Smart Water Fund

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1. Introduction

This report has been prepared by NERA Economic Consulting (NERA) for the Smart Water Fund ('the Fund') under the guidance of the four Metropolitan Melbourne water businesses, ie, City West Water, South East Water, Yarra Valley Water and Melbourne Water. Its subject is the development of an economic framework for estimating long-run marginal cost (LRMC) in the Victorian water industry. The primary objective of the Smart Water Fund in commissioning this report is to assist Victorian water businesses in estimating the LRMC associated with their services and to inform the application of LRMC pricing principles in pricing decisions.

This final report was preceded by a draft, which was prepared for consultation with a range of Victorian water industry participants as part of its refinement and finalisation. Our report is presented in 6 sections, which are structured as follows:

- section 2 outlines the context for this report;
- section 3 discusses the concept of marginal cost and its role in pricing;
- section 4 provides an economic framework for determining the particular elements of services for which a marginal cost is to be estimated and applied;
- section 5 describes the two main approaches to estimating LRMC, and the circumstances in which each is more or less appropriate;
- section 6 sets out a framework for applying each of these approaches; and
- section 7 concludes.

In addition, Appendix A provides a detailed discussion on the distinction between short-run marginal cost (SRMC), LRMC and the relationship between the two. Further, Appendix B describes the LRMC estimation methodologies adopted in other jurisdictions throughout Australia.

Our report is also accompanied by two 'high level' models that illustrate the approaches to estimating LRMC discussed in this report, as well as the nature of the information required. A discussion of these models and their applicability to two case studies is provided in Appendix C.

2. Context for this Report

This section summarises the history of LRMC estimation in the Victorian water industry as well as discussing the way in which its structure(s) affect the application of any LRMC estimation framework. We also discuss a range of other considerations and objectives that *may* play a role in ultimate decisions as to the structure of water and wastewater prices in Victoria.

2.1. LRMC in Victoria

Setting prices for water and wastewater services by reference to LRMC principles is not a new concept in Victoria. As part of its review of water and wastewater prices to be charged by the 17 Victorian water businesses from 1 July 2005, the Essential Service Commission (ESC) emphasised the importance of setting variable prices according to estimates of the LRMC of supply. The ESC emphasised that this would allow consumers to balance the relative costs and benefits of consuming water and sewerage services, but noted that the businesses did not appear to have made much progress in applying the LRMC principles. Specifically, the ESC stated: [1]

> *"[T]he Commission found it difficult to assess the extent to which the businesses' proposed prices provided appropriate signals about the costs of providing services since most businesses had not estimated the LRMC of providing services. Those that had, did not appear to have fully reflected the full economic costs of supply (including social and environmental costs) or had undertaken analysis that did not appear to be robust."*

Subsequently, the ESC consulted with businesses on the methodological issues associated with estimating LRMC. It released an Information Paper in September 2005, the purpose of which was to serve as a manual to which businesses could refer when demonstrating that they had estimated the LRMC of their various services and had had regard to those estimates in setting their variable prices. However, the Information Paper was couched in relatively 'high level' terms and, to date, there is still no common approach between water businesses to estimating LRMC.

As part of their 2009-10 Water Plans, Victorian water businesses proposed to review their tariff structures over the subsequent four years, for implementation in the 2013-18 regulatory period. To assist in the development of pricing proposals, the ESC has stated that it expects water businesses to consider a number of issues whilst undertaking their tariff reviews, including:

- ensuring variable water charges are consistent with LRMC, while acknowledging the relative changes in cost structures as a result of substantial recent investments in supply side augmentation;
- the split of costs between water and sewerage services;
- the pertinence of inclining block tariffs once supply side augmentations have been completed and water restrictions are removed;
- the effects of inclining block tariffs structures on large families; and
- the appropriateness of variable sewerage charges, given sewage discharges currently are not metered and the marginal costs of disposal are low.

In addition to these expectations, the Victorian Minister for Water established the Living Victoria Ministerial Advisory Council ('the Council') with the aim of providing recommendations on the strategic

[1] ESC, (2005), *Estimating Long Run Marginal Cost – Implications for Future Water Prices,* September 2005, p.1.

priorities for water sector reform. In March 2011, the Council outlined a number of reform priorities as part of the *Living Melbourne, Living Victoria Road Map* that included, amongst other things, establishing a common approach to economic evaluation and a review of different approaches to the pricing and valuing of all water resources.

The absence to date of a common approach to estimating LRMC across water businesses in Victoria is a potential impediment to the development of consistent price signals and efficient decision-making by both water businesses and end-users. It is the achievement of consistency in the estimation and application of LRMC that provides the impetus for this project.

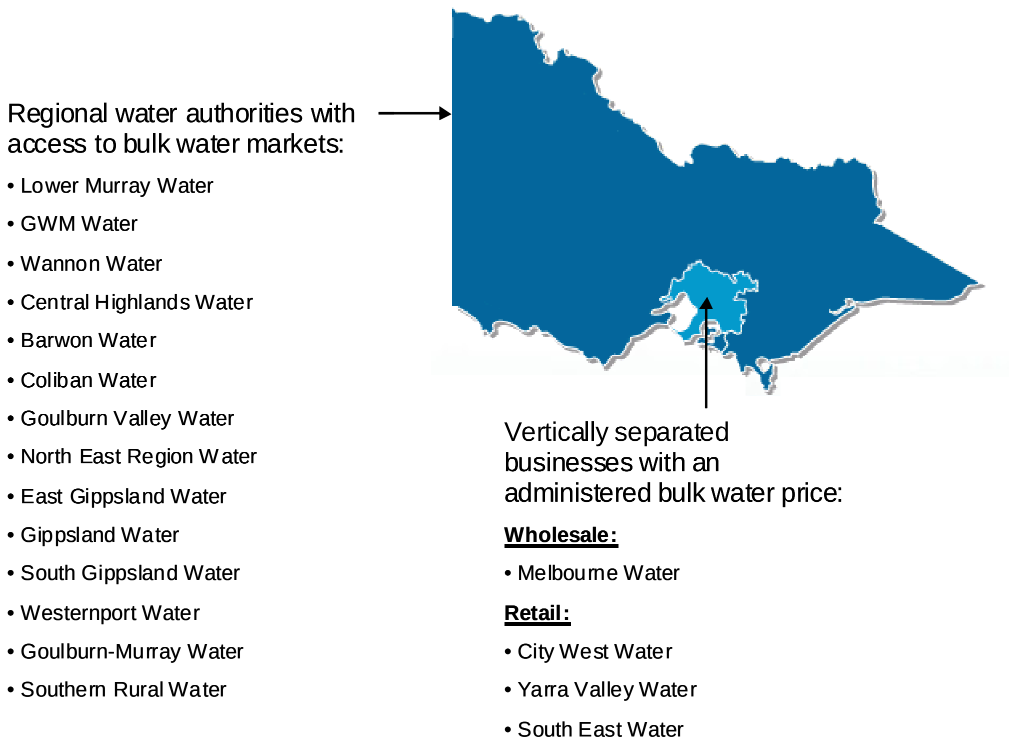
2.2. Implications of different industry structures

Victoria's water and wastewater industry is characterised by two broad industry structures, namely:

- in Melbourne, the industry has been vertically separated into retail and wholesale functional levels (ie, a 'wholesale-retailer' model), with wholesale water prices regulated by the ESC; and
- in regional areas of Victoria, water businesses are structured with access to supply sources either in the form of storages they themselves own or storages owned by rural water authorities to which they have bulk entitlements.

One consequence of the structural arrangements applying to the regional businesses operating outside of Melbourne is that they are able to trade entitlements to bulk water sources, and so can generally observe a market price for bulk water. This structural distinction between the existence or not of access to a functioning bulk water market is illustrated in Figure 2.1 below.

Figure 2.1
Structure of the Victorian Water and Wastewater Industry



Typically, estimates of LRMC for bulk water are derived in the context of a vertically integrated monopoly supplier that does not have access to a well functioning market for bulk water. Where there is a stand alone bulk water supplier, the LRMC of bulk water should be reflected in the structure of the wholesale price for water, which in turn becomes an input to the retail functional dimension.

By contrast, where bulk water prices are set in a market, the LRMC of bulk water supply represents a combination of the expected future average cost or market value of water entitlements and the expected future cost of storing and treating the bulk water to which those entitlements apply. The overall LRMC estimate would then be the sum of this long run expected average market price[2] and the long-run cost of storing and treating the bulk water.

2.3. 'Other forms of influence' on tariffs

While the focus of this study is on developing a LRMC estimation methodology for Victoria, other considerations and objectives also play a role in the ultimate setting of tariffs. For example:

- transaction and information costs mean that it is efficient to aggregate customers into 'classes' for tariff setting purposes, whether distinguished by size of connection, geographic averaging or in some other manner;
- marginal cost pricing does not guarantee that a business can recover all of its costs - other allocation mechanisms may therefore be required to breach any gap (as discussed in section 3.3 below); and
- equity considerations may well play a role in tariff setting, as may environmental objectives.

The objectives that govern the ESC's approach to urban water tariffs are set out in the Water Industry Regulatory Order (WIRO). Notwithstanding these objectives, some interested parties appear to give weight to objectives that are either not formally captured under the WIRO or go beyond what is realistic for (any) water tariff structure to be able to deliver. For example, the Council's idea of 'administered resource value' prices and the Victorian Council of Social Services' (VCOSS's) perspective on the requirements for a 'social tariff' involve concepts that appear to fall outside what is permissible or contemplated under the WIRO. Resolving these tensions will require greater clarity as to the objectives and expectations of water tariff structures in Victoria.

In addition, and perhaps as a result of the variety of conflicting goals presented to water businesses, it seems clear that current tariff structures have become unnecessarily complex and may be difficult to understand (and so respond to) by customers. For example, the predominance of inclining blocks in water tariffs and the complex arrangements for the sewerage disposal charge appear at odds with the basic objective of having customers understand what determines their bill.

There also appears to be impetus for an increasing role for social objectives to be reflected in the structure of water tariffs in Victoria. For example, VCOSS strongly advocates that social needs should be addressed through tariffs that have low fixed charges and steeply inclining blocks for the variable component.3 Further, we note that the Council's *March 2011 Living Melbourne, Living Victoria Road*

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[2] The market price of bulk water entitlement is effectively a SRMC that, when averaged into the future, represents LRMC. This relationship is discussed in more detail in Appendix A.

[3] We also note that both the National Water Commission and the Productivity Commission have discussed the merits of scarcity pricing.

Map suggests that prices should be based on an 'administered resource value'.4 If such objectives are to be pursued, it must be decided:

- what weight should be given to various objectives?
- what are the particular implications for how tariffs should be structured? and
- to what extent can any tariff structure be expected to assist with such an objective?

Finally, both the Council and Yarra Valley Water have suggested that customers should be presented with tariff options, with these linked to choices as to the level of service, eg, a water supply with or without the possibility of restrictions. We discuss the way in which the potential for customer choice fits into a LRMC framework as part of section 3.4 below.

4 We note that it is unclear as to what by an 'administered resource value' precisely means, particularly when the marginal source of additional bulk water for Melbourne may well be further desalination capacity, which involves rather different environmental resources effects than the usual, dam-related water sources.

3. Marginal Cost and its Role in Pricing

This section sets out the theory of marginal cost pricing and the practicalities associated with its implementation in the context of the water and wastewater sector.

3.1. Marginal cost pricing and economic efficiency

The term 'marginal cost' refers to the incremental cost of producing an additional unit of output or, alternatively, the cost that can be avoided by reducing production by a specified amount.[5] Economic theory suggests that the essential, resource allocation function of markets works best when prices are set equal to the marginal cost of production. When prices reflect marginal cost, allocative efficiency will be maximised, since the benefit to society from the consumption of a good or service is equated with the cost of providing that good or service, ie, society would not be 'better off' from more or less consumption.

In the context of the water and wastewater sector, setting prices equal to marginal cost encourages:

- the sustainable use of water by consumers, since the marginal benefits from the consumption of an additional kL of water is set equal to the costs of providing that water;
- efficient procurement and provision decisions by water businesses, eg, when to pump and when to use stored water; and
- efficient investment decisions, eg, investment in transportation, treatment and storage infrastructure, water efficient appliances, etc.

3.2. Marginal cost pricing in practice

While economic theory suggests that pricing by reference to marginal cost is more likely to deliver an efficient market outcome, this principle is often difficult to achieve in practice. This is because the theory of marginal cost pricing relies on a number of assumptions that often do not apply in the real world, namely:

- that production inputs are infinitely divisible;
- that products and services are single-dimensional;
- that there are no transaction costs associated with establishing, charging and responding to price signals;
- that marginal costs are static, ie, they do not change over time; and
- that all costs are quantifiable including, for example, externalities.

Further, it is not always clear whether prices are more appropriately set by reference to short-run or long-run marginal costs. This question, as well as a number of other practical issues associated with the application of marginal cost pricing in the water and wastewater sector is discussed in the sections below.

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5 Marginal cost is the first derivative of a firm's production cost function, with respect to output. However, its practical application involves the measurement of the change in a firm's cost of production when its output changes by a specified increment and is often also referred to as incremental cost or avoidable cost (where the specified change involves a reduction in output). For the purposes of this report, we have taken the concepts underpinning marginal, incremental and avoidable cost to be synonymous, since their technical distinctions have no consequences for the matters at hand. For further discussion *see:* Kahn, A, (1988), *The Economics of Regulation, Principles and Institutions, Volume 1* (MIT Press), p.66 (Hereafter: 'Kahn (1988)').

3.2.1. Short-run vs long-run marginal costs

If prices are to be set by reference to marginal costs, it must first be decided whether the relevant cost concept should be SRMC or LRMC. The distinguishing feature between SRMC and LRMC is the time frame under which they are considered and the associated implications for a supplier's ability to adjust its production process to minimise costs or meet demand, ie:

- SRMC can be defined as the cost of an incremental change in demand, holding capacity constant; whereas
- LRMC relaxes this constraint and reflects the cost of an incremental change in demand assuming all factors of production can be varied.

An important distinguishing feature of SRMC is that, in the event supply cannot expand to match demand, SRMC rises to whatever price level is necessary to curtail demand to match available supply. It therefore takes account of the costs of shortages faced by customers. This may include costs such as plant losses in residential gardens and parks, reductions in agricultural output, diminished quality of golf courses and higher production costs for breweries. In the extreme case where, say, Melbourne ran out of water, the SRMC could include the cost of bottled or tankered-in water.

Whether prices are more appropriately set by reference to SRMC or LRMC depends on the institutional circumstances of the market and the demand and supply implications of departing from either cost measure. In the water industry, pricing by reference to LRMC is often preferred (see Box 3.1 below). In practice, the realisation of any significant benefits under SRMC pricing arrangements would require customers to be able to respond to short-run changes in price. Significant technological developments and associated investment in metering infrastructure would be required for any such benefits to be available in the Victorian water industry.[6]

[6] Specifically, existing accumulation water meters would need to be replaced with meters similar to those currently being trialled in the electricity industry, ie, 'smart metering technology'. We understand that there are only limited instances of smart water meters being trialled across the globe and that, a roll out of such meters in the Victorian water industry is not anticipated in the foreseeable future. Therefore, in our view, SRMC pricing is currently unlikely to be effective in eliciting efficient demand/investment from customers in Victoria.

Box 3.1
Pricing According to LRMC vs SRMC

On the demand side, LRMC pricing may send better signals for long-term decisions that affect consumption levels, such as households' investment in water-using appliances and industries' location choices. For example, landscaping, dual-flush toilet, breweries, orchards, golf courses, parks, underground sprinkler systems and pools all last for decades and involve decisions that take consumers some time to make and implement.

In addition, the efficiency losses from setting prices further away from SRMC may be smaller than those associated with setting prices further away from the LRMC. This is because the short-run elasticity of demand is likely to be lower than the longer-run demand elasticity, reflecting both the time it takes consumers to make investments that alter consumption and the duration of these investments. For example, in the longer-term households and businesses are able to make more substantial changes to their consumption patterns than may be possible in the shorter term.

That said, if there is substantial excess capacity in the existing water system, SRMC could in fact be lower than LRMC and prices above SRMC can be said to deny customers the welfare associated with additional consumption. For example, higher prices may lead to customers limiting their garden watering or, in the case of industries, reducing production or increasing prices, even though higher levels of water use would involve gains to efficiency and reserve allocation. Conversely, if the system is facing a short-term depletion in its supply levels, pricing at LRMC may not signal the increased likelihood of future restrictions to consumers. Such pricing may then lead to over-consumption, increasing the probability of future restrictions.

The practical difficulties of implementing SRMC pricing also favours prices based on LRMC. SRMC pricing requires a means for conveying short-term consumption and pricing information to customers, which is not practicable given current metering technology/cost. In any case, such fluctuations may be undesirable from customers' perspective, with the public more likely to prefer paying a price fixed over the long term. Evidence from the national electricity market (NEM), where end-use customers pay a fixed contract price despite wholesale costs varying on a SRMC basis, suggest that customers generally they prefer to pay a premium to have short-run price risks managed for them.

A more detailed discussion of SRMC, LRMC and the relationship between the two is provided in Appendix A.

3.2.2. Indivisibility of capacity increments

The water and wastewater sector is highly capital intensive and characterised by 'lumpy' investment in new capacity. At any one time, most water and/or wastewater systems operate with some spare capacity such that the system is capable of serving additional demand at low or zero cost. Given this, it is generally not practicable to estimate the marginal cost associated with the production of a single additional kL of water or treated wastewater. Rather, marginal costs are generally measured on the basis of the change in the per unit costs of supply associated with permanent step changes in forecast demand that require some level of additional capital investment.

Put another way, at a practical level, marginal cost is most commonly defined as the per unit total cost (savings) associated with a permanent increment (decrement) of demand.

3.2.3. Multi-dimensional nature of products or services

Many products or services are multi-dimensional in that they have more than one attribute that defines both their quality and cost of production. For example, residential sewerage services involve at least two dimensions, being:

- the volume of sewage removed and treated; and
- the pollution 'load' embodied in that volume of sewage removed and treated.

While these dimensions are somewhat independent of one another, both are relevant for the determination of the marginal cost of providing residential sewerage services.

It is not always practicable to estimate, and charge, a marginal cost for *all* service dimensions. For instance, sewage outflow from residential properties is currently not metered. Given that consumption for each individual residence is not currently measured, it would simply not be practicable to charge for residential sewerage services on the basis of the marginal cost of either volume or pollution load.

When developing a marginal cost pricing framework, it is therefore necessary to first identify those service dimensions that are both possible and practicable to estimate. Our framework for undertaking this task is set out in more detail in section 4 below.

3.2.4. Product, geographic and time dimensions

In many cases, the marginal cost of production will vary between customer groups, geographic location and over time. For example, in the water and wastewater sector:

- there may be different costs associated with providing services to new versus existing customers – the cost of serving a new customer may be higher than that of existing customers if new customers require infrastructure that is specific to them or to their location;
- there will be different costs associated with servicing customer groups in different locations, eg, the cost of serving customers located in regions of relatively high altitude may be greater due to the need to pump water uphill;
- marginal costs will vary over time as a result of new capacity being added – the marginal cost of supply will be relatively low when capacity utilisation is low and the next capacity expansion is some distance in the future, but will rise as capacity utilisation increases and the timing of the next expansion is nearer; and
- there may be different costs associated with incremental increases in demand at different times, eg, the supply of an additional kL of water on a day where consumption is at its peak may be greater than an additional kL supplied provided at non-peak times.

These considerations highlight that, any analysis of marginal cost needs to be carefully defined in terms of the relevant product, location and time dimensions.

3.2.5. Existence of externalities

Broadly, there are two categories of externalities that may arise in the provision of water and wastewater services, namely:

- 'demand side' externalities, ie, external costs and benefits associated with the consumption of these services; and
- 'supply side' externalities, ie, external costs and benefits associated with supplying these services.

For efficient decision-making, the relevant marginal cost is the full cost to society, including both these types of externalities. Specifically, if a marginal cost estimate for a particular water or wastewater service excludes a positive (negative) externality then that cost, and ultimately the associated volumetric prices, are at risk of being too high (low), which could result in a lower (greater) than efficient level of consumption. It follows that externalities should enter into a marginal cost calculation to the extent that their exclusion is thought to result in a cost element being under- or over-stated.

Externalities do not represent a monetary benefit or cost that flows to or from water businesses. However, 'internalising' any externality associated with the provision of water and wastewater services has no implications for a water business's revenue requirement. Rather, the incorporation of externalities in a marginal cost estimation exercise only affects the 'structure' of prices, ie, the split between fixed and variable charges and so the nature of price signals sent to customers.

3.3. Marginal costs vs average costs

While pricing by reference to marginal cost improves allocative efficiency, in capital intensive industries characterised by high capital costs, such pricing arrangements may not be sufficient to cover an operator's capital costs and so total cost of supply. In such industries, tariff structures need to be developed such that operators are able to recover their revenue requirement while at the same time providing appropriate pricing signals to consumers.

Where the variable component of prices is set by reference to marginal cost, the task of recovering any residual necessary to ensure a service provider's revenue requirement is met should be undertaken by that element of the tariff structure that can be expected to cause the least distortion to efficient consumption decisions, ie, the least elastic dimension of consumption. The methodology for setting such residual charges falls outside of the scope of this study, although its relevance to the estimation of marginal cost is discussed further in section 4.3 below.

3.4. The role of customer choice

We discussed in section 2.3 above that both the Council and Yarra Valley Water have suggested that customers should be presented with tariff options, with these linked to choices as to the level of service, eg, water supply with or without the possibility of restrictions.

In the context LRMC estimation, this would essentially require estimating two LRMCs, ie:

- one to serve potentially restricted demand; and
- another to serve unrestricted demand.

In practice, this would require developing two separate demand forecasts (one for each type of service) and two investment profiles (that needed to meet the demand for each type of service). Naturally, there would be a high degree of interrelatedness between the two, since more of one would imply less of the other.

In our opinion, beyond this distinction, which we recognise may entail significant practical challenges, estimating these two LRMCs would not be intrinsically different from the approach set out under the framework in this report. However, the development of services differentiated in such a manner is a fundamental threshold that would need to be overcome, and one that needs attention beyond the task of developing the tariffs necessary to support it.

4. The Marginal Cost of What?

The purpose of a marginal cost pricing framework is to provide price signals to consumers and producers that encourage the efficient use of water and waster services. In order to provide such price signals, it is necessary first to identify the dimensions of water and wastewater supply that are relevant for both the cost of service provision and consumption decisions. In other words, it is necessary to identify those dimensions of service provision that have an independent effect on the cost of supply and, if priced separately, are likely to influence the level of consumption.

The development of a marginal cost pricing framework therefore involves three distinct steps:

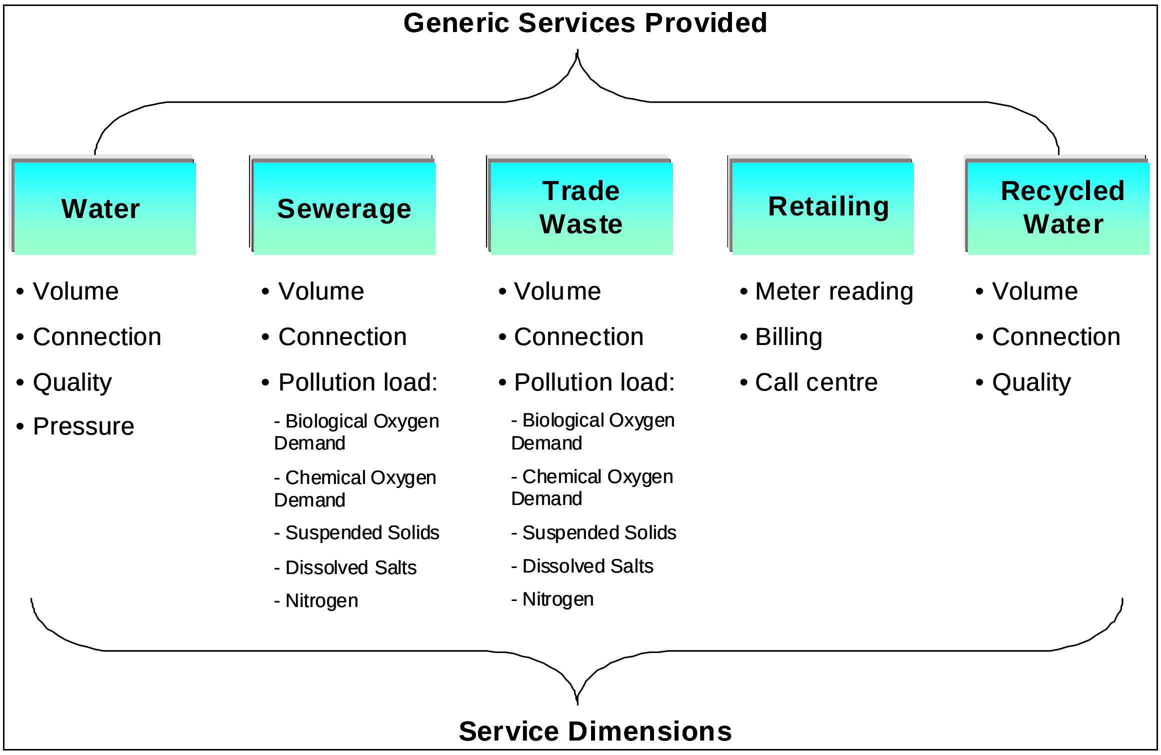
1. Identify the relevant dimensions of each service provided.
2. Determine whether it is it practicable to measure how much of each service dimension is ‘consumed’ and whether customers able to make independent decisions as to how much of a particular service dimension is ‘consumed’.
3. Assess the likelihood and magnitude of customer response to price signals for each measurable service dimension.

Each of these steps is discussed in more detail in sections 4.1 to 4.3 below. Further, section 4.4 applies these steps in the context of a generic vertically integrated water and wastewater services supplier to identify which service dimensions are likely to be suitable for LRMC estimation.

4.1. Step 1: Dimensions of the services provided

Water and wastewater businesses offer a range of services that each have different attributes or dimensions. An overview of the generic services offered by water and wastewater businesses and the different dimensions of each is set out in Figure 4.1 below.

Figure 4.1
Generic Water and Wastewater Service Dimensions



Note: The term 'quality' refers to the quality of service given connection, ie, it includes things such as the chemical composition of water, the security of supply, etc.

The cost of providing each of these services exhibits different degrees of sensitivity as to how much of each service attribute or dimension is 'consumed'. For example, the per unit incremental cost of providing an additional 10ML of water supply is likely to differ from the per unit incremental cost of providing an additional 10 households with connection.

4.2. Step 2: Determine whether customers can make independent decisions as to their 'consumption' of a particular service

In order to elicit any significant change in demand in response to a potential price signal, customers must have the ability to make independent decisions as to how much of a particular service they 'consume'. Having defined the various service dimensions in Step 1 above, it is necessary to determine for each service dimension:

- whether it is practicable to measure how much of that service dimension is 'consumed'; and
- whether customers are able to make independent decisions as to how much of each particular service dimension is 'consumed'.

These two considerations represent the necessary 'choice' conditions that must be met for any service dimension to have an expected non-zero demand elasticity. This is discussed further in section 4.3 below.

If a service dimension cannot be measured or if customers are unable unilaterally to alter their consumption of that particular dimension then they are unlikely to respond to any price signals offered by way of marginal cost pricing. For example, customers are generally not able to measure the quality of potable water supplied in terms of its chemical composition. Therefore, it is unlikely that they would be able to respond to the differential pricing of water on the basis of product quality.

By contrast, customers are able to measure the volume of water supplied to them, through their water meter. They are also able to make decisions as to how much water to consume either explicitly (eg, making the decision not to water the garden every day) or implicitly through investment in more water efficient appliances. It follows that the volume of water supplied may be a suitable service dimension for the purpose of marginal cost pricing.

4.3. Step 3: Assess the extent to which customers' are likely to respond to price signals

For those service dimensions that are both practicable to measure and for which customers can alter their consumption, it is necessary to determine the extent to which customers would be likely to respond to price signals. In other words, it is helpful to estimate the likely elasticity of demand for each service dimension that meets the criteria outlined in Step 2. Those service dimensions that have a relatively high elasticity are the most suitable candidates for marginal cost pricing since they are the most likely to elicit some form of demand response. By contrast, those service dimensions that have a relatively low expected elasticity are likely to be strong candidates for prices that have as their principal objective the recovery of any residual revenue requirement.

When estimating the relative elasticity of demand for each service dimension, it is important to consider the extent to which customers may be capable of responding to price signals over the short vs long run. We noted in section 3.2.1 above that current water meter technology in Victoria prevents customers from being presented with short-run price signals and this is unlikely to change in the foreseeable future. Therefore, in respect of volume of water supplied, it is only relevant to consider the long-run elasticity of demand.

4.4. Applying this framework

To demonstrate how the above framework may be used to determine which service dimensions are appropriate for LRMC estimation, we have applied it in the context of a generic vertically integrated water business. Specifically, we have illustrated the application of the three steps to the service dimensions identified in Figure 4.1 above. The results are set out in Figure 4.2 to Figure 4.7 below.

These examples demonstrate that the only service dimensions in the water and water waster sector that are suitable for the purpose of marginal cost pricing are water and trade waste *volumes*, trade waste *pollution loads* and, possibly, the *volume* of recycled water. However, for the purposes of this report, we have chosen not to focus on the volume of recycled water since it is not a service dimension offered by all businesses in Victoria. Further, where it is offered, the price of recycled water is essentially constrained by the price of potable water.

Figure 4.2
Water Service Dimensions Suitable for LRMC Estimation

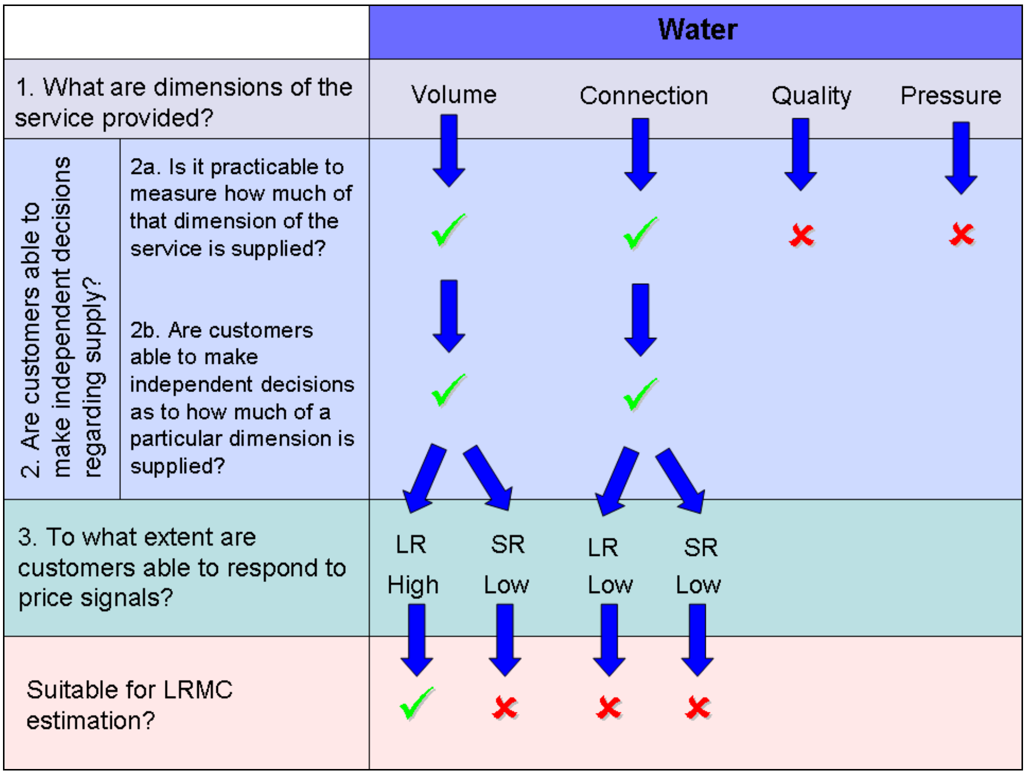


Figure 4.3
Sewerage Service Dimensions Suitable for LRMC Estimation

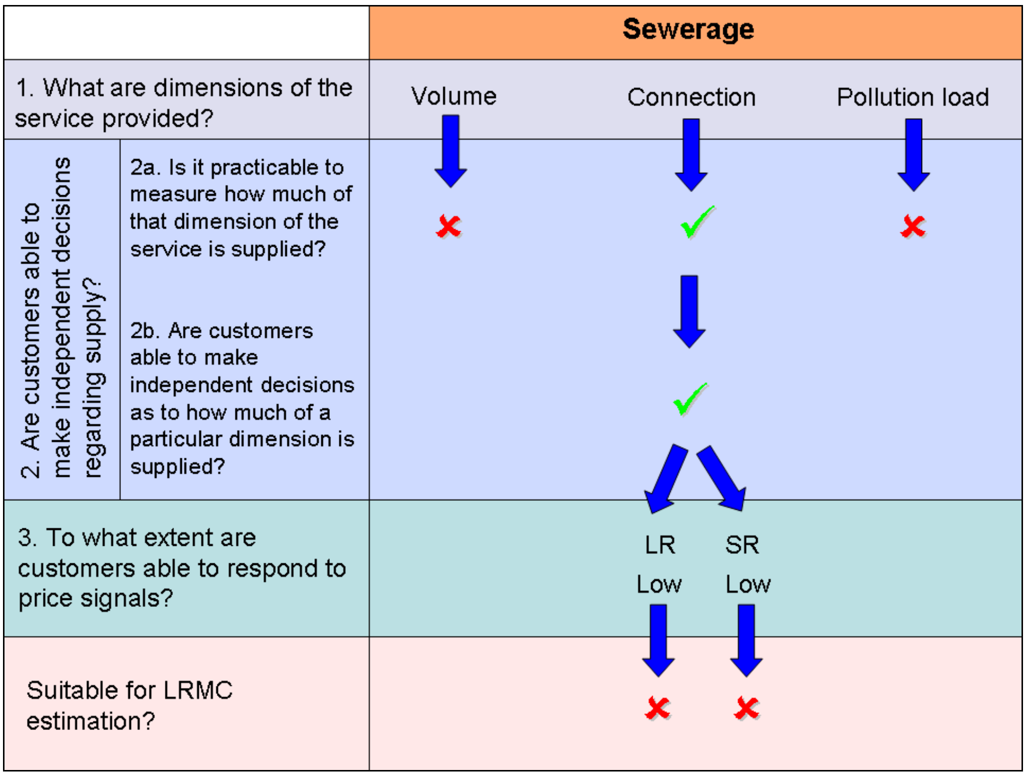
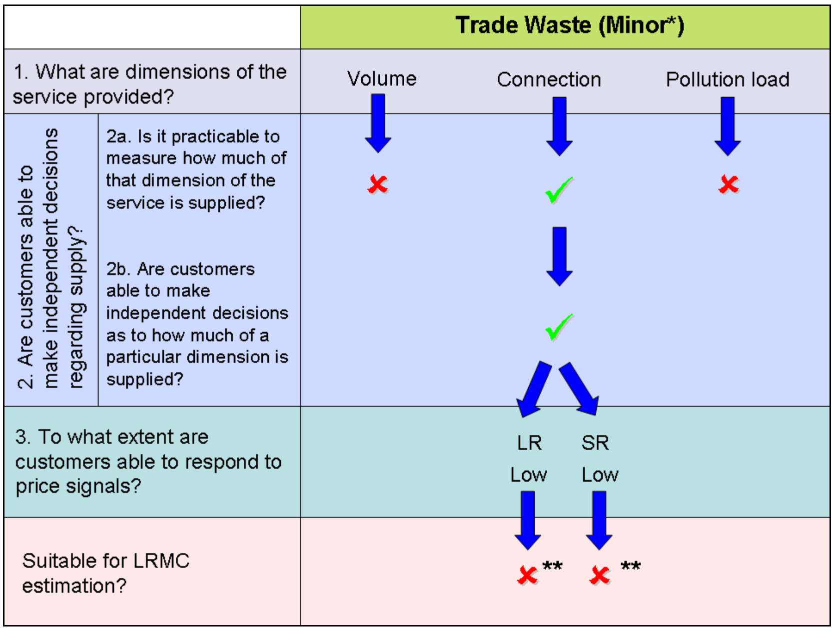


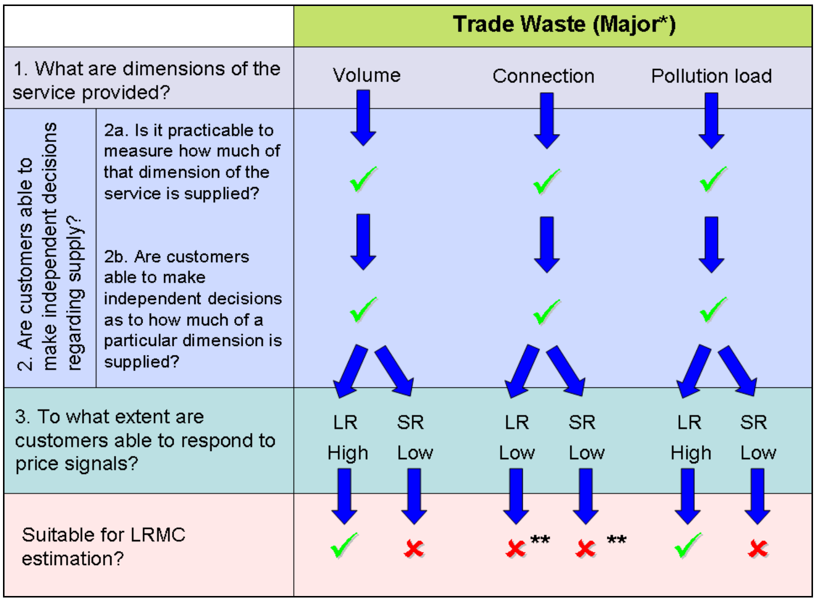
Figure 4.4
Trade Waste (Minor) Service Dimensions Suitable for LRMC Estimation



We have defined ‘minor’ trade waste customers as those without a customer specific trade waste meter.

*** If customers can be completely self sufficient in terms of trade waste disposal then they may in fact be able to respond to price signals with respect to connection, at least in the long run.*

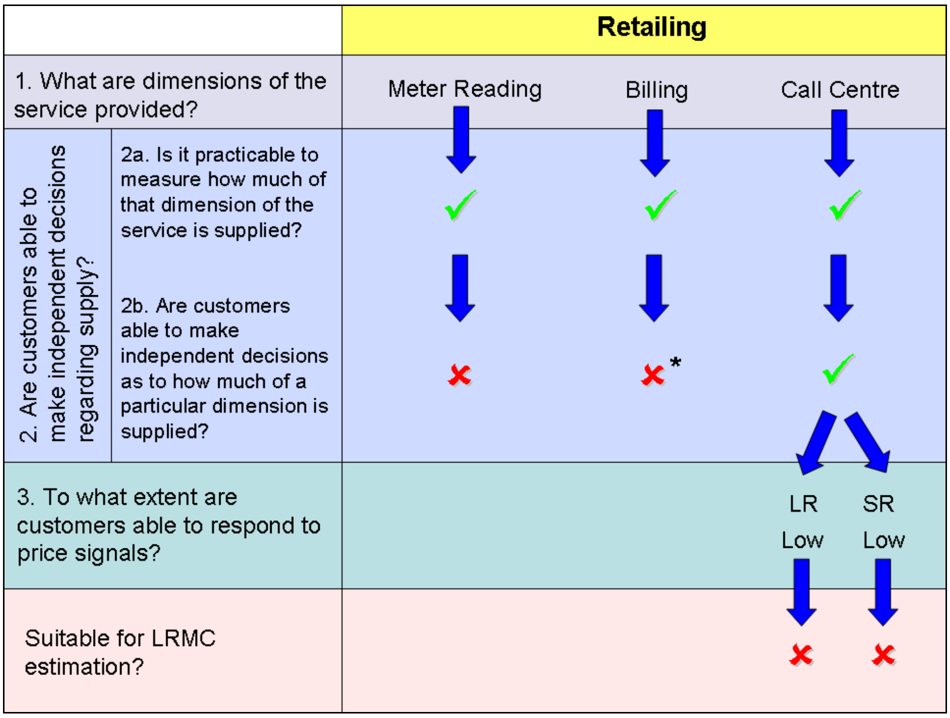
Figure 4.5
Trade Waste (Major) Service Dimensions Suitable for LRMC Estimation



** We have defined ‘major’ trade waste customers as those with a customer specific trade waste meter.*

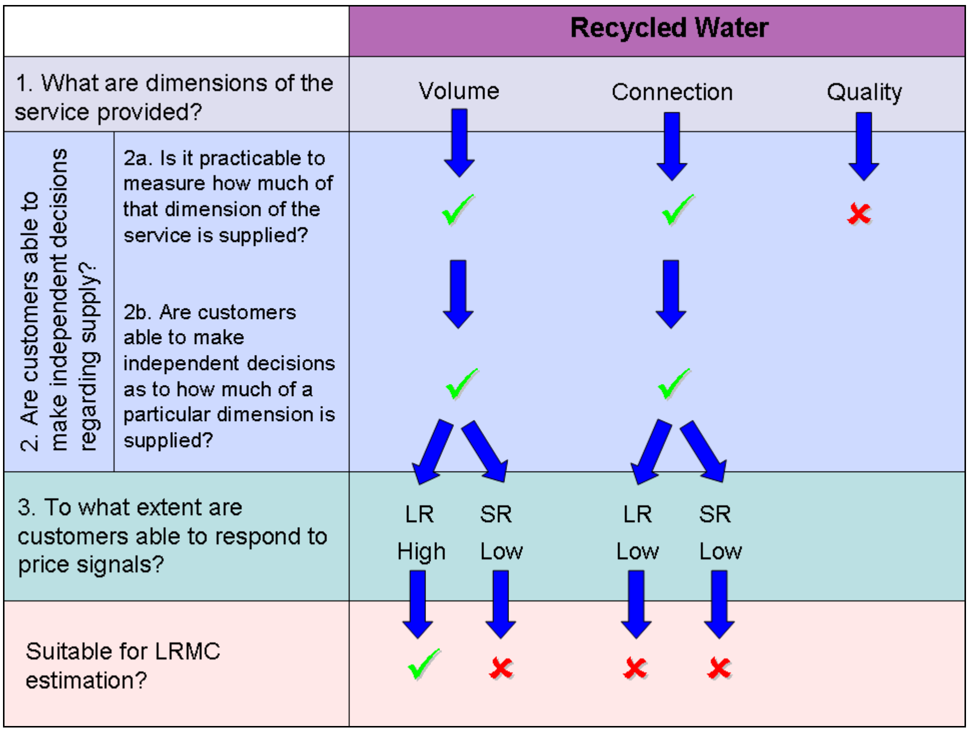
*** If customers can be completely self sufficient in terms of trade waste disposal then they may in fact be able to respond to price signals with respect to connection, at least in the long run.*

Figure 4.6
Retailing Service Dimensions Suitable for LRMC Estimation



** We note that there is an emerging ability for customers to choose the level of billing service they receive, for example electronic billing (as opposed to mail-based billing), direct debit (often with an associated cost savings to the customer) etc.*

Figure 4.7
Recycled Water Service Dimensions Suitable for LRMC Estimation



5. Frameworks for Estimating LRMC

There are two broad approaches that are used to estimate LRMC in the water and wastewater sector, ie:

- the perturbation approach (also known as the 'Turvey' approach); and
- the average incremental cost approach (AIC).

These two approaches involve similar steps, but differ in the way in which they measure the effect of changes in demand on operating and capital costs.

In the sections below we first discuss the different types of long-run marginal costs and how the service dimensions identified in section 4 as being appropriate for marginal cost pricing (ie, volume and pollution load) influence these costs. We then describe the steps involved in estimating LRMC under each of the Turvey approach and the AIC approach.

5.1. Composition of LRMC

LRMC is typically disaggregated into two elements, ie:

- long-run marginal operating costs (LRMOC), such as chemicals, power and labour, which increase broadly in proportion with demand; and
- long-run marginal capital costs (LRMCC), being those associated with future investment projects required to match supply with demand, such as reservoir or transfer system infrastructure.

LRMOC are generally simpler to estimate, since they usually have a more easily defined relationship with incremental increases in demand. Estimating marginal capital costs is more difficult. These are the costs associated with bringing forward anticipated investment in response to a hypothetical incremental increase in demand. They are not the same as the total investment costs, since an incremental increase in demand does not generally result in investment that would otherwise never be required. Rather, it speeds up system expansion.

5.2. Service dimension cost drivers

The principal service dimensions associated with water and wastewater supply that may be suitable for the purpose of marginal cost pricing (ie, water and trade waste *volume* and trade waste *pollution load*) each have different influences on both LRMOC and LRMCC. For example, a number of different functional services are performed under the broad service dimension 'volume of water supplied', being:

- bulk water procurement;
- bulk water treatment;
- transfer to storage reservoirs, ie, to the wholesale point of supply; and
- local distribution, including pumping and chemical dosing.

Of these functions, the first three involve the incurrence of significant capital costs in order to satisfy a pre-defined level of demand, and then relatively low ongoing operating costs. Additional increases in capacity (and thus additional capital expenditure) are only required where demand increases above the pre-defined level. In most cases, capacity additions are significant such that, at most times, the system operates with excess capacity and there is a considerable interval of time between each investment in new capacity. These systems are often characterised as having relatively 'lumpy' expenditure.

By contrast, the fourth function, local distribution, is characterised by much more frequent expenditure. If only one section of a local distribution network is examined, additions to capacity will appear lumpy. However, while investment can be discontinuous in separate parts of the network, expansion of the distribution network as a whole proceeds much more smoothly in relation to the growth of demand. It is this aggregate relationship between demand and expenditure that is relevant to the estimation of LRMC, since it is a network-wide average of these marginal costs that are relevant for the purposes of setting charges. These systems are often characterised as having relatively 'periodic' expenditure.

The two common approaches for estimating LRMC in the water and wastewater sector (ie, the Turvey approach and the AIC approach) embody differing levels of suitability under lumpy and more periodic expenditure. Each of these approaches is discussed in more detail below.

5.3. The Turvey approach

The Turvey approach to estimating LRMCC can be summarised as follows:

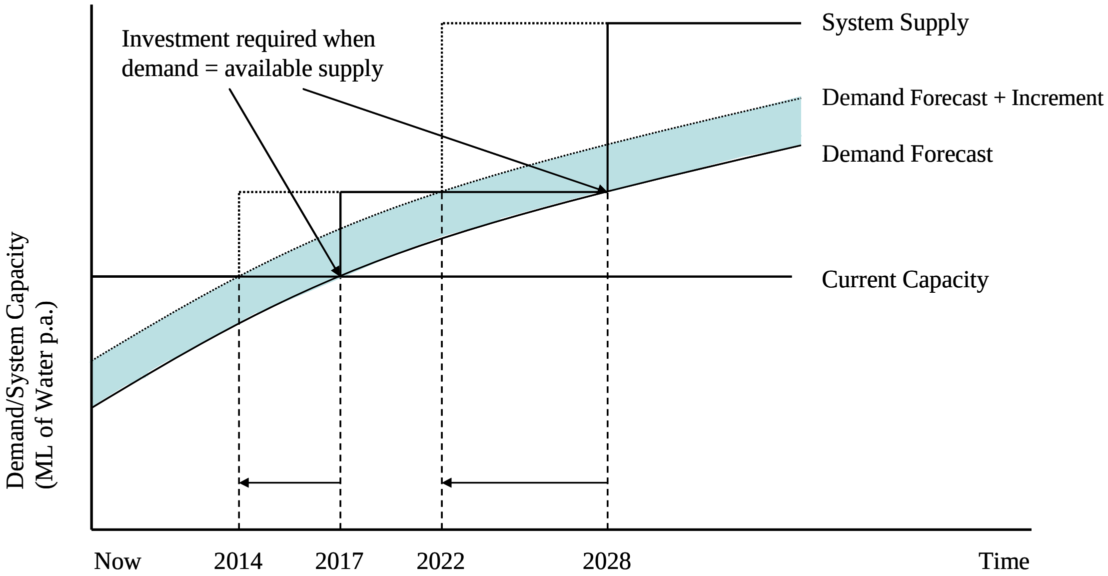
1. forecast unconstrained water demand (ie, demand based on present demand policies) over a medium to long term time period;
2. consider existing water supply capacity and assess its scope to supply unconstrained water demand over the same period;
3. develop a least cost program of capital projects and demand management options that equate water supply with unconstrained water demand over the same period;
4. increase or decrease forecast unconstrained demand by a small but permanent amount and recalculate the least cost capital program to equate demand and supply; and
5. calculate LRMCC as the present value of the change in the least cost capital program divided by the present value of the revised demand forecast compared to the initial unconstrained demand forecast.

Algebraically, the Turvey approach to estimating LMRCC can be expressed as follows:

$$LRMCC = \frac{PV(revised\,optimal\,capex - optimal\,capex)}{PV(revised\,demand - unconstrained\,demand)}$$

The Turvey approach to estimating LRMCC is illustrated in Figure 5.1 below.

Figure 5.1
Turvey Approach to Estimating LRMCC



In short, the Turvey approach considers the effect of a permanent increment (or decrement) to the base demand forecast upon capital expenditure. The solid stepped line above represents a series of projected increases to system capacity, optimised in terms of their order and timing so as to meet future demand at least present cost. The dashed stepped line represents the same services of projected increases to capacity, but brought forward as required to meet the forecast demand plus some assumed permanent increment. As noted above, LRMCC is calculated as the change in the present value of capital expenditure required to maintain the supply demand balance, divided by the present value of the marginal change in expected demand. The relevant change in demand is represented by the turquoise area between the demand forecast with and without the increment.

Although Figure 5.1 demonstrates an increment to demand, LRMCC can also be considered in the context of a decrement. However, LRMCC estimated by means of a decrement will not necessarily yield the same result as that implied by an increment in demand. We discuss this in more detail as part of section 6.3 below.

Under the Turvey approach, estimating the LRMOC is analogous to the LRMCC estimate and can be summarised as follows:

1. forecast unconstrained water demand over a medium to long term time period;
2. forecast marginal operating costs over the relevant time horizon;
3. recalculate marginal operating costs according to the change in the least cost capital program resulting from an increment or decrement in demand; and
4. calculate the LRMOC as the present value of the change in marginal operating costs divided by the present value of the increment or decrement of demand considered.

Algebraically, this is represented as follows:

$$\text{LRMOC} = \frac{\text{PV(revised marginal operating cost} - \text{marginal operating cost)}}{\text{PV(revised demand} - \text{unconstrained demand)}}$$

Overall, the estimate of LRMC under the Turvey approach is simply the sum of the estimated LRMCC and the LRMOC.

The main features of the Turvey approach are that:

- it closely approximates marginal costs because the costs represent the change necessary to respond to a specified change in demand. These costs are likely to resemble those that could be avoided should demand change and therefore provide incentives to end-use customers that reflect the 'true' opportunity cost of water supply;
- it is forward looking, since it is based on anticipated capital and demand management investments necessary to balance supply and demand; and
- it incorporates only those costs, and all costs, that are caused by demand growth above existing capacity.

It should be noted that LRMCC estimates based on the Turvey approach may be influenced significantly by the size of the increments or decrements in demand used in the calculation. It is therefore important to analyse the sensitivity of the estimate to the size of increments and decrements, which is discussed further in section 6.3 below.

One drawback with the Turvey approach is the need to forecast capital and demand management projects that represent the least cost approach to meeting demand over a long planning horizon. However, this is not a concern unique to the Turvey approach since estimating the cost of future capital projects and demand beyond ten years involves intrinsic uncertainties under any approach. We discuss the 'stress testing' of demand forecasts in section 6.5 below.

5.4. The average incremental cost approach

The average incremental cost (AIC) approach shares many of the same steps as the Turvey approach but involves a different procedure for assessing the effect of demand on LRMCC and LRMOC. Specifically, the AIC approach to estimating LRMCC can be summarised as follows:

1. consider the resource position over a suitably long time period;
2. forecast unconstrained demand over the same period;
3. identify a schedule of capital projects that can be implemented to meet capacity requirements over the period;
4. optimise the capital program to generate the least cost solution to addressing supply/demand imbalances; and
5. estimate LRMCC as the present value of the expected costs of the optimal strategy divided by the present value of the additional demand supplied (assuming the supply demand balance is maintained).

Under the AIC approach, the estimate of LRMCC can be represented as:

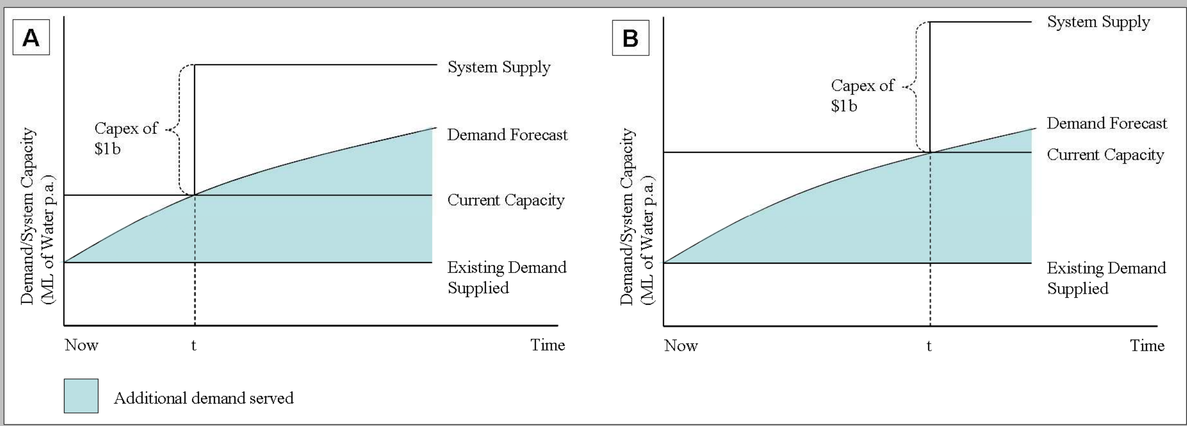
$$\text{LRMCC} = \frac{\text{PV(water supply capacity and DM programs)}}{\text{PV(additional demand served)}}$$

Importantly, the term 'additional demand served' under the AIC approach refers to the demand supplied over and above that which is *currently being supplied* and not the demand met over and above that which *could be supplied* with existing capacity. This is because in the long-run it is assumed that *all* factors of production, including existing capacity, are able to be varied. This distinction is explained in more detail in Box 5.1 below.

Box 5.1
Interpretation of 'Additional Demand Served' Under the AIC Approach

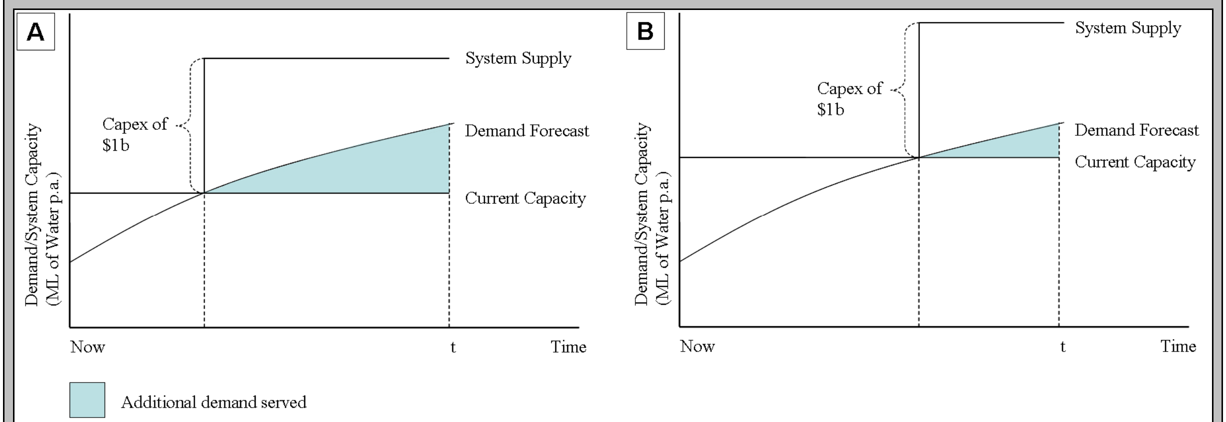
If a system is not currently capacity constrained, the cost of consuming an additional kL of water now will be low relative to an identical system that is currently capacity constrained. Put another way, assuming all other things are equal, the further into the future the next capacity investment is required, the lower the LRMC estimate should be due to the time value of money. This is illustrated in Figure 5.2 below, which shows that if the LRMC is estimated using the AIC approach under the correct definition of 'additional demand served', the LRMC for the more capacity constrained scenario (ie, scenario A) would be higher than that of a less capacity constrained scenario (ie, scenario B), ie, $LRMC_A > LRMC_B$.

Figure 5.2
Correct Interpretation of 'Additional Demand Served'



However, if 'additional demand served' is incorrectly taken to be only demand over and above that which could be served using *existing* capacity, this causes the opposite relationship between investment timing and LRMC to be observed. For example, consider the two investment scenarios depicted in Figure 5.3 below.

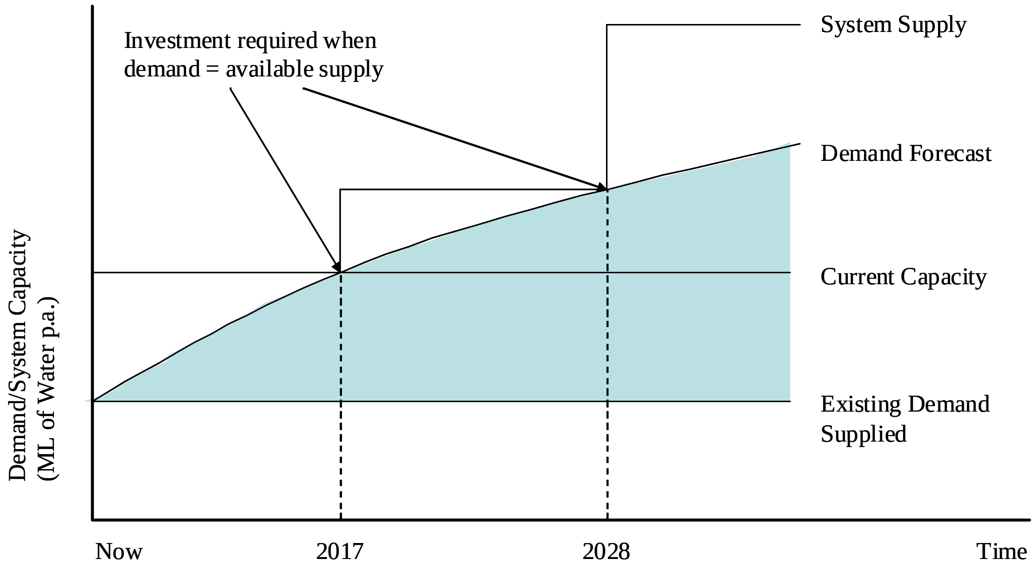
Figure 5.3
Incorrect Interpretation of 'Additional Demand Served'



Under this incorrect interpretation of 'additional demand served', the same $1b of capital expenditure is 'averaged' over a much smaller quantity in scenario B, relative to scenario A. If LRMC is estimated for each of these scenarios taking 'additional demand served' to be that which exceeds current supply capacity, it will yield an increasing relationship with the timing of investment, ie, $LRMC_A < LRMC_B$, which is counterintuitive.

A simplified version of the AIC approach (that includes no demand management options) to estimating LRMCC is illustrated in Figure 5.4 below.

Figure 5.4
AIC Approach to Estimating LRMCC



In this example, LRMCC is calculated as the present value of the expenditure associated with the optimal capital program divided by the present value of the change in present day demand, as shown by the turquoise shaded area above. Importantly, this measure of demand is not to be confused with water supply capacity either now or once the hypothetical capital projects are implemented. This is because the AIC method is seeking to estimate the marginal cost of a change in output caused by a change in demand by customers. It would make no sense simply to divide cost by capacity in the years it is available, since that would not represent the marginal cost per unit of increased future demand.

To estimate the LRMC, it is necessary also to estimate the LRMOC associated with the change in demand. The AIC approach to estimating the LRMOC is as follows:

1. forecast unconstrained demand over a long term time period;
2. forecast additional operating costs over the relevant time horizon; and
3. divide the present value of marginal operating costs by the present value of the change in demand supplied.

Algebraically, this is represented as follows:

$$LRMOC = \frac{PV(\text{additional operating cost})}{PV(\text{additional demand served})}$$

As with calculating LRMCC, it is important to recognise that the term ‘additional demand served’ refers to the demand met over and above that which is *currently being supplied* and not the demand supplied over and above that which *could be supplied*.

Further, the term ‘marginal operating cost’ refers to the operating costs of supplying demand over and above that which is *currently* being supplied and not the operating costs of supplying demand over and above that which *could be* supplied. It follows that marginal operating costs can be divided into the following two broad categories:

- the marginal operating costs of meeting demand with existing capacity (these costs will be relatively material in the case where the next capacity investment is some time in the future); and
- the marginal operating costs associated with operating new capital to meet demand.

As with the Turvey approach, the overall estimate of LRMC is simply the sum of the estimated LRMCC and the LRMOC.

The principal shortcoming of the AIC approach is that it uses average capital costs to approximate the likely marginal costs associated with a change in demand. Put another way, the AIC does not discriminate across the 'size' of projects, ie, ignoring the time value of money, all projects are treated equally in terms of their ability to match supply and demand. However, the actual task of calculating the LRMC under the AIC approach is generally a simpler exercise than under the Turvey approach.

Further, and as with the Turvey approach, the estimate of LRMC under the AIC approach will likely be sensitive to the demand forecasts used, since forecasting water demand over a long time horizon is likely to be very uncertain.

Another shortcoming of the AIC approach is that in order to generate estimates that reflect the effect of changes in demand it is necessary to separate expenditure related exclusively to the expansion of capacity from other expenditure, such as quality of service. The AIC approach may therefore reduce the degree to which LRMC estimation scenarios reflect the businesses' actual planning processes since these will inevitably include projects that relate to such objectives as water quality or reflect environmental standards. Box 5.2 below provides an example of expenditure that should be included and that which should be excluded under the AIC calculation.

Box 5.2
Treatment of Expenditure under the AIC Approach

Suppose a particular water distribution network currently services ten suburbs, or ‘zones’, and that:

- each of these zones is growing (not necessarily at the same rate);
- three of these zones require expansionary investment to meet future demand and the other seven do not;
- significant investment in quality-related infrastructure is needed throughout the network, irrespective of forecast demand; and
- that there is a uniform price structure in all zones and there is no intention to depart from this uniformity.

Since there is only one price structure applying to all customers in the network, it is appropriate to estimate just one LRMC. To estimate this LRMC using the AIC approach, the calculation should only include expenditure relating to the expansion of the network in the three zones that require it due to demand growth. However, the present value of this expenditure should be divided by the present value of the growth in volume of water supplied across *all* zones. This is because some zones are expecting volume growth with no foreseeable capital expenditure consequences while the LRMC to be calculated is that for the entire network.

Any expenditure in the other zones not related to growth in demand as well as the significant quality-related expenditure should not be included in the AIC calculation. This is because such expenditure does not represent the incremental cost of providing an additional unit of water over and above that which is currently supplied, ie, they are ‘unavoidable’. Put another way, if no water demand growth was predicted across the network, this expenditure would still be undertaken.

By way of an extension to this example, suppose that two new geographic zones are to be established (and connected to the network) as a result of new subdivisions being developed. Given that there is to be no differentiation of charges according to zones requiring expansion, expenditure associated with extending the network in such a manner should not be included in AIC calculation for existing customers’ water tariffs. This is because expenditure is driven by a desire to expand the geographic reach of the network and not by an increase in the volume of water demanded *per se*. It follows that altering volumetric tariffs for all customers on account of the cost of these expansion services is unlikely to alter demand in a manner that will affect expansions, ie, it is unlikely that the suburbs will not to be developed.

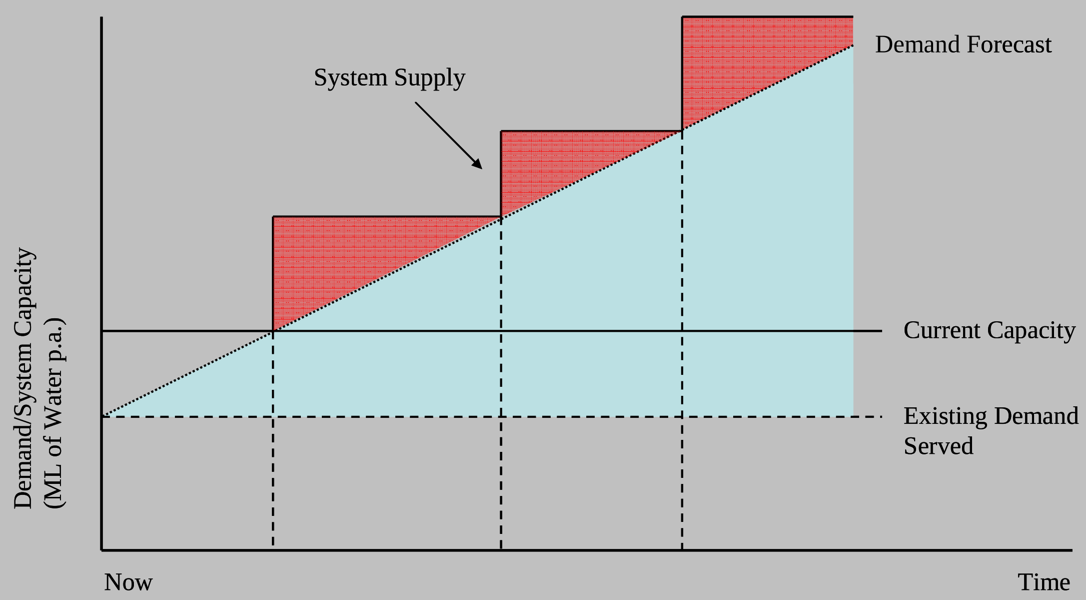
Notwithstanding its averaging approach to incorporating future capital expenditure, the AIC approach may in fact be quite suitable in circumstances where capex increases ‘periodically’ with demand. We explain this in more detail in Box 5.3 below.

Box 5.3
AIC in Situations of Periodic Capex

We noted above that the principal shortcoming of the AIC approach is that it does not explicitly consider the water supply capacity associated with marginal capital projects. Rather, the AIC approach averages the cost of future projects by dividing by the present value of the change in demand supplied by them without discriminating between the ‘size’ of individual projects.

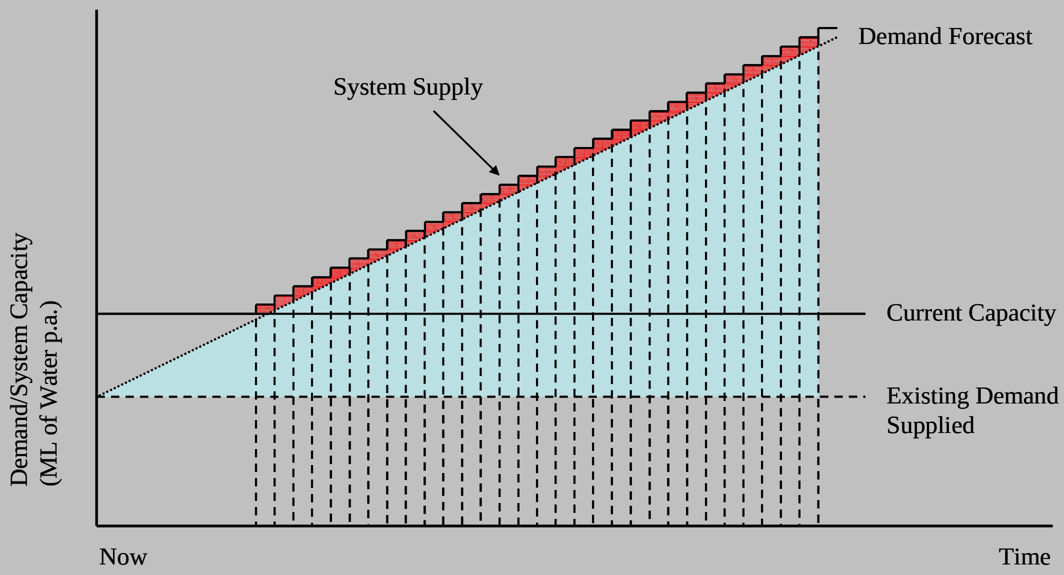
In circumstances where the marginal capex for a business (or system) is relatively ‘lumpy’, this can lead to a relatively large amount of ‘spare’ capacity entering into the marginal cost calculation under the AIC approach, as illustrated by the red triangles in Figure 5.5 below. Put another way, under the AIC approach the numerator of the LRMCC calculation (ie, the present value of all investments in water supply capacity and demand management) incorporate the cost of this capacity but the denominator (ie, the additional demand served) does not. This gives rise to a disconnect between the cost of water supply capacity and demand management investments and the associated level of demand that these investments are able to meet.

Figure 5.5
AIC Approach to Estimating LRMCC Under 'Lumpy' Capex



However, in circumstances where system capacity is expanded periodically by similar amounts as demand also increases, then the AIC serves as a good approximation to estimating LRMC under the Turvey approach. This is because the extent of ‘spare’ capacity is significantly reduced, as illustrated by the relatively small red triangles in Figure 5.6 below.

Figure 5.6
AIC Approach to Estimating LRMCC Under More Periodic Capex



In the extreme case, where capacity can be added on an as-required kL by kL basis, the AIC approach would provide a perfect LRMC estimate (assuming demand and supply forecasts are accurate). This would be illustrated by a system supply curve that is collinear with the demand forecast. However, this is unlikely to be a realistic scenario in industries such as water supply, where significant economies of scale are present in supply side investments.

5.5. NERA's recommended approach to estimating LRMC

Having identified water *volumes* and trade waste *volumes* and/or *pollution load* as the likely appropriate dimensions of service for the application of LRMC pricing, we recommend that:

1. for the functional levels of these service dimensions subject to a relatively 'lumpy' profile of capital expenditure, LRMC should be estimated using the Turvey approach; and
2. for the functional levels of these service dimensions subject to a relatively smooth, 'periodic' profile of capital expenditure, LRMC can be estimated using the AIC approach.

Our first recommendation is predicated on the fact that, in the presence of lumpy expenditure, the AIC approach does not accurately account for the cost of investing in 'spare' capacity. By contrast, the Turvey approach does take into account the cost of any capacity that may be 'spare', even though that capacity is part of an optimal investment program. The Turvey approach has the further advantage that it relieves businesses of the requirement to distinguish demand-related expenditure from other expenditure, which is usually not a straightforward task.

However, in circumstances where the time profile of capital expenditure is relatively smooth, the AIC approach represents a simpler alternative means of estimating LRMC that involves only modest compromises in terms of accuracy. It follows that, in instances where a functional level of a service dimension is characterised by a more periodic, smooth profile of expected expenditure, we recommend that LRMC be estimated using the AIC approach.

Of course, where a water supplier operates across multiple functional levels in the supply chain (such as for a vertically integrated supplier), various estimates of LRMC at different levels in the supply chain need to be summed to obtain an overall LRMC for that service dimension.

6. A Framework for Applying the Preferred Approach

Developing an economic framework for estimating LRMC in the context of the Victorian water sector requires a set of common assumptions/procedures to assist businesses in the *application* of the preferred approaches identified in section 5 above. This section therefore sets out:

- the relevant considerations applying to the forecasting of demand (section 6.1 below);
- the way in which forecast demand and supply should be 'matched' (section 6.2 below);
- the importance of defining the demand increment (or decrement) under the Turvey approach (section 6.3 below);
- the way that assumptions pertaining to the discount rate can affect any LRMC estimate (section 6.4 below);
- the reasons why any LRMC estimate is a product of its underlying assumptions and so stress testing the sensitivity of any estimate to these assumptions is paramount (section 6.5 below); and
- the reason why Victoria's recent recycled water target has no procedural implications for any LRMC estimation going forward (section 6.6 below).

6.1. Demand forecasts

One of the most important inputs to any estimate of LRMC is the base case demand forecast, since it determines the timing of expected investment projects, which ultimately drive any LRMC estimate. For example, under the Turvey approach, the present value implications of bringing forward by one year a new capacity investment that is due to be built in twenty years will be significantly less than the cost of bringing forward the same investment by one year if it is due to be built in two years time. The rate of forecast demand growth before the application of any increment is usually critical for determining how near or far in time is the next major augmentation.

The base case demand forecasts adopted in both the Turvey and AIC approaches should be unconstrained in the sense that they do not include the anticipated effects of any additional future demand management programs. To the extent this is not the case, an LRMC estimate is likely to under-state the true position given that capacity augmentations and/or other demand management programs would otherwise be scheduled at an earlier date. Demand forecasts should also include *both* changes in the consumption of existing customers and the growth in demand resulting from new customers connecting.

Demand forecasts should ideally be developed on a 'probability distribution basis, rather than as a single 'most likely outcome'. A probability distribution estimate reflects the stochastic nature of demand and so provides a more robust basis for assessing the likelihood that the system will be able to meet expected demand in line with the system security standard. Point estimates of demand do not provide the information necessary to determine how likely a system is to fail in its ability to meet expected demand.

In addition to a well developed demand forecast, it is also important to understand how demand is likely to respond to changes in prices or non-price demand management initiatives. Such information will help determine whether it is preferable to increase the capacity of the system or, alternatively, whether more emphasis should be given to price or non-price mechanisms other mechanisms should used to contain demand within existing capacity levels or whether a combination of supply and demand side initiative is preferred. For example, it may be possible to delay investment projects some considerable time through demand management strategies such as education campaigns or regulations increasing the use of water-efficient appliances. Ideally, detailed demand-side information and analysis is required to make such assessments. Whether it is better to increase capacity or reduce demand at any given point will depend on the tradeoffs customers are willing to accept and the relative costs of supply side versus the costs of demand management.

Further, where LRMC estimates suggest there should be a significant change in the variable tariff, this information itself needs to be fed back into the demand forecast and the ultimate LRMC estimate, so as to avoid any 'overcorrection' in an imbalance between estimated LRMC and tariff levels. Put another way, in forecasting demand, tariffs should not be treated as exogenous. It follows that the demand and the tariff consequences of any adopted LRMC estimate will need to be assessed iteratively.

Given the significance of forecast demand to any LRMC estimate, businesses should subject the underlying assumptions to sensitivity testing and estimate LRMC according to a number of scenarios, as outlined in section 6.5 below.

6.2. Matching supply and demand

Once forecast demand has been established, both the Turvey and AIC approaches require the specification of establishing an investment program that is expected to meet security of supply targets given that demand forecast. In applying this investment program to LRMC estimation, it is critical to ensure that the anticipated projects represent the lowest cost option over the investment horizon. This will be achieved through the optimisation of capital expenditure, ie, by minimising the cost of meeting demand given security of supply constraints.

The optimal investment program needs to be developed by reference to an acceptable balance between supply and demand. This is likely to be expressed in the form of the probability that base line supply plus the yield delivered by individual supply augmentation capital projects is greater than or equal to the base demand less the demand yields of individual demand side capital projects plus some preset security of supply margin.

In optimising their investment programs businesses should take account of the following considerations:

- if no capital expenditure is undertaken, what is the 'base' (or current) supply capacity expected to prevail in future years?
- what are the annual expected supply yields of individual investment projects?
- excluding any expected effects of future demand management projects, what is the current best forecast of demand over the period?
- what are the annual expected demand management yields from demand-side projects?
- what is the security of supply margin?
- what are the relevant reliability levels?

The targeted level of system security will underpin many of the other assumptions that are critical to estimating the LRMCC. System security targets will both determine, and be affected by, two critical parameters for storage-based bulk supply systems, ie, the average reliable yield of the existing system storage capacity as well as any restriction stages and their effects on demand. System security levels are therefore inter-related with both the supply and the demand assumptions.

From a supply perspective, targeted security of supply will help determine the timing and the type of investment projects. Small changes in targeted security can have quite substantial effects on LRMC estimates, since they have the effect of changing the effective capacity of the existing infrastructure. For example, under conditions of growing demand, an increased security standard could mean that anticipated investment projects would need to be brought forward several years. From a demand perspective, the targeted level of system security will also affect the points at which administrative rationing of water takes place and its likely impact on consumption levels.

The potential for leakage reduction is also an important consideration in achieving demand supply balance. Leakage reduction allows businesses to increase the supply capacity of existing infrastructure and may offset capacity related expenditure. It follows that expenditure related to leakage reduction should be included in a business's least cost investment schedule.

It is also important that the investment program only includes expenditure relating to water volume. For example, the costs of quality improvement projects should only be accounted for to the extent they change the cost of future water supply options. Quality improvement programs whose timing is unaffected by demand forecasts should therefore be excluded.

Costs associated with increasing the capacity of extending the reach of the distribution or transfer system to allow for geographical expansion into other areas should generally not be included in the marginal cost calculation for existing customers' water tariffs. This is because altering volumetric tariffs for all customers on account of expanding the geographic reach of services is unlikely to alter demand behaviour in a way that alters the cost of those expansions, ie, charging customers for a new water supply pipeline and/or sewer trunkline attributable to a new subdivision is unlikely to cause the subdivision not to be developed.

Further, it is important to note that different investment projects will have different operating costs and in order to optimise the investment program over time, relative operating and capital costs must both be considered. For example, if demand is expected to grow rapidly, a larger plant with lower operating costs and higher capital costs may be preferred, whereas if demand is expected to grow slowly, investment in a smaller plant with higher operating costs might be more cost effective because it implies less investment in temporarily 'idle' capacity.

6.3. The demand increment

We discuss in section 5.3 above that under the Turvey approach, a non-zero increment of demand needs to be added or subtracted to the original demand forecast. There is no commonly adopted rule for the precise size of that this demand increment or decrement should be. Nevertheless, on the assumption that the LRMC estimate is to be applied to water volumetric tariffs applying constantly all year, the increment should be specified in terms of a change in demand of that same nature. However, we noted in section 5.3 above that, different increments will have different implications for the investment program and so may have significant effects on the ultimate LRMC estimated under the Turvey approach.

We recommend that, in selecting the relevant demand increment or decrement, businesses take into account both the materiality of the change (in terms of percentage of current demand) as well the plausibility of such a change. Consistent with our suggestion for the other input assumptions, we also recommend that businesses conduct sensitivity tests (as discussed in section 6.5 below) on the size of the demand change used. In addition, we note that LRMC estimated by reference to a demand increment is unlikely to be the same that is estimated by reference to a demand decrement, and so these scenarios should also be tested as part of the due diligence outlined in section 6.5 below.

6.4. The discount rate

We noted in sections 5.3 and 5.4 above, both the Turvey and AIC approaches require costs *and* demand to be expressed in 'present value' terms. Put another way, LRMC calculations under both approaches are based on future streams of both costs and demand and subsequently need to be discounted to a present date in order to be brought onto a consistent basis. The discount rate used to convert these future cost/demand streams into their present value equivalent is therefore likely to have a material affect on LRMC estimates, for example:

- assuming a 6 per cent discount rate, the cost of bringing forward a $10,000,000 investment by one year in five years time is approximately $450,000; while
- assuming a 10 per cent discount rate, the cost of bringing forward a $10,000,000 investment by one year in five years time is approximately $620,000, ie, an increase of approximately 38 per cent relative to a discount rate of 6 per cent.

As a matter of principle, there are two broad options for the choice of discount rate, ie:

- the use of an individual businesses' cost of capital, either adopted from or re-estimated on a consistent basis with that in the most recent price review; or
- to use an estimate of the real risk free rate.

The choice between these two broad options is not self-evident. The estimation of LRMC does not involve risks commensurate with those associated with financing a water businesses' investment program, but neither is it risk free. Further, as mentioned above, any LRMC estimate will likely exhibit sensitivity to the selection of discount rate. Given the conceptual uncertainty as to which form of discount rate is appropriate, we recommend that different levels of discount rate be included in the sensitivity testing process in section 6.5 below.

6.5. Sensitivity testing

It is important to emphasise that marginal cost estimation is a forward-looking concept and so relies as much on probability and expectation as it does on fact. It follows that any estimate of LRMC involves a degree of uncertainty as it depends on a set of assumptions regarding forecasts of the future state of the world. This poses particular challenges for infrastructure dominant industries, where forecasts of demand are subject to considerable potential variation and uncertainty.

Where uncertainty around particular assumptions can be quantified, we recommend undertaking a probability weighted average estimate of LRMC. This essentially 'smooths' the risk of particular assumptions changing and minimises the expected deviation between the outturn and the states of world on which a LRMC estimate was based. However, the ability to undertake such a smoothing exercise is contingent on being able to:

1. identify future 'events' that would alter any input assumptions and their effects; and
2. assign probabilities to each of these events.

Where these requirements cannot be met, we recommend undertaking a number of different scenarios, where each is defined as a combination of input assumptions representing various states of the world that could reasonably be expected to occur.

Further, whether these conditions are met or not, we also recommend undertaking a range of sensitivity tests on the assumptions underlying the LRMC estimate. Sensitivity testing allows for the effect of the various uncertainties in LRMC assumptions to be examined, and so to convey the range of uncertainty attributed to any particular estimate.

6.6. Recycled water

In 2002 the Victorian government set a target to recycle 20 per cent of Melbourne's wastewater by 2010, which was applied to all water businesses operating in Melbourne. In February 2008 the Minister for Water announced the achievement of this target two years ahead of schedule, with

Melbourne recycling 22.5 per cent of its wastewater in 2006–07.[7] Given the target was met in 2006-07 and that there is presently no replacement going forward, there are no implications for the estimation of LRMC under either the Turvey or AIC approaches. In the event such a target was to be updated or reinstated, its implications for both the demand forecasts and water volume capital investment program would need to be incorporated into those elements of the LRMC estimation process.

We also understand that, as a result of the previous recycling target, some Melbourne water businesses have incurred significant costs associated with reusing recycled water. This fact does not itself complicate the estimation of LRMC for potable water, since the recycled water programs would simply continue to represent background expenditure that (on the assumption these programs are fixed) has no direct effect on the LRMC estimation process.

7 Department of Sustainability and Environment website, available at: www.dse.vic.gov.au

7. Conclusions and Recommendations

Before estimating any LRMC, one must first be clear about *what it is* that is to be measured. Specifically, the impetus for undertaking any LRMC estimate is to enhance the role of prices in bringing about the efficient consumption of water services. The critical first steps are identifying:

- the dimensions of the services provided that, if varied, are likely to have some independent effect in the cost of provision; and
- that, if those services were priced separately, customers would be placed in a position where they have the ability to respond to those price signals by varying their consumption of that service dimension.

Recommendation 1: It is critical that the service dimensions that are appropriate for LRMC based pricing be carefully identified before any estimates of LRMC are developed.

We outline in section 4.4 above that water *volumes* along with trade waste *volumes* and/or *pollution load* are likely to be the only service dimensions for which it is appropriate to estimate LRMC for application in tariff structure decisions. However, each water business should apply the framework in section 4 above to identify for themselves the service dimensions for which it makes sense to estimate and apply LRMC principles in setting the structure of prices.

Having identified the likely appropriate service dimensions for estimation of LRMC and its application in tariff structure decisions, we recommend that:

Recommendation 2: For the functional levels of service dimensions characterised by a relatively 'lumpy' profile of capital expenditure, LRMC should be estimated according to the Turvey approach.

Recommendation 3: For the functional levels of service dimensions characterised by a relatively 'smooth' profile of capital expenditure, LRMC should be estimated according to the AIC approach.

Overall, since any estimate of LRMC is based on a forward looking set of assumptions and so is a product of these underlying assumptions, we strongly recommend that sensitivity and/or scenario testing be conducted to ascertain the extent to which changes in these assumptions affect the estimated LRMC.

Recommendation 4: Any LRMC estimate should be tested for its robustness to changes in its underlying assumptions.

Appendix A. Short and Long Run Marginal Costs

We noted in section 3.2.1 above that the distinguishing feature between short run marginal cost (SRMC) and long run marginal cost (LRMC) is the time frame under consideration and the implications of this for a supplier's ability to adjust its production process to minimise costs or meet demand, ie:

- SRMC can be defined as the cost of an incremental change in demand, holding capacity constant; whereas
- LRMC relaxes this constraint and reflects the cost of an incremental change in demand assuming all factors of production can be varied.

This appendix discusses each of these concepts and the relationship between.

A.1. Short run marginal cost

SRMC is the additional cost of meeting an incremental change in demand, holding capacity constant. Critical to the concept is that suppliers must serve all demand from within their existing capacity, ie, by producing more with what they already have.

SRMC is often construed as simply the operating and maintenance costs associated with providing the water or sewage service. It is important to note this does not always hold. When an incremental change in demand can be met through increased supply from existing capacity, the SRMC *will* be equal to the operating and maintenance costs associated with producing those additional units.

However, an important but often overlooked element of SRMC is that, in the event that supply cannot expand to match the incremental change in demand, SRMC rises to whatever level is necessary to curtail demand to match available capacity, ie, by imposing water restrictions. Specifically, in situations where there is an increased risk of supply shortages, the costs associated with this demand side component cause SRMC to rise well above variable costs. Importantly, it is during periods of scarcity that suppliers are able to make a contribution to their fixed costs, which do not vary with output over the short-term and so are not a formal component of SRMC.

The intuitive explanation for this demand side element to the concept of SRMC is that in times of scarcity the cost of serving one customer must, by definition, include the value foregone by other customers who cannot be served as a consequence. For example, if Melbourne's water supply began to run low, continuing to supply some customers may mean placing restrictions on the usage of others. The costs imposed by those restrictions may be very high and may include such categories as plant losses in residential gardens and parks, reductions in agricultural output, diminished quality of golf courses, higher production costs for breweries and, in the extreme case, the cost of bottled or tankered-in water. All of those costs form a part of the SRMC of serving one customer, and restricting supply to another.

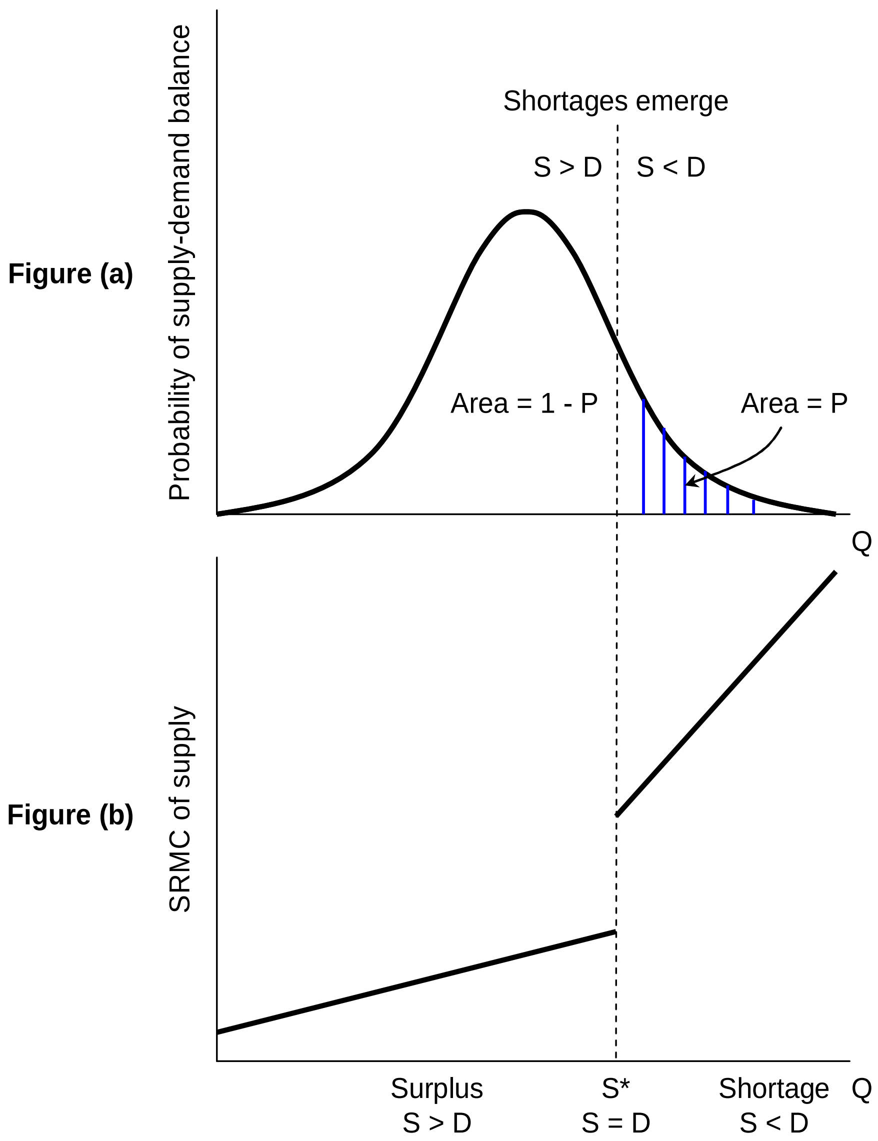
Although SRMC can be estimated as at any particular point in time, its magnitude varies from one point in time to another. Its application in the context of decisions affecting the future therefore relies as much on probability and expectation as on fact. A forward-looking SRMC is the sum of the various additional costs arising under different scenarios (holding capacity constant), multiplied by the probabilities of these scenarios occurring. Formally, the expected SRMC is given by:

- the SRMC when supply exceeds demand (ie, operating and maintenance costs), multiplied by the probability that supply exceeds demand; plus
- the SRMC when supplies are less than demand (ie, including the costs of shortages) multiplied by the probability that supply is less than demand.

Figure A.1 below shows the SRMC under conditions of surplus and shortage. Figure (a) shows a probability density function of different supply and demand balances. The maximum capacity that the system can supply is shown as S*. Below S*, supply exceeds demand (S>D), and there is no shortage. Above S*, supply is less than demand (S<D), and shortages occur. The shaded area under the probability density function shows the probability of shortages (P). The probability that there are no shortages is given by the remaining area under the curve (1-P).

Figure (b) shows the cost conditions associated with surplus and shortage. In the absence of shortages, SRMC is low, but increases when supplies become less ample relative to demand in order to ration the available capacity (which is fixed in the short run). This reflects the fact that the cheapest means of supply will be used first, followed by increasingly expensive source of supply as the supply-demand surplus falls (often referred to as 'the lowest hanging fruit' principle). Beyond the capacity constraint, S*, shortages occur, resulting in a sharp jump in SRMC, reflecting the cost to customers of the marginal unit of shortage.

Figure A.1
Short Run Marginal Cost



SRMC will also be affected by changes in the supply/demand balance. The tighter is that balance, the more likely it is that SRMC will need to increase to curtail demand, since the more susceptible the market is to temporary disruptions, ie:

- when supply is plentiful, there is little probability of shortages and SRMC is relatively low, ie, the probability-weighted cost of curtailing demand will be low or zero; and
- when supply becomes scarce, the probability of shortages increases and SRMC will rise, ie, the probability-weighted cost of curtailing demand will start to increase.

By way of example, a prolonged drought in Victoria that significantly lowers dam levels can be expected to have a greater effect on the SRMC of supplying water when it exacerbates an already tight supply/demand balance.

To summarise, SRMC can be defined as the cost of an incremental change in demand, holding capacity constant. Importantly, its estimation takes account of the potential costs of shortages faced by customers. In the event supply cannot expand to match demand, SRMC rises to whatever price level is necessary to curtail demand to match available supply.

A.2. Long run marginal cost

In contrast to SRMC, LRMC reflects the cost of serving an incremental change in demand in a market, assuming all factors of production can be varied. Importantly, because LRMC is a long run concept, it accounts for the fact that suppliers have the option of expanding their capacity in order to meet an incremental increase in demand. Measuring LRMC therefore involves estimating the costs associated with undertaking a capacity expansion sooner than would otherwise be the case in response to a change in demand. The two primary approaches to estimating LRMC are described in section 5 above.

In most industries it is not practicable to add capacity in very small increments.[8] Rather, there are often ‘economies of scale’ associated with augmentations. For example, when a water business is deciding to build a new potable water or sewerage pipeline it will likely make sense to ‘oversize’ that pipeline to some extent. This is because adding the extra capacity now will be much cheaper than adding it later. Putting this another way, it is likely to be more expensive (in unit cost terms) to add capacity ‘as required’, ie, on a ‘ML by ML’ basis, than it is to allow for this future capacity in the initial build.

For infrastructure based services, capacity is therefore often added in ‘lumps’ rather than very small increments. The likely effect of a permanent increment in demand is therefore to bring forward the time at which a planned future ‘lump’ of capacity needs to be added. LRMC is therefore the costs – both operating and capital cost – associated with undertaking that expansion sooner than would otherwise be the case in response to the incremental change in demand, and the associated congestion costs.[9]

This implies that that where capacity must be added in ‘lumpy units’ (rather than in very small increments), this gives rise to time-dependent fluctuations in LRMC. Specifically, the LRMC of supply in such a market will be relatively low when capacity utilisation is low and the next capacity expansion

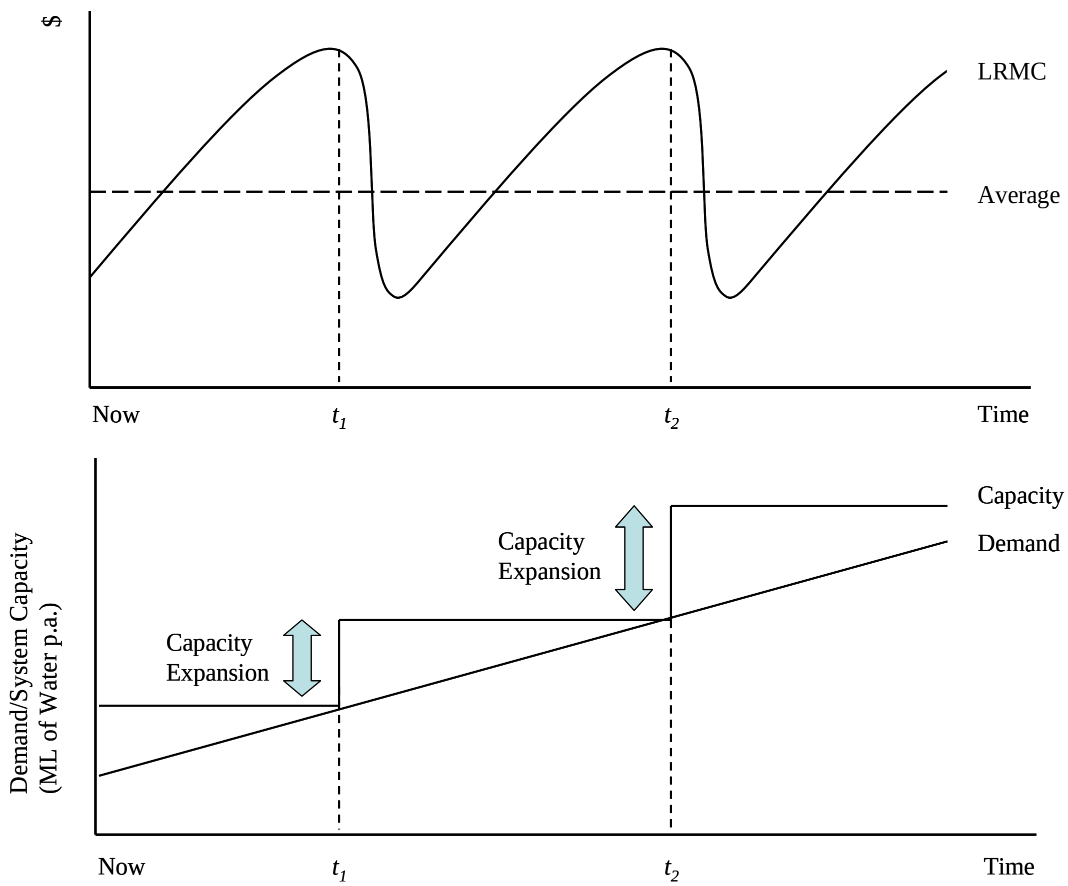
[8] The exception is industries in which assets are highly mobile and capacity can be added in very small increments. In these circumstances, any level of demand can be met by quickly adding (or subtracting) capacity, ie, there is never any need to curtail demand. Of course, such industries are rarely seen in practice.

[9] To be clear, LRMC does *not* equal the total operating and capital costs associated with that expansion. This is because an incremental increase in demand does not generally result in investment that would otherwise never be required; rather it brings forward the timing of an expansion.

is some distance in the future, but will rise as capacity utilisation increases and the timing of the next expansion becomes nearer.

LRMC therefore changes over time as new capacity is added. This is because the time value of money means that cost today of, say, a $10m investment in one year's time is much greater than the cost of a $10m investment expected to be made in 10 years' time. This is illustrated in Figure A.2 below.

Figure A.2
LRMC, Demand and Capacity over Time



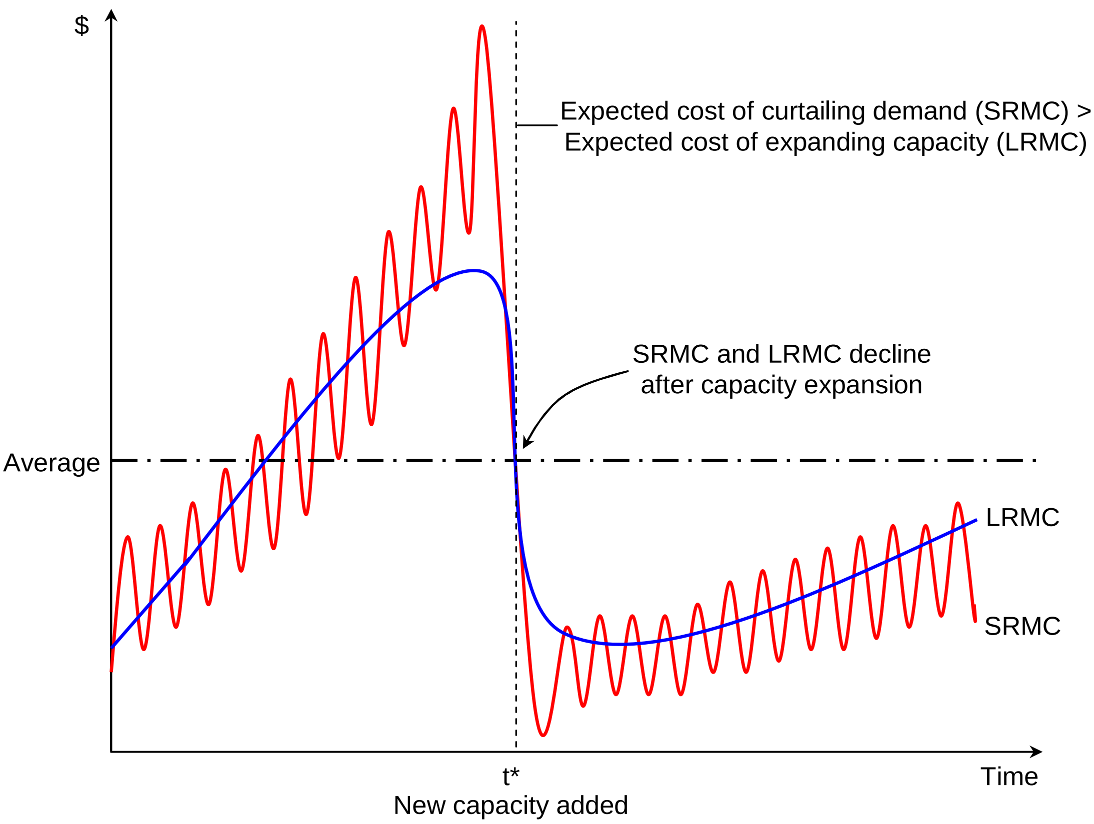
In summary, LRMC reflects the cost of serving an incremental change in demand, assuming all factors of production can be varied. Importantly, because LRMC is a long run concept, it accounts for the fact that suppliers have the option of expanding their capacity in order to meet an incremental increase in demand. Measuring LRMC involves estimating the costs involved with undertaking a capacity expansion sooner than would otherwise be the case in response to that change in demand.

A.3. Relationship between SRMC and LRMC

The previous two sections explained that SRMC is the cost of an incremental change in demand, holding capacity constant, whereas LRMC reflects the cost of meeting that change in demand assuming capacity can vary. Unless assets are highly mobile and capacity can be added in very small increments – conditions that are rarely seen[10] – there is no reason to expect SRMC and LRMC to be the same at any particular point in time. However, there is still a strong 'in principle' link between SRMC, LRMC and capacity expansion decisions.

Specifically, when demand is growing over time, or subject to short term fluctuations, SRMC can be expected to increase to the point at which the cost of curtailing demand exceeds the cost of expanding capacity to meet that demand, ie, when LRMC < SRMC. This relationship is illustrated in Figure A.3 below, which depicts the SRMC and LRMC in a market in which demand is increasing over time.

Figure A.3
SRMC, LRMC and Capacity Expansion



In the first instance, medium term demand growth can only be met through increased risk of demand curtailment during short run peaks, as reflected in the rising SRMC leading up to t*. However, there eventually comes a 'tipping point' at which the expected SRMC of curtailing demand increases beyond the expected LRMC cost of expanding capacity to meet that demand. This occurs at t*, at which point new investment takes place.

Exactly the same principles apply to a market in which demand is declining over time. In the first instance, declining demand can be met by suppliers continuing to serve the market with their existing

[10] When these conditions are present, *there is no distinction* between SRMC and LRMC since, by definition, there is no difference between the short run and the long run. Any level of demand can be met by quickly adding (or subtracting) capacity and so the need to curtail demand never arises. In these circumstances, SRMC and LRMC are always equivalent, and constant at all times. Of course, industries that exhibit such characteristics are rare.

capacity. However, there will again be a ‘tipping point’ at which the long run costs that would be avoided by reducing or redeploying capacity exceed the SRMC of continuing to supply the product at the current level of capacity, at which point, capacity is redeployed to other markets where returns are more attractive.

Of course, in practice, it is often very difficult to time capacity expansions and reductions to coincide perfectly with the expected emergence of times at which demand will inefficiently need to be curtailed, ie, when scarcity is either too common (or too infrequent). This is particularly the case when capacity must be added and withdrawn in large increments that alter substantially the supply/demand balance. There may therefore be times when:

- SRMC is above LRMC for a period as the market waits for new capacity to come on-stream; and
- SRMC is below LRMC for a period as the market waits for redundant capacity to be re-deployed elsewhere.

However, such instances of ‘misalignment’ are neither unexpected, given the imperfections that can affect real world markets, nor a cause for concern, provided that they are transitory. Nonetheless, provided that the concepts are measured over a sufficiently long timeframe, the link between SRMC, LRMC and new investment decisions should mean that, on average, there is no material difference between the value of SRMC and LRMC.

Apendice B. LRMC Estimation in Other Jurisdictions

This appendix discusses the approaches to estimating LRMC that have been adopted in other jurisdictions throughout Australia. Specifically, it covers methodologies adopted to by the following regulatory bodies:

- the Economic Regulatory Authority (ERA) in Western Australia;
- the Independent Pricing and Regulatory Tribunal (IPART) in New South Wales;
- the Queensland Competition Tribunal (QCA); and
- the Essential Services Commission of South Australia (ESCOSA).

The approaches established in each of these jurisdictions are summarised below.

B.1. ERA, Western Australia

In Western Australia, the government has retained the price setting function for urban water service providers.[11] Under this arrangement, the Minister for Water sets water charges for the Water Corporation through a by-law process under the Water Agencies (Powers) Act 1984 and approves the charges for other urban water service providers (Aqwest and Busselton Water) set by their respective boards.[12]

During the above processes, the Minister for Water considers the recommendations made in pricing inquiries conducted by the Economic Regulatory Authority (ERA). Although the ERA does not hold the formal role as a price regulator for urban water and wastewater services, it indirectly performs this function through inquiries that result in tariff recommendations to the government.[13]

As part of the ERA's 2005 price inquiry, the Water Corporation used a Turvey approach to estimate the LRMC of supplying water and an AIC approach for estimating the LRMC of wastewater services.[14] In assisting the ERA review the Water Corporation's methodologies, the Allen Consulting Group noted that both the Turvey approach and the AIC approach are fundamentally sound and have been individually recommended by a range of regulators and industry bodies around the globe.[15] However, the Water Corporation's justification for choosing these respective methodologies is not obvious and the Allen Consulting Group note this by stating:[16]

> *"While the approach adopted [the AIC approach] is acceptable, it is not entirely clear as to why it has been chosen given that the Corporation has calculated the long-run marginal cost of water services using the Turvey approach."*

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11 The ERA administers the licensing of water service providers and monitors their performance. As part of this role, the ERA requires rural water businesses to provide a written submission on proposed prices or charges, and the methodology for determining prices or charges, for its approval. Subsequent proposals to amend charges must also be forwarded to the ERA for approval. Further, as a condition of their licence, water supply agencies are also required to consult with customers, at least annually, on proposed tariffs.

12 Government of Western Australia, Department of Water website – available at: www.water.wa.gov.au

13 ERA, (2009), *Inquiry into Tariffs of the Water Corporation, Aqwest and Busselton Water*, Final Report, 14 August 2009, p. 3.

14 The Allen Consulting Group, (2005), *Review of Asset Values, Costs and Cost Allocation of Western Australian Urban Water and Wastewater Service Providers*, Report to the Economic Regulation Authority, April 2005, pp. 82 – 87.

15 The Allen Consulting Group, (2005), *Review of Asset Values, Costs and Cost Allocation of Western Australian Urban Water and Wastewater Service Providers*, Report to the Economic Regulation Authority, April 2005, pp. 86 & 90.

16 The Allen Consulting Group, (2005), *Review of Asset Values, Costs and Cost Allocation of Western Australian Urban Water and Wastewater Service Providers*, Report to the Economic Regulation Authority, April 2005, p. 90.

Further, this lack of transparency is observed in the ERA's selection of LRMC estimation methodology for Aqwest and Busselton Waters' water supply, which is stated to be AIC.[17] However, it may be that AIC is justified on the basis that these systems have less lumpy capex and can be augmented more smoothly than that of the Water Corporation. For example, the ERA states that Aqwest can augment its system in small increments and, according to Aqwest, the next source of supply can be relatively easily and quickly bought on line.[18] Further, the Water Corporation caters for approximately 97 per cent of Western Australia's population[19] and so relatively large/lumpy capital expenditure is likely to be required, which may have been the reasoning for the ERA rendering the Turvey approach more appropriate than AIC.

As part of the latest ERA inquiry into the tariffs of the Water Corporation, Aqwest and Busselton Water, the ERA notes the following issues with using LRMC as a measure of the value of water:20

- that LRMC estimates can be relatively broad in situations where additional capacity requirements are not very predictable due to uncertain inflows to dams;
- that the estimated LRMC varied when using different deviations in demand (ie, using demand decrements instead of increments and by using large rather than small deviations in demand);
- that the results vary between using the Turvey approach (used by the Water Corporation) and the average incremental cost approach; and
- the embedded assumption of constant technological progress, especially with respect to the cost of desalination technology.

Overall, the ERA notes the shortcomings associated with the LRMC for estimating the long term cost of water but acknowledges that this approach may still deliver the best estimate.[21]

B.2. IPART, New South Wales

In New South Wales, IPART is responsible for determining the maximum prices that can be charged for metropolitan water, wastewater and stormwater services as well as for services related to bulk water services, including water resource management. As part of its 2005 metropolitan price determination, IPART noted the importance of aligning its price determinations with the LRMC of water supply.[22] However, IPART also noted that estimating LRMC can be a complex and uncertain task as it involves estimating the costs and water savings associated with both supply augmentation and demand management options.[23]

At the time of the 2005 metropolitan price determination, IPART employed an AIC methodology to estimate the LRMC and this approach has been retained in subsequent determinations to date. In justifying its selection of AIC, IPART state that debate surrounding the most appropriate estimation of

17 ERA, (2005), *Inquiry on Urban Water and Wastewater Pricing,* Final Report, 4 November 2005, p. 26.

18 ERA, (2005), *Inquiry on Urban Water and Wastewater Pricing*, Draft Report, 18 March 2005, pp. 121 - 122.

19 Government of Western Australia, Department of Water website – available at: www.water.wa.gov.au

20 ERA, (2009), *Inquiry into Tariffs of the Water Corporation, Aqwest and Busselton Water*, Final Report, 14 August 2009, p. 17.

21 ERA, (2009), *Inquiry into Tariffs of the Water Corporation, Aqwest and Busselton Water*, Final Report, 14 August 2009, p. 17.

22 IPART, (2005), *Sydney Water Corporation, Hunter Water Corporation, Sydney Catchment Authority: Prices of Water Supply, Wastewater and Stormwater Services*, Final Report, September 2005, p. 18.

23 IPART, (2005), *Sydney Water Corporation, Hunter Water Corporation, Sydney Catchment Authority: Prices of Water Supply, Wastewater and Stormwater Services*, Final Report, September 2005, p. 18.

marginal cost has continued for decades and that both methodologies have their supporters and detractors.24 Specifically, IPART state that:[25]

- the Turvey approach tends to be highly sensitive to the assumptions made about costs, demands and the size of the permanent decrement in demand and that, apparently, experience has shown that even modest changes in any of these parameters can lead to great variations in results and uncertainty in estimates; and
- the AIC approach is much simpler and produces reasonable and reliable estimates that can be made with more modest amounts of data without being subject to wide fluctuations resulting from small changes in underlying assumptions.

IPART has applied the AIC approach to calculate LRMC for the Sydney Water determinations in 2005 and 2008, the recent 2009 determinations for the Central Coast councils as well as the 2009 determination for Hunter Water Corporation.[26]

B.3. QCA, Queensland

In Queensland, part of the QCA's role in the water industry is to investigate and report on the pricing practices of certain declared monopoly or near monopoly business activities of State and local governments. The Queensland government extended the QCA's price oversight jurisdiction to the water sector in 1999 and, to help facilitate the effective implementation of these new duties, directed the QCA to develop specific water pricing principles.

Amongst the principles developed, the QCA states that the structure of prices should reflect the LRMC of service provision.[27] Specifically, the QCA states that the volumetric charges in a two-part tariff should be set to LRMC and that, in practice, would involve the estimation of AIC.[28]

Notwithstanding, as part of the September 2002 Final Report on the pricing practices of the Gladstone Area Water Board (GAWB), the QCA stated that as a method of calculating LRMC they consider the Turvey approach provides a more appropriate estimate than AIC as it more closely reflects incremental costs.[29] Indeed, the QCA recommended:[30]

> *"That, subject to the revenue adequacy requirements of GAWB, GAWB's prices be based on the long run marginal costs of providing services, on the basis of the Turvey method."*

However, during its investigation into the pricing practices of GAWB to apply from 1 July 2005, the QCA appears to have changed stance on the most appropriate methodology for estimating the LRMC. Noting its earlier conclusion that the Turvey method provided a more appropriate estimate of LRMC than the AIC, the QCA stated that it had since become aware that, in a number of instances (not related to GAWB), the Turvey and AIC methods have been applied with significantly different

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24 IPART, (2008), *Review of Prices for Sydney Water Corporation's Water, Sewerage, Stormwater and Other Services*, Determination and Final Report, June 2008, p. 223.

25 IPART, (2008), *Review of Prices for Sydney Water Corporation's Water, Sewerage, Stormwater and Other Services*, Determination and Final Report, June 2008, p. 223.

26 IPART, (2009), *Review of Prices for Water, Sewerage, Stormwater and Other Services for Hunter Water Corporation*, Determinations and Final Report , July 2009, pp. 125 – 126.

27 QCA, (2000), *Statement of Regulatory Pricing Principles for the Water Sector*, December 2000, p. i.

28 QCA, (2000), *Statement of Regulatory Pricing Principles for the Water Sector*, December 2000, p. 67.

29 QCA, (2002), *Gladstone Area Water Board: Investigation of Pricing Practices*, Final Report, September 2002, p. 27.

30 QCA, (2002), *Gladstone Area Water Board: Investigation of Pricing Practices*, Final Report, September 2002, p. 27.

results.[31] Further, the QCA noted that Ofwat had identified AIC as the more common methodology adopted by water businesses in the United Kingdom.[32]

In the Queensland context, the QCA commissioned Marsden Jacob Associates (MJA) to undertake a thorough review of both the Turvey and AIC methodologies. From a practical point of view, the assessment undertaken by MJA supported the AIC approach on the grounds that: [33]

- the AIC approach will produce more stable prices as it incorporates all augmentations over the planning horizon, and not just the first augmentation as is the case with the Turvey method;
- the AIC approach has advantages in cost and decision rules being fully transparent and readily explainable to stakeholders; and
- the AIC is the easier approach to understand and is computationally straightforward, despite a requirement for forward looking data for capital and associated marginal operating costs, which is more comprehensive than that required for the Turvey approach.

In addition, the QCA outlined a 'more fundamental issue' with the Turvey approach as being that it has not been fully developed in the academic literature and there is some imprecision in its application, when compared to the relative clarity of applying the AIC approach. [34]

Overall, as part of the 2005 investigation into the pricing practices of GAWB, the QCA recommended that LRMC be estimated using the AIC methodology. This approach has been retained in all subsequent QCA pricing investigations for GAWB.

B.4. ESCOSA, South Australia

In South Australia, ESCOSA is the economic regulator for the monopoly supplies of urban water and sewerage services. At the direction of the South Australian Treasurer, since 2004 ESCOSA has undertaken inquiries into government processes for setting SA Water's water and wastewater charges. These inquiries focus on ensuring that the government has committed to set prices such that they comply with agreed pricing principles, including the 1994 Council of Australian Governments (CoAG) pricing principles and the principles contained in the National Water Initiative (NWI), an agreement entered into by all jurisdictions in June 2004.

As part of ESCOSA's 2009-10 pricing decision, it is stated that the South Australian government focused on increasing water usage charges consistent with SA Water's estimate of LRMC.[35] In the context of this review, SA Water stated that its LRMC estimate was based on the potential future expansion of the planned Adelaide desalination plant from 50 GL to 100 GL and that it has been calculated according to the AIC approach.[36] Specifically, SA Water stated that its approach to estimating LRMC yielded an estimate of approximately $2.35 per kL ($2009-10) and was based on the following assumptions:[37]

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[31] QCA, (2005), *Gladstone Area Water Board: Investigation of Pricing Practices*, Final Report, March 2005, p. 41.

[32] QCA, (2005), *Gladstone Area Water Board: Investigation of Pricing Practices*, Final Report, March 2005, p. 41.

[33] QCA, (2005), *Gladstone Area Water Board: Investigation of Pricing Practices*, Final Report, March 2005, pp. 42 - 43.

[34] QCA, (2005), *Gladstone Area Water Board: Investigation of Pricing Practices*, Final Report, March 2005, p. 43.

[35] South Australian Government, (2009), *Water and Wastewater Prices in Metropolitan and Regional South Australia 2009-10,* Transparency Statement – Part A, February 2009, p. 29.

[36] South Australian Government, (2009), *Water and Wastewater Prices in Metropolitan and Regional South Australia 2009-10,* Transparency Statement – Part A, February 2009, p. 29.

[37] South Australian Government, (2009), *Water and Wastewater Prices in Metropolitan and Regional South Australia 2009-10,* Transparency Statement – Part A, February 2009, pp. 29-30.

- capital costs of $640 million (in 2007-08 dollars);
- operating costs of $60 million;
- a plant life of 25 years;
- residual plant value of 25% of the initial capital cost;
- WACC of 6% (pre-tax real);
- plant operating capacity of 100% for the first two years; and
- plant operating capacity of about 75% thereafter.

The same methodology was retained by SA Water as part of the latest (2010-11) pricing decision but resulted in a LRMC estimate of approximately $2.40 per kL ($2010-11).[38]

Although SA Water states that it uses AIC to estimate LRMC, it is not obvious why it selected AIC over the Turvey approach. ESCOSA noted this lack of transparency as part of the most recent pricing inquiry, ie:[39]

> *"[I]n previous Inquiries the Commission has expressed concerns about the lack of information provided to support the estimate of LRMC. Transparency Statement – Part A again notes that the LRMC was derived based on the expansion of the ADP from 50GL to 100GL, but does not provide any further information on the method used. Accordingly, the Commission considers that disclosure around efficient resource pricing could be improved by SA Water providing more information regarding its method of estimating LRMC."*

Further, wastewater services (both sewerage services and large trade waste services) in South Australia are currently not set by reference to any cost calculation. Given the practicalities of measuring sewage discharge, only large trade waste dischargers face volumetric-based charges (reflecting the avoidable costs they impose on the wastewater system), with the remainder of wastewater charges being based on property value, subject to a minimum charge.[40]

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[38] South Australian Government, (2010), *2010-11 Potable Water and Sewerage Prices,* Transparency Statement – Part A, May 2010, p. 54.

[39] ESCOSA, (2010), *Inquiry into the 2010-11 Metropolitan and Regional Potable Water and Sewerage Pricing Process,* Final Report, October 2010, p. 57.

[40] South Australian Government, (2009), *Water and Wastewater Prices in Metropolitan and Regional South Australia 2009-10,* Transparency Statement – Part A, February 2009, pp. 30 – 31.

Apendice C. NERA's High Level Models

The Excel file titled '*NERA - Final high level models with SWF branding (24 January 2012).xls*' accompanying this report includes two high level models, which have been developed to demonstrate how both the Turvey and AIC approaches can be applied to estimate LRMC. These models are not intended to be exhaustive in terms of their comprehensiveness and so are likely to need modification or extension before they could be applied any specific circumstance. Rather, they are intended to illustrate the LRMC calculations underlying both the Turvey and AIC approaches, as well as they way in which different investment programs affect the ultimate LRMC estimate.

To assist in their illustrative role, these models have been applied to two distinct case studies, namely:

- a situation with relatively 'lumpy' profile of expenditure; and
- a situation with more 'periodic' profile of expenditure.

The sections below provide an overview of the models and their application to each of these two case studies.

C.1. Overview of the models

The models we have developed are 'high level' in the sense that they are intended only to be illustrative of the calculations involved in the Turvey and AIC approaches to estimating LRMC rather than to be used in the actual development of water tariffs. The models do not include the level of detail likely to be required if a business were to estimate LRMC for the purpose of developing volumetric tariffs, for example:

- demand forecasts are assumed to be exogenous;
- optimising the investment program is also considered to be exogenous;41
- both models assume a constant 20 year planning horizon; and
- capital and operating expenditure is not project-specific, ie, the optimised investment program enters as a 'line item' and there is no delineation between the expenditure associated with specific projects or between capacity based investments and demand management investments.

Both models calculate LRMOC and LRMCC (as well as the LRMC in total) by reference to the water *volume* dimension of service. Although we identified in section 4.4 some other service dimensions as perhaps being appropriate for LRMC estimation, for ease of exposition we have assumed that water volume is of interest for the purposes of the two case studies.

In both models a relatively simplistic assumption has been made that a certain 'margin' of capacity needs to be maintained for security of supply reasons. We have dubbed this margin the 'security of supply margin' (SSM) and have assumed that in both models and under both case studies it is 500ML per annum. However, in reality this margin will depend on the system in question, and may in fact not be required if investment 'triggers' are instead based on an estimated probability of demand exceeding supply.

We noted in section 6.3 above that the estimate of LRMC under a Turvey approach depends on the magnitude of the demand increment assumed. For the purposes of these high level models, we have assumed a demand increment of 8 per cent, as agreed during the stakeholder consultation process. This demand increment is assumed to bring forward demand by approximately 5 years, an illustrative parameter that was also agreed during the stakeholder consultation.

Finally, both models are colour coded, with the main input cells shaded blue and automatic calculation cells shaded grey.

[41] We note that in reality, there is likely to be a significant interrelatedness between the demand forecast and investment optimisation, meaning that these processes should be undertaken iteratively.

C.2. 'Lumpy' expenditure case study

The 'lumpy' expenditure case study has been developed in consultation with stakeholders so as to represent the typical investment program of systems in the supply chain that require relatively large and infrequent investments, ie, bulk water procurement and transfer. Specifically, this case study assumes that where demand is expected to exceed supply, a new 50GL desalination plant is required with the following cost characteristics (both assumed to be constant in real terms):[42]

- $474.64m in capital expenditure; and
- $24.5m in operating expenditure per annum.

Applying the NERA high level models results in the LRMC estimates shown in Table C.1.

Table C.1
LRMC Estimates in the Presence of Lumpy Expenditure (2012$/kL)

Model	LRMOC	LRMCC	LRMC
Turvey	$ 0.59	$ 0.36	**$ 0.95**
AIC	$ 1.23	$ 0.98	**$ 2.21**

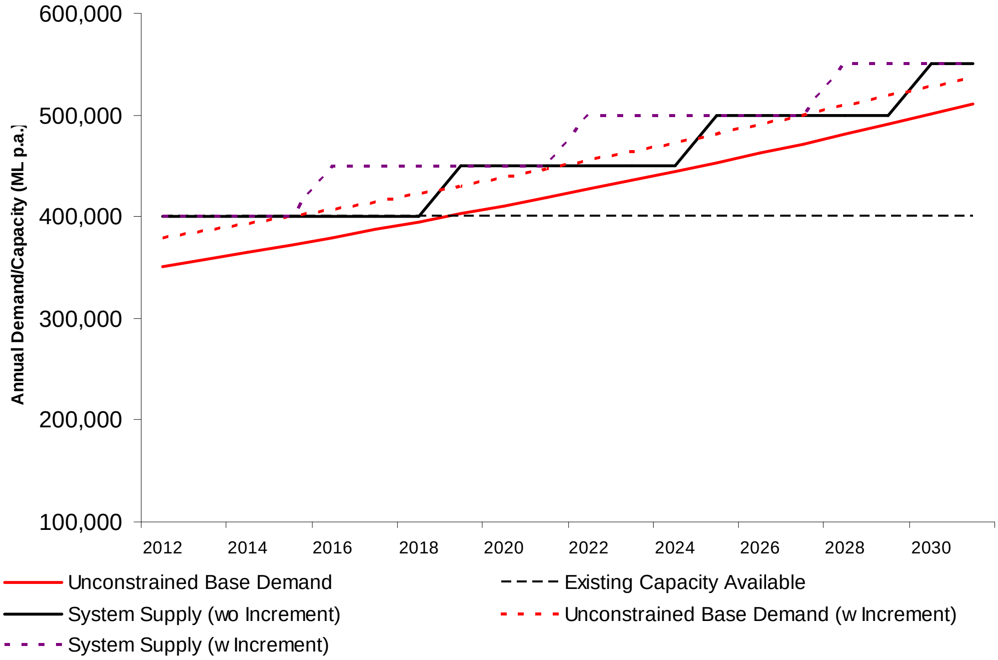
For detail on the calculations behind these LRMC estimates, please refer to the Excel models.

Under these assumptions, the AIC approach yields a LRMC that is approximately 132 per cent higher than that estimated using the Turvey approach. This significant difference is the result of the AIC approach not being able to capture the 'spare' capacity associated with the lumpy expenditure. The shortcoming of the AIC approach is discussed in section 5.4 above.

The annual supply and demand balance in each model is summarised graphically in Figure C.1 and Figure C.2 below.

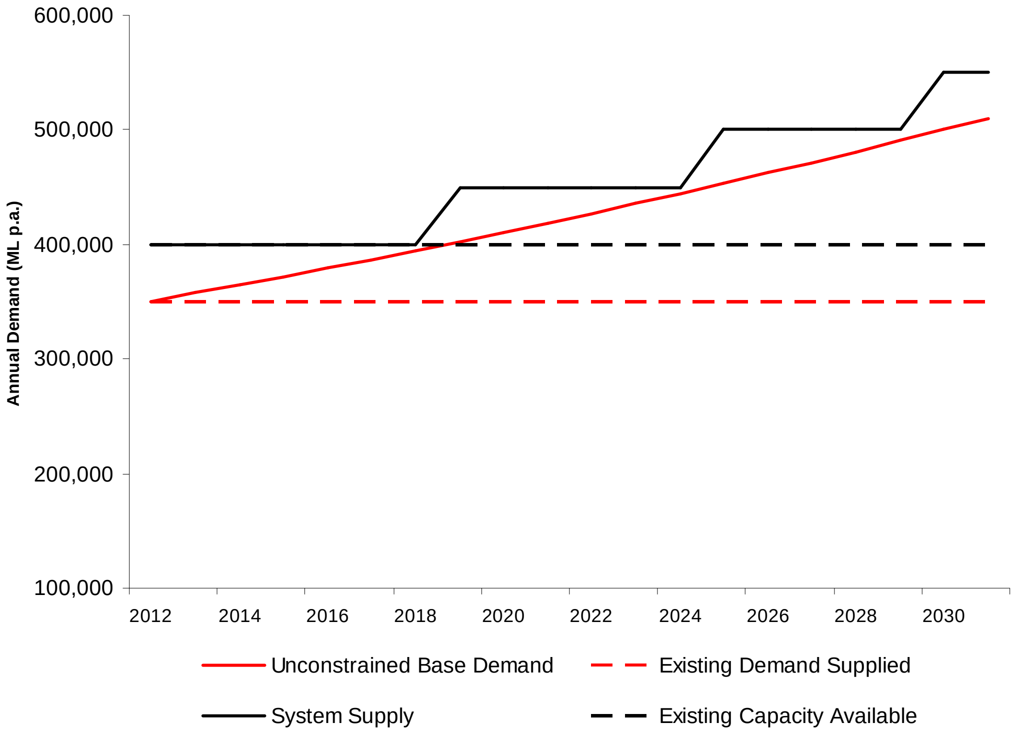
42 These cost characteristics were developed and agreed upon as part of the stakeholder consultation.

Figure C.1
'Lumpy' Expenditure Case Study (Turvey Model)



Note: Demand forecasts are inclusive of the SSM.

Figure C.2
'Lumpy' Expenditure Case Study (AIC Model)



Note: Demand forecasts are inclusive of the SSM.

C.3. 'Periodic' expenditure case study

The more 'periodic' expenditure case study was again developed in consultation with stakeholders so as to represent the investment program of systems in the supply chain that require relatively small and frequent investments, ie, retail level distribution. Specifically, this case study assumes, where demand is expected to exceed supply, that capacity can be added in 6GL increments and that each increment has the following cost characteristics (both assumed to be constant in real terms):[43]

- $91m in capital expenditure; and
- $2.5m in operating expenditure per annum.

Applying the NERA high level models results in the estimated LRMCs shown in Table C.2 below:

Table C.2
LRMC Estimates in the Presence of Lumpy Expenditure (2012$/kL)

Model	LRMOC	LRMCC	LRMC
Turvey	$ 0.67	$ 1.02	**$ 1.69**
AIC	$ 0.56	$ 1.46	**$ 2.02**

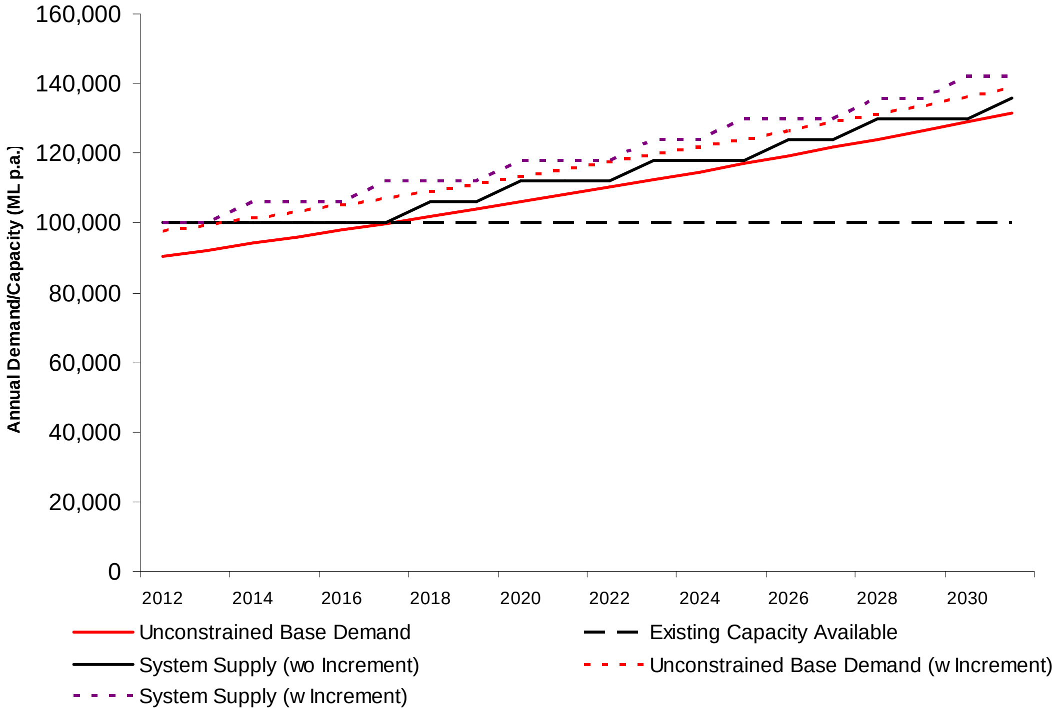
For detail on the calculations behind these LRMC estimates, please refer to the Excel models.

We discussed in section 5.4 above that the AIC approach involves less compromise in terms of accuracy when expenditure has a relatively smooth profile than it does when the time profile is lumpy. This can be observed by the reduced discrepancy between the two estimates in this case studies. In this case study, the AIC approach yields a LRMC estimate that is approximately 20 per cent greater than the Turvey estimate, whereas under the lumpy expenditure case study the difference was 132 per cent. This is a consequence of the reduction in 'spare' capacity associated with investments in this case study, as discussed in section 5.4 above.

The annual supply and demand balance in each model is summarised graphically in Figure C.3 and Figure C.4 below.

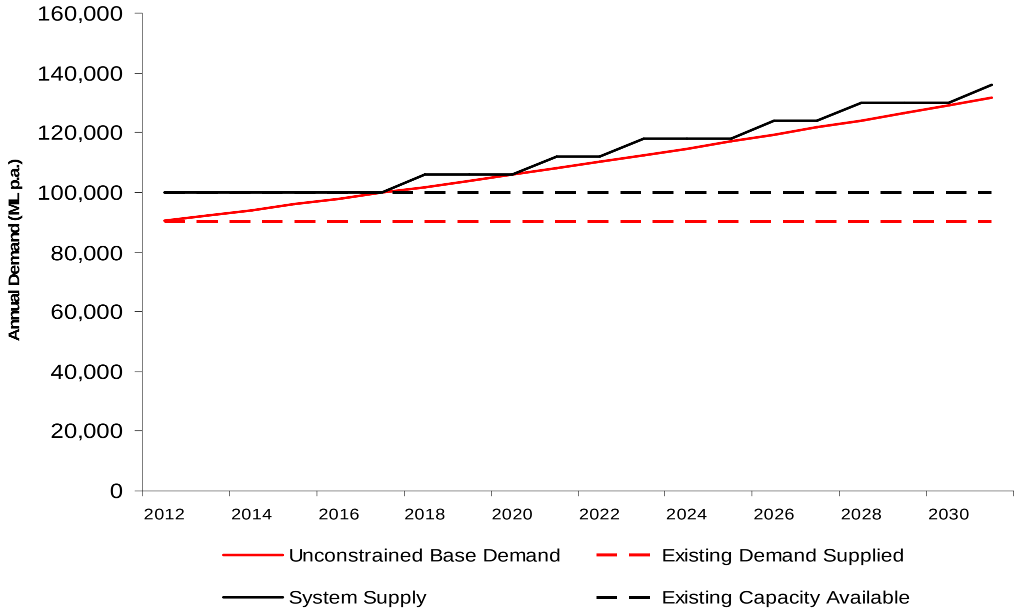
43 These cost characteristics were developed and agreed upon as part of the stakeholder consultation.

Figure C.3
'Periodic' Expenditure Case Study (Turvey Model)



Note: Demand forecasts are inclusive of the SSM.

Figure C.4
'Periodic' Expenditure Case Study (AIC Model)



Note: Demand forecasts are inclusive of the SSM.