Department of Climate Change,
Energy, the Environment and Water

Case study C – Water conservation cost-benefit analysis in an inland community with a mid-size 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 8: Case study C – Mid-size 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.

A8.1 Problem definition

Case study C considers an inland local water utility seeking to deliver long-term water security to 15,000 customers.

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").

A8.2 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. Option 2 uses *additional* water conservation campaigns as part of the drought-response plan to align supply and demand.

All options involve the same investments in supply side measures under the long-term plan. Primarily this is construction of a pipeline to extract additional supply yield from existing water supplies, for example, joining existing dams. 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 have been designed to test the *additional value* that water conservation provides if it complements 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* (upfront and ongoing conservation costs). Importantly, the options and CBA results will *not* identify the need for, or value of, the existing measures.

Figure 97 shows the options tested as part of this CBA:

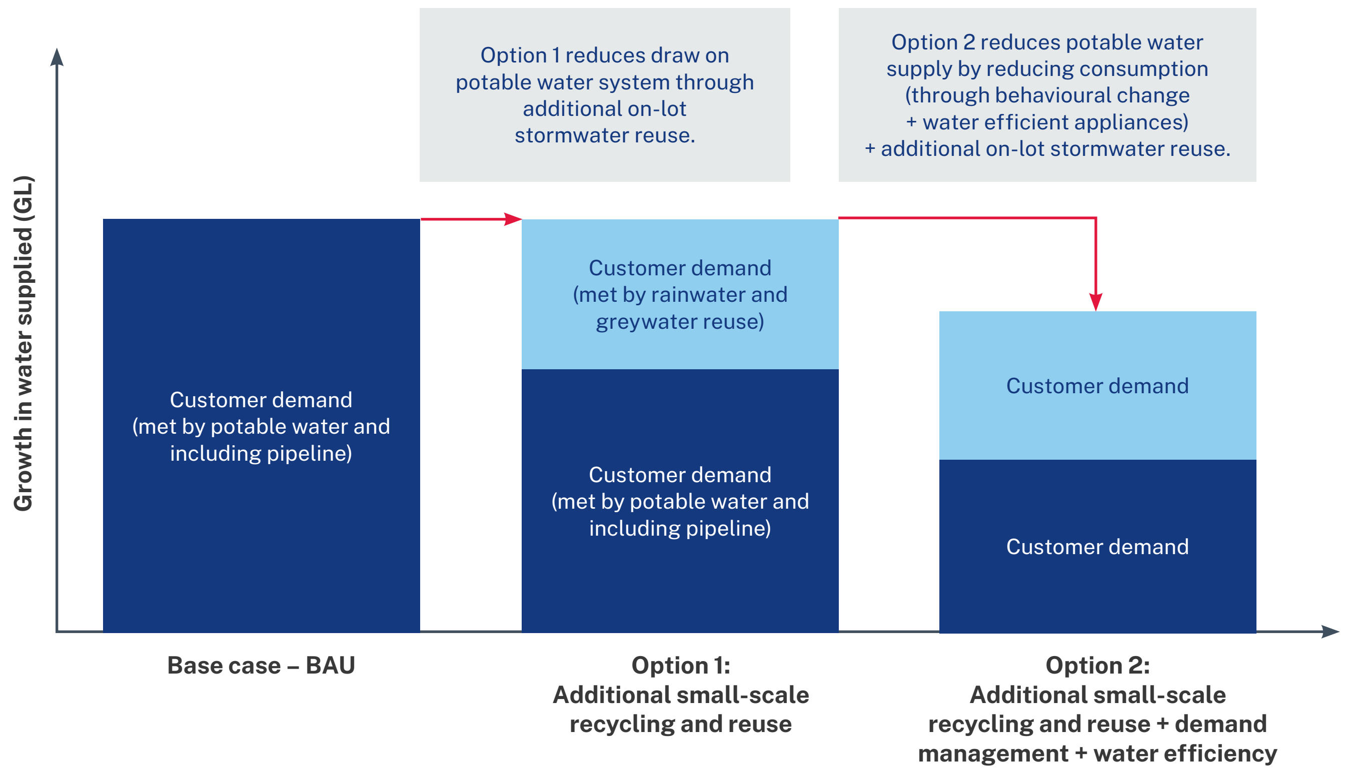
- **Base case,** BAU approach to managing supply and demand including construction of a pipeline to extract additional supply yield from existing water supplies, for example, joining existing dams. This has potential for water restrictions and additional pipeline operation as storages fall.
- **Option 1: Additional small-scale on-lot supply and reuse.** Rainwater tanks and on-lot recycling, including greywater. 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.
- **Option 2: Additional small-scale supply and reuse, 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.

Figure 97: Case study C – indicative options

	Base case – business as usual	Option 1: Additional small-scale reuse	Option 2: Additional small-scale reuse + demand management + water efficiency
LONGER-TERM PLAN	**Business-as-usual** approach to managing supply and demand including construction of a pipeline.	Additional on-lot stormwater reuse. Residual demand met as per **base case**.	On-lot stormwater reuse + education/ rules to reduce baseline consumption + water-efficient appliances. Residual demand met as per **base case**.
DROUGHT-RESPONSE PLAN	Water restrictions (including enforcement and education) and increased operation of pipeline.	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 **Figure 98**, 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 98: Case study C – indicative water balance



As a result, there will still be a role for investment in supply side measures, albeit deferred with water conservation. This would form part of a long-term plan to meet forecast growth in demand in this case study (see **Figure 99**), in addition to measures required under the drought-response plans (see **Figure 100**).

Figure 99: Case study C – the need for supply side and demand side measures under long-term plan

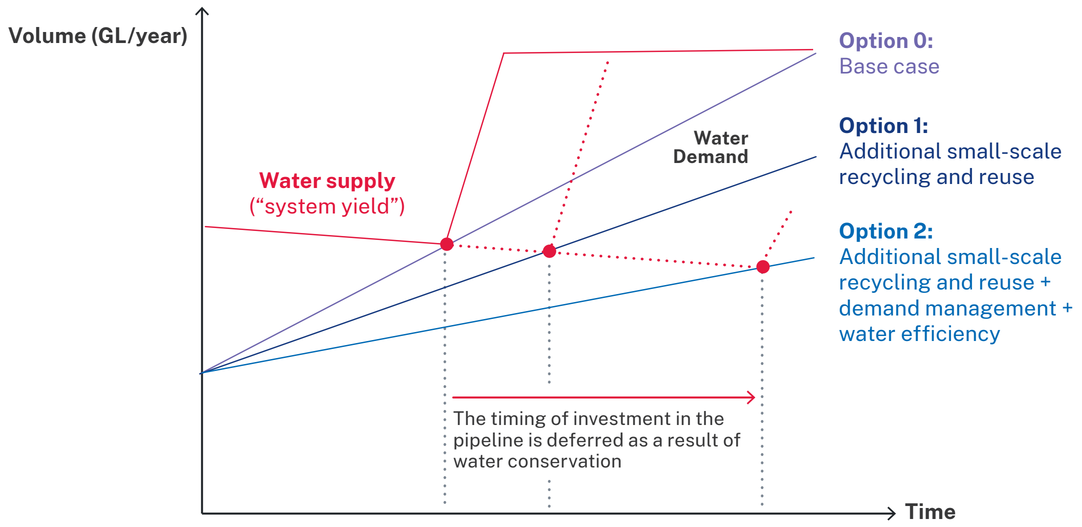
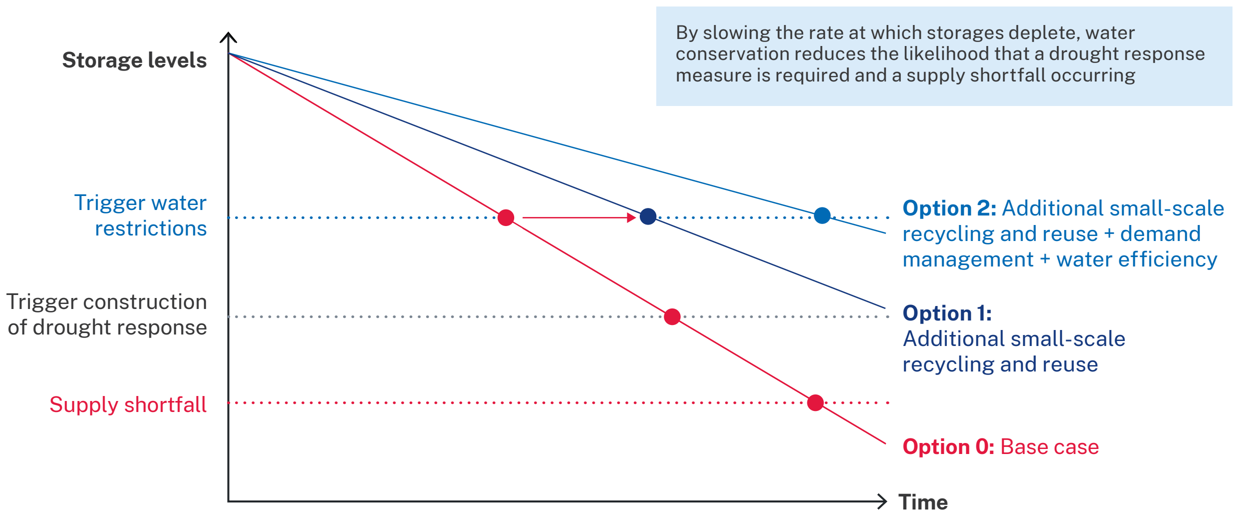


Figure 100: Case study C – Drought response plan



A8.3 Benefit and costs categories

Table 21 outlines the relevant costs and benefits for case study C.

Table 21: Case study C – 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 stormwater management	Captured qualitatively		
Avoided costs of managing a water quality event	Captured qualitatively		
Costs of water conservation	Water savings (in kL)	Incremental cost of the water conservation measure(s), including capital, operating, and administration costs.	N/A
Avoided cost of a drought-response (operation of pipeline)	N/A	Estimated cost of constructing and operating a pipeline.	Likelihood under different options.
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.	Likelihood of different stages of water restrictions.
Avoided cost of administering water restrictions	Captured qualitatively		
Avoided cost of a shortfall	Size of the shortfall (in kL).	Community WTP to avoid a shortfall.	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		

A8.4 Inputs and assumptions

- Population = 60,000.
- Total annual potable water demand 11.680ML.[83]
- Drought response = water restrictions followed and increased operation of a pipeline.
- The LRMC of wastewater is relatively high ($2.25/kL respectively) given the capacity constraints in the system.
- As the local water utility does not have a LRMC of water available, the usage price acts as a proxy, recognising the limitations of doing so. The usage price is relatively high given the supply constraints of the system ($2.5/kL).
- Estimated cost of drought response = $80 million.
- Small-scale supply and reuse is administered through rainwater tanks and the on-lot reuse of "grey" wastewater from washing machines, showers, and/or sinks. For the purpose of case study C, we have assumed small-scale supply and reuse reaches 20 per cent of households over the modelling period. We assume small-scale recycling and reuse to cost $300,000 per year.
- Demand management is administered through education programs and is assumed to cost $10,000 per year. We assume 30 per cent of households are captured under this water conservation measure over the modelling period.
- Water efficiency is administered through the installation and use of water-efficient showerheads and washing machines. A rebate program funds the scheme. We have assumed water-efficient showerheads are administered to 10 per cent of households and water-efficient washing machines will be administered to 5 per cent of households over the modelling period. The cost of these measures is about $27,500 per year.[84] This does not include the costs of administering the scheme.

A8.5 Cost-benefit analysis results

Figure 101 below summarises the results of the CBA, outlining the present value of incremental costs and present value of incremental benefits for each option. It shows that Option 1 and Option 2 deliver a net benefit to society as the NPV > 0 and BCR > 1 at a 5 per cent discount rate. In other words, the incremental benefits of *additional* water conservation outweigh the *additional* costs. As the NPV of Option 2 ($7.61m) is greater than the NPV of Option 1 ($3.58m), Option 2 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.[85]

As noted early, 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.

83 This number has been adapted from the Albury Shire Council daily potable water consumption. Source: www.alburycity.nsw.gov.au/services/water-and-sewer/water-supply-and-management

84 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.

85 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 related events occurring.

Figure 101: Case study C – indicative cost-benefit analysis results incremental to the base case (NPV terms, $FY23 millions)

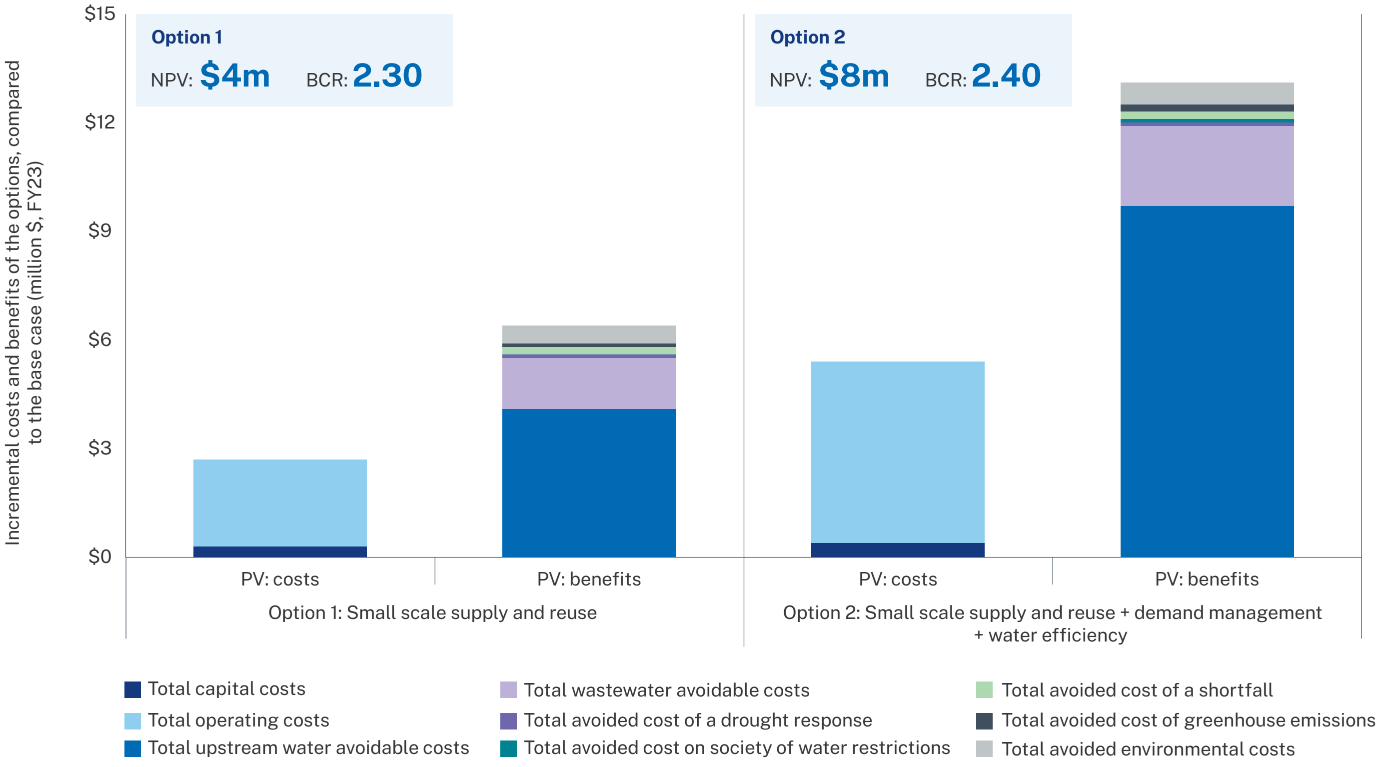


Table 22: Case study C – indicative cost-benefit analysis results incremental to the base case (NPV terms, $FY23, millions)

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		-$0.32	-$0.44
Total operating costs		-$2.42	-$5.00
Total upstream water avoidable costs		$4.06	$9.71
Total wastewater avoidable costs		$1.37	$2.18
Total cost of a drought response		$0.10	$0.10
Total cost on society of water restrictions		$0.02	$0.08
Total cost of a shortfall		$0.19	$0.19
Total cost of greenhouse emissions		$0.09	$0.21
Total avoided environmental costs		$0.51	$0.59
Net present value		**$3.58**	**$7.61**
Benefit cost ratio		**2.30**	**2.40**

Table 23 analyses the qualitative costs and benefits of each option. Because most of the qualitative impacts are expected to be of minor benefit, except for the additional cost of administering the rebate scheme, 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, additional water conservation delivers additional value to the community.

Table 23: Case study C – 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 small-scale stormwater reuse and rainwater tanks under Option 1 and Option 2 can reduce the volume of stormwater managed downstream of the premises. This can reduce the cost of managing stormwater. However, understanding the materiality of this benefit requires site-specific information on the proposed stormwater solution and how it would change as a result of the water conservation measure. This can be challenging to access.	Option 1 + Option 2: Moderate benefit
Avoided cost of managing a water quality event	By reducing draw on the potable water system, Option 1 and Option 2 can reduce the costs of managing a water quality event because households are consuming less water.	Option 1 + Option 2: Minor benefit
Avoided cost of administering water restrictions	Small-scale supply and re-use can decrease the rate at which storage levels deplete and the likelihood of administering water restrictions, resulting in an avoided cost saving for the utility.	Option 1 + 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 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 regular irrigation of open space and tree canopy reduces urban temperatures. In this way, water conservation measures can contribute to avoided health costs associated with urban heat, for example, loss in productivity due to extreme heat. 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	By reducing the likelihood of water restrictions and shortfall, water conservation can reduce exposure to drought-related economic stressors and declining mental health outcomes in affected individuals.	Option 1 + Option 2: Minor benefit

A8.6 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 costs (as seen in **Figure 102**)
- 20 per cent decrease in capital costs (as seen in **Figure 103**)
- higher and lower discount rates (7 per cent/3 per cent) (as seen in **Figure 104** and **Figure 105**).

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, the options continue to deliver value to the community under alternative assumptions. That is, 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, or 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) or 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 102: Case study C – indicative cost-benefit analysis results incremental to the base case – 20 per cent increase in costs (NPV terms, $FY23 millions)

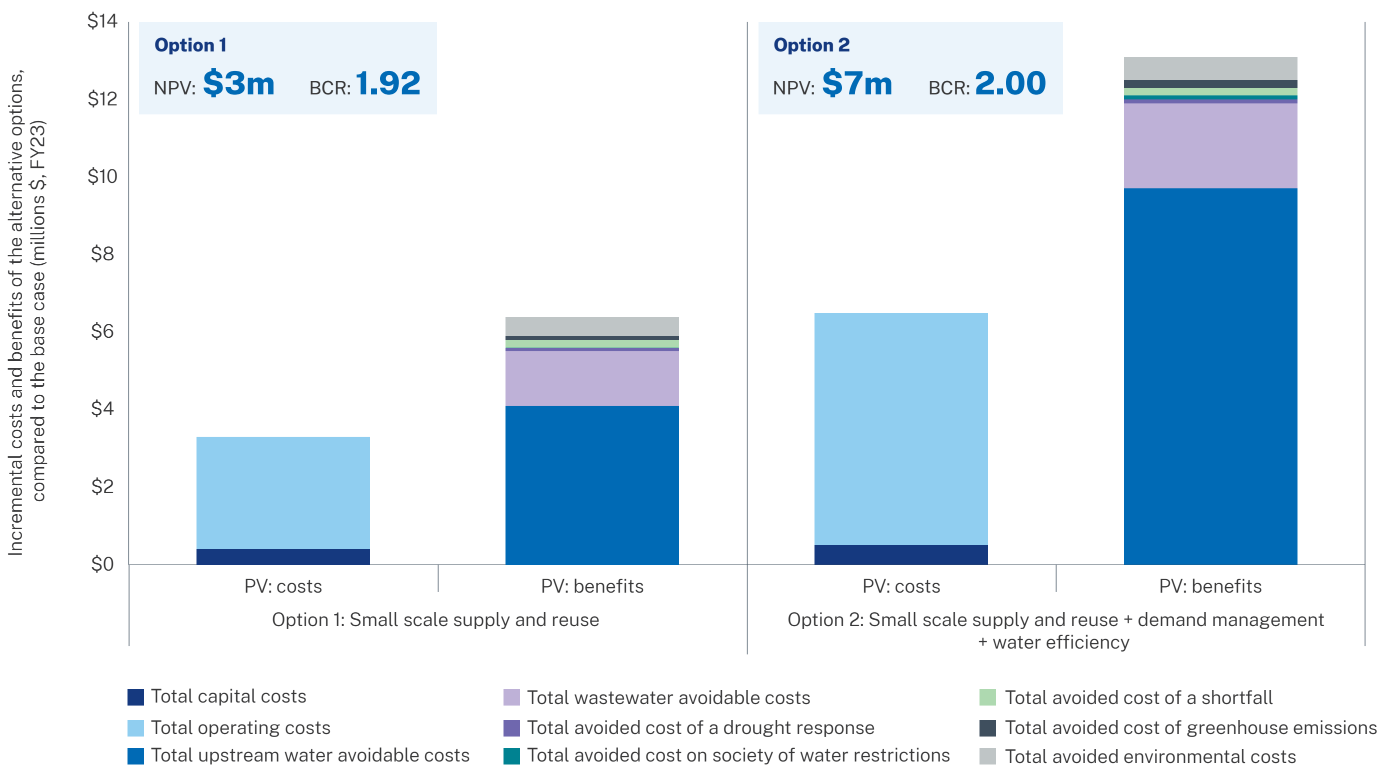


Figure 103: Case study C – indicative cost-benefit analysis results incremental to the base case– 20 per cent decrease costs (NPV terms, $FY23 millions)

Figure 104: Case study C – indicative cost-benefit analysis results incremental to the base case – 7 per cent discount rate (NPV terms, $FY23 millions)

Figure 105: Case study C – indicative cost-benefit analysis results incremental to the base case – 3 per cent discount rate (NPV terms, $FY23 millions)

A8.7 Distribution of costs and benefits

Option 2 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 2, compared to the base case:

- The indicative distributional analysis captured in **Figure 106** 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 2 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.[86] 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. This is primarily in the form of reduced costs and therefore 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. Other minor qualitative benefits, such as avoided input costs associated with water-intensive appliances, primarily accrue to the local community. Specifically, they accrue to customers installing water-efficient appliances.
- The other minor benefits of water conservation (above the Y axis) are in the form of avoided waterway health impacts and avoided costs of greenhouse emissions received by the broader and NSW community.

86 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 the primary impactors and beneficiaries of these water conservation measure 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. This includes improved reputation and the mental health benefits of reduced risk of a supply shortfall.

Figure 106: Case study C – indicative distributional analysis incremental to the base case – Option 2 (NPV terms, $FY23 millions)

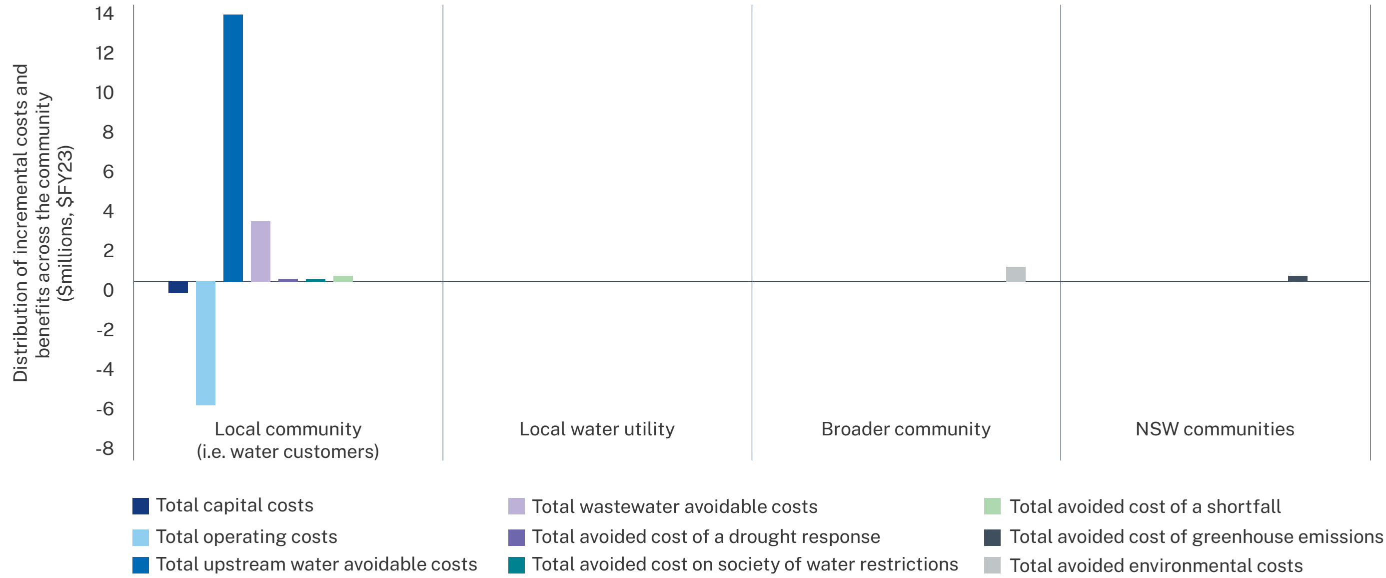


Table 18: Case study C – indicative distributional analysis incremental to the base case – Option 2 (NPV terms, $FY23 millions)

	Local community	Local water utility	Broader community	NSW communities
Total capital costs	-$0.44	$–	$–	$–
Total operating costs	-$5.00	$–	$–	$–
Total upstream water avoidable costs	$9.71	$–	$–	$–
Total wastewater avoidable costs	$2.18	$–	$–	$–
Total avoided cost of a drought response	$0.10	$–	$–	$–
Total avoided cost on society of water restrictions	$0.08	$–	$–	$–
Total avoided cost of a shortfall	$0.19	$–	$–	$–
Total avoided cost of greenhouse emissions	$–	$–	$–	$0.21
Total avoided environmental costs	$–	$–	$0.59	$–