Long run marginal cost

Estimates for water services for 2025-30 Price Review

Sydney WATER

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Introduction

The prices that we propose for our water services are informed by our estimate of the long run marginal cost (LRMC) for water. For the purposes of water usage prices, we propose a point estimate of $3.01/kL (in $23-24). For estimating avoided costs of water saving measures, we propose an LRMC range of $1.49/kL to $5.47/kL (in $23-24).

1.1 Context

LRMC is the cost of producing an additional unit of output when all factors of production can be varied. In practice, it is generally more efficient to produce these additional units of output through large incremental investments than producing them individually. This is typically described as the problem with calculating marginal costs in the context of significant and indivisible investments.

This means that for our industry, we interpret LRMC as the incremental cost (per kL of water) to ensure we are delivering our customers' forecast demand needs over the long-term. IPART has used a similar interpretation for estimating LRMC for our business during the 2008, 2012, 2016 and 2020 Price Reviews.

Like in our 2020 Price Proposal, we have modelled LRMC to include the incremental cost of:

- Bulk water: constructing and operating additional supply sources that add to water yield
- Non-bulk:
  - Constructing and operating additional headwork assets or increasing the capacity of existing ones
  - Constructing and operating additional network distribution assets.

IPART continues to use LRMC as a principle for water usage pricing,[1] even as it considers more sophisticated price structures such as drought pricing. Accordingly, we continue to use LRMC as a basis for informing our proposed water prices.

1.2 Methodology

LRMC is a forward-looking concept. It is the change in the future costs of our water supply system for a given change in output. This treats existing infrastructure as sunk. Following consensus from IPART's LRMC Working Group and consistent with our approach in earlier reviews, we continue to include the unused capacity from those sunk investments as the first viable source of meeting that additional water demand. Consistent with IPART's approach, we also take a modelling approach that enables analysis to continue to the lifetime of the final supply augmentation considered in the analysis.[2]

In conjunction with the demand forecasts that we explore in our Price Proposal, the LRMC method calculates the timing of augmented (or delayed) investment. The difference in the stream of future costs, discounted by our estimate of the pre-tax WACC to reflect the time value of money, on a per kL basis, provides our LRMC estimates.

We have applied this general approach to two different methodologies that exist in the literature for calculating LRMC:

- Average incremental cost (AIC)
- Turvey/Marginal incremental cost (Turvey).[3]

[1] IPART (2023) Water Regulation Handbook, p. 48.

[2] In our previous review, our approach was to annuitise the capital expenditure of augmentations. This resulted in the analysis calculating LRMC using a proportion of the capital investment that was equal to the proportion of the asset life that was captured in the analysis period (typically 30 or 50 years). We understand that this approach is still used commonly in other jurisdictions, but have acquiesced to IPART's approach.

[3] ±5% Turvey shock used.

We understand that the AIC and Turvey methods are the most common methods used by regulators in Australia and the UK. In addition, we have applied IPART's algebraic methods (with and without spare capacity).

Like in 2020, we estimate the LRMC for bulk and non-bulk water infrastructure. For the purposes of pricing signals and water conservation, a marginal increase in water saved would have cost impacts for both. However, for avoided cost calculations underpinning our water and recycled water investment decisions, non-bulk water costs may be accounted for elsewhere. Therefore, caution must be taken in applying these estimates. Table 1 identifies the LRMC approaches used for each type of infrastructure:

Table 1: LRMC estimation methods applied by water asset type

Water asset type	AIC	Turvey	IPART
Bulk water	🟢	🟢	🟢
Headwork assets	🟢	🟢	🔴
Distribution assets	🟢	🟢	🔴

Our LRMC calculations are a function of the following variables:

- **Current system yield:** 520 GL. In line with the modelling underpinning the GSWS, we assume yield of 515GL to 540GL (with yield declining to 460GL by 2050) based on hydrological modelling conducted in conjunction with WaterNSW.
- **Forecast demand:** The forecast demand profile adopts the 'average weather' scenario used for the basis of cost and revenue modelling as at September 2023, discussed in our Price Proposal.
- **Unused capacity:** The operating costs of existing spare capacity is considered in the analysis. The base case assumption is a weighted average between purchasing additional water from SDP (15%) and WaterNSW (85%).
- **Additional capacity:** The capital and operating costs of new water supply capacity and the incremental yield it provides. This includes augmentations over the long-term, designed to deliver resilient and reliable water supply. Augmentations include expansion to SDP, PRW, and the Illawarra and Northern Beaches Desalination Plants.
- **Discount rate:** 4.4% real, pre-tax WACC. Sensitivities of 4.2%, 5.0%, and 5.4% were also tested.
- **Non-bulk water costs:** The capital and operating costs of augmentation at six of our water filtration plants, and network costs in Potts Hill.

1.2.1 Current system yield

Our water supply consists of a range of sources that contribute to total system yield. The system has an active storage of around 2,600GL of water. Using a network of transfer pipelines and pumping stations, the system is interconnected in a way that allows this water to be supplied to Sydney, the Blue Mountains, and the Illawarra. Aside from active storages, the system also has access to a desalination plant with a capacity to produce around 91GL/year.

This is estimated to provide a current system yield of 515GL to 540GL.[4] This range was developed using WATHNET modelling conducted in consultation with WaterNSW. Review of the WATHNET model has confirmed that this approach for calculating system yield is common for urban water supply systems.[5]

However, the review noted a few refinements needed with the approach. For example, assuming that climate change is stationary is no longer valid and other factors affecting yield such as demand are uncertain. As such, we test a range of yield sensitivities: 510GL,

[4] See, e.g. Department of Planning and Environment (2020) Greater Sydney Water Strategy, pp. 58-62.

[5] WREMA (2021) Wathnet Model Independent Review.

520GL, 530GL, 540GL, and the option to have current system yield declining to 465GL by 2050 (GSWS' Scenario 1 of paleoclimate data resulting in system yield declining). Our base case assumption for LRMC modelling is 520GL.

1.2.2 Forecast demand

The forecast demand profile adopts our Run 68 'average weather' demand scenario. This run reflected an updated water usage price in response to a first round of LRMC modelling as at September 2023. Like our previous reviews, we do not test demand sensitivities. We consider this is a reasonable approach as the range of yield sensitivities tested account for a significant range of possible demand and supply futures.

It is unlikely that a low yield and high demand scenario (which would have compounding effects that result in a higher LRMC) outside the yield sensitivities tested will occur. This is because demand and yield are generally positively correlated: higher demand means dams spend less time at high levels. Accordingly, less water is lost to spillage and evaporation, and in turn, means a greater yield.

1.2.3 Unused capacity

To properly account for unused capacity, our modelling accounts for the operating costs of existing unused capacity. Our base case assumes that each GL of marginal demand will draw 15% from SDP at a cost of $0.748/kL (the per kL cost of energy and non-energy opex under IPART's 2023 Determination[6]) and 85% from WNSW at a cost of $0.078/kL (the volumetric charge of an additional kL under IPART's 2020 Determination[7]).

We assume no operating restrictions apply to the use of the desalination plant (beyond those assumed by WaterNSW which lead to a yield contribution of up to additional 91GL). For the purposes of LRMC modelling, we assume it is not likely a second plant would be commissioned while there are material levels of spare capacity in the existing plant.

1.2.4 Additional capacity

Bulk water augmentation

In our 2020 Price Review, we considered a range of bulk water supply augmentations. In response to the conclusions of the GSWS, many of these surface water augmentations are no longer being considered in the water supply augmentation portfolio required to ensure safe and secure water supply.[8] The analysis from our Resilient and Reliable Water Supply (RRWS) business case recommends a range of water supply augmentations to deliver water security in the long-term. These augmentations provide the highest net present value, using the following desalination and purified recycled water (PRW) solutions:

- Expansion to the SDP (91.2GL)
- Quakers Hill PRW treatment plant (Stage 1 – 9.2GL – 2029; Stage 2 – 25.6GL – 2029)
- Fairfield PRW treatment plant (Stage 1 – 10GL – 2036; Stage 2 – 10GL – 2047)
- Liverpool PRW treatment plant (12GL – 2036)
- Glenfield PRW treatment plant (14.4GL – 2042)
- Illawarra Desalination Plant (37GL), and
- Northern Beaches Desalination Plant (104.5GL).

[6] IPART (2023) Sydney Desalination Plant Pty Ltd Review of prices to apply from 1 July 2023, pp. 39-56.

[7] IPART (2020) Maximum prices for Water NSW's Greater Sydney Services from 1 July 2020, p. 3.

[8] The analysis undertaken in the GSWS identified inter-related challenges relating to water supply including population growth, system reliance on Prospect, climate change and environmental impact: DPE (2022) Greater Sydney Water Strategy, pp.10-1.

While all these augmentations are designed to contribute to water system yield, the PRW plants are primarily driven by a need to provide wastewater servicing in Western Sydney.[9] As such, investment in these augmentations are required by certain dates to deliver a wastewater solution regardless of marginal changes in water demand. Our modelling captures the cost of accelerating these investments due to water demand but does not allow for deferral beyond these required dates. Our modelling also uses the additional costs of incremental treatment and pumping (compared to river release, the alternative wastewater disposal solution). Due to high EPA discharge requirements to inland waterways, this only means the costs of undertaking a further UV advanced oxidation process and transporting the recycled water to Prospect.

The remaining water supply augmentations considered for LRMC analysis are the expansion to SDP, and the Illawarra and Northern Beaches Desalination Plants. Since our 2020 Price Review, the specification for the SDP expansion has been amended to 91GL per annum on top of the existing plant's capacity (duplicates the existing modules). In contrast, designs for the Illawarra and Northern Beaches Desalination Plants currently plan to provide 37GL and 104.5GL respectively. Our modelling accounts the full cost of the infrastructure (including renewals and maintenance) for the lifetime of the augmentation, and the variable costs involved with operating these plants. We also test whether greater energy efficiency of future plants affects the results (30% more energy efficient).

We assume a 70-year asset life for all bulk water supply assets, including this expansion to SDP. In our 2020 Price Review, our analysis was truncated at the 50-year mark. To accommodate for the truncation, the capital costs required were annuitised over the lifetime of the asset. Following the consensus of the LRMC Working Group, our modelling this time takes a different approach – modelling for the full life of the asset. We note that this involves forecasting into the longer-term when demand and the costs of augmentation and of using existing supply sources are more likely to vary than the assumptions discussed throughout.

Insufficient supply to meet forecast demand in the analysis period

Due to extending the analysis period to the end of the useful life of the final augmentation, supply is not expected to meet the demand we forecast in the long-term. For the purposes of LRMC modelling, we exclude future demand that is above the current system yield plus the SDP expansion from NPV calculations. That is, the NPV calculations only capture the incremental water demand that is addressed by the additional water produced by SDP expansion.

Our approach is consistent with IPART's recommendations in this respect.

Demand momentarily rising above system yield

As is common for LRMC modelling, our approach finds a theoretical point in time to augment water supply: when demand is forecast to exceed current system yield. However, a question arises as to how to treat augmentation when demand exceeds yield for only a brief period. Our modelling approach determines an augmentation trigger at the point where future forecast demand never falls below system yield.

This means that there must be an additional exercise of judgment on whether a momentary period of demand exceeding yield creates a yield gap that is unsustainable. However, this approach is more flexible to practical considerations (such as a decision to not invest if demand is only marginally above yield for a short period and is expected to fall due to usage price increases between regulatory periods) that are made when it comes to investing in costly infrastructure that becomes sunk once investments commence.

1.2.5 Discount rate

The base case discount rate adopted for this analysis is 4.4%. This is the pre-tax, real WACC we forecast for the 2025-30 period. This forecast was developed in February 2024. Our approach to developing this estimate is explored in our Price Proposal.

Sensitivities were tested using discount rates of 4.2%, 5.4% and 5.0%. Respectively, these are the pre-tax, real WACC using IPART's 2020-24 WACC, our forecast of IPART's pre-tax real 2030-35 WACC estimated in February 2024, and a mid-point between 4.4% and 5.4%.

[9] As explored in our proposal and in our RRWS business case, this portfolio of augmentations provides the highest expected net present value to deliver our services. While it is contingent on accepance of our indirect PRW approach, it provides safe and resilient water that our customers value, at the lowest total servicing cost. This is discussed in our Price Proposal.

1.2.6 Non-bulk water: Headwork and distribution assets

To estimate the non-bulk water components of LRMC accurately, we needed to distinguish between costs that were driven by marginal changes in water use and costs that were driven by other factors such as growth in the number of water connections (rather than water demand).

As discussed in our Price Proposal, growth drives a significant proportion of our costs. Much of the cost of servicing growth is driven by the need to service new areas and is largely independent of changes in water demand. For LRMC purposes, we've sought to isolate the cost of servicing changes in water demand itself.

Maximum daily demand versus average daily demand

Isolating these costs are difficult because headwork assets and distribution networks are often driven by changes in water demand during peak hours (maximum daily demand or "MDD"), rather than just water demand. That is, a marginal change in total demand that does not affect MDD may have a relatively small impact cost.

As such, the augmentation costs used for this methodology were based on changes in average daily demand (ADD), instead of MDD.

Baseline and forecast demand scenarios

Unlike in our 2020 Price Proposal, we compare changes in cost for a given system to changes in demand for that system. This approach results in separate LRMC estimates each of the distribution networks and headwork systems. The demand profiles we relied on come from our most recent Growth Servicing Investment Plan's ADD forecasts for the relevant water systems.

We weight these LRMCs by their incremental demand to develop a single estimate for our entire water distribution system.

Deferred and brought forward investments

Our base case costs were determined using outputs from our developer charges process conducted in 2022. The ±10% change in ADD were tested as sensitivities to these base case costs in 2023 as an ancillary process to the developer charge outputs. For headwork assets, we test key water filtration plants. Due to the complexity of conducting this assessment for our entire network of distribution assets, we focussed on Potts Hill. We consider this would be representative of the average type of costs which are being incurred by our entire water network in response to changes in water demand.

Table 2: Systems for headwork and distribution network LRMC calculations and their demand weights

Headwork assets	Headworks demand weighting		Distribution network	Networks demand weighting
	AIC	Turvey		
Prospect WFP • Prospect North • Prospect South	71.1%	87.9%	**Potts Hill**	100%
Orchard Hills	7.3%	3.8%		
Macarthur	0.4%	0.3%		
Nepean	19.5%	6.5%		
North Richmond	0.5%	1.0%		
Warragamba	1.3%	0.6%		

1.3 Results

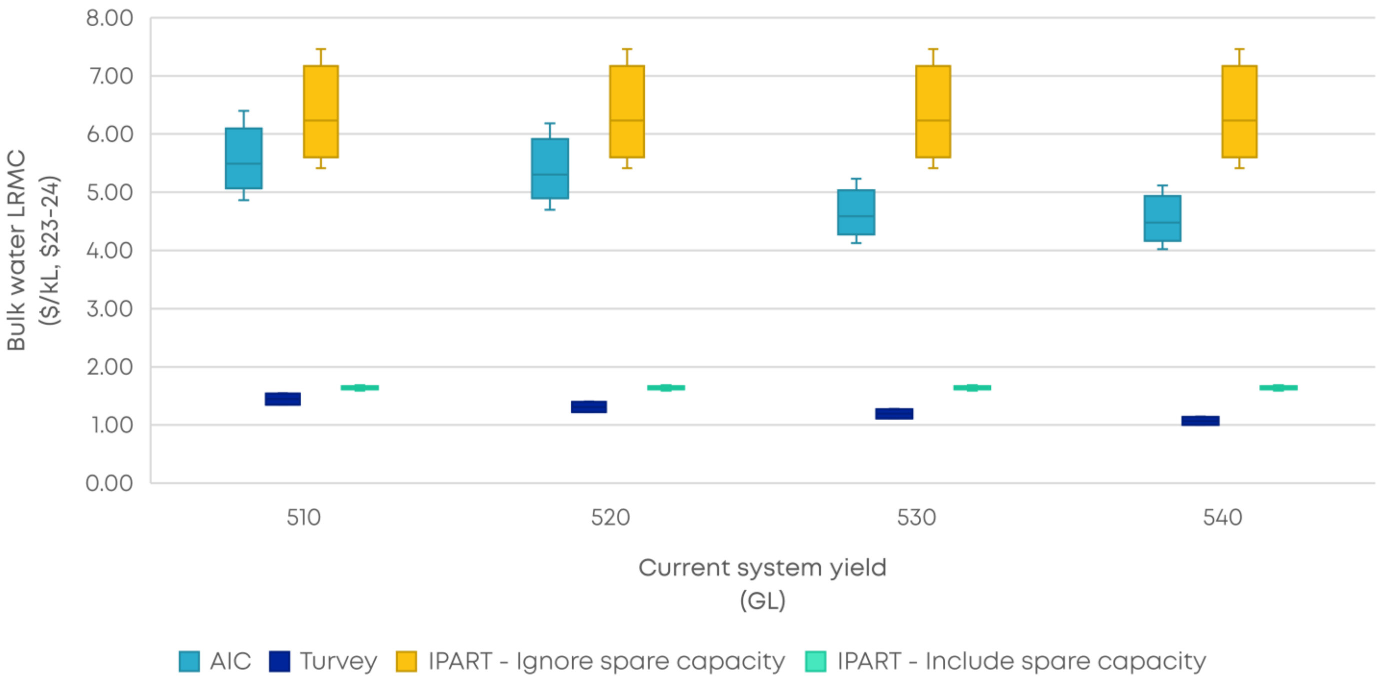
1.3.1 Bulk water LRMC range

Using the methodology outlined above, we develop bulk water LRMC ranges between:

- AIC: $4.02/kL to $6.40/kL
- Turvey: $1.00/kL to $1.55/kL
- IPART – Ignoring spare capacity: $5.41/kL to $7.46/kL
- IPART – Including spare capacity: $1.59/kL to $1.68/kL

This is illustrated in Figure 1.

Figure 1: Bulk LRMC by current system yield ($23-24)

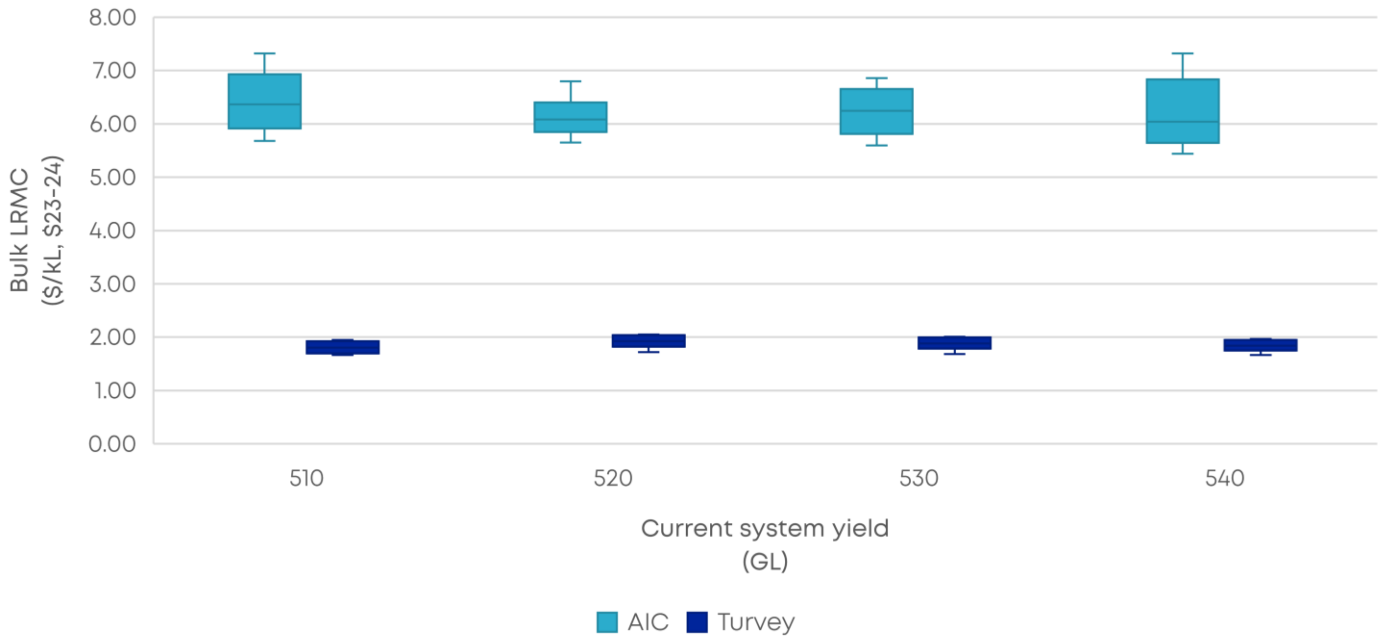


Accounting for declining system yield in response to paleoclimate trends increases these estimates:

- AIC: $5.44/kL to $7.32/kL
- Turvey: $1.66/kL to $2.05/kL

This is illustrated in Figure 2.

Figure 2: Bulk LRMC by current system yield with declining yield to 465GL by 2050 ($23-24)

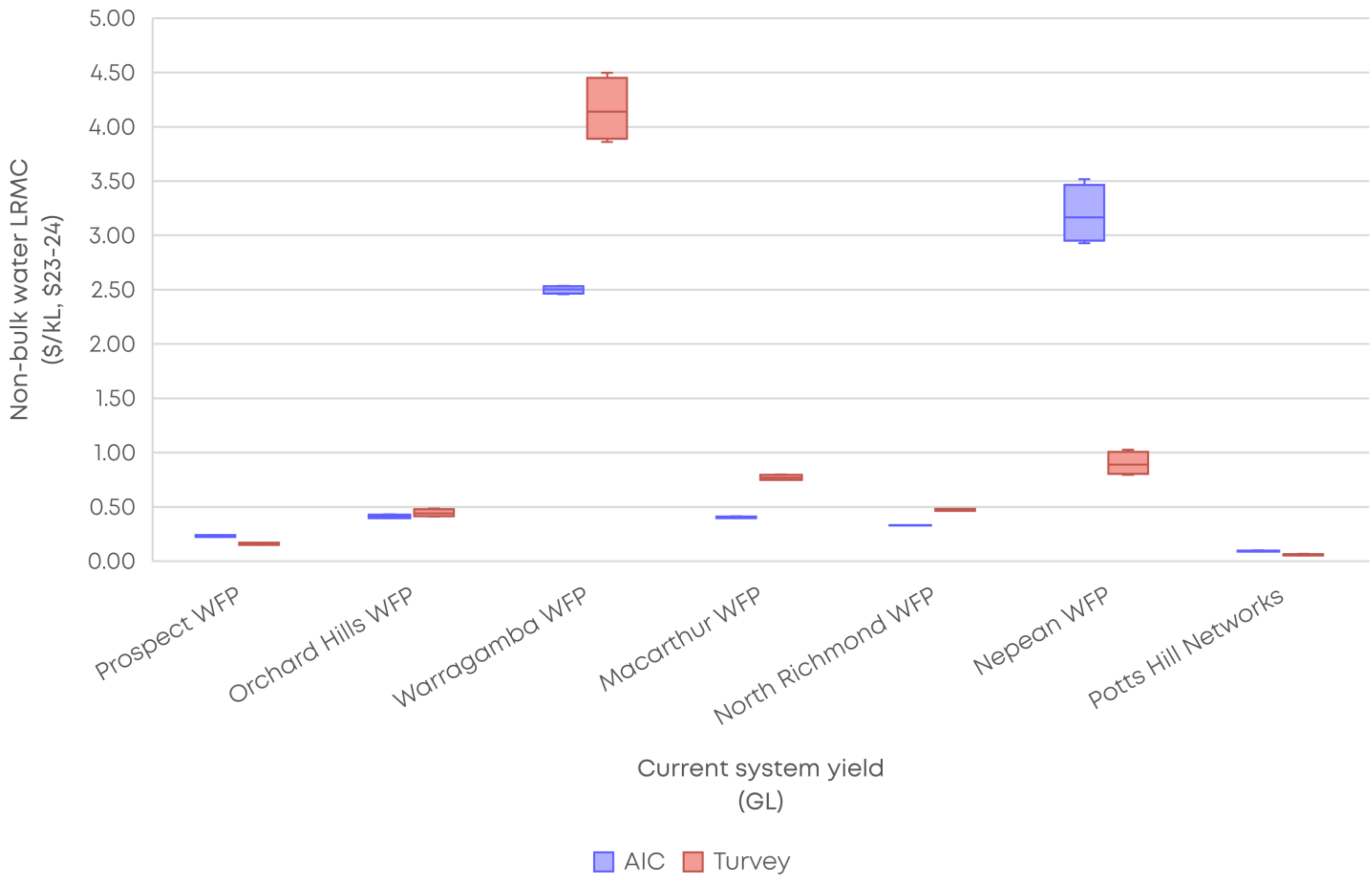


Our full results are extracted in **Appendix A**.

1.3.2 Non-bulk water LRMC range

Using the methodology outlined above, we develop non-bulk water LRMC ranges across different water systems.

Figure 3: Non-bulk LRMC by water system



Weighting these estimates by incremental demand provides an LRMC range across our entire water distribution system:

- AIC: $0.40/kL to $0.43/kL
- Turvey: $0.27/kL to $0.31/kL.

1.4 Discussion

Figure 1 to Figure 3 demonstrate that there is significant variation in the LRMC of water between the different approach used. As noted in Section 1.2, this is common in the literature. Our AIC method consistently estimates a higher LRMC than our Turvey method for both bulk and non-bulk water costs. This is not the case for IPART's method which ignores spare capacity. However, following the outcomes of the LRMC working group, we consider this estimate is not appropriate for our LRMC purposes.

We find there is a significant divergence in LRMC estimates between the 520GL and 530GL current yield assumptions for the Sydney Desalination Plant. This is because current yield below 530GL creates a supply gap in the short-term (water demand at around 520GL in 2025-26), requiring almost immediate augmentation. Of the two scenarios tested below 530GL (yields between 510GL and 520GL) both require immediate augmentation, resulting in little difference between the two.

This increase between yield assumptions is exacerbated using our approaches to modelling the AIC and Turvey compared to IPART's approach. This is because of a significant timing difference caused by the treatment of demand rising above yield, but only momentarily, as explored in Section 1.2.4. Conversely, IPART's approach assumes a linear increase in demand. Using this approach, demand cannot momentarily rise above yield.

Using our base case assumptions (Run-68 demand, pre-tax real WACC of 4.4%, current system yield of 520GL, but declining to 465GL, and the with future desalination plants being as energy efficient as the current desalination), $6.59/kL and $2.31/kL for the AIC and Turvey methods respectively. IPART's method including spare capacity estimates an LRMC of $1.68/kL plus $0.41/kL or $0.27/kL for non-bulk water.

For the purposes of usage prices, we consider $3.01/kL (in $23-24) for 2025-26 is an appropriate point estimate of LRMC. This is a marked increase on the current usage price – $2.67/kL in 2024-25 – and we must consider the impacts of a step change in water usage prices on each of our water customer cohorts. This is discussed in more detail in our Price Proposal. However, for the purposes of testing avoided costs of alternative water supply augmentations and water-saving measures, we propose to use a range of $1.49/kL to $5.47/kL (in $23-24).

Appendix A: Results tables

Aggregate results

RESULTS STATIC TABLE										
					Bulk water ($/kL, $23-24)				Non-bulk water ($/kL, $23-24)	
Demand profile	Discount rate (real, pre-tax)	Current yield (GL)	Declining current system yield	Efficiency of future desalination plants	AIC	Turvey	IPART - Ignore spare capacity	IPART - Include spare capacity	AIC	Turvey
Run-68	4.20%	510	No	30% more energy efficient	4.86	1.35	5.41	1.64	0.40	0.27
		520			4.70	1.23				
		530			4.13	1.12				
		540			4.02	1.00				
	4.40%	510			5.06	1.35	5.70	1.63	0.41	0.27
		520			4.89	1.22				
		530			4.27	1.11				
		540			4.17	1.00				
	5.00%	510			5.69	1.35	6.62	1.61	0.42	0.30
		520			5.52	1.22				
		530			4.74	1.11				
		540			4.64	1.00				
	5.40%	510			6.15	1.35	7.30	1.59	0.43	0.31
		520			5.98	1.23				
		530			5.08	1.12				
		540			4.99	1.01				
	4.20%	510		Same energy efficiency	5.11	1.55	5.57	1.68	0.40	0.27
		520			4.91	1.41				
		530			4.29	1.28				
		540			4.17	1.15				
	4.40%	510			5.30	1.54	5.85	1.68	0.41	0.27
		520			5.10	1.40				
		530			4.44	1.27				
		540			4.31	1.14				
	5.00%	510			5.93	1.54	6.78	1.65	0.42	0.30
		520			5.72	1.39				
		530			4.90	1.26				
		540			4.78	1.13				
	5.40%	510			6.40	1.54	7.46	1.62	0.43	0.31
		520			6.18	1.40				

		530			5.23	1.27				
		540			5.12	1.13				
	4.20%	510	Yes	30% more energy efficient	5.68	1.73			0.40	0.27
		520			5.65	1.84				
		530			5.59	1.81				
		540			5.44	1.77				
	4.40%	510			5.87	1.72			0.41	0.27
		520			5.84	1.83				
		530			5.78	1.80				
		540			5.61	1.76				
	5.00%	510			6.50	1.69			0.42	0.30
		520			6.46	1.82				
		530			6.39	1.78				
		540			6.16	1.75				
	5.40%	510			6.96	1.66			0.43	0.31
		520			5.87	1.72				
		530			6.50	1.69				
		540			6.96	1.66				
	4.20%	510		Same energy efficiency	6.03	1.95			0.40	0.27
		520			5.99	2.05				
		530			5.91	2.01				
		540			5.75	1.96				
	4.40%	510			6.23	1.94			0.41	0.27
		520			6.18	2.04				
		530			6.10	2.00				
		540			5.92	1.95				
	5.00%	510			6.86	1.90			0.42	0.30
		520			6.80	2.02				
		530			6.70	1.98				
		540			6.46	1.93				
	5.40%	510			7.32	1.87			0.43	0.31
		520			6.23	2.01				
		530			6.86	1.96				
		540			7.32	1.91				

Non-bulk water LRMC by water system

		AIC	Turvey	AIC demand weighting	Turvey demand weighting	AIC	Turvey
4.20%	Prospect WFP	0.22	0.15	71.1%	87.9%	0.40	0.27
	Orchard Hills WFP	0.40	0.41	7.3%	3.8%		
	Warragamba WFP	2.54	3.86	0.4%	0.3%		
	Macarthur WFP	0.41	0.75	19.5%	6.5%		
	North Richmond WFP	0.33	0.46	0.5%	1.0%		
	Nepean WFP	2.93	0.80	1.3%	0.6%		
	Potts Hill Networks	0.09	0.05	100.0%	100.0%		
4.40%	Prospect WFP	0.22	0.15	71.1%	87.9%	0.41	0.27
	Orchard Hills WFP	0.40	0.42	7.3%	3.8%		
	Warragamba WFP	2.52	3.98	0.4%	0.3%		
	Macarthur WFP	0.41	0.76	19.5%	6.5%		
	North Richmond WFP	0.33	0.47	0.5%	1.0%		
	Nepean WFP	3.02	0.83	1.3%	0.6%		
	Potts Hill Networks	0.09	0.05	100.0%	100.0%		
5.00%	Prospect WFP	0.23	0.16	71.1%	87.9%	0.42	0.30
	Orchard Hills WFP	0.42	0.46	7.3%	3.8%		
	Warragamba WFP	2.48	4.30	0.4%	0.3%		
	Macarthur WFP	0.40	0.78	19.5%	6.5%		
	North Richmond WFP	0.33	0.48	0.5%	1.0%		
	Nepean WFP	3.31	0.95	1.3%	0.6%		
	Potts Hill Networks	0.10	0.06	100.0%	100.0%		
5.40%	Prospect WFP	0.24	0.17	71.1%	87.9%	0.43	0.31
	Orchard Hills WFP	0.43	0.48	7.3%	3.8%		
	Warragamba WFP	2.46	4.50	0.4%	0.3%		
	Macarthur WFP	0.40	0.80	19.5%	6.5%		
	North Richmond WFP	0.33	0.48	0.5%	1.0%		
	Nepean WFP	3.52	1.03	1.3%	0.6%		
	Potts Hill Networks	0.10	0.07	100.0%	100.0%		