Department of Climate Change,
Energy, the Environment and Water

Case study A – Water conservation cost-benefit analysis in a metropolitan coastal community with a large 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*.

Contents

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 6: Case study A – Large metropolitan coastal 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.

A6.1 Problem definition

Case study A assumes a coastal metropolitan water utility seeking to deliver water security to customers (circa 750,000 households). All options (or portfolios) must balance supply and demand over time to 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").

A6.2 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. This compares 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 dam) and the same supply side (desalination) and demand side (restrictions) under the drought-response plans. However, Option 1 and Option 2 involve *additional* (but different) water conservation measures to complement these BAU measures.

The **2** alternative options have been 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 under the long term and drought-response plan) 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.

As shown in **Figure 77**, these are the options tested as part of this CBA:

- **Base case**, BAU approach to managing supply and demand including construction of dam to manage growth in demand and use of water restrictions with potential for investment in climate-independent supply (such as desalination) 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[73], however, these measures may be delayed as a result of water conservation.
- **Option 2: Additional demand management, water efficiency, and rainwater tanks.** 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.

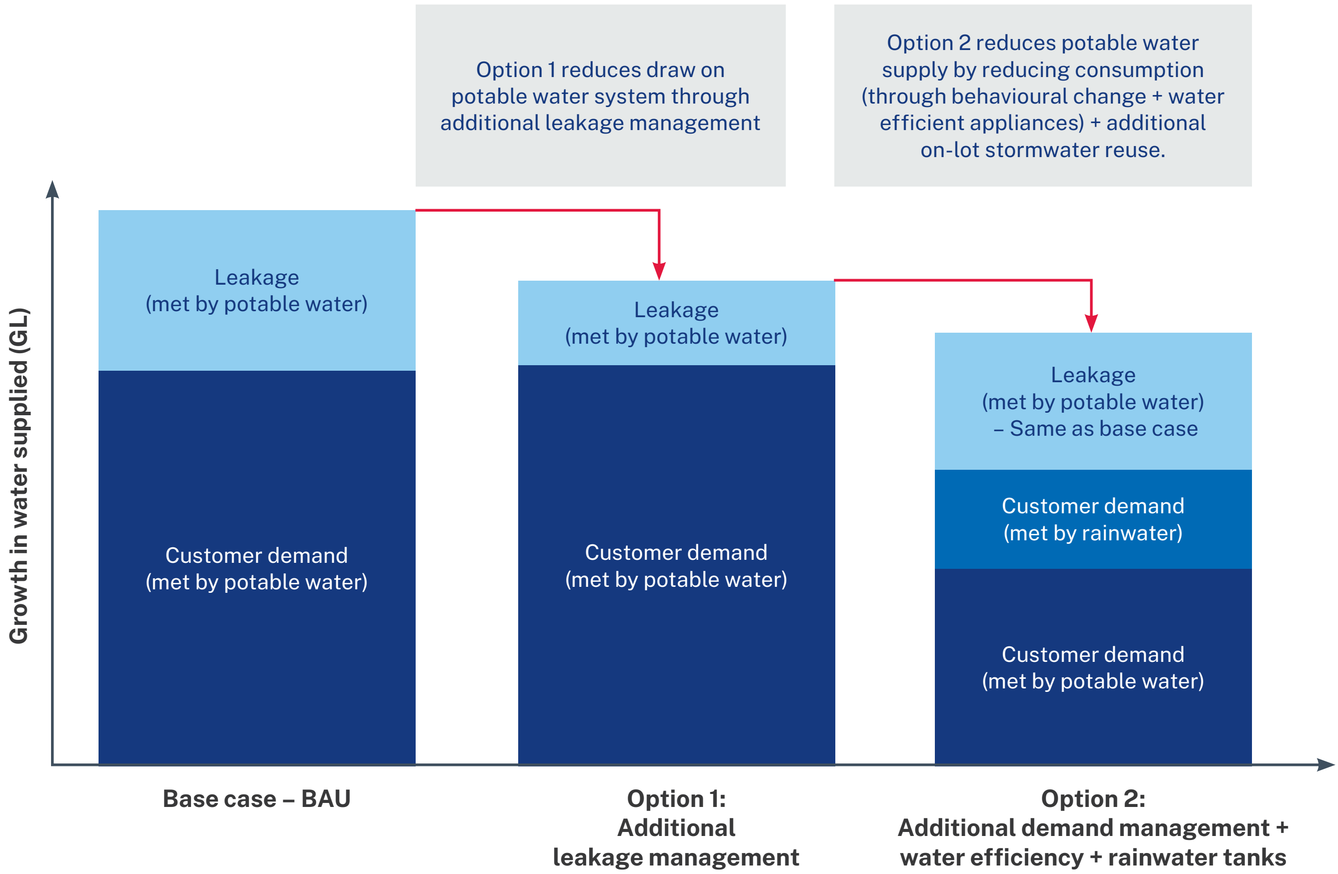
73 i.e., the dam will still be the primary long-term measure with water restrictions and potential for emergency climate independent supply (desalination) as the drought-response measure under options 1 and 2.

Figure 77: Case study A – indicative options

	Base case – business as usual	Option 1: Additional leakage management	Option 2: Additional demand management + water efficiency + rainwater tanks
LONGER-TERM PLAN	**Business-as-usual** approach to managing supply and demand including construction of a dam.	Increased utility and customer leakage management. Residual demand met as per **base case**.	Additional education/rules to reduce baseline consumption + water efficient appliances + on lot stormwater reuse. Residual demand met as per **base case**.
DROUGHT-RESPONSE PLAN	Water restrictions, and then potential for investment in emergency climate-independent supply (such as desalination) as storages fall.	As per **base case**.	As per **base case**.

As shown in the indicative water balance in **Figure 78**, 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 78: Case study A – 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 on potable water supplies in Option 1 may be smaller. Similarly, the customer demand met by rainwater is also shown in this indicative water balance to be relatively high for illustrative purpose only, and in practice the impact of rainwater tanks 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 (albeit deferred) for investment in supply side measures as part of a long-term plan to meet forecast growth in demand in this case study (see **Figure 79**). This is in addition to measures required under the drought-response plans (**Figure 80**).

Figure 79: Case study A – timing of supply side and demand side measures under long-term plan

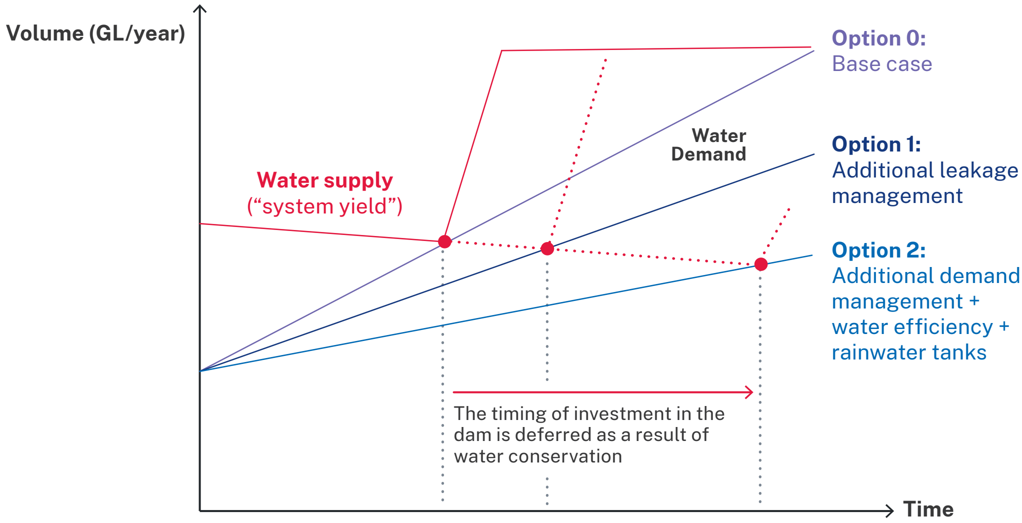
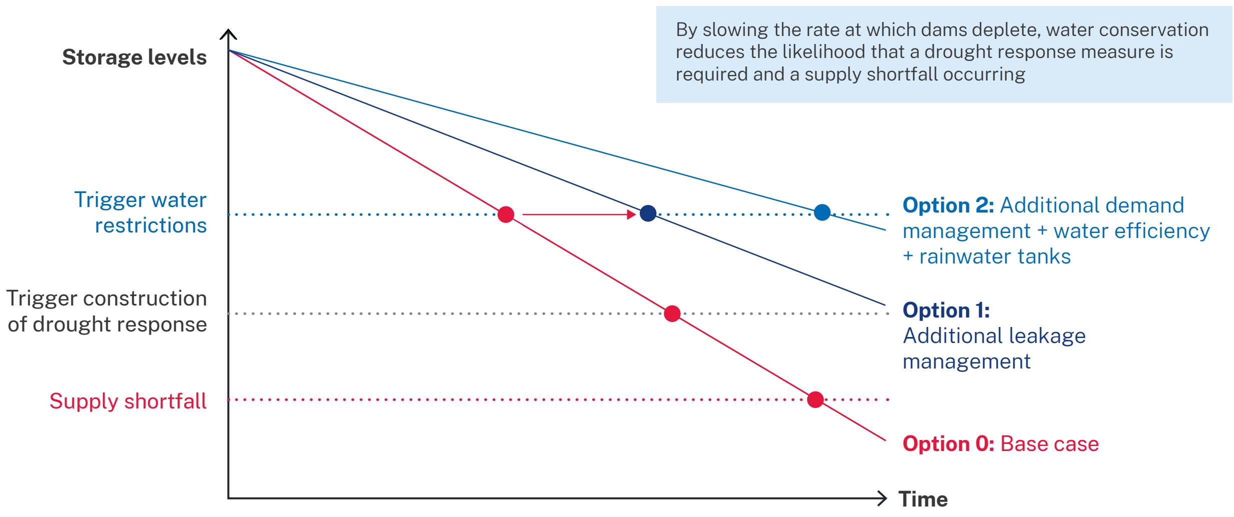


Figure 80: Case study A – drought-response plan



A6.3 Benefit and costs categories

Table 15 outlines the relevant costs and benefits for case study A.

Table 15: Case study A – indicative costs and benefits

Cost or benefit	Change in outcomes (ΔQ)	Change in price (P)	Change in likelihood (ΔL)
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.	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.	N/A
Avoided costs of managing water quality events	Captured qualitatively		
Avoided costs of stormwater management	Captured qualitatively		
Costs of water conservation	N/A	Estimate of incremental cost of the water conservation measure(s), including capital, operating, and administration costs.	N/A
Cost of climate-independent water supply (for example, desalination plant) as part of drought- response plan	N/A	Estimated cost of construction and operation of a desalination plant.	Change in likelihood of triggering a drought response.
Avoided cost of water restrictions as part of drought- response plan	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 administering water restrictions as part of drought- response plan	Captured qualitatively		
Avoided cost of a shortfall	Size of the shortfall (in kL).	Community WTP to avoid a shortfall.	Change in likelihood of a shortfall.
Improved biodiversity and waterway health	Change in length of healthy waterway.	Community WTP for improvements in waterway health.	N/A
Recreation opportunities	Captured qualitatively		
Amenity benefits	Captured qualitatively		
Avoided health costs related to urban heat	Captured qualitatively		
Avoided health costs related to inactivity	Captured qualitatively		
Avoided mental health costs of reduced risk of drought	Captured qualitatively		

A6.4 Inputs and assumptions

- Population = 3 million.
- Total annual potable water demand is assumed to be about 300GL per year.
- Drought response = water restrictions followed by construction and operation of a desalination plant.
- The LRMC of water and wastewater is relatively high ($2.00/kl and $2.00/kl respectively) because the systems are capacity constrained.
- Estimated cost of drought-response desalination plant = $250 million.
- Leakage management on the utility and customer side of the meter is assumed to cost $4 million per year. The leakage management is assumed to reduce water supplied by about 10 per cent by the end of the modelling period.
- Demand management in terms of behavioural change is administered through education programs and is assumed to cost $200,000 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 over the modelling period.
- Water efficiency is administered through the installation and use of water-efficient showerheads and washing machines. We have assumed both appliances are administered via a rebate scheme. The cost of each rebate scheme is $300,000 and $187,500 per year. For the purpose of case study A, we have assumed water-efficient showerheads are administered to 20 per cent of households and water-efficient washing machines are administered to 5 per cent of households over the modelling period.
- Rainwater tanks are administered via a scheme whereby households receive a rebate for the installation of a 4000kL tank. Rainwater tanks cost $4000 each, with half the costs paid by the LWU through a rebate scheme. For the purpose of case study A, we have assumed rainwater tanks are administered to 2 per cent of households per year.

A6.5 Cost-benefit analysis results

We summarise the CBA results in **Figure 81** below, outlining both the present value of incremental costs and present value of incremental benefits for each option. It shows that Option 1 and Option 2 both deliver a net benefit to society as the NPV > 0 and BCR > 1 at a discount rate of 5 per cent. In other words, the incremental benefits of additional water conservation to complement the other existing measures outweighs the additional costs.

As the NPV of Option 1 ($399m) is greater than the NPV of Option 2 ($164m), Option 1 delivers the greatest value to the community, and therefore, 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 investments under the long-term plan are larger than the avoided costs associated with triggering a drought response.[74]
- The avoided wastewater costs associated with water conservation reducing the volume of wastewater transported through and treated in the wastewater network.

As noted above, these results do not indicate whether there is value in pursuing other measures that could substitute for or complement water conservation (such as large-scale recycling) in providing an acceptable level of water security.

74 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) because water conservation in this case study leads to a relatively small change in the likelihood of these drought-related events occurring.

Figure 81: Case study A – indicative cost-benefit analysis results incremental to the base case (NPV terms, $FY23, millions)

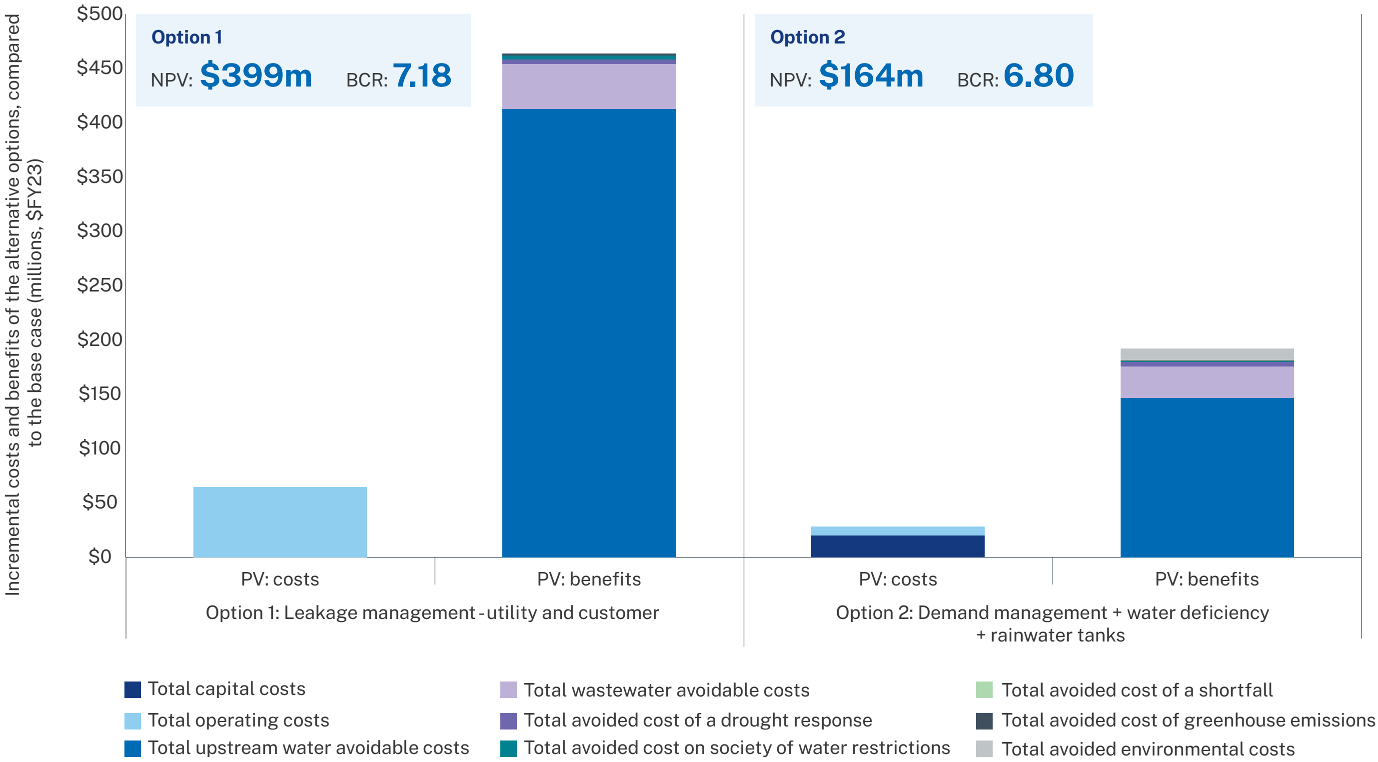


Table 16: Case study A – indicative cost-benefit analysis results incremental to the base case (NPV terms, $FY23, millions)

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		$–	-$20.18
Total operating costs		-$64.56	-$8.07
Total upstream water avoidable costs		$412.74	$146.44
Total wastewater avoidable costs		$41.27	$29.29
Total avoided cost of a drought response		$3.87	$3.87
Total avoided cost on society of water restrictions		$3.90	$1.13
Total avoided cost of a shortfall		$0.09	$0.13
Total avoided cost of greenhouse emissions		$1.71	$0.86
Total avoided environmental costs		$–	$10.47
Net present value		**$399.03**	**$163.94**
Benefit cost ratio		**7.18**	**6.80**

We analyse the qualitative costs and benefits of each option in **Table 17**. As the qualitative impacts are expected to be of minor benefit, we anticipate the results of the qualitative assessment will not change the preferred option identified above, nor the broad finding that, in this case study, additional water conservation in the form of additional leakage management (Option 1) delivers additional value to the community.

Table 17: Case study A – indicative cost-benefit analysis results – qualitative costs and benefits

Impact	Summary	Likely materiality
Economic costs and benefits		
Avoided cost of stormwater management	The use of rainwater tanks under Option 2 can reduce the volume of stormwater managed downstream of the premises. This can reduce the cost of managing stormwater. However, the proposed coverage of this water conservation measure is relatively small, and so will derive a minor benefit in reducing the volume of stormwater managed downstream.	Option 2: Minor benefit
Avoided cost of managing a water quality event	The use of a portfolio of water conservation measures under Option 1 and Option 2 can reduce draw on the potable water system, thereby reducing 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 household spend on detergents, resulting in an avoided cost saving to water customers under Option 2.	Option 2: Minor benefit
Social costs and benefits		
Amenity and recreation opportunities	The water conservation measures considered under Option 1 and Option 2 can create additional amenity and recreation 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 space. As such, the recreation benefit relates to reducing the time in which the space is not useable because it "browns off".	Option 1 + Option 2: Minor benefit
Avoided health costs related to urban heat	The water conservation measures considered under Option 1 and Option 2 can contribute to avoided health costs associated with urban heat by allowing for the regular Irrigation of open space and tree canopy. However, the materiality of this benefit will depend on the scale of the intervention (that is, influencing urban heat requires large-scale irrigation).	Option 1 + Option 2: Minor benefit
Avoided health costs related to inactivity	The use of water conservation under Option 1 and Option 2 can increase opportunity for active recreation (as discussed above) and reduce the risk of inactivity-related diseases and additional costs to the healthcare system.	Option 1 + Option 2: Minor benefit
Avoided mental health costs	Reducing exposure to drought-related economic stressors could reduce the risk of declining mental health outcomes in affected individuals. The water conservation portfolios considered under Option 1 and Option 2 can reduce the likelihood of a shortfall on society and the associated impacts on affected people's mental health.	Option 1 + Option 2: Minor benefit

A6.6 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 capital and operating costs of water conservation (as seen in **Figure 82**)
- 20 per cent decrease in capital and operating costs of water conservation (as seen in **Figure 83**)
- higher (7 per cent) and lower discount rates (3 per cent) relative to the recommended central estimate (5 per cent) (as seen in **Figure 84** and **Figure 85**).

The results of the sensitivity tests, outlined below, indicate that the results of the CBA are robust to changes in capital costs and discount rates. In other words, the options continue to deliver value to the community under some alternative states of the world and assumptions. They perform better than the base case under the risk and uncertainty analysis.

This scenario analysis has not tested other risks from other 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, the impact of other uncertainties that could be tested through more complex analysis, such as real options analysis, have not been tested in this section. 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 (such as 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 82: Case study A – indicative cost-benefit analysis results incremental to the base case – 20 per cent increase in costs (NPV terms, $FY23 millions)

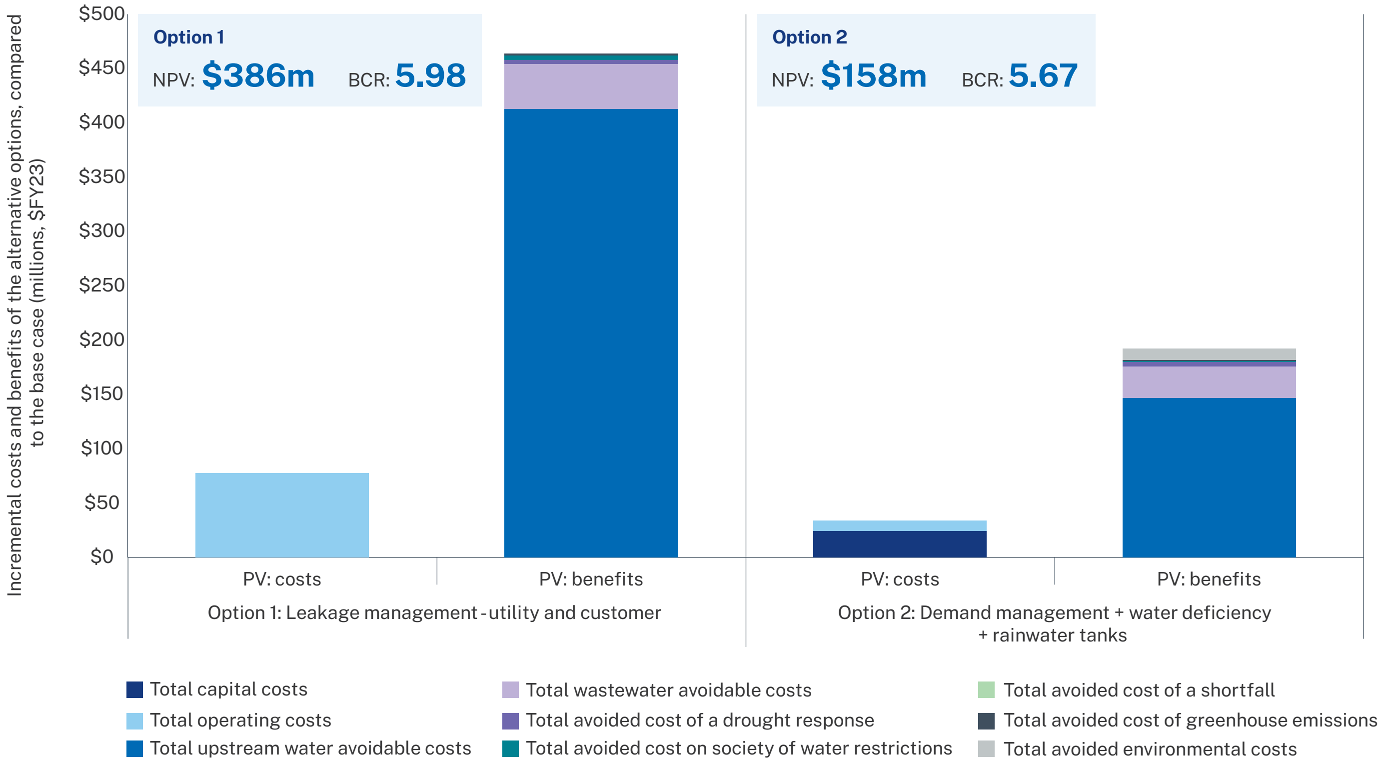


Figure 83: Case study A – indicative cost-benefit analysis results incremental to the base case – 20 per cent decrease in costs (NPV terms, $FY23 millions)

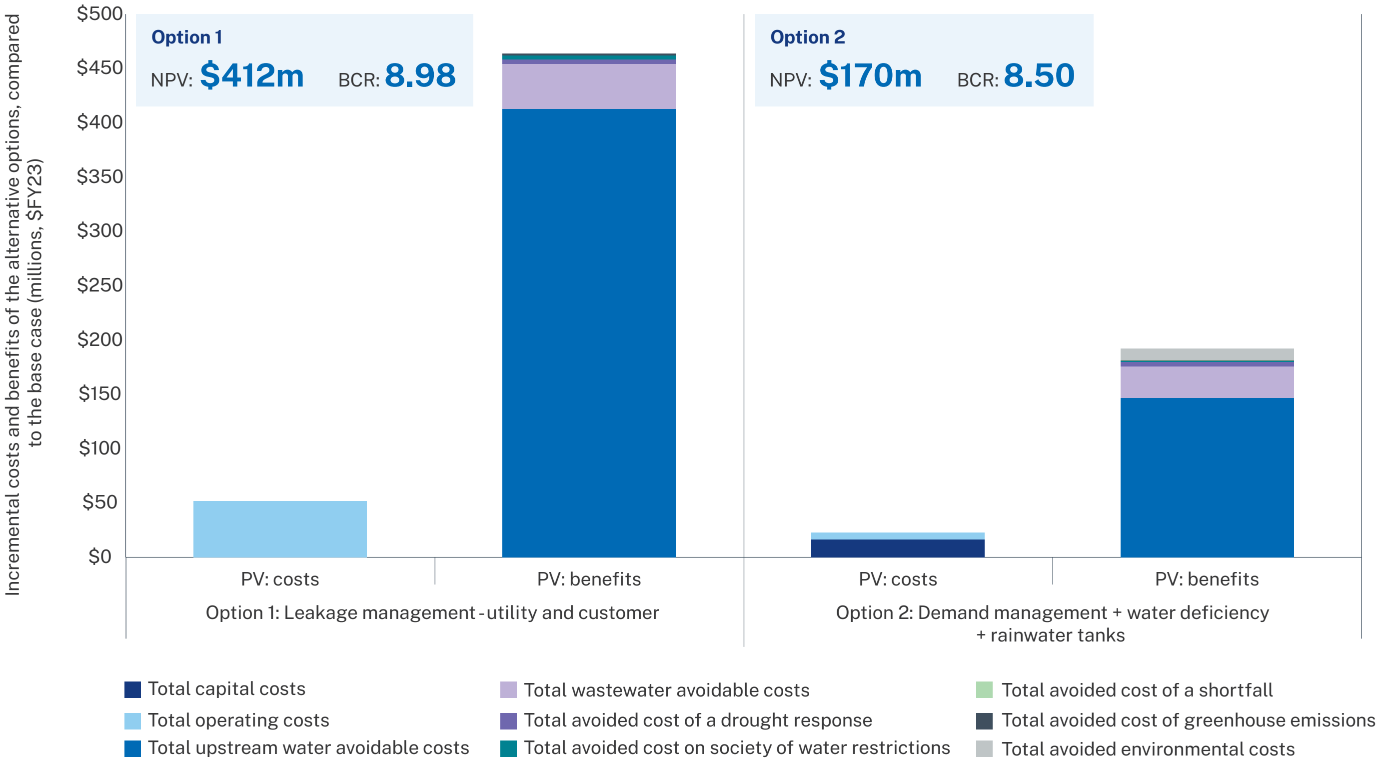


Figure 84: Case study A – indicative cost-benefit analysis results incremental to the base case – 7 per cent discount rate (NPV terms, $FY23 millions)

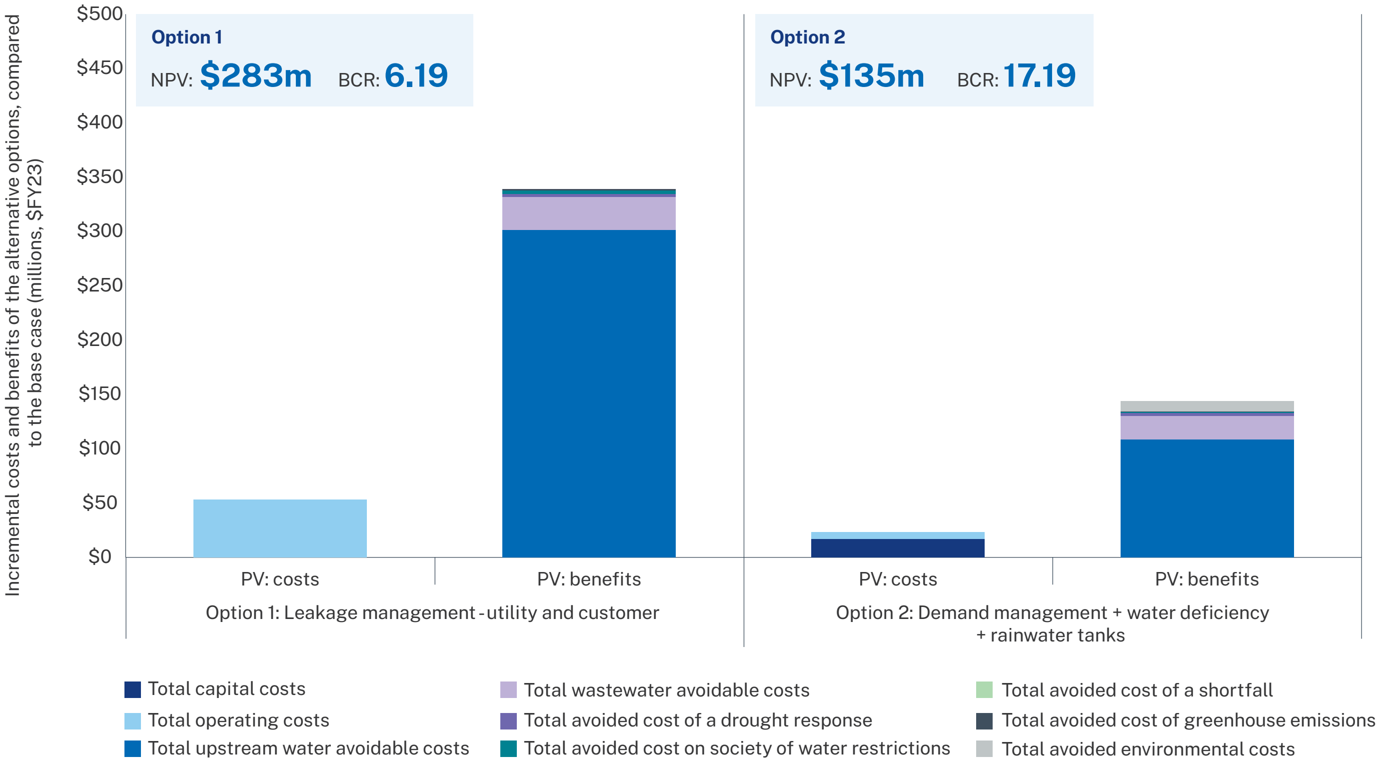
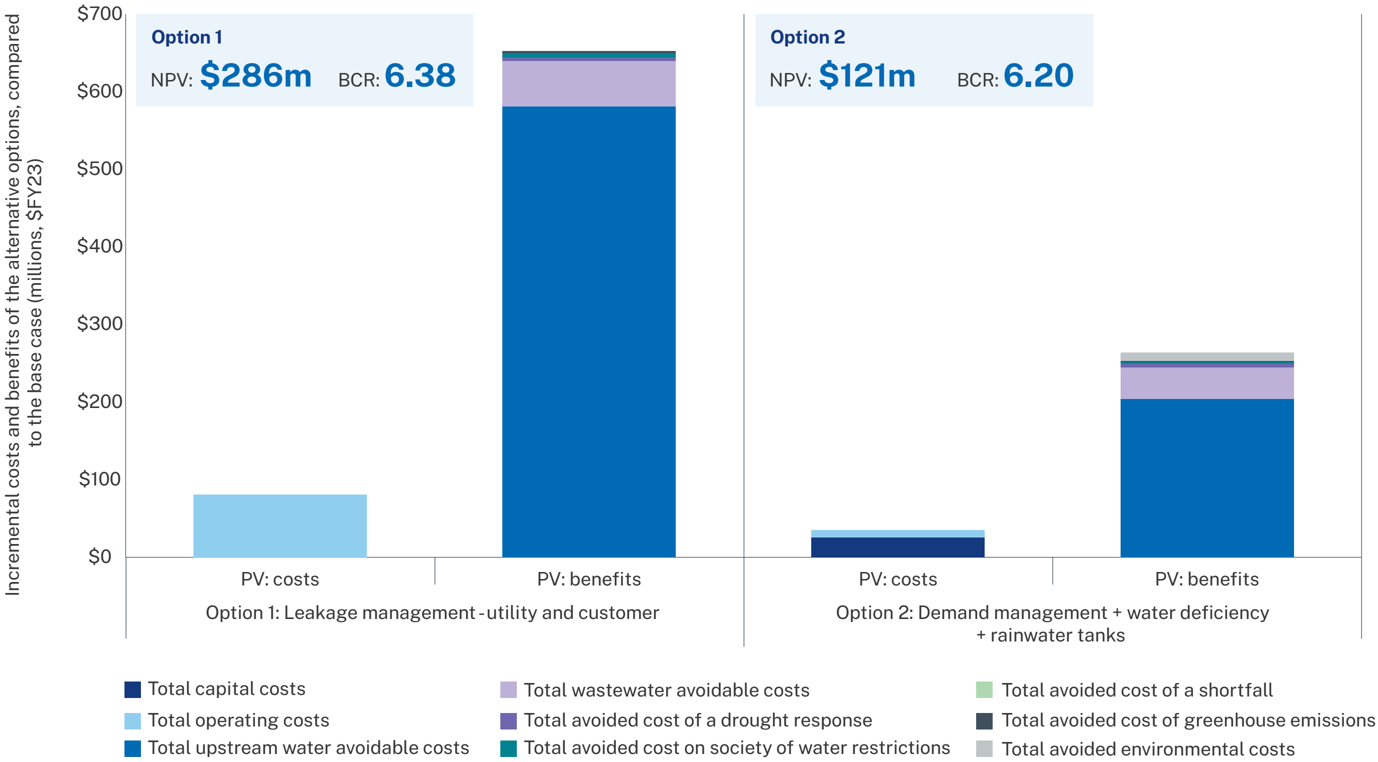


Figure 85: Case study A – indicative cost-benefit analysis results incremental to the base case – 3 per cent discount rate (NPV terms, $FY23 million)



A6.7 Distribution of costs and benefits

Option 1 is preferred 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.[75]

The indicative distributional analysis captured in **Figure 86** and **Table 18** illustrate that:

- 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 (in the form of additional expenditure to reduce water leakage on utility and customer side) will be recovered through regulated water prices levied on water customers and therefore will be borne by the local community. That is, the water utility's customer base.[76] In reality, some of these measures may be funded through other means, such as government grants.
- The local community receives the benefits of water conservation (above the Y axis), primarily in the form of reduced costs. This results in lower overall water prices relative to the base case to meet service levels and the avoided social impact of drought. Avoided drought-response measures include restrictions. Within the local community, customers who reduce leaks receive larger benefits because they will benefit from lower prices and lower billable usage.
- Other minor qualitative benefits, such as avoided input costs associated with water-intensive appliances, primarily accrue to the local community. More specifically, they accrue to those customers installing these water conservation measures.
- The other minor benefits of water conservation (above the Y axis) are in the form of avoided costs of greenhouse emissions. The NSW community receives this.

75 This means that costs and benefits relevant to Option2 (such as environmental benefits and the costs of rainwater tanks, including the rebate program which is split between the LWU and users) do not appear on this chart.

76 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

This highlights that the local community in the form of water customers are both impactors and beneficiaries of these water conservation measure in line with the standard funding hierarchy set out in **Section 8.1**. That is, the broader regional or NSW community is not a key impactor or beneficiary of these 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 86: Case study A – indicative distributional analysis incremental to the base case – Option 1 (NPV terms, $FY23 millions)

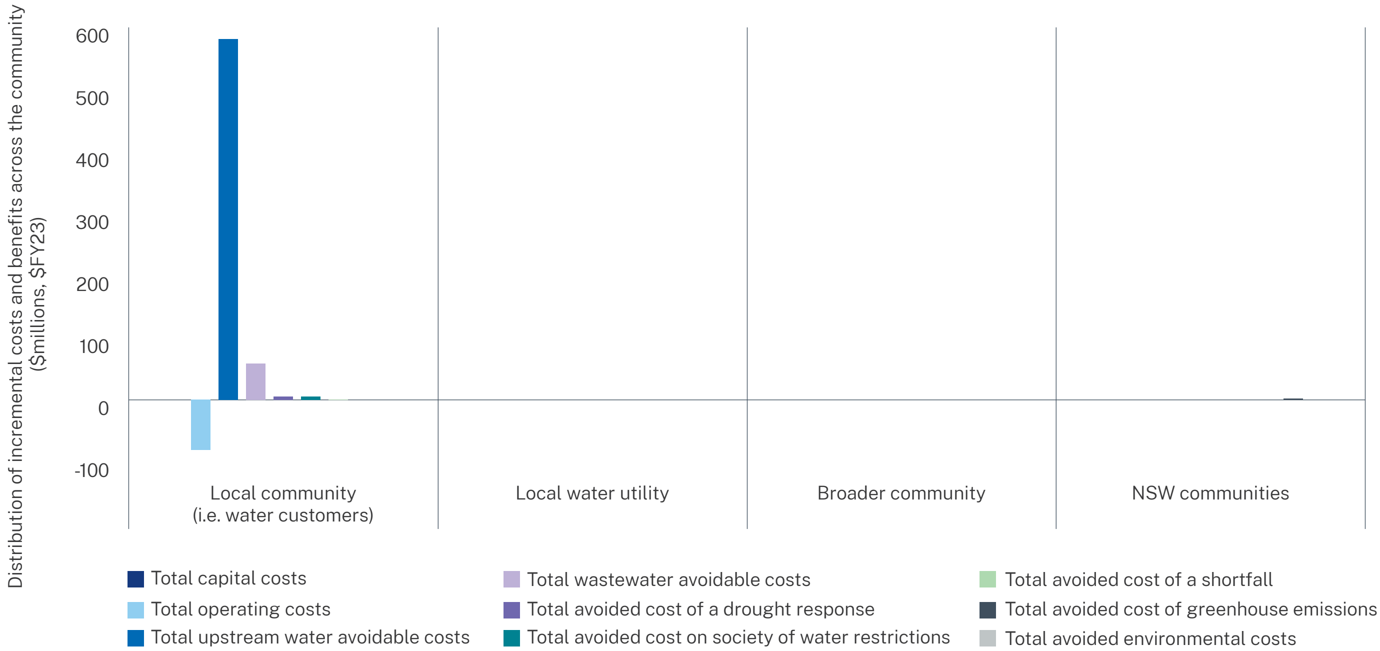


Table 18: Case study A – indicative distributional analysis incremental to the base case – Option 1 (NPV terms, $FY23 millions)

	Local community	Local water utility	Broader community	NSW communities
Total operating costs	**-$64.56**	$–	$–	$–
Total upstream water avoidable costs	**$412.74**	$–	$–	$–
Total wastewater avoidable costs	**$41.27**	$–	$–	$–
Total avoided cost of a drought response	**$3.87**	$–	$–	$–
Total avoided cost on society of water restrictions	**$3.90**	$–	$–	$–
Total avoided cost of a shortfall	**$0.09**	$–	$–	$–
Total avoided cost of greenhouse emissions	$–	$–	$–	**$1.71**