Department of Climate Change,
Energy, the Environment and Water

Case study B – Water conservation cost-benefit analysis in an inland community with a small population

Extracted from the Water conservation cost-benefit analysis guidelines

September 2024

The *Water conservation cost-benefit analysis guidelines* have been developed to provide a framework to undertake cost-benefit analysis of urban water conservation options. These guidelines will assist utilities to consider the broad range of costs and benefits of water conservation initiatives. Their purpose is to encourage utilities to consider and evaluate water conservation initiatives on an equal basis with supply side measures that improve water security.

For ease of use, the full *Water conservation cost-benefit analysis guidelines* have been broken into the following sections to guide utilities through the analysis process:

- **About the *Water conservation cost-benefit analysis guidelines*** – Summary of the purpose, background and process for conducting a cost-benefit analysis.
- **Undertaking a cost-benefit analysis** – Describes the steps involved.
- **Valuation methodologies** – A successful analysis will assess economic, social, environmental and cultural costs and benefits.
- **Case study A** – Water conservation cost-benefit analysis in a metropolitan coastal community with a large population.
- **Case study B** – Water conservation cost-benefit analysis in an inland community with a small population.
- **Case study C** – Water conservation cost-benefit analysis in an inland community with a mid-size population.

Visit **water.dpie.nsw.gov.au** to download these documents or a copy of the full *Water conservation cost-benefit analysis guidelines*.

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Appendix 5: Generic assumptions – case studies

We have developed 3 case studies for illustrative purposes only. They provide guidance on applying this framework in real-world contexts. Local water utilities considering specific water conservation measures should not use the assumptions and results to support their evaluation.

The generic assumptions applied to case studies A, B, and C are listed in **Table 14**. Additional case study-specific assumptions are listed in the relevant appendix.

Table 14: Generic assumptions – case studies

Assumption	Details
Modelling period	30 years
Baseline year (price year)	2022/23 ($2023)
Real discount rate	5 per cent (with sensitivity tests at 3 per cent and 7 per cent)
Inflation	3 per cent
Demand growth	2 per cent
Distribution loss factor (DLF)	1.0637[66]
Marginal loss factor (MLF)	1.0048[67]
Emissions intensity factor	0.6497[68]
Carbon price	$126/tonne in 2024[69]
Households	Each household contains 4 people
Willingness to pay (WTP) survey applicability	To be conservative, when we use a WTP study to value a cost or benefit we assume 50 per cent of households will share the same views and willingness to pay as the study.
Water conservation expenditure	We consider all water conservation measures, excluding rainwater tanks and small-scale reuse, as operating expenditure for the purpose of our analysis.
Likelihood of water restrictions	In assuming a utility will deliver a given level of service to customers, we have assumed the cumulative likelihood of water restrictions will not exceed 5 per cent for any case study option.

66 AEMO (2021). Distribution Loss Factors for the 2021/2022 Financial Year. Essential Energy's general DLFs: Low voltage.
67 AEMO (2022). Marginal Loss Factors: Financial Year 2022-23. Marginal Loss Factors NSW: Gosford.
68 AEMO (2022). Carbon Dioxide Equivalent Intensity Index. CDEII results – current year.
69 NSW Treasury (2023). Technical note to the NSW Government Guide to Cost-Benefit Analysis TPG23-08.

Assumption	Details
Likelihood of triggering a drought response	In assuming a utility will deliver a given level of service to customers, we have also assumed the likelihood of triggering a drought response will not exceed 3 per cent for any case study option.
Rainwater tanks volume	2000-3999kL
Rainwater tanks water savings	38kL of water savings per household per year[70]
Water-efficient showerheads water savings	105kL of water savings per household per year[71]
Water-efficient washing machines water savings	18kL of water savings per household per year[74]
Incremental costs and benefits	Costs and benefits are incremental to the base case.
Small-scale supply and reuse water savings	42kL per household of water savings per year[72]
Demand management water savings	1kL per household per year

70 Sydney Water (2011). Rainwater tank monitoring report. www.sydneywater.com.au/content/dam/sydneywater/documents/rainwater-tank-monitoring-report.pdf

71 Australian Government Department of Climate Change, Energy, the Environment and Water (2023) report that *"Flow rates for showers are on the water rating label in litres per minute (L/min). Every 1 L/min difference will save a family of 4 nearly 12 kilolitres (kL) of water and $35 each year (based on an 8-minute shower per person per day with water at $2.99 per kL). For a family of 4, replacing a shower that flows at 15 L/min with a 3-star shower at 9 L/min will save 70 kL and $210 each year on water bills and a 5-star shower at 6 L/min will save 105 kL and $315 each year on water bills. There will also be savings on energy bills because less water will need to be heated"*. Australian Government Department of Climate Change, Energy, the Environment and Water (2023). Water efficiency: Showers. www.energy.gov.au/households/water-efficiency

72 This assumption builds on the assumed water savings of a rainwater tank (38kL) combined with an additional water savings derived from the on-lot re-use of 'grey' water. We have made a simplifying assumption that this additional saving is the equivalent of 4kL per household per year.

Appendix 7: Case study B – Small inland community

We have developed this case study for illustrative purposes only. It provides guidance on applying this framework in real-world contexts. Local water utilities considering specific water conservation measures should not use the assumptions and results to support their evaluation.

A7.1 Problem definition

Case study B considers an inland local water utility seeking to deliver water security to 2,500 customers. All options (or portfolios) must balance supply and demand over time. They must provide an acceptable level of water security as demand grows ("long-term plan") and as periods of water scarcity potentially become more severe ("drought-response plan").

A7.2 Options

The utility considers a **base case** of business-as-usual (BAU) measures to manage growth in water demand over the long-term and periods of water scarcity compared to **2** alternative options (or portfolios) that use *additional* water conservation measures as part of the long-term plan to align supply and demand.

All options involve the same investments in supply side measures under the long-term plan (primarily a large-scale recycling), however Option 1 and Option 2 involve *additional*, but different, water conservation measures to complement these BAU measures. In terms of the drought-response plan, all options involve the same supply side (additional groundwater extraction and trucking) and demand side (restrictions) measures. However, Option 1 and Option 2 involve additional water conservation to complement these measures.

The 2 alternative options are designed to test the *additional value* that water conservation provides if it were to complement the existing measures.

The results of the CBA will illustrate whether the *additional benefits* of water conservation, in terms of deferring these supply and demand side measures, outweigh the *additional costs*, in terms of upfront and ongoing conservation costs. Importantly, the options and CBA results will not identify the need for or value of the existing measures. That is, whether large-scale recycling is more valuable than a dam in providing an acceptable level of water security.

Figure 87 shows the following options tested as part of this CBA:

- **Base case**, "business as usual" approach to managing supply and demand including construction of large-scale recycling to manage growth. This has potential for additional groundwater extraction, trucking, and water restriction measures as storages fall.
- **Option 1: Additional leakage management**, on utility and customer side of the meter. Residual water demand is met using BAU approach to managing supply and demand[77], however, these measures may be delayed as a result of water conservation.
- **Option 2: Additional leakage management, demand management, and water efficiency**. Residual water demand is met using BAU approach to managing supply and demand, however, these measures may be delayed as a result of water conservation.

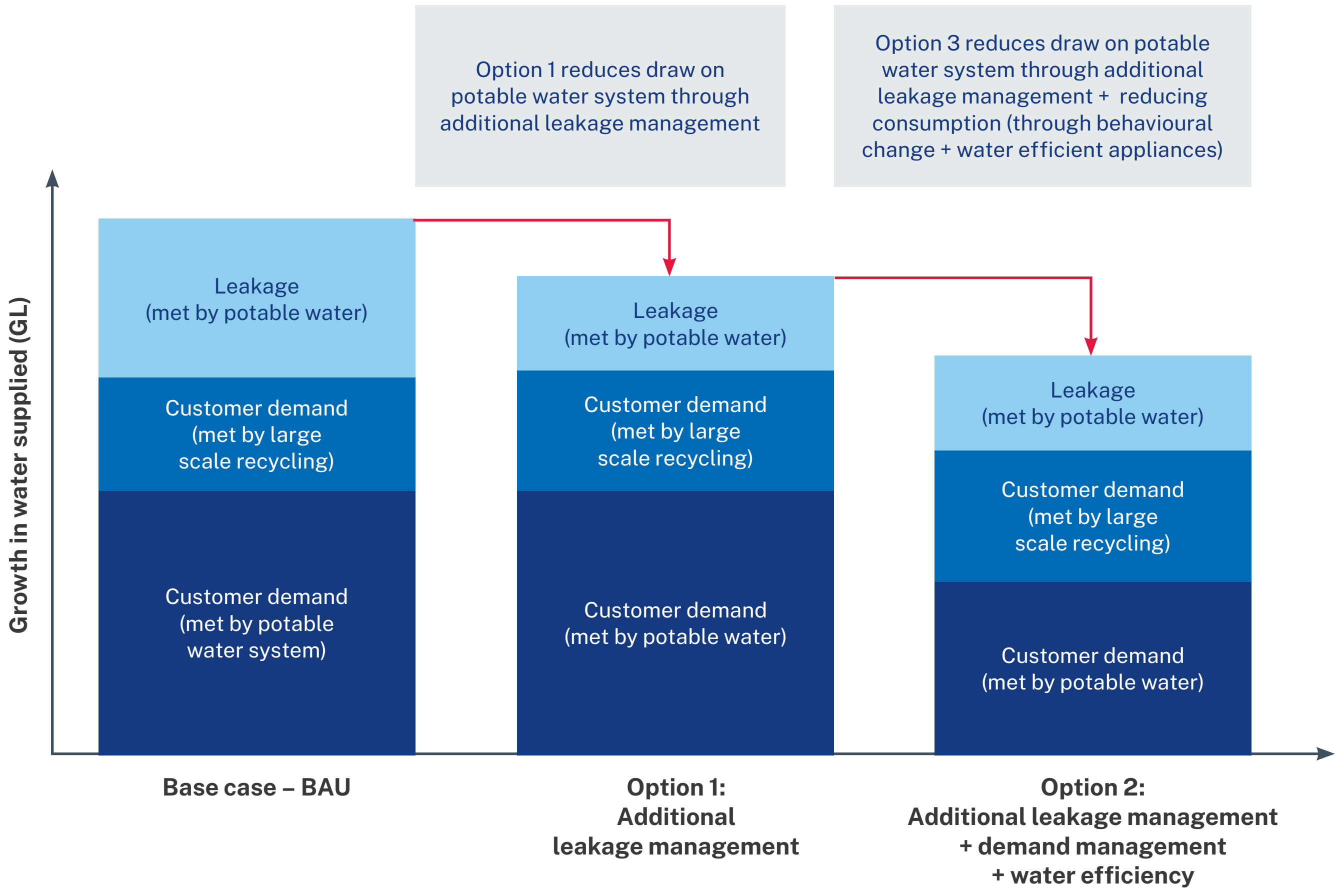
77 i.e., large scale water recycling will still be the primary long-term measure with water restrictions and potential for emergency supply (groundwater extraction and trucking) as the drought-response measure under Option 1 and 2.

Figure 87: Case study B – indicative options

	Base case – business as usual	Option 1: Additional leakage management	Option 2: Additional leakage management + demand management and water efficiency
LONGER-TERM PLAN	**Business-as-usual** approach to managing supply and demand incl. construction of large-scale recycling.	Increased utility and customer leakage management. Residual met using BAU approach.	Increased utility and customer leakage management + education/rules to reduce baseline consumption + water efficient appliances. Residual met using BAU approach.
DROUGHT-RESPONSE PLAN	Water restrictions, additional groundwater extraction and associated infrastructure and potential for emergency measures including trucking water.	Additional water conservation campaigns. Residual demand met as per **base case**.	Additional water conservation campaigns. Residual demand met as per **base case**.

As shown in the indicative water balance in **Figure 88**, while the water conservation measures in Option 1 and Option 2 reduce the volume of water supplied, water conservation alone is insufficient to close the gap between the growth in forecast supply and demand.

Figure 88: Case study B – indicative water balance



Note: Leakage is deliberately shown in this indicative water balance to be relatively high for illustrative purpose only, and in practice the impact of leakage management in Option 1 and Option 2 on potable water supplies may be smaller. Key assumptions used in the CBA are listed below.

As a result, there will still be a role for investment in supply side measures, albeit deferred with water conservation, as part of a long-term plan to meet forecast growth in demand in this case study (see **Figure 89**). This is in addition to measures required under the drought-response plans (see **Figure 90**).

Figure 89: Case study B – timing of supply side and demand side measures under long-term plan

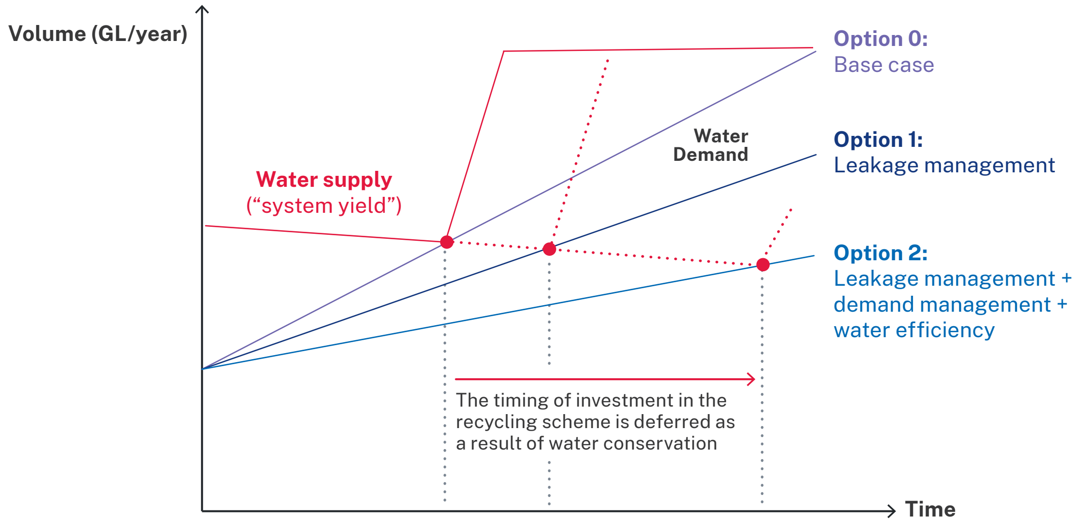
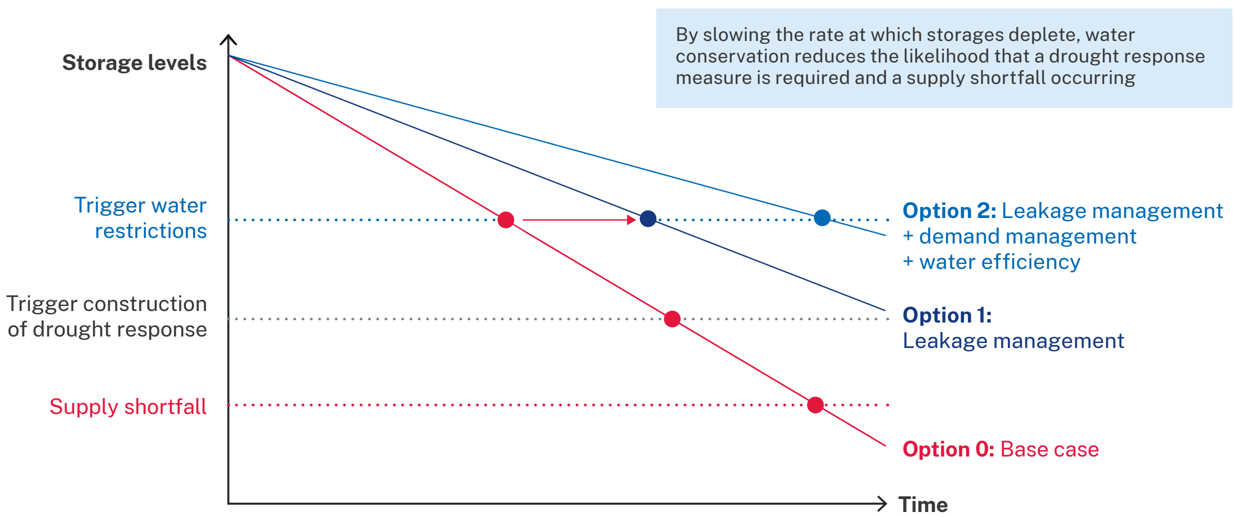


Figure 90: Case study B – drought-response plan



A7.3 Benefit and costs categories

Table 18 outlines the relevant costs and benefits for case study B.

Table 18: Case study B – indicative costs and benefits

Cost or benefit	Change in outcomes (ΔQ)	Change in price (P)	Change in likelihood
Value of reduced water demand	Change in volume of water supplied/volume of wastewater or stormwater reused.	Long-run marginal cost (LRMC) of bulk and non-bulk water supply. As an LRMC is not available, the usage price has been used as a proxy.	N/A
Value of avoided wastewater costs	Change in volume of wastewater transported through the wastewater network/volume of wastewater reused.	Long-run marginal cost (LRMC) of wastewater management. Where LRMC is not available, the SRMC of wastewater can be used as a proxy.	N/A
Avoided costs of managing water quality events	Captured qualitatively		
Cost of drought response (excluding carting water)	N/A	Estimate of incremental cost of a drought response – ground water extraction including additional infrastructure – and administering water restrictions.	Change in likelihood of triggering a drought response.
Cost of carting in water	Volume of water to be supplied via carting (in kL).	Water carting charge (in kL).	Change in likelihood of a carting.
Costs of water conservation	Water savings (in kL).	Estimate of incremental cost of the water conservation measure(s), including capital, operating, and administration costs.	N/A
Improved biodiversity and waterways	Change in length of healthy waterway.	Community WTP for improvements in waterway health.	N/A
Avoided cost of water restrictions	Duration of water restrictions and size of restricted demand (in kL).	Community WTP to avoid water restrictions.	Change in likelihood of different stages of water restrictions.
Avoided cost of a shortfall	Size of the shortfall (in kL).	Community WTP to avoid a shortfall.	Change in likelihood of a shortfall.
Recreation opportunities	Captured qualitatively		
Amenity benefits	Captured qualitatively		
Avoided health costs related to urban heart	Captured qualitatively		
Avoided health costs related to inactivity	Captured qualitatively		
Avoided mental health costs	Captured qualitatively		

A7.4 Inputs and assumptions

- Population = 10,000.
- Total annual potable water demand is assumed to be around 1GL per year.
- The LRMC of wastewater is relatively low ($1.10/kL respectively) because the network does not require augmentation for many years. There is excess capacity.
- As the local water utility does not have a LRMC of water available, it adopts the usage price as a proxy, but recognises the limitations of doing so. The usage price is relatively low given the capacity in the system ($1.25/kL).
- Drought response involves the use of water restrictions followed by ground water extraction, including additional infrastructure. Estimated cost of drought response, excluding carting water = $20 million.[78]
- Leakage management is assumed to increase over the modelling period to save about 10 per cent of water supplied by the time modelling finishes. Leakage management is assumed to cost $130,000 per year.
- Demand management is administered through education programs and is assumed to cost $10,000 per year. Demand management is assumed to save 1kL of water per household per year of investment. We assume the education program will induce a behavioural change in 30 per cent of households.
- Water efficiency is administered through the installation and use of water-efficient showerheads and washing machines. A rebate scheme funds the water-efficiency measures. We have assumed water-efficient showerheads are administered to 15 per cent of households and water-efficient washing machines will be administered to 5 per cent of households per year. The cost of these measures is about $170,000 per year.[79] This does not include the costs of administering the scheme.

A7.5 Cost-benefit analysis results

Figure 91 below summarises the results of the CBA, outlining both the present value of incremental costs and present value of incremental benefits for each option. It shows the following:.

- Option 1 delivers a net benefit to society as the NPV >0 and BCR >1. In other words, the incremental benefits of additional water conservation to complement the other existing measures outweighs the additional costs.
- Option 2 delivers a net cost to society as the NPV <0 and BCR <1. In other words, the additional costs of water conservation do not outweigh the additional benefits under Option 2.

Option 1 delivers the greatest value to the community and is the preferred option overall.

The primary benefits in both cases are the avoided water related costs associated with water conservation reducing the draw on the potable water system. The avoided costs associated with deferring investment under the long-term plan are larger than the avoided costs associated with triggering a drought response.[80]

As noted earlier, these results do not indicate whether there is value in pursuing other measures that could substitute for or complement water conservation in providing an acceptable level of water security.

78 The cost of carting water is included separately.

79 Importantly, this is the cost to the community of the water conservation measures, rather than the cost of the rebate scheme from the LWU utility's perspective or the net cost to the customer. These financial costs of the rebate to the LWU should be the focus of a separate financial analysis.

80 The former avoided costs are significantly larger than the latter avoided costs (including costs of the drought response plan and broader social costs of restrictions, and supply shortfall costs) as water conservation in this case study leads to a relatively small change in the likelihood of these drought events occurring.

Figure 91: Case study B – indicative cost-benefit analysis results incremental to the base case (NPV terms, $FY23 millions)

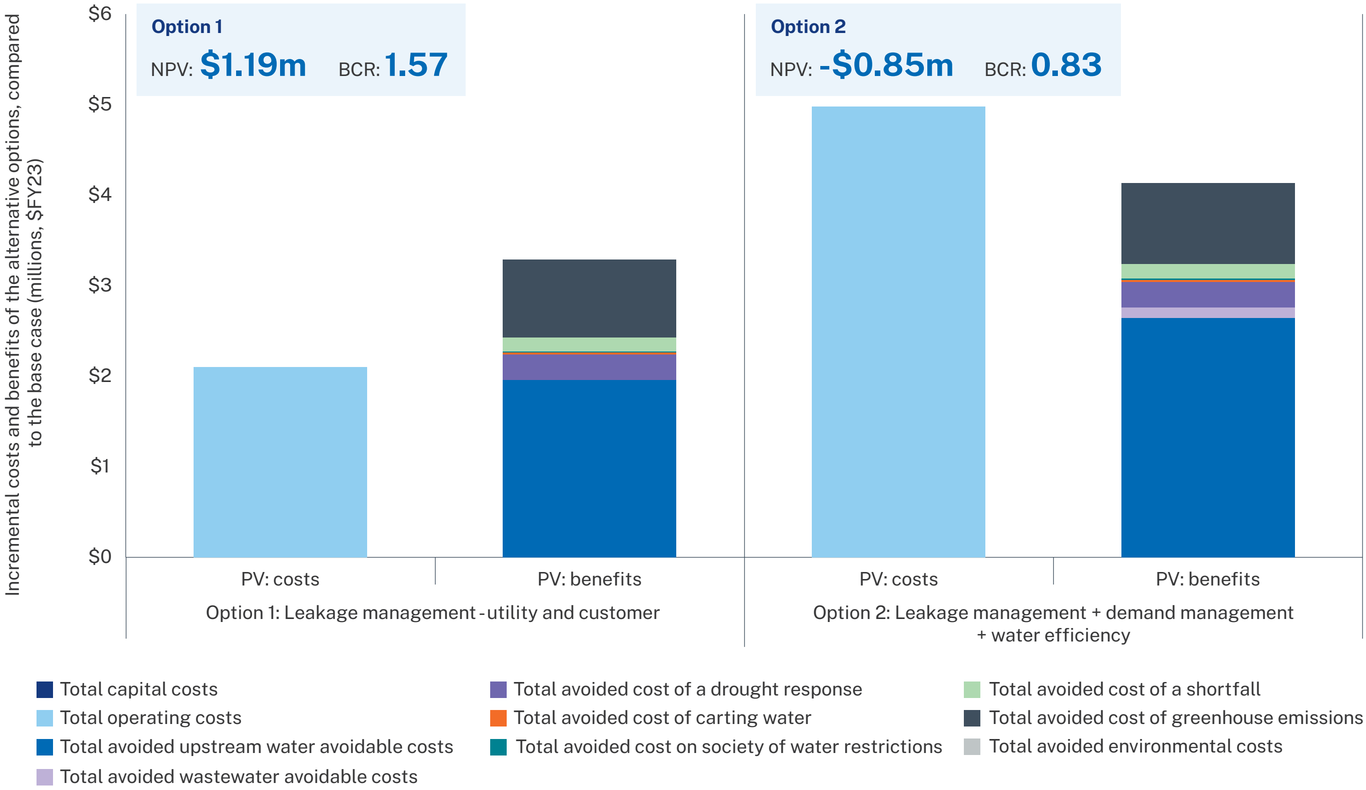


Table 19: Case study B – indicative cost-benefit analysis results incremental to the base case (NPV terms, $FY23 millions)

Cost or benefit	Option 0 – base case	Option 1: Leakage management – utility and customer	Option 2: Demand management + water efficiency + rainwater tanks
Total capital costs		$–	$–
Total operating costs		-$2.10	-$4.98
Total avoided upstream water avoidable costs		$1.96	$2.64
Total avoided wastewater avoidable costs		$-	$0.12
Total avoided cost of a drought response		$0.28	$0.28
Total avoided cost of carting water		$0.02	$0.02
Total avoided cost on society of water restrictions		$0.01	$0.02
Total avoided cost of a shortfall		$0.16	$0.16
Total avoided cost of greenhouse emissions		$0.86	$0.89
Total avoided environmental costs		$-	$0.00
Net present value		**$1.19**	**-$0.86**
Benefit cost ratio		**1.57**	**0.83**

Table 20 analyses the qualitative costs and benefits of each option. The qualitative impacts are expected to be of minor benefit of Option 1, so we anticipate the results of the qualitative assessment will not change the preferred option identified above. Nor will it change the broad finding that, in this case study, Option 1 delivers additional value to the community.

It should be noted that we have not included the costs of administering the rebate scheme under Option 2, and therefore the costs of Option 2 are likely to be understated.

Table 20: Case study B – indicative results – qualitative costs and benefits

Impact	Summary	Likely materiality
Economic costs and benefits		
Avoided cost of managing a water quality event	The water conservation measures considered under Option 1 and Option 2 can reduce draw on the potable water system. This reduces the cost of managing a water quality event, because households are consuming less water. We assume this will derive a minor benefit under both options.	Option 1 + Option 2: Minor benefit
Avoided input costs to water-intensive appliances	The use of water-efficient washing machines can reduce the consumption of detergents, resulting in an avoided cost saving to water customers under Option 2.	Option 2: Minor benefit
Additional cost of administering the rebate scheme	The rebate scheme is likely to result in additional costs associated with administering the scheme. Given the relatively small number of households receiving the rebate, the administration costs may be a relatively large proportion of scheme costs.	Option 2: Material cost
Social costs and benefits		
Amenity and recreation opportunities	Option 1 and Option 2 can create additional recreation and amenity opportunities through the deferral of water restrictions and provision of water for the irrigation of open space. In other words, delivering green irrigated space. However, this benefit is likely to be minor as it is not creating additional open space, rather, just irrigating existing open space.	Option 1 + Option 2: Minor benefit
Avoided health costs related to urban heat	The water conservation measures identified under Option 1 and Option 2 can contribute to avoided health costs associated with urban heat, for example, loss in productivity due to extreme heat. They reduce urban temperatures through the regular irrigation of open space and canopy. However, the materiality of this benefit will depend on the scale of the intervention. Influencing urban heat requires large-scale irrigation.	Option 1 + Option 2: Minor benefit
Avoided health costs related to inactivity	Option 1 and Option 2 can reduce the risk of inactivity-related diseases through increasing the availability of irrigated open space and opportunities for active recreation.	Option 1 + Option 2: Minor benefit
Avoided mental health costs of a drought	Water conservation can reduce exposure to drought-related economic stressors and reduce the risk of declining mental health outcomes in affected individuals. By reducing the risk of a shortfall on society, Option 1 and Option 2 can reduce the likelihood or extent of declining mental health among affected individuals.	Option 1 + Option 2: Minor benefit

A7.6 Risk and uncertainty analysis

To ensure an accurate comparison of costs and benefits across response options, robust economic assessment should include tools for managing risk and uncertainty. This case study includes sensitivity analysis to identify how the value for money of the options change when key assumptions are varied. These uncertainties include:

- 20 per cent increase in costs of water conservation (as seen in **Figure 92**)
- 20 per cent decrease in costs of water conservation (as seen in **Figure 93**)
- higher and lower discount rates (7 per cent/3 per cent) (as seen in **Figure 94** and **Figure 95**).

The results of the sensitivity tests, outlined below, indicate the results of the CBA are robust to changes in capital costs and discount rates. In other words, in most cases, the relative performance of the options does not alter as a result of changes in key assumptions. Option 1 continues to perform better than the base case and Option 2.

This scenario analysis has not tested other risks from potential states of the world that could impact the value of these investments. These include:

- higher/lower increases in forecast demand due to population or demographic change
- larger/smaller changes to supply yield from changes in rainfall and storage inflows.

Similarly, this section has not tested the impact of other uncertainties that could be evaluated through more complex analysis, such as real options analysis. This could include the:

- potential for large shock in demand – from an uncertain source such as a large industrial customer
- opportunities to use new technologies – purified recycled water where there is community acceptance
- significant regulatory change such as restrictions on wastewater discharge to waterways.

These events could impact the base case and as a result the incremental value of additional water conservation.

Figure 92: Case study B – indicative cost-benefit analysis results incremental to the base case – 20 per cent increase in costs (NPV terms, $FY23 million)

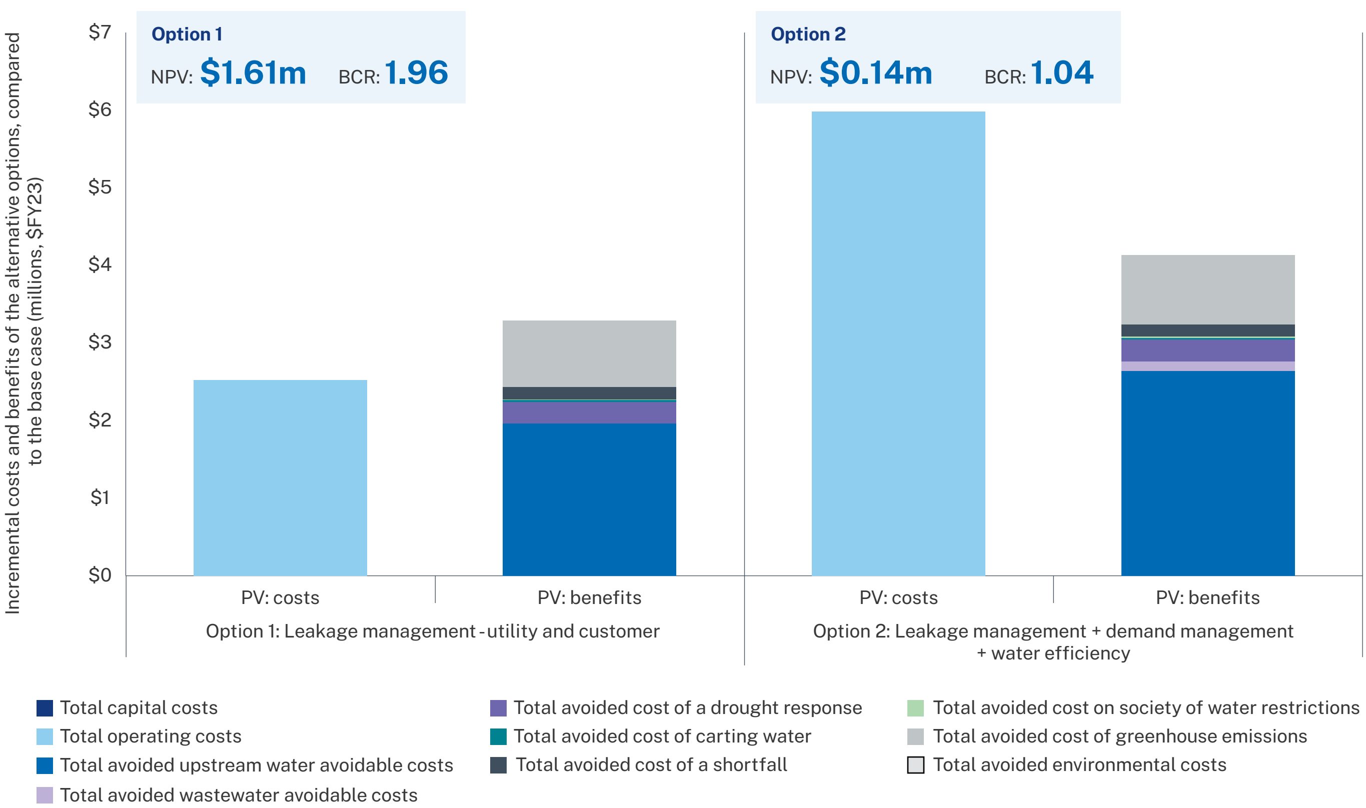


Figure 93: Case study B – indicative cost-benefit analysis results incremental to the base case – 20 per cent reduction in costs (NPV terms, $FY23 millions)

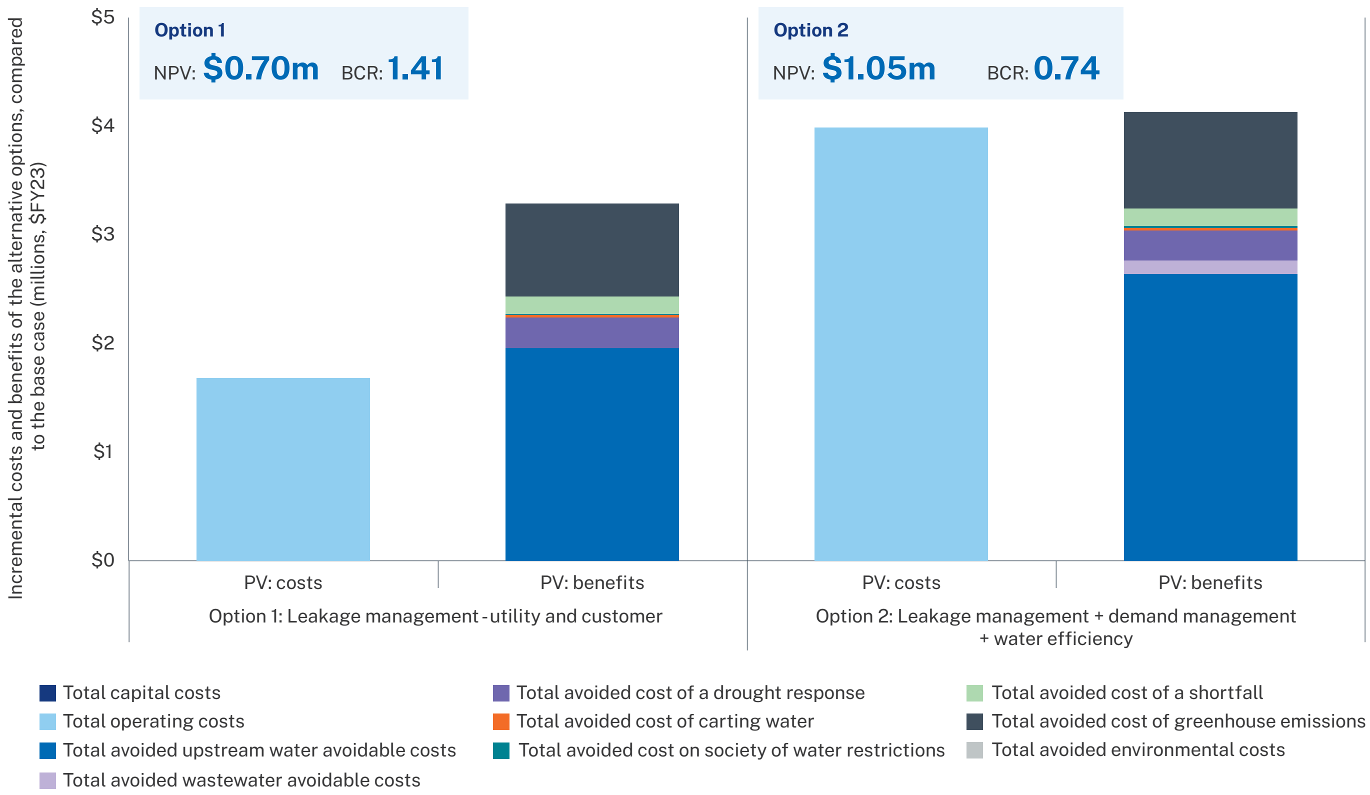


Figure 94: Case study B – indicative cost-benefit analysis results incremental to the base case – 7 per cent discount rate (NPV terms, $FY23 millions)

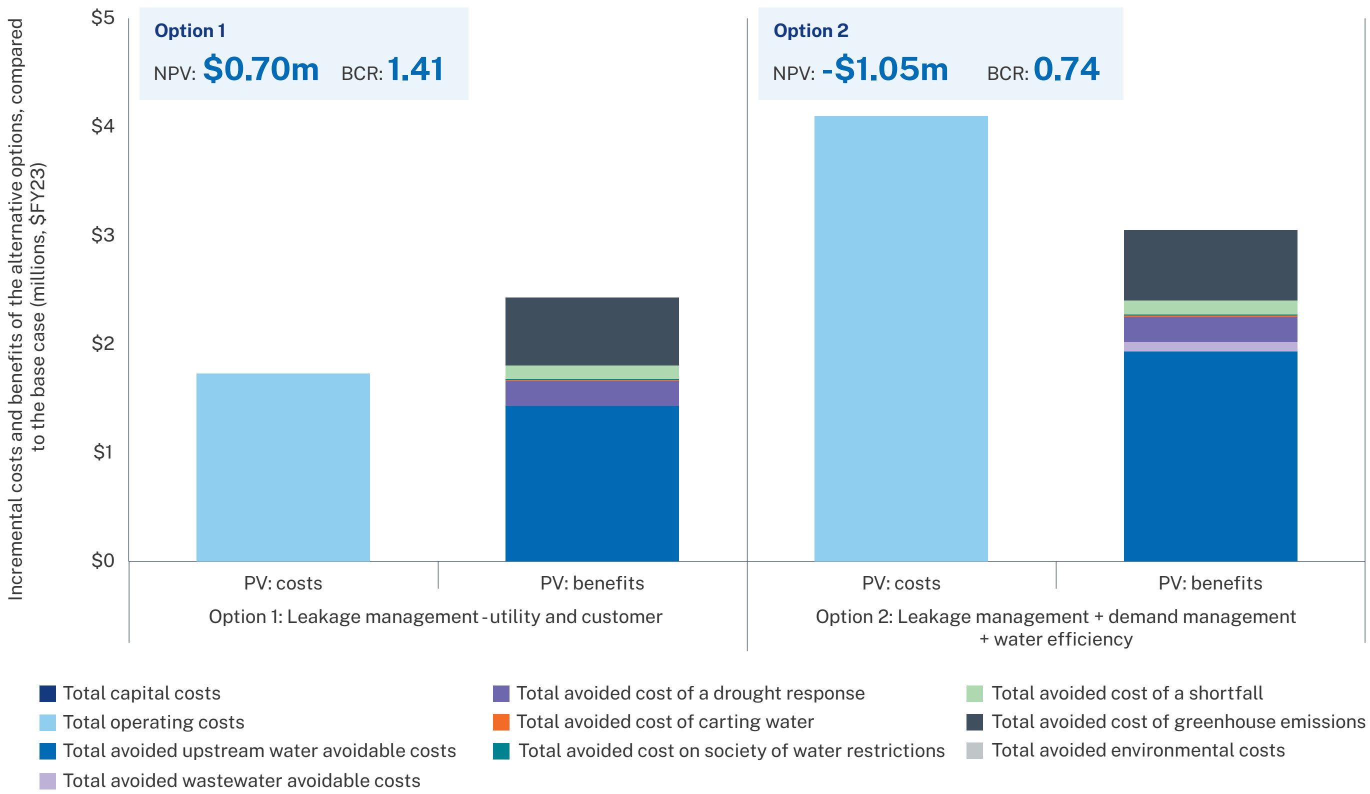
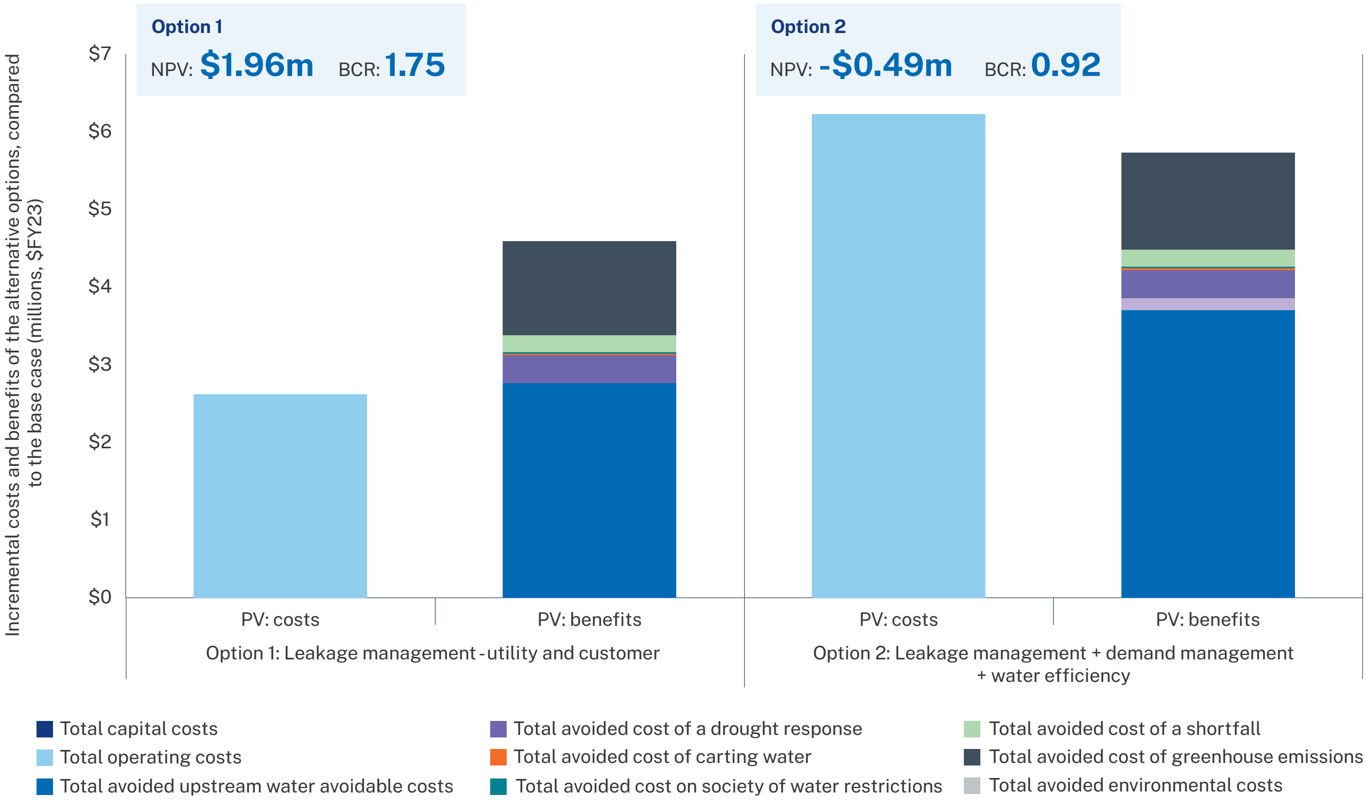


Figure 95: Case study B – indicative cost-benefit analysis results incremental to the base case – 3 per cent discount rate (NPV terms, $FY23 millions)



A7.7 Distribution of costs and benefits

Option 2 is the preferred option from a CBA perspective because it delivers the greatest net benefit to the community. This analysis has focused on the distribution of the incremental costs and benefits of Option 1, compared to the base case.

The indicative distributional analysis captured in **Figure 94** and **Table 18** illustrate the following:

- The incremental costs (below the Y axis) of water conservation are borne by the local community. We have assumed the upfront and ongoing costs of Option 1 will be recovered through regulated water levied on customers and therefore will be borne by the local community, that is, the water utility's customer base.[81] In reality, some of these measures may be funded through other means, such as government grants.
- The majority of the benefits of water conservation (above the Y axis) are received by the local community, primarily in the form of reduced water costs. This results in lower overall prices relative to the base case to meet service levels and the avoided social impact of drought. Avoided drought-response measures include restrictions. The primary beneficiary of these avoided costs within the local community will be specifically the small proportion of water customers who use less water and pay lower water charges as a result of installing these water conservation measures.[82] Other minor qualitative benefits, such as avoided input costs associated with water-intensive appliances, primarily accrue to the local community and more specifically those customers installing these water conservation measures.
- The other benefits of water conservation (above the Y axis) are in the form of avoided costs of greenhouse emissions. The NSW community receives these.

81 The *Regulatory and Assurance Framework for Local Water Utilities* expects Local water utilities to undertake strategic planning to a reasonable standard, which among others, includes implementing sound pricing and prudent financial management. It includes guidance on cost recovery mechanisms that provide efficient pricing signals. See website here: www.water.nsw.gov.au/__data/assets/pdf_file/0008/548630/guidance-implement-sound-pricing-and-prudent-financial-management.PDF

82 Noting that residential customers installing these water conservation measures will likely to result in limited to no reduction in wastewater bills as usage is not metered.

This highlights that the local community in the form of water customers are both the primary impactors and beneficiaries of these water conservation measures in line with the standard funding hierarchy set out in **Section 9.1**. However, the broader NSW community is a beneficiary of avoided greenhouse emissions from these water conservation measures. We note that some of the qualitative costs or benefits may accrue to local water utilities or the broader regional or NSW community. These include improved reputation and the mental health benefits of reduced risk of a supply shortfall.

Figure 96: Case study B – indicative distributional results incremental to the base case – Option 1 (NPV terms, $FY23 millions)

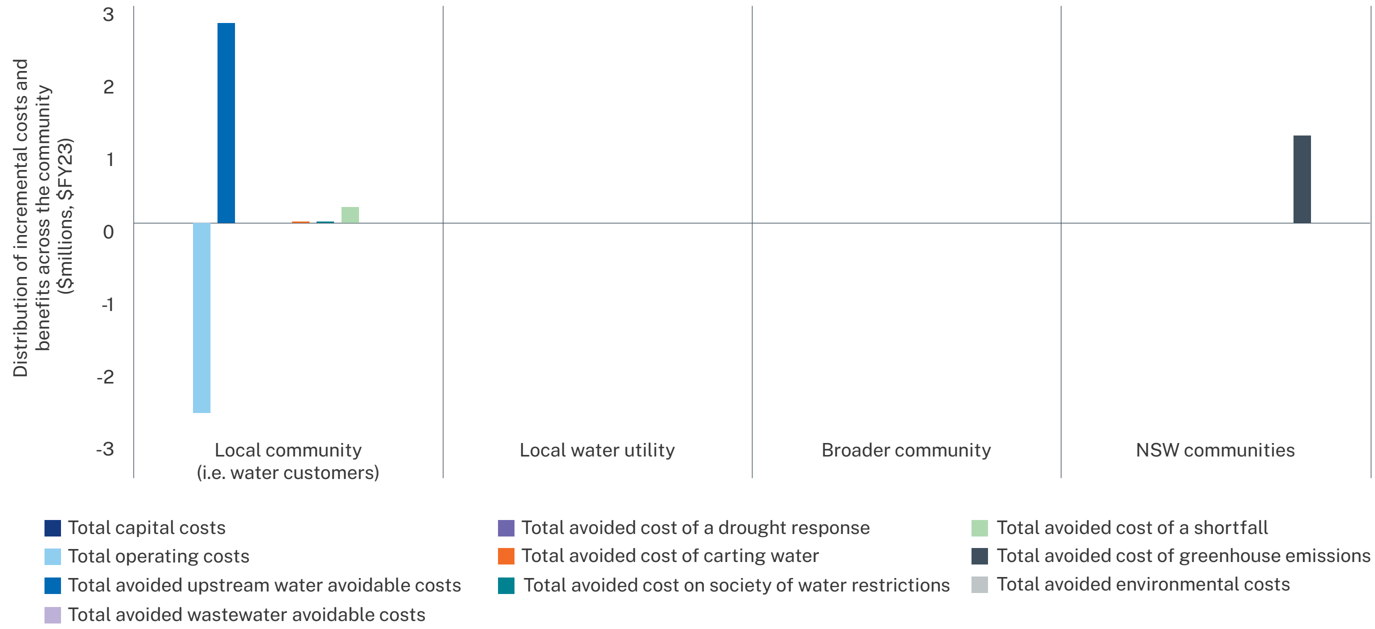


Table 18: Case study B – indicative distributional analysis incremental to the base case – Option 1 (NPV terms, $FY23 millions)

	Local community	Local water utility	Broader community	NSW communities
Total capital costs	**$–**	$–	$–	$–
Total operating costs	**-$2.10**	$–	$–	$–
Total avoided upstream water avoidable costs	**$1.96**	$–	$–	$–
Total avoided cost of carting water	**$0.02**	$–	$–	$–
Total avoided cost on society of water restrictions	**$0.01**	$–	$–	$–
Total avoided cost of a shortfall	**$0.16**	$–	$–	$–
Total avoided cost of greenhouse emissions	$–	$–	$–	**$0.86**