Department of Planning and Environment

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Guidance on strategic planning outcome - Understanding solutions to deliver services

Regulatory and assurance framework for local water utilities

November 2022

Acknowledgement of Country

The Department of Planning and Environment acknowledges that it stands on Aboriginal land. We acknowledge the Traditional Custodians of the land and we show our respect for Elders past, present and emerging through thoughtful and collaborative approaches to our work, seeking to demonstrate our ongoing commitment to providing places in which Aboriginal people are included socially, culturally and economically.

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Contents

1.Introduction

Local water utilities can best meet the needs of their customers, and manage key risks, when their decisions and activities are based on effective, evidence-based strategic planning.

The NSW Department of Planning and Environment is committed that all local water utilities should have in place effective, evidence-based strategic planning. This will ensure utilities deliver safe, secure, accessible, and affordable water supply and sewerage services to customers. It will also ensure they can manage keys risks now and into the future, and in the event of significant shocks. Local water utilities remain responsible for conducting strategic planning.

The department gives assurance of effective, evidence-based strategic planning. Local water utilities not making dividend payments[1] are encouraged, but not compelled, to use the department's assurance framework, experience and capacity to support effective strategic planning.

Through the department's assurance role under section 3 of the Regulatory and assurance framework for local water utilities (PDF, 1613.11 KB) - Regulatory and Assurance Framework - we establish what outcomes we expect effective, evidence-based strategic planning to achieve (see section 3.2 of the Regulatory and Assurance Framework) and assess if a utility's strategic planning achieves these outcomes to a reasonable standard (see sections 3.3 and 3.4 of the Regulatory and Assurance Framework).

We give separate, optional guidance in the department's guidance Using the Integrated Planning and Reporting framework for local water utility strategic planning (PDF, 573.33 KB) to explain how utilities can achieve the strategic planning outcomes to a reasonable standard using the *Integrated Planning and Reporting Framework* for councils under the *Local Government Act 1993*.

1.1. Purpose of this document

This document supplements the Regulatory and Assurance Framework and gives guidance on achieving the outcome of understanding solutions to deliver services to a reasonable standard.

This guidance is consistent with the objectives and principles established under the Regulatory and Assurance Framework, including being outcomes focused and risk-based.

This document sets out good practice for **all local water utilities** to apply when doing strategic planning to achieve the outcome of understanding solutions to deliver services.

1.2. Structure of this document

This guidance is structured providing:

[1] Sections 3 and 4 of the Regulatory and Assurance Framework, are also the Guidelines for council dividend payments for water supply or sewerage services, under section 409(6) of the *Local Government Act 1993*. Before taking a dividend payment from a surplus of the council's water supply and/or sewerage business, a council must have in place effective, evidence-based strategic planning in accordance with section 3 of the Regulatory and Assurance Framework.

- the expectations for achieving this outcome to a reasonable standard
- an appendix with optional ‘how to’ guidance that helps utilities achieve assurance expectations
- an appendix providing templates, case studies and tools useful for utilities to achieve assurance expectations.

1.3. Review of this guidance

As part of our commitment to continuous improvement, we will review the performance of the Regulatory and Assurance Framework within 2 years from finalisation. There will also be periodic reviews of the full suite of relevant regulatory and assurance documents, which will happen at least every 5 years.

We welcome feedback on this guidance and will update it when needed based on feedback or a ‘lessons learned’ review following our assessment of strategic planning by local water utilities.

2. Oversight of local water utility strategic planning

Under section 3 of the Regulatory and assurance framework for local water utilities (PDF, 1613.11 KB), the department establishes what outcomes it expects effective, evidence-based strategic planning to achieve (see section 3.2) and assesses whether a local water utility's strategic planning achieves these outcomes to a reasonable standard (see sections 3.3 and 3.4).

Councils making a dividend payment from a surplus of their water and/or sewerage business must meet the expectations set out in section 3 and section 4 of the Regulatory and Assurance Framework.[2] Local water utilities not making dividend payments are encouraged, but not compelled, to utilise the department's assurance framework, experience and capacity to support effective strategic planning.

For effective, evidence-based strategic planning to occur, the department expects strategic planning to achieve the following outcomes to a reasonable standard:

- Understanding service needs
- Understanding water security
- Understanding water quality
- Understanding environmental impacts
- Understanding system capacity, capability and efficiency
- Understanding other key risks and challenges
- Understanding solutions to deliver services **(this guidance)**
- Understanding resourcing needs
- Understanding revenue sources
- Make and implement sound strategic decisions
- Implement sound pricing and prudent financial management
- Promote integrated water cycle management

A **reasonable standard** is met if the utility considers and addresses an outcome in a way that is:

- **sufficient:** underpinned by evidence-based analysis that supports the conclusions reached
- **appropriate:** underpinned by relevant departmental guidance and industry standard approaches to conduct planning and reach conclusions

[2] Sections 3 and 4 of the Regulatory and Assurance Framework, are also the Guidelines for council dividend payments for water supply or sewerage services, under section 409(6) of the *Local Government Act 1993.* Before taking a dividend payment from a surplus of the council's water supply and/or sewerage business, a council must have in place effective, evidence-based strategic planning in accordance with section 3 of the Regulatory and Assurance Framework.

- **robust:** underpinned by evidence that draws on appropriate sources and recognises and rebuts potential alternative interpretations.

The assessment considerations the department will apply and how these may be addressed are set out in more detail in the Regulatory and Assurance Framework.

3. Guidance on understanding solutions to deliver services

Under section 3.2 of the Regulation and Assurance Framework, the department expects utilities to achieve to a reasonable standard the strategic planning outcome **understanding solutions to deliver services**. This includes considering:

- How are options for delivering services and managing risks analysed?
- How are supply and demand side options for water supply identified and evaluated?
- How are assets managed over their life cycle to ensure service levels are met?
- How are the preparedness and resilience management during extreme events considered?

3.1. Understanding solutions to deliver services

In general, the department's expectations are that a local water utility:

- understands the economic, environmental, and social costs and benefits of viable options to deliver services
- considers adequately key risks and uncertainty, adaptability and resilience in its options evaluation and asset management.

This can assist the utility in optimally managing its risks, lowering costs and maximising the value of its investments to its customers over the long-term. It can also ensure the utility is fully informed when making strategic decisions and determining solutions to implement.

In the following sections we set out **what** the department's expectations are for **understanding solutions to deliver service** to a reasonable standard. In Appendix A and Appendix B, we provide optional guidance and case-studies and tools on **how** some of these expectations could be met.

3.2 How are options for delivering services and managing risks analysed?

The local water utility should base the development and evaluation of options for service delivery on its understanding of service needs – this is its service objectives

The first step in options development and evaluation is for the utility to clearly identify its service needs (that is, its objectives for service delivery). Clearly identifying and understanding the objectives is key to options analysis.

As set out in the guidance on the outcome of understanding service needs, this should generally be consistent with the requirements and expectations of regulators (which often determine minimum service levels or outcomes), and/or the values and preferences of customers (where service levels or outcomes are not mandated by regulation, or customers are willing to pay for service levels/outcomes above minimum levels mandated by regulation).

Separate guidance relating to service needs (objectives) is given in the guidance on the outcomes of understanding service needs, water quality, water security, and environmental impacts.

The local water utility should identify all viable options for meeting service needs

The utility should identify and consider all viable options to achieve its service needs, to ensure it ultimately identifies the option that delivers the greatest net benefit to the community. This should include consideration of viable supply and demand side options, including options that promote integrated water cycle management (see guidance on the outcome of promote integrated water cycle management).

This could initially include a broader consideration of potential options and refining this long-list against transparent criteria. The appendices provide added optional guidance on:

- evaluating an initial long-list of options – using tools such as a multi-criteria analysis (MCA) or rapid cost benefit analysis (CBA)
- assessing a shortlist of options, using more detailed analysis including economic evaluation and consideration of risk, ideally applying cost benefit analysis (CBA).

The complexity of the analysis of the shortlisted options should vary depending on the complexity and significance of the decision being evaluated. For example, a simpler CBA – akin to a cost effectiveness analysis (CEA) – may be appropriate where a utility is confident that broader economic, social, and environmental outcomes are equivalent across the options. Regardless, it is critical to consider the performance of options given risk and uncertainty.

Importantly, CBA does not require quantification of every cost or benefit. Impacts that cannot be quantified – due to either lack of data or lack of a robust methodology for monetising the value – can be accounted for qualitatively.

Shortlisted options subject to more detailed analysis should realistically achieve the objective, for example, they should be technically feasible.

The local water utility should consider and, where feasible, evaluate the economic, environmental, and social costs and benefits of each option over their life cycle

The utility should identify and, where feasible, evaluate all costs and benefits of viable (shortlisted) options and assess and compare the net benefits of each option. This should consider and assess all economic, environmental, and social costs and benefits of options to the broader community, including the lifecycle costs of assets.

This should allow the utility to identify the option that can achieve the required outcome at greatest net benefit – or least net cost if it undertakes cost-effectiveness analysis.

The extent of analysis undertaken for a CBA, and options analysis in general, should match the size, complexity, level of risk, and estimated cost on a case-by-case basis. That is, the analysis should be proportionate given the proposed option to address the business need.

The local water utility's evaluation of the costs and benefits of options should identify and consider key risks

In evaluating the costs and benefits of options, the utility should identify key risks and incorporate these into the analysis. This includes:

- incorporating, where possible, the probability and consequence of key risks into the evaluation and quantification of the costs and benefits of options
- conducting sensitivity and scenario analysis on key assumptions – which investigates the sensitivity and viability of the project to changes in underlying assumptions.

For some potentially large and significant investments, the utility should also consider whether to apply real options or adaptive pathways analysis. This may be particularly useful where: it is possible to break the investment into multiple stages; there are material differences in outcomes depending on the resolution of uncertainty; and the plan can be altered as information comes to light that resolves uncertainty.

Separate guidance related to considering risk is given in the guidance on the outcomes of understanding water security, water quality, environmental impacts, and other key risks and challenges.

3.3 How are assets managed over their life cycle to ensure service levels are met?

The local water utility should base the development and evaluation of options on an asset management system that is of a reasonable standard

Robust asset management systems are critical to developing and evaluating service options that rely on infrastructure. The local water utility should implement an asset management system proportionate to its size and capacity. This could range from a spreadsheet-based system to sophisticated asset management software that supports the analysis of data specific to each asset and enables more informed decisions about managing the assets.

The asset management system should be consistent with industry good practice and relevant asset management standards such as ISO55001. This allows predictive modelling that informs prudent, efficient, and sustainable asset life cycle investment decisions. It covers routine maintenance to achieve asset class life, and replacement timing. Appendix A and Appendix B provide optional further guidance, and an example of a conceptual asset management model.

A reasonable standard asset management system

To be of reasonable standard, the utility's asset management system should:

- **Include a comprehensive set of records about its assets that accurately informs assets in place, the condition of those assets, business risk of failure for each asset, standard asset class life, performance, and capability.**

  The quality of asset information the utility holds should allow it to routinely monitor and assess the performance of each asset type (determined by the prudent disaggregation of the asset base) throughout its lifespan. This information will form the basis for identifying investment needs and inform the evaluation of options and the development of solutions to maintain appropriate service standards at minimal cost.

  The primary purpose of a good asset management system and strategy is to enable the utility to use asset data – for example, condition, age, performance, asset life, and business risk of failure – to inform life cycle maintenance and renewal requirements, including the timing of major asset renewal. The utility can use information on asset condition and risk of failure to proactively develop asset maintenance, renewal, and disposal plans, rather than overly relying on reactive maintenance. Appendix A provides a description of such an approach.

- **Have a structured, co-ordinated, and consistent process for assimilating and reviewing the asset description and condition data to inform its asset management plans**

  The utility should establish asset investment decision making and risk-management frameworks and processes in keeping with good industry practice and consistent with ISO55001 principles.

  The utility should develop an asset life cycle investment decision making processes that governs the identification, selection, and delivery of prudent, efficient, and sustainable investments.

  The utility should implement an asset-risk management process that enables it to identify, assess, and account for key risks in evaluating options and in managing its assets.

- **Define the utility's asset class strategies and asset management strategies to understand how it can achieve its service levels**

  The asset class strategies should clearly define how the utility will manage each asset over its lifespan to maintain the operational integrity of the assets, keeping them fit for purpose and in good serviceable and operating condition.

- **Define the actions and timing of investments required to deliver the asset management strategies**

  The utility should implement investment planning activities that include asset, network and, most importantly, service delivery risk analysis. It should develop and implement asset life cycle decision-making frameworks and processes that underpin the establishment and operation of asset maintenance planning, asset-renewal planning, risk-mitigation planning and other asset-investment planning for implementing the asset management strategies.

This should provide the utility with the necessary insight, scope, cost (for example, capex, opex, totex) and risk information to inform development of cost-effective maintenance systems to ensure an appropriate quality/level of service delivery over the asset's lifespan.

- **Include a well-defined investment delivery framework that ensures efficient and effective delivery of asset management activities.**

  The framework should accommodate operations, maintenance (fault, emergency, planned), and project (small, medium, large) related activities, considering long-term asset management planning, asset-renewal planning, capacity development planning, resourcing planning, financial planning, and other related organisational supporting planning.

- **Have a structured approach to reviewing the effectiveness of its asset management activities by monitoring and reporting on asset performance in achieving targeted service levels**

  The utility should establish and implement an appropriate performance monitoring system to measure and monitor asset performance, and to capture, review, and report all information required to improve the effectiveness of its asset management strategies over time. The performance monitoring system should support the continual development and improvement of asset planning, delivery, and management strategies.

3.4 How are preparedness and resilience management during extreme events considered?

The local water utility's options analysis should incorporate consideration of uncertainty, resilience and preparedness for extreme events

To ensure an accurate comparison of costs and benefits across potential options in a world of uncertainty, the options analysis (CBA) should consider how options manage, and adapt to, uncertainty and support resilience and preparedness for extreme events.

The utility should consider:

- incorporating options that include preparedness and resilience measures in the evaluation of options (for example, comparing the costs and benefits of an option with pre-planning of a drought and/or extreme event response, compared to an option without pre-planning)
- incorporating the probability and consequence of key risks into the options evaluation, including when quantifying the costs and benefits of options
- undertaking sensitivity and scenario analysis on key assumptions – which investigates the sensitivity of the economic viability or ranking of options to changes in underlying assumptions
- using real options analysis (ROA) or adaptive pathways analysis – which incorporates options that allow flexibility to defer some of the decision making until the future (when there may be less uncertainty) to identify the optimal timing of investment and other potential options. ROA or adaptive pathways analysis will involve drawing on information on the relevant

constraints (for example, capacity of the wastewater system or water supply system) to determine the relevant timing of decisions.

The approach to considering uncertainty, risks and resilience should be proportionate to the potential size of the risks and impacts (costs and benefits) of the options being evaluated. For instance, simple sensitivity analysis that varies key assumptions (such as discount rate) may be appropriate for small projects; whereas ROA may be more appropriate for large projects (e.g., major water supply augmentation projects) that are subject to a range of uncertainties, with potentially significant impacts.

Further guidance relating to addressing risk and uncertainty is given in the guidance on the outcome of understanding other key risks and challenges.

3.5 How are supply and demand-side options for water supply identified and evaluated?

The local water utility should evaluate costs and benefits of all viable supply and demand-side options in determining the best way to balance water supply and demand

In considering measures to ensure water supply can match demand over the short, medium, and long-term, the utility should consider both supply and demand-side options – as the value of water saved is the same as the value of water generated (albeit the economic, environmental, and social costs of options can vary).

Options to consider could include:

- water supply augmentation options such as a new dam or augmentation to existing water storages, a desalination plant, measures to enhance water transfers to/from a neighbouring catchment or utility's area of operations, and water recycling (sewage and/or stormwater)
- water conservation and demand management on the utility side (for example, reduced leakage from the network) and/or the customer side (for example, incentives and programs to promote the reduction of leaks from customers' plumbing, the installation of water-efficient devices and appliances, and more efficient usage).

As with other options, the utility should:

- identify its objective, given the services required to meet customers' needs over the long-term
    - For example, this could be the required volume of water to be generated/saved over a given period (taking into account population growth and required service levels), subject to any key constraints or other requirements (for example, environmental requirements, climate uncertainty)
- identify the range of potential options to meet this objective, including supply and demand-side options, and 'traditional' and 'non-traditional' options

- conduct preliminary analysis of these options, to develop a shortlist subject to cost benefit analysis
- assess the costs and benefits of shortlisted options, including their economic, social, and environmental costs and benefits
- incorporate risk and uncertainty into the evaluation and quantification of the costs of benefits of the options, including seeking to quantify the probability and consequence of key risks, applying sensitivity analysis and/or considering using real options or adaptive pathways analysis
    - For example, this is likely to be particularly important when assessing options that are more climate dependent than others or when there may be uncertainty about the future value of a key cost or benefit
- identify the options, or portfolio of options, which achieve the required outcome at greatest net benefit or least net cost to the community over the long-term.

Appendix A: Optional how-to guidance for understanding solutions to deliver services

To support utilities in achieving the strategic planning outcome **understanding solutions to deliver services** to a reasonable standard, we offer the following optional how-to guidance.

The optional how-to guidance in this section covers a variety of areas that may help address one or more of the expectations set out in section 3 of this guidance document.

How to shortlist options using multi-criteria analysis

As outlined above, utilities can use multi-criteria analysis (MCA) to evaluate a longlist of options to identify the shortlist – which would then be subject to cost benefit analysis (CBA). Rapid cost benefit analysis is another tool utilities could use to evaluate a longlist and generate a shortlist for more thorough CBA. And, in some cases, it may be appropriate for the utility to move straight to a CBA of a shortlist of options, without needing to evaluate a longlist.

MCA

MCA entails identifying pre-defined criteria, assigning weights to them, and scoring options, programs or projects on how well they perform against each weighted criterion. Use these scores to rank each program/project.

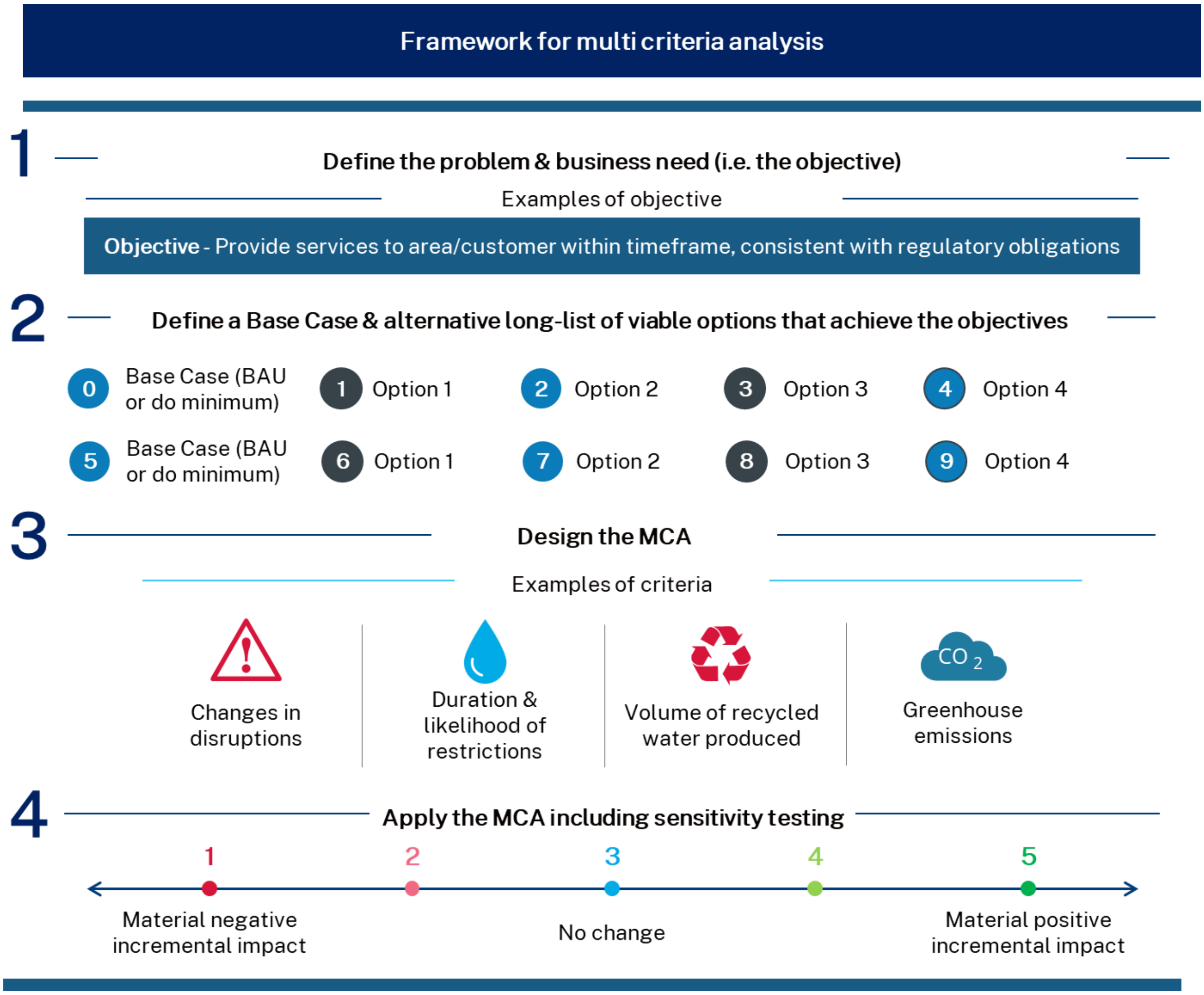
As shown in Figure 1**,** undertaking an MCA involves 4 key steps.

- **Step 1:** Define the problem or business need (that is, the objective or objectives).
- **Step 2:** Define the longlist of options (that is, a base case and range of alternative viable options that could achieve the objective/s).
- **Step 3:** Design the MCA.
- **Step 4:** Apply the MCA, including sensitivity testing the results.

Importantly, **MCA only supplements but does not substitute for a CBA.** It does not enable comparison of broader costs and benefits on an "apples with apples" basis. As NSW Treasury notes: "Given its disadvantages, notably the lack of any valuation principles, MCA should not be used as a substitute for CBA".[3]

[3] NSW Treasury (2017), NSW Government Guide to Cost-Benefit Analysis 17-03, p.67

Figure 1. Framework for multi-criteria analysis



Source: DPE

Step 1: Defining the problem or business need – the objective

As with a CBA (discussed below), the first step in undertaking an MCA for shortlisting options is to clearly identify the objective(s) to be achieved, for example, the service levels or service outcomes. Objectives should be consistent with customers' and the community's service needs. These needs reflect:

- requirements and expectations of regulators – which often determine minimum service levels or outcomes
- needs, values, and preferences of customers, as revealed through consultation with customers – which can determine service levels or outcomes where the regulatory framework allows discretion, for example, where:
  - regulation does not mandate service levels or outcomes
  - customers are willing to pay for service levels/outcomes above minimum levels the regulation mandates.

The more clearly defined the objective, the easier it is to identify options to achieve it, and the more targeted options evaluation can be in assessing the costs and benefits of these options.

Defining the objective is a critical step. It is worthy of careful consideration before continuing to the next steps. Getting the objective 'right' can reduce the risk of undertaking an evaluation of options that may not identify the 'best' (that is, largest net benefit) option.

For this reason, utilities can use a range of principles to help guide the selection of the problem/opportunity and objective. These include the objective being:

- clearly stated in terms of welfare outcomes and outputs (ends rather than means), and not in terms of the completion of a process (or what is to be built or delivered)
- broad enough to allow exploration of a range of innovative alternatives, but specific enough to ensure the analysis reveals reliable and relevant information to decision making
- separable, unless the utility is addressing more than one interdependent outcome through a single initiative (that is, where there are synergies between projects).

This is consistent with the approach to defining the problem or business need adopted when undertaking a CBA (as discussed below).

Step 2: Defining the long list of options

An MCA is a comparison between a base case option and an alternative longlist of options. The second step in an MCA is to clearly define the credible set of longlisted options that could achieve the objective.

Utilities can then use the MCA to shortlist the options for further detailed consideration as part of a CBA (as discussed below).

Defining the base case option

The base case consists of a 'real-world assessment' of what would occur in the absence of implementing alternative options. The base case should represent what is realistically likely to happen without the specific project or investment – not before and after.

The approach to defining the base case for an MCA is the same as for a CBA. We explain this further below under Step 2 for a CBA.

Identifying alternative options

The local water utility should identify and consider all viable options to achieve the specified objective. This ensures it delivers the greatest net benefit to the community.

Table 4 below lists some guiding principles utilities could use to identify and review options.

Step 3: Designing the MCA

The next step involves designing the MCA, which involves identifying the following appropriate measures.

- **Criteria** – outcomes or indicators that assess an option against the stated objectives. Criteria are typically weighted.

- **Measures** – these link the underlying quantitative evidence or qualitative judgements to the criteria scoring. There are multiple measures per criterion, and they are scored and potentially weighted in a similar way to the criteria.
- **Weighting –** the relative importance of a given criterion within the scope of the decision context. They are used to develop a weighted score for each option against the objective – or against each of the objectives. Weights can also help define the relative importance of the measures that inform the criteria – where there are multiple measures per criterion – and to combine scores against multiple objectives into a single score for each option. Although, as outlined below, Infrastructure Australia notes that presenting the results of an MCA as a single score per option can imply a misleading level of accuracy.[4]
- **Scores** – an assessment of the option's performance compared to the appropriate base case against the criteria. This should ideally be based on quantitative evidence so a decision-maker can understand how scores have been determined.

Each stage is discussed in more detail below.

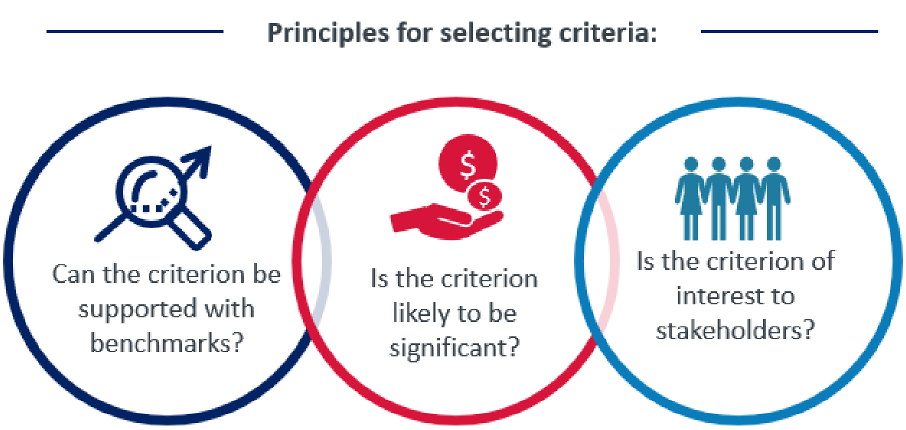
Identifying criteria

As discussed above, criteria are the outcomes or indicators by which an option is assessed against the stated objective(s).

There is no set rule for the number or type of criteria, however, as Infrastructure Australia notes, many typical decision contexts have from 5 to 40 criteria in total.[5] Principles to help guide the selection of criteria include:

- **availability of benchmarks –** can independent benchmarks support the criterion?
- **materiality** – is the criterion likely to significantly alter the performance of the option?
- **stakeholder interest –** is the criterion likely to be of significant stakeholder interest, for example, changes in environmental outcomes or extent of land acquisition required?

Figure 2. Principles for identifying the appropriate degree of monetisation



Source: DPE adapted from Infrastructure Australia

[4] Infrastructure Australia, *Guide to Multi-Criteria Analysis, Technical Guide of the Assessment Framework*, July 2021, p 19.
[5] Infrastructure Australia (2021), Assessment Framework 2021, Guide to multi criteria analysis.

Take care to ensure the completed MCA is consistent with subsequent analysis. For example, include criteria and give appropriate weighting, as discussed below, that reflects the key costs and benefits of options, and which are therefore likely to drive the CBA results. If the costs and benefits of options are not adequately represented, there is a risk the MCA filters out options that should have been subject to a CBA or retains options that should be excluded.[6] Utilities should consider the connection between the MCA design and the major impacts measured in the CBA.

Table 1 shows examples of criteria for a project aimed at providing water security.

Table 1: MCA – examples of criteria

MCA objective	MCA criteria
Objective 1: provide water services to the area, consistent with regulatory obligations and community expectations	Criterion 1: increase the number of customers served Criterion 2: reduce the volume of wastewater discharged to the environment
Objective 2: improve the reliability of services for those living and working in the area	Criterion 3: reduce duration and extent of supply shortages or interruption

Measures

Underpin each criterion with one or more measures that provide the evidence base for scoring. While the preference is to use quantifiable metrics, in the absence of quantification, use qualitative metrics. Importantly, **represent the measures as compared to the base case**.

The relevant measures will vary on a project-to-project basis, and there is no long list of universally applicable measures. When selecting measures, utilities should consider the key drivers of performance of the options (that is, the drivers of costs and benefits, any sources of risk and uncertainty). As noted above, take care to ensure the MCA's criteria, weights, and measures capture the key impacts (costs and benefits) of options, which are also likely to drive the CBA results.

Table 2 shows examples of measures for a project aimed at providing water security.

Table 2. MCA – examples of measures

MCA objective	MCA criteria	MCA measures
Objective 1: provide water services to the area, consistent with regulatory obligations and community expectations	Criterion 1: increase the number of customers served	Measure 1: number of properties with a connection compared to the base case in 2030 Measure 2: capital and operating cost
	Criterion 2: reduce the volume of wastewater discharged to the environment	Measure 3: volume of recycled water Measure 4: volume of wastewater discharged

[6] Infrastructure Australia (2021), Assessment Framework 2021, Guide to multi criteria analysis

MCA objective	MCA criteria	MCA measures
Objective 2: improve the reliability of services for those living and working in the area	Criterion 3: reduce duration and extent of supply shortages or interruption	Measure 5: forecast changes in number of disruptions compared to the base case in 2030 Measure 6: duration and likelihood of water restrictions in 2030

Scoring compared to the base case

Compare all options against the base case to understand how outcomes change as a result of adopting an alternative approach or option. To ensure transparent scoring compared to the base case, as shown in Table **3**, a combination of a ‘traffic light’ and rating approach could be used, where:

- options that perform positively compared to the base case (for example, cost savings or additional benefits) receive green lights and higher scores out of five
- options that perform similarly to the base case receive a grey light and a score of three out of five
- options that perform poorly compared to the base case (for example, an additional cost or reduced benefit) receive red lights and score two or less out of five.

Table 3. MCA – example of scoring compared to the Base Case

MCA rating	Score	Summary
Strong positive	5	Material positive incremental impact (benefit)
Moderate positive	4	Moderate positive incremental impact (benefit)
No significant impact	3	No change
Moderate negative	2	Moderate negative incremental impact (cost)
Strong negative	1	Material negative incremental impact (cost)

Source: DPE adapted from Infrastructure Australia

Compare the performance of each option against the base case for every criterion.

Weighting

Weights are a way of combining multiple scores from one level of the MCA to determine a consolidated score. Consistent with Infrastructure Australia’s recommendations:

- measures should be scored but not weighted
- to score criterion, develop a combined score based on the measures for each criterion
- criterion is weighted based on an analysis of the relative importance of each criterion
- the score of each option against each objective is the sum of its scores against the weighted criteria relevant to the objective

- the scores of options against each objective are used to rank and select options to proceed for more detailed analysis.

The weights may vary on a project-to-project basis.

- In its simplest form, MCA weights can be applied equally to all criteria. This may be appropriate where stakeholders have indicated no strong preference for one criterion over another.
- In more complex applications, MCA weights can be used to place more, or less, emphasis on certain criterion. An example of this is using matched pair weighting, which states whether the criterion is more, less, or the same importance as another criterion.

Generally, simple approaches are most appropriate for developing weights in a transparent way.

However, regardless of the weights selected, it is critical to transparently document the approach adopted to selecting the weights.

Step 4: Applying the MCA, including sensitivity testing the results

The final step is to bring together steps 1 to 3 and apply the MCA, including sensitivity testing the results of the MCA to key uncertainties and alternative weightings.

Infrastructure Australia does not recommend presenting the results of the MCA as a single weighted score, as this can imply a misleading level of accuracy and cause results to be treated like a definitive benefit cost ratio (BCR). If a single score is presented, it recommends that the basis for the results is clearly explained.[7]

Table 4 shows an example presentation of an MCA, applied to criterion 1 and 2 from the example above. In this table, calculations go from scoring the performance of the two options on the right-hand side to the application of weights on the left-hand side and shows.

- Option 1 serves more customers than the base case and option 2.
- Option 2 is considerably more expensive than the base case, while option 1 is slightly more expensive,
- Option 1 performs similarly to the base case in terms of wastewater discharged, while option 2 significantly increases the volume of wastewater reused (and thus reduces the volume discharged).
- While option 1 performs better than option 2 in some measures and worse in others, overall, option 1 performs better under criterion 1 and option 2 performs better under criterion 2.
- As criterion 1 is more highly weighted than criterion 2 (75% compared to 25%), option 1 is preferred based on the MCA.

[7] Infrastructure Australia, *Guide to Multi-Criteria Analysis, Technical Guide of the Assessment Framework*, July 2021, p 19

Table 4. MCA - Applying the MCA

MCA objective	MCA criteria	Weighting applied to criterion	Criterion score		MCA measures	Performance compared to the base case	
			Option 1	Option 2		Option 1	Option 2
Objective 1: provide water services to the area, consistent with regulatory obligations and community expectations	Criterion 1: increase number of customers served	75%	4	2	Measure 1: number of properties with a connection compared to the base case in 2030	5	3
					Measure 2: capital and operating cost	2	1
	Criterion 2: reduce the volume of wastewater discharged	25%	3	5	Measure 3: volume of recycled water	3	5
					Measure 4: volume of wastewater discharged	3	5

Sensitivity testing of the results

As with CBA, a range of uncertainties drives the results of an MCA. For example, the actual capital cost of an investment might be higher or lower than forecast or be incurred earlier or later in the appraisal period. This means the net benefit of certain options may be volatile, and potentially higher or lower than the base case.

Figure 14 in the section further below on CBA provides a summary of commonly identified risks and uncertainties of water investments.

As with undertaking a CBA discussed below, local water utilities should be able to identify the following.

- The risks and uncertainties that are of most relevance to decision-making. Importantly, in addition to the factors discussed above, every MCA should vary the weights and scores adopted as part of the analysis to understand how the performance of the options may vary.
- The option that delivers the greatest value to the community, after taking account of risk and uncertainty through tools such as sensitivity analysis (which investigates how sensitive the performance of the options are to underlying assumptions).
- The community value that is available from reducing risk and uncertainty.

For more detail see below under step 5 of CBA.

Importantly, testing the MCA results does not overcome the risks and limitations of MCA. **Therefore, the MCA is only appropriate as a shortlisting tool and should be combined with CBA** (discussed below).

How to analyse options for delivering service and managing risks

Cost benefit analysis (CBA) is a systematic method that assesses options for delivering services and managing risks. It assesses the incremental costs and benefits of options to meet an objective or address a need (for example, to deliver services to a given standard), relative to a base case. This can help decision makers identify the option that delivers the greatest net benefit or achieves the objective at the least net cost to society.

Utilities can scale and tailor CBA analysis to match the size of the project – which means, for example, the analysis to inform decisions about large scale water supply augmentation projects should be more detailed and extensive than for smaller projects.

CBA considers all costs and benefits that affect the community, including:

- economic costs and benefits, such as costs and cost-savings associated with the provision of water, wastewater, recycled water, and stormwater services
- social or liveability-related costs and benefits, such as improved amenity and liveability outcomes climate independent supply provides and/or reduced outages, or urban cooling benefits (such as reduced disease burden or energy demand) arising from providing irrigated open space

- environmental costs and benefits, such as improved waterway health or improved air quality/lower carbon emissions arising from reductions in stormwater or wastewater discharge or activities to reduce energy consumption or waste.

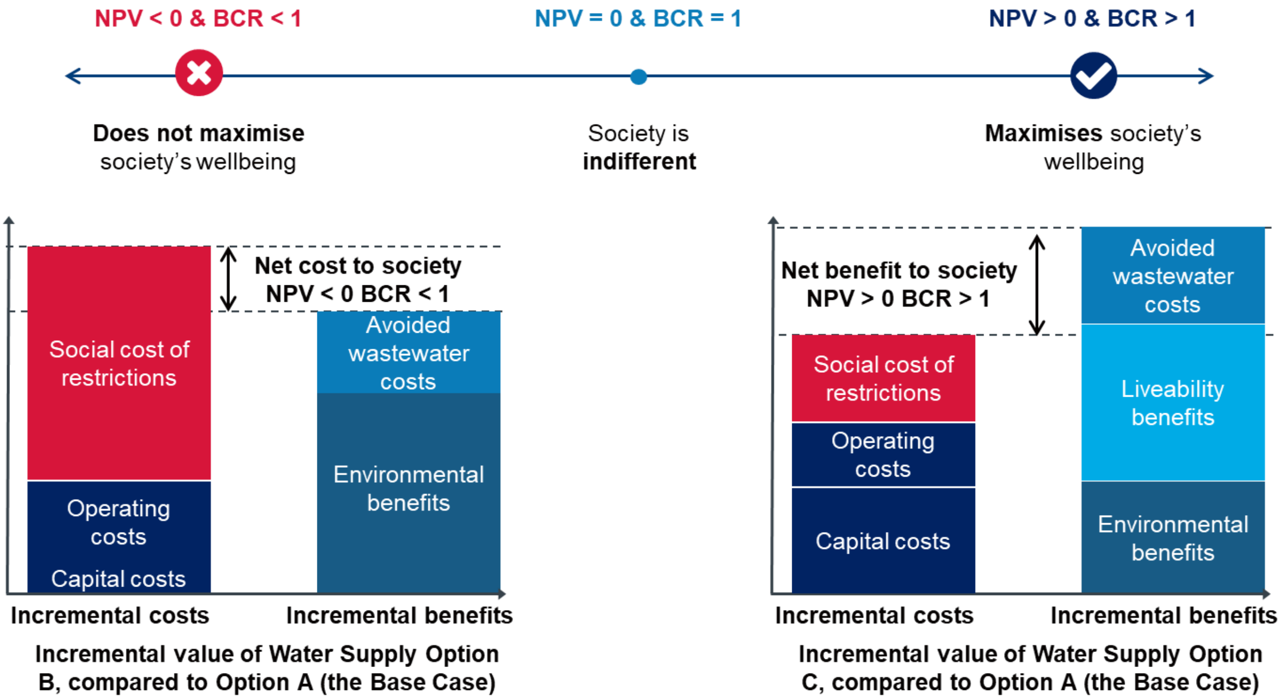
Importantly, as NSW Treasury notes: "Use of CBA instead of MCA does not mean that the criteria considered are only those that can be valued in dollars. While some categories of benefits and costs may not be readily valued, it does not follow that CBA should be abandoned in favour of other alternative methods of analysis."[8]

To compare the incremental economic, social, and environmental costs and benefits that accrue to the NSW community over time, CBA:

- identifies the incremental impact (cost or benefit) of an option relative to the base case
- converts each cost or benefit to a monetary (dollar) value, without any double counting
- compares these values to the base case to identify the 'incremental value' to the community from moving away from the base case
- discounts these values using a social discount rate to a single metric – presented in:
  - net present value (NPV) terms – present value of economic, social, and environmental benefits *minus* present value of economic, social, and environmental costs over the period
  - benefit-cost ratio (BCR) terms – present value of economic, social, and environmental benefits *divided* by present value of economic, social, and environmental costs over the period.

As shown in Figure 3, the option with the largest NPV and BCR generates the largest incremental benefit to the community (compared to the base case).

Figure 3. CBA involves considering which options generate the highest community net benefits – an illustrative example



[8] NSW Treasury (2017), NSW Government Guide to Cost-Benefit Analysis 17-03, p.67

Steps involved in a CBA

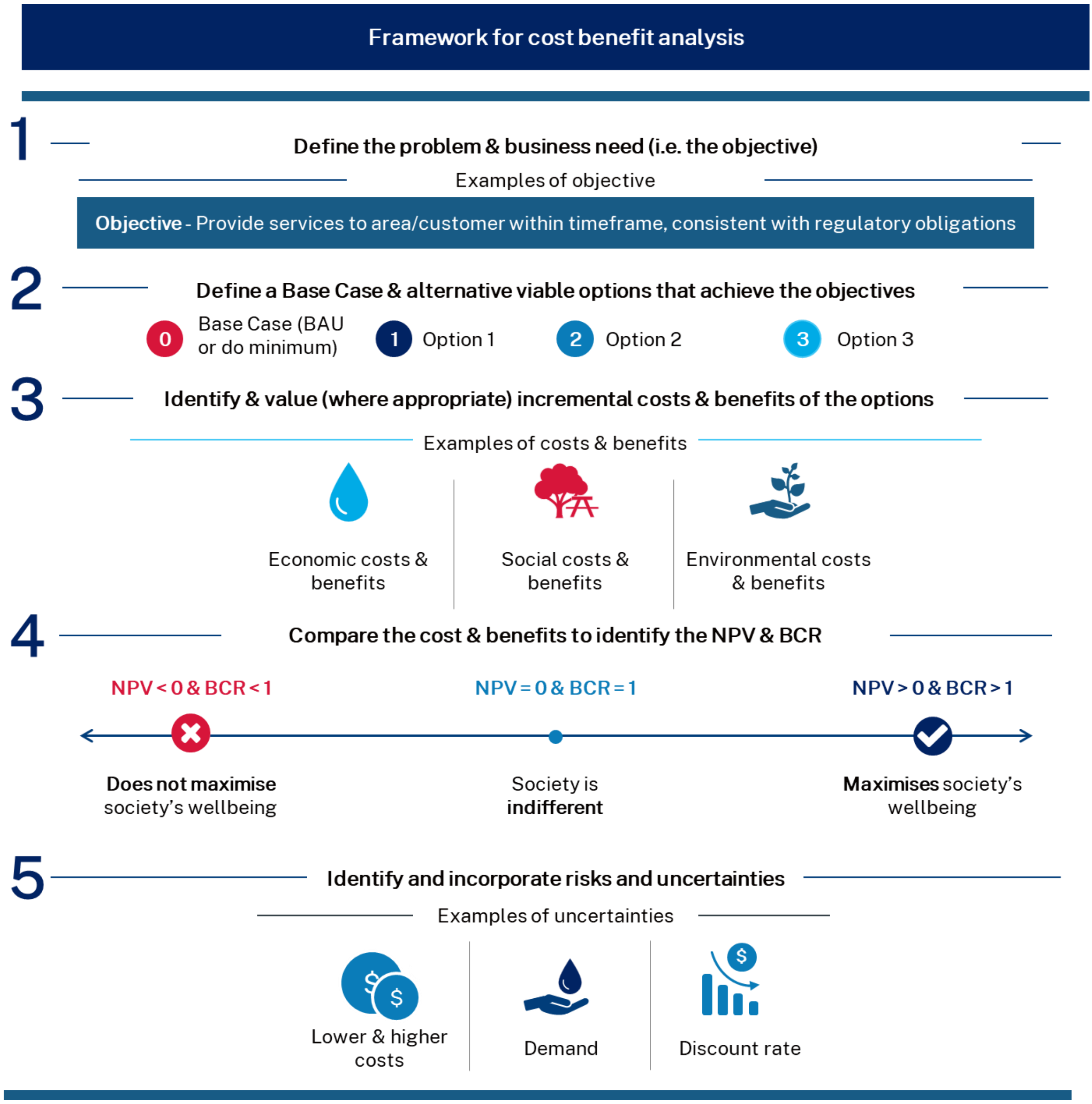
As shown in Figure 4, undertaking a CBA involves the following steps.

- **Step 1:** Define the problem or business need (that is, the objective)
- **Step 2:** Define a base case and range of alternative viable options that achieve the objective.
- **Step 3:** Identify and value (where appropriate) the incremental economic, social, and environmental costs and benefits of the options over their life cycle (that is, relative to the base case).
- **Step 4:** Compare the costs and benefits of the options (relative to the base case) to identify the NPV and BCR of each option.
- **Step 5:** Identify and incorporate risks and uncertainties.

For significant projects, to ensure the options evaluation is as robust as possible – including drawing upon the best available information and reflecting the broad range of options available –there is value in engaging with key stakeholders throughout the options assessment process. This includes the department and regulators such as the NSW Environment Protection Authority and NSW Health.

Consultation with customers on their willingness to pay for certain service outcomes or attributes can also inform estimates of the benefits (value) of these outcomes or attributes, and hence the evaluation of options. Separate guidance is provided on achieving the strategic planning outcome of understanding service needs, including understanding customers' needs, values and preferences.

Figure 4. Key steps in a CBA



Local water utilities can take a proportional approach to CBAs

CBA doesn't necessarily need to be complex, detailed, and expensive to undertake. Even a simple CBA can be informative and cost-effectively support decision making. This is because a CBA 'framework' is primarily a process for organising the available information in a logical and methodical way to support decision making. It requires utilities to be clear about their objective (that is, what they seek to achieve), the potential options for achieving the objective, and to follow a transparent and objective evaluation process comparing these options.

The appropriate degree of analysis will vary from one project to another and should be matched to the size, complexity, level of risk, and estimated cost on a case-by-case basis. Common sense should guide the degree of analysis – that is, the extent to which a simple or more detailed CBA is warranted – particularly when assessing benefits or costs that are difficult to quantify, and the level of risk and resilience analysis required.

As discussed in more detail below, in many cases, the decision and choice of option will have limited impact on the utility and its customers or may be of limited interest to other stakeholders. If so, a simple CBA may be appropriate to support the business case. **This simple CBA could be similar to a cost-effectiveness analysis (CEA)**[9] where proponents are confident that broader economic, social, and environmental outcomes are equivalent across the options. In these situations, a utility can perform a CEA, noting the CEA will involve some of the same key steps as a CBA (see **step 3** for more detail).

In other cases, the project(s) may be considered "of significance" to one or more parties including the utility, its customers and/or stakeholders such as the department. This may warrant a more detailed CBA that meets NSW Government CBA guidelines. If so, the utility may require further technical guidance and specific expertise to assist in developing or reviewing key aspects of the CBA.

Table 2. Identifying the level of effort and resourcing required for a detailed CBA

Guiding principle	Implication	Example	Effort and resourcing required
Is the project associated with significant non-monetary impacts?	May be significant environmental or social impacts	Impact on waterway health of wastewater discharge	May warrant elements of a detailed CBA, including gathering and valuing site-specific outcomes.
Would the project impose significant financial costs on the utility and/or its customers?	May involve life cycle expenditure over $10m	Mains replacement	May warrant elements of a detailed CBA, including more complex risk and uncertainty analysis and distributional analysis
Is the project subject to significant risk and uncertainty?	Community value may differ significantly depending on future states of the world	Construction of a desalination plant as a drought response	May warrant elements of a detailed CBA, including more complex risk and uncertainty analysis, such as real options analysis
Is the project subject to cost-recovery risk and/or require co-funding?	May need to demonstrate value and distribution of benefits to sections of community (for example, to access co-funding)	Water sharing between two local water utilities	May warrant elements of a detailed CBA, including gathering and valuing site-specific outcomes and detailed distributional analysis

[9] A cost-effectiveness analysis aims to identify the option that achieve specified outcome(s) at least cost

Guiding principle	Implication	Example	Effort and resourcing required
Is the project of significant community interest?	May need to demonstrate value and distribution of benefits to sections of community	Expansion of a dam	May warrant elements of a detailed CBA, including gathering and valuing site-specific outcomes and distributional analysis

Table 3. Getting started: practical differences in level of effort and resourcing required

Step	Simple CBA		Detailed CBA		Key differences
	Summary	Example	Summary	Example	
1. **Defining the business need and objective (that all options must achieve)**	Objectives can include identifying the value of different levels of service/standard or identifying the value of options to achieve the level/standard	Deliver water services to customers, consistent with regulatory obligations	As per simple CBA	As per simple CBA	N/a (both involve identifying the objective that all options must achieve)
2. **Defining options (including a base case and at least two alternative options)**	Identifies the range of possible options to achieving the objective – in a 'do nothing' base case, nothing will only be appropriate in some, but not all, circumstances	Undertaking ongoing maintenance of an aging asset (base case) compared to replacing the aging asset today	As per simple CBA	As per simple CBA	N/a (both involve identifying options, including a base case, that achieve the objective

Step	Simple CBA		Detailed CBA		Key differences
3. **Identifying and valuing benefit and costs**	Likely to only include economic costs, and so won't require valuing non-monetary social and environmental impacts	Capital and operating costs (including renewals) of constructing and operating a pipeline	Likely to involve valuing broader economic, social, and environmental outcomes (some of which are non-monetary), using site-specific information	Benefit to the community of reduced greenhouse emissions or improvements in waterway health from reduced wastewater discharge	Detailed CBAs are more likely to involve the valuation of broader economic, social, and environmental costs and benefits
4. **Comparing the value of the options**	Calculates NPV and BCR to compare economic costs across the options	Similar to least-cost analysis/CEA	Calculates NPV and BCR to compare economic, social, and environmental costs and benefits across the options	Detailed CBA that values the broader economic, social, and environmental outcomes	While both involve calculating the NPV and BCR, simple CBA is more likely to resemble a least-cost analysis/CEA
5. **Accounting for risks & uncertainties**	Likely to involve simple sensitivity analysis of key assumptions	3 discount rates combined with 3 forecast water demands.	Likely to involve more detailed sensitivity, scenario analysis and/or real options analysis	The use of real options analysis to identify the value of adaptive decision making in response to drought	Simple CBA is likely to involve much simpler sensitivity analysis (for example, varying a few key assumptions)
6. **Identifying high-level distribution of costs and benefits**	Likely to have few broader impacts (impacted parties are likely to be the utility and its customers) Should be qualitative	Water saving shower heads – primary beneficiaries are households and local community	Likely to involve more detailed distributional analysis (broader range of parties) to inform potential co-funding Should be quantitative	Water sharing between two utilities – communities of both utilities benefit	Simple CBA is likely to have a smaller range of impacted parties and the distributional analysis is likely to be qualitative

Step 1: Defining the objective

The first step in options evaluation is to clearly identify the objective (for example, the service levels or service outcomes) to be achieved. Objectives should be consistent with customers' and the community's service needs. These needs reflect:

- requirements and expectations of regulators – which often determine minimum service levels or outcomes
- needs, values, and preferences of customers, as revealed through consultation with customers – which can determine service levels or outcomes where the regulatory framework allows discretion, for example
    - regulation does not mandate service levels or outcomes
    - customers are willing to pay for service levels/outcomes above minimum levels regulation mandates.

Options analysis (CBA) can inform both the determination of service levels or outcomes (where the regulatory framework allows some discretion in these service levels/outcomes), and then the decision about how to best deliver these service levels or outcomes.

In such a case, to minimise the risk and complexity of too many variables in the CBA, a utility could undertake a sequential analytical process whereby the subject of the options analysis (the CBA) is:

- **first, the level of service or service outcome to be achieved** (that is, the level of service that maximises net benefits to the community, for example, the frequency of wet weather overflows or other outcome-based waterway health metric)
- **second, how the optimal level of service is best achieved** (that is, the infrastructure option or suite of measures designed to meet this frequency of wet weather overflows or waterway outcome that maximises net benefits to the community).

The more clearly defined the objective, the easier the identification of options to achieve this objective and the more targeted a CBA can be in assessing the costs and benefits of these options.

Defining the objective is a critical step worthy of careful consideration before proceeding to the next steps. Getting the objective 'right' can reduce the risk of undertaking an evaluation of options that may not be identifying the 'best' (that is, largest net benefit) option.

For this reason, utilities can use a range of principles to help guide the selection of the problem/opportunity and objective. These include the objective being:

- clearly stated in terms of welfare outcomes and outputs (that is, ends rather than means), and not in terms of the completion of a process (or what is to be built or delivered)
- broad enough to allow a range of innovative alternatives to be explored, but specific enough to ensure the analysis reveals reliable and relevant information to decision-making
- Separable, unless several interdependent outcomes are being addressed through a single initiative – that is, where there are synergies between projects.

Step 2: Defining the base case and project options

A CBA is a comparison between a base case option and an alternative set of options. The second step in a CBA is to clearly define the credible set of options that could achieve the objective.

The local water utility should identify and consider all viable options to achieve the specified objective, to ensure that it ultimately identifies the option that delivers the greatest net benefit to the community.

As discussed above, a utility can use an MCA to help inform the selected options for assessment as part of the CBA (the detailed assessment).

Defining the base case option

The base case consists of a 'real world assessment' of what would occur in the absence of implementing alternative options. The base case should represent what is realistically likely to happen without the specific project, investment, program, or policy change under consideration. It is a comparison of the state of the world 'with' the proposal (and its alternatives) to the state of the world 'without' the proposal (the base case). It is not a 'before and after' comparison.

The base case will often be the 'business as usual' or 'no policy change' scenario – that is, continuation of the current quantity and quality of services such as planned maintenance and usage. In some cases, the base case might be a 'do nothing' or 'spend nothing' scenario. In other cases, the base case might entail minimum investment or effort designed to meet requirements – the 'do minimum' option.

In the case of system augmentation or an expansion of policy or activities, the base case would represent a continuation of the existing system or policies, including asset maintenance. A 'business as usual' low asset maintenance program may eventually result in significant cost increases if assets fail or need to be replaced. This means one benefit of 'doing something' (relative to this base case) may be to avoid these costs.

In the case of assessing the costs and benefits of a potential change to a service standard, the base case might be a continuation of the current standard – if that is a realistic 'business as usual' scenario.

Alongside step 1, a well-established base case is critical to a robust and informative CBA as it provides the foundation for identifying the incremental value of alternative options or project cases. Getting the base case right reduces the risk of misreporting the incremental value of alternative options or project cases.

Identifying alternative options

The utility should identify and consider all viable options to achieve the objective. Table 7 below lists some guiding principles that could identify and review these options in determining a shortlist that is subject to further analysis (that is, assessment of their costs and benefits).

Table 4. Defining the project options for inclusion in a CBA – key principles

Guiding principle	Why	Example	Potential issues
Do the options achieve the objective?	Enables 'apples with apples' comparison	If the aim of the project is to provide wastewater services to the catchment area it is not appropriate to include an option that does not achieve that objective	Care should be taken when undertaking projects aimed at setting the standard/level of service and identifying the preferred option to achieve that standard As discussed in step 1, in this case, one option may be to undertake a sequential analytical process whereby the CBA is used to set the level of service first and then a separate CBA considers options to achieve this level of service
Do the options consider the feasible range of approaches to achieving the objective?	Ensures 'all options are on the table' to identify the option that delivers the greatest benefit to the community	If the aim of the project is to provide a water service to a development, it is not appropriate to only consider options that provide recycled water (that is, not considering traditional, treat and dispose options)	Care should be taken to consider the broad range of policy, regulatory, and build or non-build investment options, rather than focusing on a subset of potential solutions (that is, predetermining the solution before completing the analysis)
Are the options technically feasible?	Ensures all options can be implemented in practice, and therefore achieve the objective	Untested new technologies may not deliver the objective	Care should be taken to balance considering the broad range of options with ensuring they represent practical solutions

Guiding principle	Why	Example	Potential issues
Are the options forward looking?	Ensures capture of changes that can be reasonably expected in policy, regulatory, or market factors	The options (and base case) should not assume nothing will change over time – changes that can be reasonably expected (for example, increases in population and water demand) should be incorporated	This requires considering future changes (for example, forecasting changes in demand over time), which can be challenging, especially in the case of biophysical changes (that is, changes in biophysical outcomes)
Do the options enable identification of the counter-factual?	Enables identifying the value of intervention by comparing what would happen in the absence of the project (that is, compare the state of the world with and without the project)	A project that involves potentially expanding an existing wastewater plant should be compared to a base case that involves no expansion of the existing plant, rather than a base case of no wastewater plant	This requires understanding what would happen in the absence of the option (that is, the causal link between the option and outcomes), which can be challenging, especially for options that involve multiple steps in the causal chain

While it will depend on the objective and decision being sought, as well as the level of risk and uncertainty, utilities should typically shortlist between 2-4 alternative options to the base case for inclusion in the CBA. The process for short-listing these options is a key component of the CBA and broader business case (see Box 1). Shortlisting can involve the use of an MCA (as discussed above) or a rapid CBA. For example, if the CBA is supporting a typical strategic business case, where the decision relates to potential pathways or business directions, then a smaller number of broad options may be appropriate. If the CBA is supporting a final business case relating to a large investment decision, then a larger set of options may be appropriate (say covering differences in scope, timing, size, and location of investment).

Box 1. Shortlisting options for inclusion in the CBA

It is best practice for a business case to articulate the process for shortlisting the options. This would include setting out the following.

- The longlist of potential policy, regulatory, and build and non-build solutions, and a high-level discussion of:
  - the intended outcome and resources required. In the early stages of identifying options, only summary data may be required. Later in the process and before significant funds are committed, the confidence required increases and added detail should be included
  - how, where, and when these resources will be used

- how the intended outcome meets the needs of the community
  - broader considerations (including social and environmental impacts)
  - any risks.
- The criteria used to short-list the options.

For example, the longlist of options could be assessed based on whether they meet a range of criteria, including:

  - the capacity of the options to meet the needs of the growing population
  - the capacity of the options to contribute to a range of other objectives
  - the feasibility of the options in practice
  - the consistency of the options with broader long-term resource planning and regulation
  - the extent to which solutions represent the least-cost approach to servicing customers, consistent with the local water utility's regulatory obligations.
- A shortlist that includes a base case and typically between 2-4 alternative options.

It is critical to retain feasible options as part of the shortlisting process on the basis of broader considerations that should be captured as part of the CBA. For example, a traditional treat and discharge approach to managing wastewater should not be ruled out (unless it would conflict with a licence requirement) because it imposes additional environmental costs. Rather, the CBA should incorporate these environmental costs to allow a comparison of all costs and benefits of this 'traditional' approach with those of other options.

Step 3: Identify and value key incremental costs and benefits

The third step in a CBA is to identify the types of economic, social, and environmental outcomes that accrue to the NSW community from the options, and to then forecast and value in monetary terms (that is, convert to a dollar basis) over the modelling period those outcomes most likely to materially differ between the base case and the alternative options ('the key incremental costs and benefits').

This cost and benefit valuation step can often be the most resource, time, and effort-intensive and it is where there may be key differences between a simple and complex CBA. The appropriate degree of analysis in this valuation step will vary from one project to another and should be matched to the size, complexity, level of risk, and community interest on a case-by-case basis.

Identifying costs and benefits

CBA captures the economic, social, and environmental outcomes or impacts on community welfare. These are outcomes (costs and benefits) that accrue to the NSW community rather to simply to the local water utility.

Benefits relate to any improvements in economic, social, and environmental outcomes from each option – for example, a $10 million economic saving in the form of avoided or deferred capital expenditure or a $10m environmental saving in avoided greenhouse emissions. Both outcomes form part of the benefit side of the CBA 'ledger' (see step 4 on incorporating these benefits into the BCR calculation and NPV calculation).

Costs relate to any deterioration in economic, social, and environmental outcomes as a result of each option – for example, $10m in added operating expenditure or $10m in reduced amenity or recreation from a deterioration in waterway health. Both outcomes form part of the costs side of the CBA ‘ledger’ (see step 4 on incorporating these costs into the BCR calculation and NPV calculation).

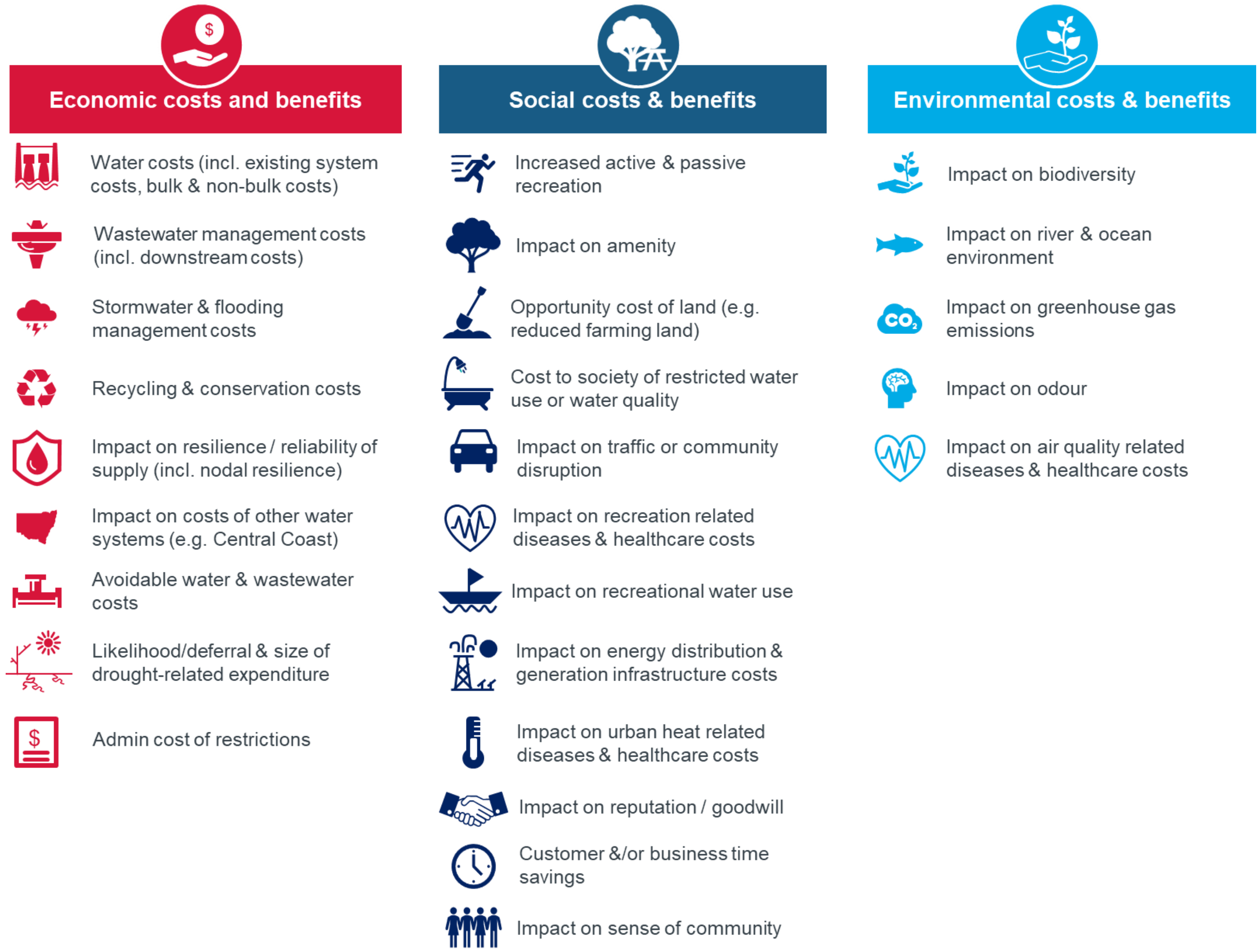
Ultimately, it does not matter whether an improvement (or deterioration) in community welfare is in the form of changes to economic, social, or environmental outcomes. There is no need to overly focus on classifying costs and benefits into these categories. Unlike a multi-criteria analysis (MCA) where weights are attached to certain outcomes, key changes in community welfare are valued in monetary terms (converted to a dollar basis) and summed over the modelling period. For this reason, a $10m economic, social, or environmental benefit provides the same value to the NSW community.

Figure 5 below sets out some common costs and benefits that may be relevant to the CBA. However, this is an illustrative list rather than a ‘menu’ from which to choose. Ultimately, costs and benefits will be situation-specific and will depend on the options to achieve the specified objective.

Costs and benefits incorporated into a CBA must meet the following key principles.

- **Costs and benefits should represent changes in ‘resource’ outcomes from the perspective of the NSW community**, rather than simply financial costs and benefits from the perspective of the local water utility and/or its customers.
- **Costs and benefits should directly result from the option with a clear and documented ‘causal link’ between the option and the outcome.**
- **Costs and benefits should be measured on an incremental basis relative to the base case** (that is, changes in NSW community outcomes that result from ‘moving away’ from the base case).

Figure 5. Overview of commonly identified costs and benefits of water industry investments



Determining the appraisal period

In evaluating options to deliver services, the key costs and benefits of each option should be forecast over a period of time ('appraisal period'). This enables a robust comparison of the economic, social, and environmental outcomes of the options – some of which may not occur until years into the future.

Typically, the appraisal period is between **20 and 30 years**, however the choice of appraisal period will depend on several factors, including the following.

- The nature of the objective and potential options to achieve this, including the economic life of any investments. In general, the longer the asset life, the longer the appraisal period, but where options involve differing assets and/or measures a:
  - shorter appraisal period can be used in combination with a 'residual value' – representing the additional value provided by the investment beyond the appraisal period. An example is a pipeline or dam with a value of 80-100 years, which is beyond the choice of 20–40 years appraisal period, or a specific option requires additional investment towards the end of the appraisal period.
  - longer appraisal period can be used in combination with a 'renewal value' – representing the cost of renewal and replacement of assets with a shorter economic

life. An example is IT systems, which typically provide greater flexibility and/or lower level of risks than large long-lived investments.

- The ability to forecast key costs and benefits over this period. This includes consideration of key factors that might influence outcomes over this period, for example, population and demand, technological changes, climate change, and rainfall. In general, the more certainty regarding forecast key costs and benefits, the longer the appraisal period. However, where there are uncertainties impacting forecasts, these can be addressed through:
    - simple sensitivity analysis
    - more complex real options or adaptive pathway analysis (see step 5).

As the stream of costs and benefits are discounted in step 4, the 'importance' attached to outcomes diminishes in the later years of the appraisal period. For this reason, the choice of appraisal period will be a balance between time, effort, and resourcing required to compile reasonable estimates of costs and benefits over the period, and additional value obtained — in terms of differentiating the options — from a longer period.

Forecasting and valuing costs and benefits over the appraisal period

Forecasting and valuing the key incremental outcomes over the modelling period can be resource, time, and effort-intensive. Importantly, a CBA does not require the valuation of <u>all</u> relevant impacts.

A CBA likely requires forecasting costs for capital projects, which may require forecasts of the quantities and prices of resources involved such as land, labour, material and capital; and forecasting operating costs, which will be a function of the scale of operations.

These forecasts may be straightforward. For many simple CBAs, these economic outcomes may be the key differentiating factor between the options and therefore the focus of the CBA. Where this is the case, or where the size and scope of the project does not justify the work entailed in quantifying other social and/or environmental costs and benefits[10], a simple CBA may be similar to a CEA (see Box 2). In this context, proponents should be confident that key economic, social, and environmental outcomes are equivalent across the options or that valuing and including these non-market social or environmental outcomes would not materially impact the CBA or business decision.

[10] That is, the cost and time involved in benefit valuation and data collection are not consistent with the scale or scope of the options being evaluated

Box 2: Cost-benefit analysis vs cost-effectiveness analysis

Cost effectiveness analysis (CEA) aims to identify the option that achieves the specified objective(s) at least cost (Figure 6).

CEA involves undertaking many similar sets of steps, applying similar principles, and using similar evidence as CBA, except that non-market costs and benefits are typically not quantified and valued. Unlike CBA, CEA identifies the least cost option to achieve a specified objective and cannot indicate whether the preferred option provides a net benefit or 'value for money' to the community (Figure 7).

Figure 6. CEA identifies Option B as achieving the specified objectives(s) at least cost

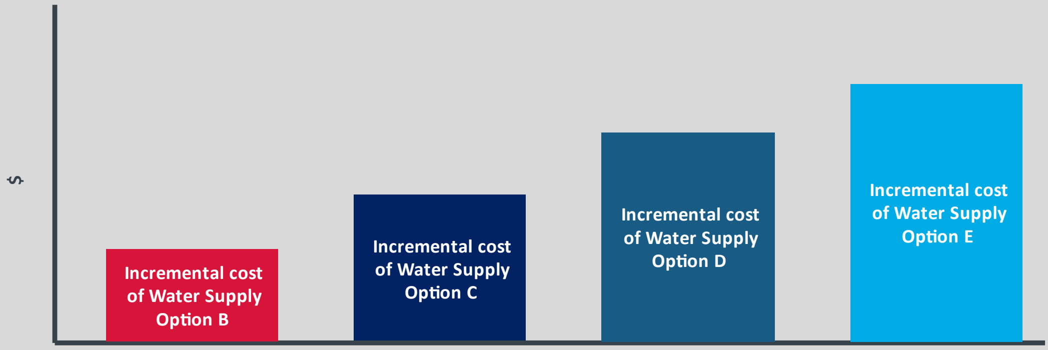
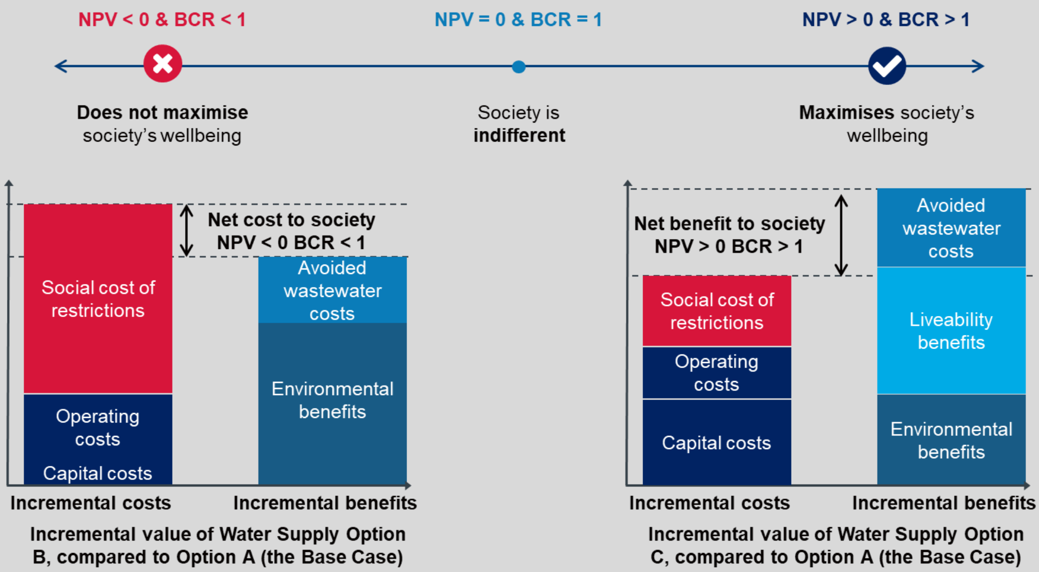
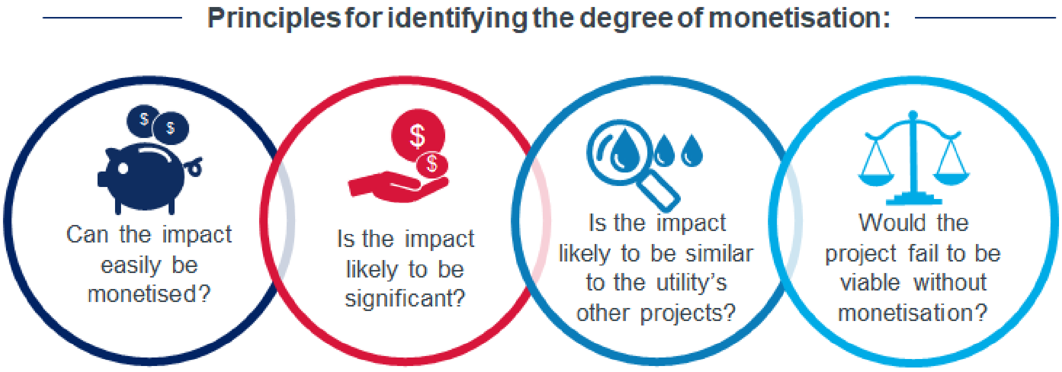


Figure 7. CBA identifies Option C as achieving the specified objective in a way that maximises welfare or value for the community



If there are material social or environmental outcomes that could differentiate the options, this could require developing a forecasting and valuation method. This can be a resource, time, and effort intensive process, particularly for those that require site- specific information that may not be readily available. This work may require input from specialists including environmental, hydrology, or economic experts.

Figure 8. Principles for identifying the appropriate degree of monetisation



As set out in Figure 9, valuing social and environmental outcomes typically requires three steps.

1. Identifying the key attributes of each option relevant to the outcome (that is, what exactly is being undertaken that is relevant to forecasting the social or environmental outcome).
2. Forecasting the change in 'biophysical outcomes' from each of the outcomes (that is, the change in outcome that we are trying to value), for example, the reduction in water or wastewater volumes at a specific point (measured in kL), the reduction in energy or greenhouse emissions (measured in MWh or tonne CO_2), the reduction in likelihood of water restrictions (measured in likelihood and duration of water restrictions per year) or the availability of land for recreation (measured in hectares of land and percent of the time it is available). This is often expressed as the 'quantity' term in the valuation formula (see Figure 10).
3. Applying a monetisation technique to value this biophysical change, for example, the value of water conserved ($/kL). This is often expressed as the 'price' term in the valuation formula (see Figure 10). These techniques can typically be classified as:
    - primary approaches – which use original data, say from a revealed preference study, or stated preference survey from the project site or context to derive a monetary value for some quantified change in outcomes caused by an option
    - secondary approaches – which take values from a pre-existing study, project, or piece of research and applies them to a new project or context (known as benefit-transfer).

Figure 9. Process for valuing economic, social, and environmental outcomes: Example of integrated water cycle management (IWCM)

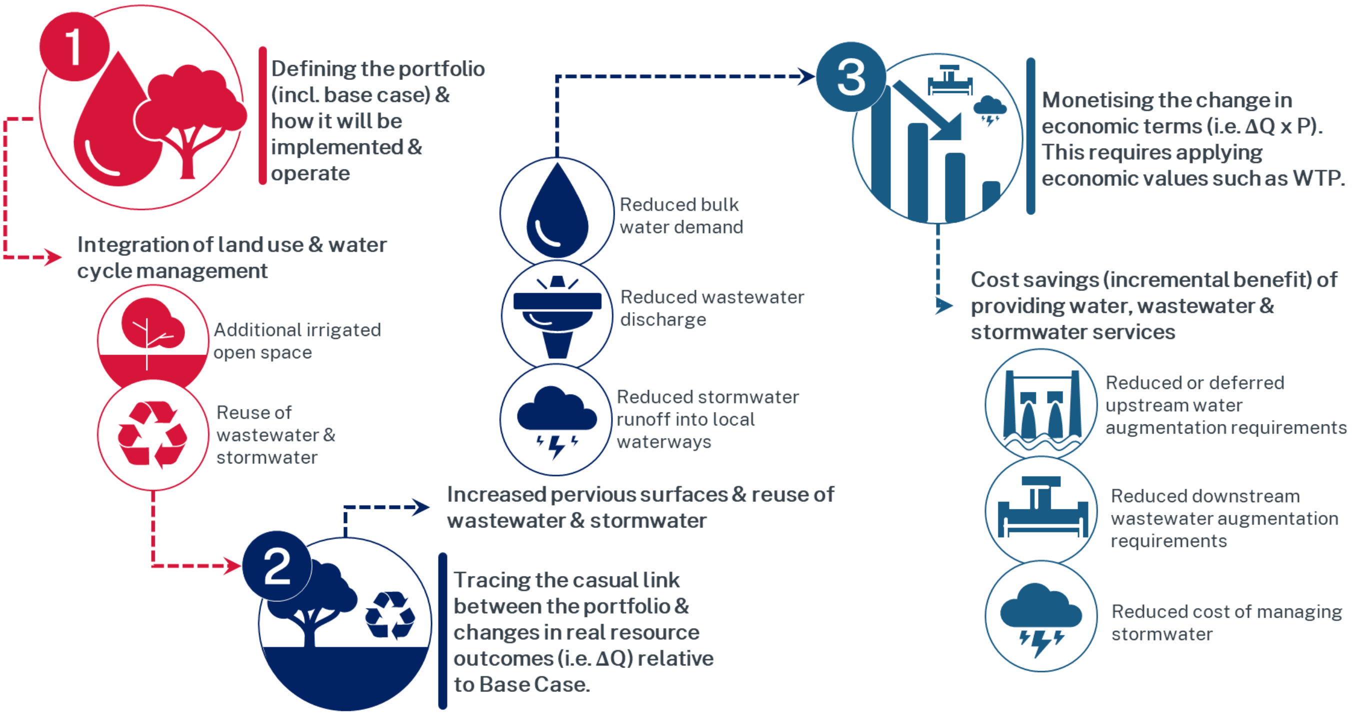
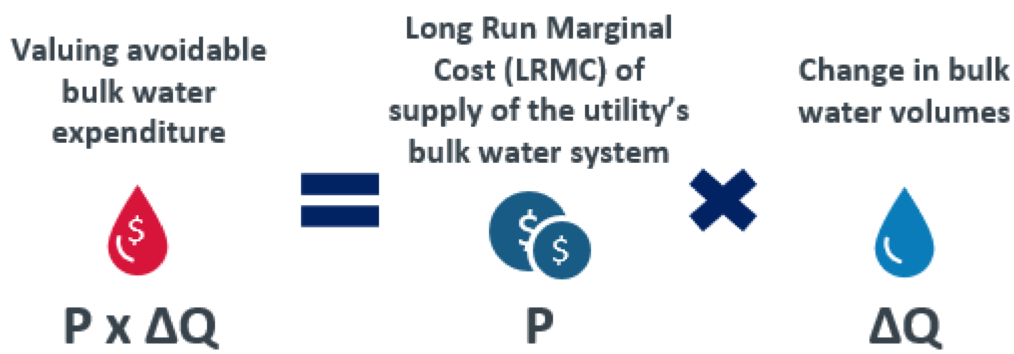


Figure 10. Valuing avoidable bulk water expenditure



When forecasting and valuing economic, social, or environmental outcomes:

- express them on an annual basis
- use well-accepted tools and techniques
- ensure they derive from best available information and use common planning assumptions (where relevant)
- expressed them in real dollars (for example, FY23 without the impact of inflation).

Step 4: Compare the costs and benefits to identify the NPV and BCR

The fourth step in a CBA involves comparing the costs and benefits to report the overall net benefit to the community.

Calculating BCR and NPV

The purpose of CBA is to compare the full range of incremental economic, social, and environmental costs and benefits of an option, compared to the base case, to inform decision makers. To achieve this, aggregate costs and benefits across time into an overall measure of net social benefit. The two measures used to compare the overall measure of social benefit are:

- net present value (NPV) – equal to the present value of the incremental economic, social, and environmental benefits *minus* the present value of the incremental economic, social, and environmental costs over the period
- benefit cost ratio (BCR) – equal to the present value of incremental economic, social, and environmental benefits *divided* by the present value of the incremental economic, social, and environmental costs over the period.

Figure 11. Calculating net present value

Figure 12. Calculating benefit cost ratio

Critically, both BCR and NPV use the same information – the present value of incremental benefits and the present value of incremental costs.

Categorising monetised costs and benefits correctly

NPV and BCR metrics identify the size or ratio of the incremental benefits to the costs. A key step then is to ensure that costs and benefits have been categorised correctly, that is, on the correct side of the CBA ledger.

As discussed above, a BCR should represent the present value of all benefits (including avoided costs) divided by the present value of all costs (including disbenefits). The NPV represents the difference between the costs (including disbenefits) and benefits (including avoided costs). For example:

- An incremental cost to society includes any economic, social, or environmental change that represents a deterioration in community welfare – that is, a disbenefit – whether it is $10m in incremental capital expenditure or $10m in additional greenhouse emissions. They form part of the denominator in the BCR calculation and the second term in the NPV calculation.
- Similarly, a $10m saving in the form of avoided or deferred capital expenditure should be treated in the same way as $10m in avoided greenhouse emissions. They both represent an improvement in community welfare – a benefit. They form part of the numerator in the BCR calculation and the first term in the NPV calculation.

Discounting the costs and benefits

When comparing costs and benefits that occur over different time periods, discount them to current period dollars.

Discounting means that costs and benefits that occur in the future are given less weight than costs or benefits that occur sooner.

An intuitive justification for discounting is that there is a time value of money: it is preferable to receive one dollar today than one dollar in a year's time. Also, there is an opportunity cost of spending a dollar now on an infrastructure item rather than 10 years in the future. This measures the rate of return that dollar could have earned over the 10 years had it been available to be invested or deployed elsewhere (rather than spent on the infrastructure item).

To value a future cost or benefit in today's terms, discounting the future cost or benefit using a discount rate determines the present value. Present values allow for decisions to be made in the present about initiatives that have different costs and benefits in the future. It also allows for comparisons over time or across proposals with different analysis periods.

The NSW Government Guidelines to Cost-Benefit Analysis[11] states:

> "The recommended social discount rate is 7% (in real terms). Sensitivity testing should be undertaken at 3% and 10% (in real terms)."[12]

Reporting and interpreting the CBA results

The option with the largest NPV and BCR generates the largest incremental net benefit to the community (compared to the base case). In particular:

- NPV>0 and BCR>1 indicates the option results in a net benefit to the community relative to the base case (that is, incremental benefits of the option exceed incremental costs)
- NPV = 0 or BCR = 1 indicates the incremental benefit of the option exactly equals its incremental costs
- NPV < 0 and BCR < 1 indicates the option results in a net cost to the community relative to the base case (that is, the incremental costs of the option exceed incremental benefits).

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[11] NSW Government, The Treasury (2017), NSW Government Guide to Cost-Benefit Analysis

[12] This guidance is relatively consistent with Australian government agencies requiring a 7% discount rate since 1989 according to the Grattan Institute (Grattan Institute (2018), Unfreezing Discount Rates; Transport Infrastructure for Tomorrow)

Identifying qualitative factors

The quantifiable costs and benefits are the main part of a CBA, but in some cases quantification may not be practical. Impacts that cannot be quantified should be accounted for qualitatively.

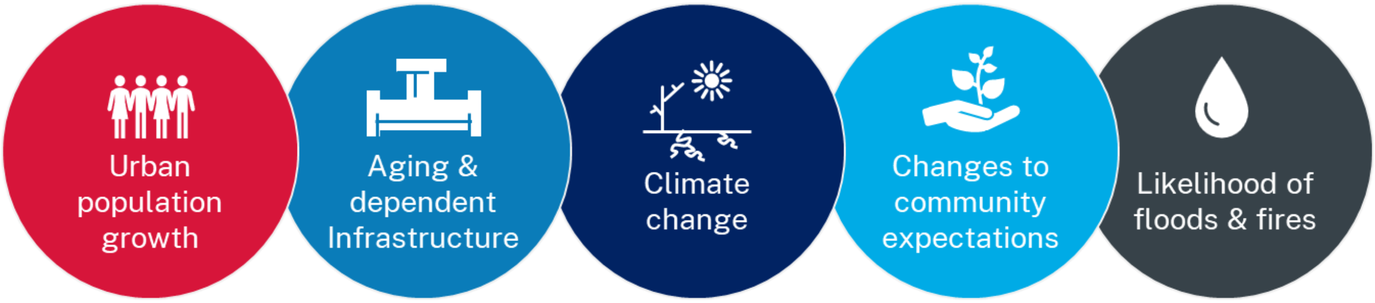
Utilities may include a list of qualitative factors in the CBA to inform decision makers (such as the direction of impact and likely significance). They should present these factors without subjective formal weightings.

Step 5: Account for key risks and uncertainties in the CBA

Decision-making in the water sector is subject to an increasing number of challenges.

To ensure an accurate comparison of costs and benefits across potential options in a world of uncertainty, the options analysis (CBA) should include tools for assessing and managing risk and uncertainty. Failure to address resilience puts Australia's water sector at risk, potentially imposing significant economic, social, and environmental costs.

Figure 13. Decision-making in the urban water sector is subject to an increasing number of challenges

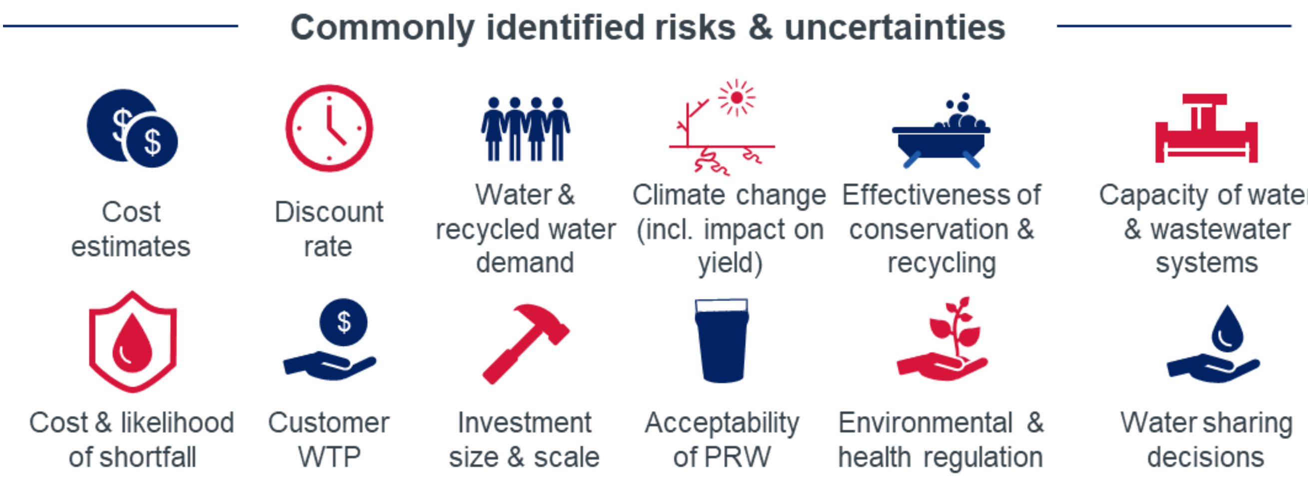


Identifying key risks and uncertainties

The result of a CBA is often a single estimate of the ratio of benefits to costs. However, in reality, a range of uncertainties will drive the size or level of costs and benefits. For example, the actual capital cost of an investment might be higher or lower than forecast, or be incurred earlier or later in the appraisal period. This means the net benefit of certain options may be volatile, and potentially higher or lower than the base case.

Figure 14 provides a summary of commonly identified risks and uncertainties of water investments.

Figure 14. Commonly identified risks and uncertainties



Local water utilities should be capable of:

- Identifying risks and uncertainties of most relevance to decision-making
- identifying which option delivers the greatest value to the community, after taking account of risk and uncertainty
- incorporating robust methods of risk analysis into the economic evaluation to identify which measures, in what timeframe, are most resilient
- identifying the community value that is available from reducing risk and uncertainty.

Determining an approach to account for risk and uncertainty

To ensure an accurate comparison of costs and benefits across potential options in a world of uncertainty, and in line with NSW Treasury *CBA Guidelines*[13] and NSW Treasury and Infrastructure NSW (INSW) *Guidelines for Resilience in Infrastructure*,[14] robust CBA should include tools for assessing and managing risk and uncertainty.

In general, the approach taken to identifying risk and uncertainty should be proportionate to the size of the project. For example, simple sensitivity analysis that varies key assumptions (such as the discount rate) may be appropriate for a simple CBA, whereas real options analysis (ROA) may be more appropriate for a detailed CBA of a large project that is subject to a range of uncertainties (for instance, major water supply augmentation options).

Some potential variables/assumptions that could be subject to sensitivity analysis include:

- capital and operating cost estimates
- the discount rate (as discussed above, NSW Treasury requires sensitivity analysis be undertaken on the discount rate)
- water and recycled water demand – which can influence the timing of investment requirements

[13] NSW Government, The Treasury (2017), NSW Government Guide to Cost-Benefit Analysis

[14] NSW Treasury and Infrastructure NSW (2019), Guidelines for Resilience in Infrastructure Planning: Natural Hazards

- climate change (impacting supply/yield, demand and potentially some costs)
- the effectiveness of conservation and recycling projects (including the assumed uptake and the volume of recycled water assumed to offset potable water demand)
- the capacity of water and wastewater systems – which will influence the timing of investment requirements, and thus the benefits of avoiding or deferring the augmentation requirements (for example, through the use of recycling and conservation)
- The cost and likelihood of a shortfall in supply (running out of water), which may be a low-probability, but high-cost event
- customer willingness to pay (WTP) for social and environmental outcomes, such as WTP to protect biodiversity or avoid water restrictions
- investment size and scale
- community acceptability of water supply options, such as potable reuse
- environmental and health regulations, which can drive supply costs (for example, managing wastewater volumes consistent with environmental regulation) and thus the benefits of alternative approaches to delivering water-related services
- water sharing decisions by other parties (such as a neighbouring local water utility) – which can, for example, influence the volume of water available in a utility's catchment.

Given the range of potentially relevant risks and uncertainties, it is not possible to include all uncertainties in the analysis. Utilities should place their focus on quantitatively addressing the uncertainties that are likely to have the most material impact on the value of an option, and qualitatively assessing other relevant uncertainties.

Approaches to managing risk and uncertainty

Standard CBA considers a predetermined single stream of costs and benefits. However, in practice, a range of uncertainties[15] may drive the likelihood of achieving benefits, which, in the presence of more certain (and higher) costs, means the net benefit of certain options may be volatile, and potentially negative.

To ensure an accurate comparison of costs and benefits across potential options in a world of uncertainty, and in line with NSW Treasury CBA Guidelines,[16] robust CBA should include tools for assessing and managing risk and uncertainty. As shown in Figure 15, these tools include:

- simple sensitivity and scenario analysis on all key assumptions – which investigates the sensitivity of the economic viability and/or ranking of the project to changes in underlying assumptions
- the use of real options analysis (ROA) or adaptive pathways analysis – which incorporates options that allow flexibility to defer some of the decision-making until the future (when there may be less uncertainty) to identify the optimal timing of investment decisions.

[15] For example, the likelihood of achieving benefits associated with potable reuse is likely to depend on community acceptance of potable reuse.

[16] Such as NSW Government, The Treasury (2017), NSW Government Guide to Cost-Benefit Analysis

Where possible, incorporating the likelihood and consequence of key risks into the quantification of costs and benefits of different options can be another way to account for risk in options evaluation (as discussed further below).

Figure 15. Overview of common approaches to assessing risk and uncertainty

Technique	**Sensitivity analysis**	**Scenario analysis**	**Real Options analysis / Adaptive pathways analysis**
Summary	• Illustrates how sensitive the NPV is to assumptions made about some or all key variables (how much a variable would have to fall or rise to make it not worth undertaking a project).	• Illustrates how sensitive the NPV is to changes in technical, economic, political factors.	• Values the benefit of flexible decisions to respond to risk and uncertainty. • Identifies 'no regrets' & 'wait and see' options. • Suitable when there is significant uncertainty, incl. when there are potentially large irreversible investments, particularly if they can be staged.
Comments	Should be used to test assumptions about key drivers of the costs and benefits (e.g. assess how the NPV changes with discount rates).	Scenario analysis should be undertaken with (or taking into account the assumptions tested in) sensitivity analysis.	ROA is less relevant when the investment decision needs to be made upfront as an 'all or nothing' commitment.
Complexity of assessment	Low	**Complexity of assessment**	High

In general, the approach taken to identifying risk and uncertainty should be proportionate to the size of the project. For example, simple sensitivity analysis that varies key assumptions (such as discount rate) may be appropriate for small projects, whereas ROA may be more appropriate for large projects (for example, supply augmentation projects) that are subject to a range of uncertainties.

Sensitivity analysis

Sensitivity analysis can provide information about how changes in different variables will affect the overall costs and benefits of the project options, as well as the distribution of the costs and benefits. It can be a useful tool to manage the inherent uncertainty over future costs and benefits of project options, particularly for those parameters that may be material to the project evaluation.

The complexity of sensitivity analysis is likely to vary with the detail of the CBA. For example, undertaking sensitivity analysis for:

- a simple CBA may involve different discount rates (consistent with NSW Treasury requirements) combined with 'high', 'medium', and 'low' water demand and lifecycle cost estimates

- a more complex CBA may involve more combinations of sensitivities.

Scenario analysis

Scenario analysis tests the sensitivity estimates of net present value to key technical, economic, political, or other uncertainties that could affect the success of a project. Scenario analysis does not involve forecasts, but seeks to describe 'what if' situations that might occur over the medium to long term.

Scenarios usually consist of descriptions of the alternative future environments that differ in crucial respects, usually in terms of significant or 'big picture' factors.

It is best undertaken in conjunction with (or taking into account the assumptions tested in) sensitivity analysis. This is because sensitivity analysis occurs within a particular state of the world, whereas scenario planning explores different states of the worlds.[17]

Real options analysis (ROA) or adaptive pathways analysis

It is possible to manage some projects (and their inherent uncertainties) in a dynamic way in response to new information. ROA (also known as adaptive pathways analysis) captures the value of this flexibility. It models the prospective cashflows that result from responding to new information in the future (when uncertainty is likely to be resolved) and identifies the pathway that maximises the expected payoff. For example, building a sequence of small, recycled water plants rather than one large, recycled water plant may provide greater flexibility, given the uncertainty around community acceptance of potable reuse in the future.

In the presence of significant risk and uncertainty, standard CBA won't necessarily identify the approach that generates the highest benefit-cost ratio, as it assumes a fixed investment strategy that remains unchanged as circumstances change. It ignores the flexibility to respond to new information and does not account for the fact that achieving the outcomes in practice may be uncertain.

In contrast, ROA or adaptive pathways analysis recognises upfront that:

- there is uncertainty about future outcomes (for example, demand for recycled water, the frequency and duration of drought)
- new information emerging over time may resolve this uncertainty
- the investment can, in certain circumstances, be adapted in response to the new information
- this flexibility to adjust the investment can be valuable – utilities can use it to exploit beneficial outcomes, while avoiding negative outcomes.

As shown in Figure 16, the steps in undertaking real options analysis involves:

- identifying key sources of uncertainty – uncertainties may be future drought, water quality issues, community acceptance of water supply (such as purified recycled water, PRW) and recycled water demand

[17] NSW Government, The Treasury (2017), *NSW Government Guide to Cost-Benefit Analysis*.

- identifying options to respond to that uncertainty – in the case of uncertainty about the acceptance of PRW, options to respond may include building a large scheme today or building a small PRW scheme today and deferring the decision to expand until later (when uncertainty is resolved)
- building a decision tree that maps the key uncertainties and options – given the range of outcomes, incorporating every possible response is likely to be difficult to map, let alone model, therefore focus is best placed on the most material
- calculating the expected present value of each branch – this will depend on the NPV of each scenario and the probability of outcomes occurring.

Figure 16. Real options analysis/adaptive pathways analysis – key steps

Identifying the appropriate technique to assess risk and uncertainty

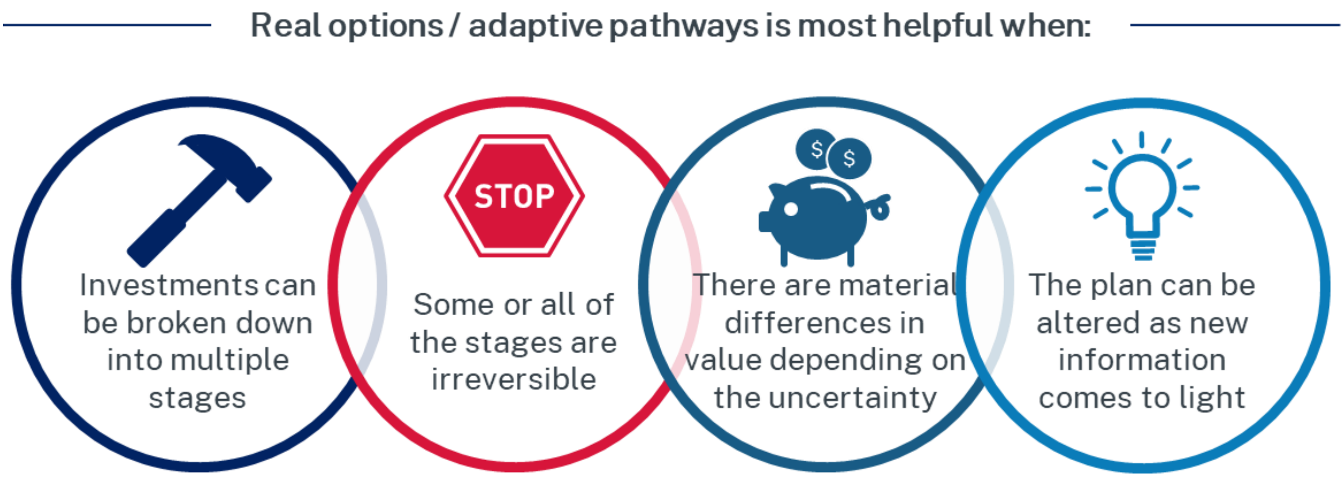
While useful, ROA can be complex and time consuming to implement.[18] In contrast, sensitivity and scenario analysis can be undertaken much quicker than ROA/adaptive pathways analysis and can provide an indication of whether the uncertainty has a material impact on the option/investment. However, it cannot value flexibility to respond to that uncertainty. Where the flexibility is valuable, traditional approaches to managing risk and uncertainty will understate the value of an option with flexibility.

The applicability of ROA should therefore be assessed on a case-by-case basis and compared to the potentially significant costs of undertaking the analysis. While its appropriateness will vary project to project, in general it is helpful when:

- the investment is potentially large and significant – for example, potential new supply augmentation measures to meet demand over the medium to long-term
- investments can be broken down into multiple stages, and where some or all of these stages are irreversible (that is, once a particular action is undertaken, and its associated costs are incurred, it cannot be reversed easily, or at all)
- there are material differences in outcomes depending on the resolution of uncertainty (for example, resolution of community acceptance may drive the feasibility of PRW)
- the plan can be altered as new information comes to light that resolves uncertainty.

[18] Real-options analysis involves undertaking separate CBA on each end-node of the investment strategy, and thus requires information on all relevant impacts for each end-node, which can be time-consuming and difficult to obtain.

Figure 17. Principles for identifying when to use real options analysis/adaptive pathways analysis



In particular, ROA may be less relevant when the investment decision needs to be made upfront as an ‘all or nothing’ commitment.

Incorporating the likelihood and consequence of events occurring

The performance of options can depend significantly on the likelihood and consequence of events occurring. Where there is reasonable information to support estimates of the likelihood and consequence of key risks, incorporate them into the quantification of costs and benefits (multiplying the likelihood (%) by the consequence ($) of an event occurring).

For example, a servicing solution initially considered lowest costs (a traditional water reticulation network versus an ‘enhanced’ reticulation network) may actually be higher cost after factoring the likelihood and consequence of drier weather from climate change (in the form of higher operation and maintenance costs, a shorter asset life and/or higher levels of leakage) into the analysis (see Figure 18).

Figure 18. Incorporating risk (probability and consequence) into the consideration of costs and benefits of options

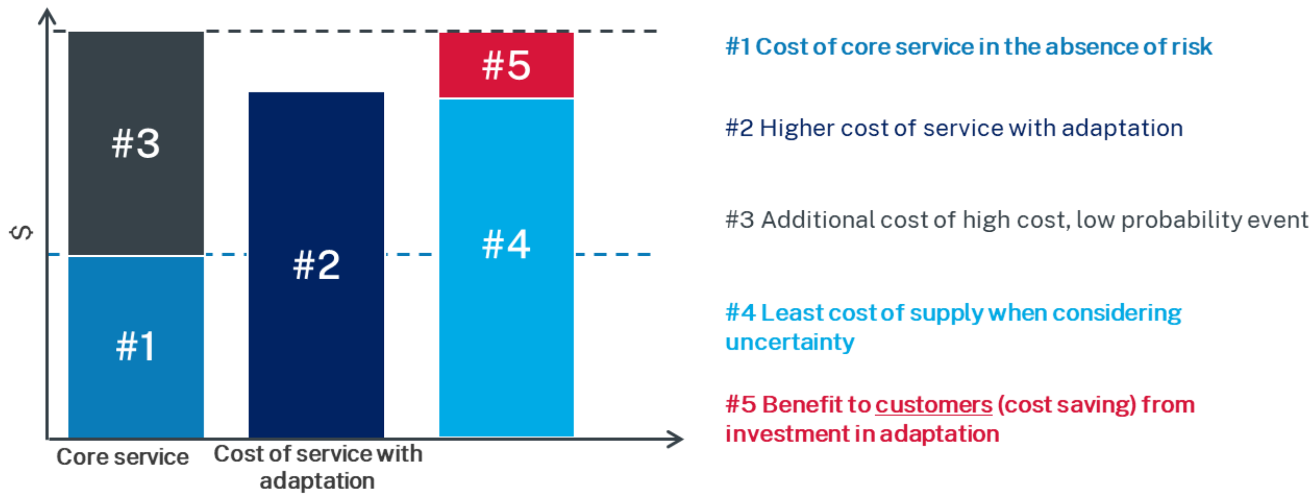


Figure 19 outlines a framework for incorporating risk and uncertainty into options analysis and investment decisions, by including estimates of likelihood and consequences (outcomes) into the evaluation of costs and benefits.

Figure 19. Applying the framework – an example of operational resilience

Managing assets over their life cycle to ensure service levels are met

Step 1: Developing an asset management framework

An asset management system comprises several key documents, including:

- the asset management policy, which outlines the utility's general rules and principles for asset management
- the strategic asset management plan (SAMP), which provides guidance and direction on what the utility wants to achieve through asset management.

Good industry practice dictates that asset management models align with the general principles outlined in ISO55001. Appendix B provides an example of a popular asset management model.

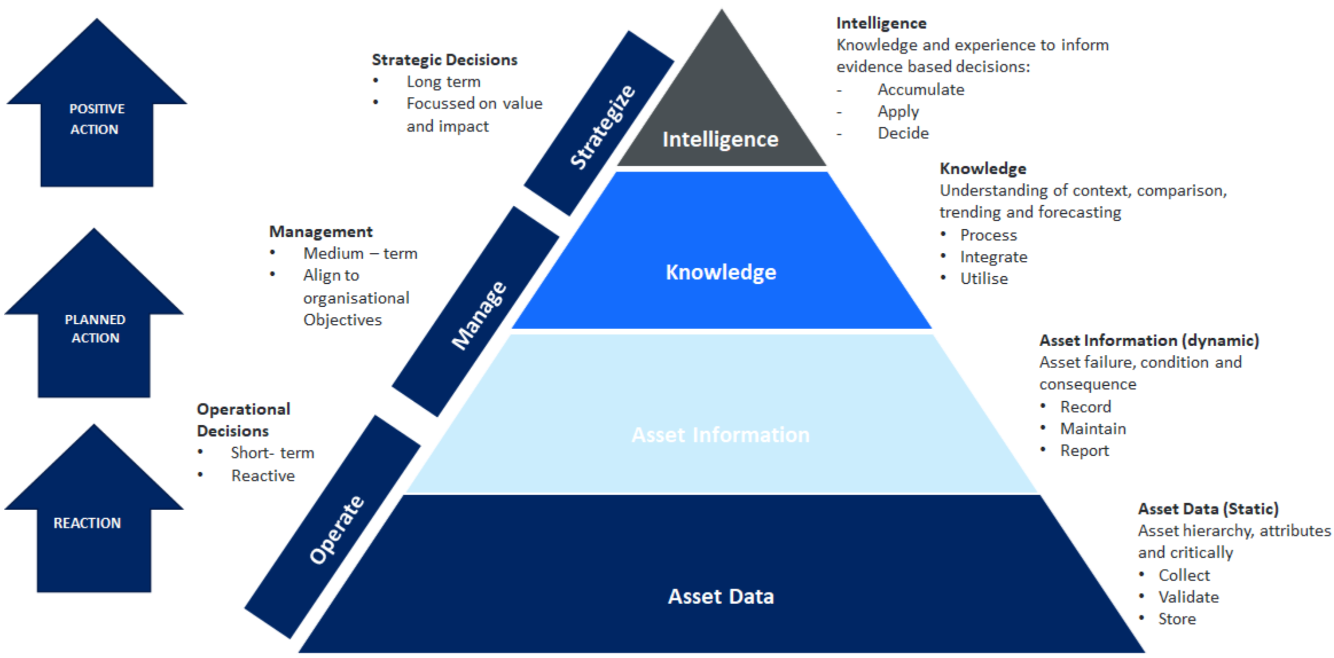
Step 2: Developing a comprehensive asset register and a proposed process for transitioning asset information to asset intelligence

Collect asset information appropriate to enable evidence-based responses to the following questions.

- What level of disaggregation of assets is prudent to develop distinct asset classes?
- What and where are my assets?
- What condition are they in and is that condition consistent with expectations given the age and operation of the asset?
- How critical is an asset within the system (in terms of impact on service levels), that is, can it be allowed to run to failure, or does it need to be refurbished or replaced ahead of failure?
- How do assets perform compared to design and required-delivery expectations?
- Is the asset maintenance regime adhered to?
- What are the actual costs to operate and maintain these assets?

The following figure provides a guide for improving the robustness of evidence that can underpin current and future investments by transitioning asset information to asset intelligence.

Figure 20. An example process for transitioning asset information to asset intelligence



Step 3: Developing the plans for managing the assets in a structured, co-ordinated, and consistent manner

1. Determine the standard asset classes applicable to the utility. These could be assets that have specific characteristics and maintenance requirements. For example, this could be a type of pump (submersible, mixed flow, axial). The size could also be a differentiator – for example, large versus small centrifugal pumps.
2. Determine the standard asset life for each asset class. This could be defined from available historical maintenance and failure data, supplemented by literature reviews of public domain information, and engineering and technical experience of staff and consultants. The standard life could be considered the low-risk life of the asset.
3. Determine standard asset class condition decay curves. For each asset class a decay curve can be defined in terms of age, number of operations, time in operation, and number of loading cycles. These decay curves can then be standardised on a percentage basis and applied across the asset base to provide an age-based assessment of asset condition. A typical condition assessment may be based on a condition rating over a scale of 1 to 5, where 1 is new and 5 is close to fail.
4. Determine the probability of failure applicable to each asset class using a combination of the decay curve and a normal distribution of asset failures. For assets where the condition is unknown, the probability of failure could be derived from an aged-based assessment of the condition using the decay curve and a range of standard deviations. Where asset conditions have been assessed through inspections, the assessed condition can be applied to derive the probability of failure across a range of standard deviations.
5. Risk appetite is generally linked to the consequence of failure. Failures with a minor consequence might be acceptable to the business, but as the consequence of a failure increases, the business might be less accepting of the failure occurring. The consequence of a failure is typically assessed across four risk categories:
    - public and worker safety – the consequence from causing injury or loss of life
    - environment – the consequence resulting due to interaction with the environment
    - service levels – the consequence from failing to meet service levels (supply, quality)
    - financial –any other costs resulting from the failure, such as the cost of replacing the asset and repairing other collateral damage.

    A monetary value can be attributed to risk by multiplying likelihood by consequence. This can assist the utility in prioritising asset investments and evaluating investment options (as noted in this guidance document when discussing how to incorporate risk into cost benefit analysis when evaluating options).

Table 8. Monetised risk matrix example

Likelihood of consequence		Risk				
		Minor	Moderate	Significant	Major	Catastrophic
		$100,000	$1,000,000	$5,000,000	$50,000,000	$100,000,000
Almost certain	1.000	$100, 000	$1,000,000	$5,000,000	$50,000,000	$100,000,000
Likely	0.500	$50,000	$500,000	$2,500,000	$25,000,000	$50,000,000
Possible	0.200	$20,000	$200,000	$1,000,000	$10,000,000	$20,000,000
Unlikely	0.050	$5,000	$50,000	$250,000	$2,500,000	$5,000,000
Rare	0.015	$1,500	$15,000	$75,000	$750,000	$1,500,000
Very rare	0.002	$200	$2,000	$10,000	$100,000	$200,000
Extremely rare	0.001	$50	$500	$2,500	$25,000	$50,000

Step 4: Determining the asset management strategies for managing assets to achieve service levels

Asset management strategies should enable utilities to deliver their services to required standards at minimum cost, while optimally managing risk (including corporate, environmental, and service delivery risk). They should therefore be purpose-driven and determined for each asset class. They should consider requirements to achieve service levels and to maintain service potential, ongoing operational performance and service capacity in the context of existing asset specific issues and expected future issues. This takes into account advancements in technologies, legislation, and community expectations.

As the cost of asset failure increases, the greater the desire to avoid failure. The utility's asset management strategies may therefore vary across the risk matrix and include:

- extreme – early replacement and refurbishment of assets as required to maintain service levels
- high – prioritised replacement and refurbishment of assets as required to maintain service levels
- moderate – scheduled maintenance, condition monitoring, and risk mitigation
- low – run to failure.

Step 5: Determining the actions and timing of investments to deliver the asset strategies

A program of activities to deliver the asset strategies may consist of inspections, condition monitoring, and servicing of assets. These activities should aim at proactively detect and action corrective measures to ensure service levels are met.

Utilities may establish standard replacement and refurbishment programs to address specific asset issues, applying the asset risk assessment and decision-making framework.

Step 6: Determining the delivery framework

A works delivery framework typically consists of a set of management tools and techniques employed to manage teams, tasks, resources, and time. Establishing a delivery framework would generally revolve around a work management software system employed by the utility that provides the tools and project management features to control and optimise the productivity of teams. It may include, but would not be limited to, the management of workorders, detailed work instructions, and assigning of work crews.

There are delivery models that deliver works. Examples include in-house, outsource and mixed in-house, and outsourcing. It is important the utility chooses the appropriate delivery model for each of its work streams. For example, routine inspections might be an in-house activity, allowing the utility to maintain insights on asset conditions; whereas scheduled maintenance works might be undertaken using a blended approach to leverage contractor resourcing; and replacement and refurbishment works might be an outsourced activity to leverage competitive pricing.

Step 7: Reviewing the effectiveness of the asset management activities

Use a system of performance measures to describe and measure the effectiveness of asset-management strategies. These measures can consist of a range of both leading and lagging indicators. Leading indicators provide a measure of performances that points towards potential future events and allows for proactive responses. Lagging indicators provide a measure of performance based on events that have occurred and are a means of monitoring the impact from responses to leading indicators.

Leading performance measures a utility could apply to proactively identify and improve asset management strategies include (but are not limited to): service outages (frequency and duration), overdue inspections, overdue maintenance work, overdue preventative works, overdue corrective works, overdue replacements and refurbishments, and the number of poor health assets.

Lagging performance measures a utility could apply to monitor the effectiveness of its asset management strategies include (but are not limited to): in-service asset failures, condition-based safety incidents, environmental incidents, and service level breaches.

Other performance measures may include (but are not limited to): annual maintenance cost per asset, annual capital cost per asset, and cost per failure.

Appendix B: Templates, case studies and tools

To support utilities in achieving the strategic planning outcome of **understanding solutions to deliver services** to a reasonable standard, we give the following optional templates, case studies and tools.

Options and cost benefit analysis

There is a range of guidance available on options analysis and cost benefit analysis

Guidance is available in a range of places, including the following:

- NSW Government Guide to Cost-Benefit Analysis
- Infrastructure Australia's Assessment Framework[19]
- Infrastructure Australia, Guide to multi-criteria analysis, Technical Guide of the Assessment Framework, July 2021, including a multi-criteria analysis Excel template

Case study: simple CBA, upgrading an existing wastewater treatment plant

Problem definition

Wastewater volumes in the local water utility's service area are expected to increase significantly over the next 30 years as a result of growth and development. This will place pressure on the existing wastewater system and treatment plant, which is forecast to reach its capacity in the next 10 years.

Action is required to ensure that wastewater services can continue to be provided to the area, consistent with the utility's regulatory requirements and the level of service expected by the community.

[19] While the investment may not be large enough for the Infrastructure Australia's Priority List, the Assessment Framework contains useful guidance for options evaluation and CBA framework.

Options

All options must achieve the objective of managing wastewater in the area (that is, do nothing is not an option).

Base case – business as usual/do minimum to manage wastewater in the area. Wastewater would continue to be transported and treated at the existing treatment plant for discharge in the nearby waterway. The capacity of the treatment plant would be expanded to ensure it can meet increased demand,.

Option 1 – recycled water for irrigation of open space. This includes upgrading the existing wastewater treatment plant to include infrastructure to treat/recycle wastewater and transport the recycled water to a nearby open space.

Option 2 – third pipe recycled water for non-potable in residential dwellings. As per option 1, this includes upgrading the existing wastewater treatment plant to include infrastructure to treat/recycle wastewater. It also includes the provision of third-pipe infrastructure to transport recycled water for non-potable use in residential dwellings.

Benefit and costs categories

Table 9 summarises the main benefit and cost categories for the project. As option 1 and option 2 include the production of recycled water, they provide the opportunity to reduce potable water demand and defer or avoid the need to upgrade the potable water system (also known as avoidable costs). However, this recycled water infrastructure comes at an added cost, compared to the base case (additional capital and operating expenditure).

The option with the highest net present value (NPV) is generally preferred.

Table 9. Benefit and cost categories, relative to the base case

Benefits	Quantified?	Costs	Quantified?
Capital cost savings	Yes	Capital costs	Yes
Operating and maintenance cost savings	Yes	Operating and maintenance costs	Yes
Avoidable potable water costs from the use of recycled water	Yes	Greenhouse emissions from the treatment of wastewater	No
Improved waterway health from reduced wastewater discharge	No		

Inputs and assumptions

- Analysis period: 30 years
- Base year (price year) = 2022-23 ($2023)
- Real discount rate = 7% (with sensitivity tests at 3% and 10%)
- Costs/benefits are incremental to the base case

- Asset lives of investment: 30 years
- Investment costs (in 2023, undiscounted):
    - base case: $8m
    - option 1: $10m
    - option 2: $15m
- O&M costs (from 2023):
    - base case: $500k per annum
    - option 1: $750k per annum
    - option 2: $1m per annum
- Standard procurement processes for design development and construction will be followed.

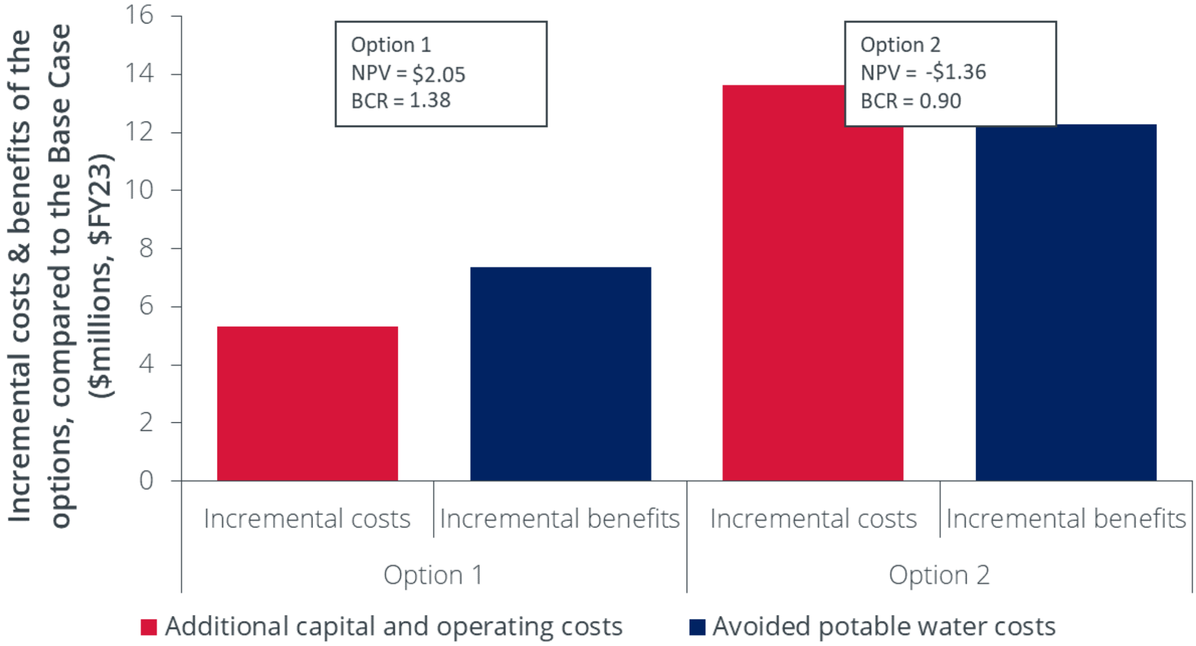
CBA results

Figure 21 below summarises the results of the CBA, outlining the present value of the incremental costs and the present value of the incremental benefits for each option. It shows:

- **option 1 has a positive NPV and a BCR greater than 1,** indicating that the incremental benefits outweigh its incremental costs (the option delivers a net benefit to the community).
- **option 2 has a negative NPV and a BCR less than 1,** indicating its incremental costs outweigh its incremental benefits (the option would result in a net cost to the community). Although the option delivers a greater volume of recycled water and, therefore, a larger potable water avoidable cost (the dark blue bar), this is not sufficient to outweigh the additional costs of delivering the third-pipe infrastructure.

On this basis, option 1 (recycled water for irrigation of open space) is preferred.

Figure 21. Case study 1 – indicative CBA results



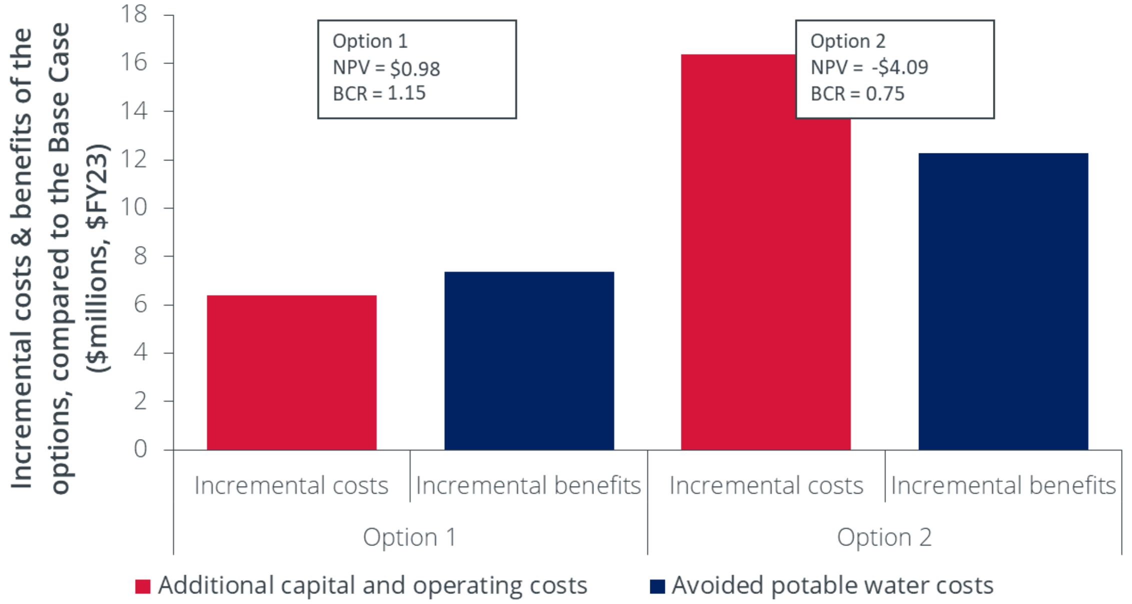
Risk and uncertainty analysis

There is uncertainty associated with forecast costs and benefits. For example, the actual capital cost of the options might be higher or lower than forecast. To assess how this could affect the CBA, we have undertaken the follow sensitivity tests:

- 20% increase in capital and operating costs
- 20% decrease in capital and operating costs
- higher and lower discount rates (10% and 3%).

The results of the sensitivity tests, outlined below, indicate the results of the CBA are robust to changes in costs and discount rates. **Option 1 continues to be the preferred option.**

Figure 22. Case study 1 - indicative CBA results - 20% increase in capital and operating costs



Note that with lower capital and operating costs, option 2 has a positive NPV and BCR greater than 1, but option 1 remains the preferred option as its NPV and BCR are larger (see Figure 23).

Figure 23. Case study 1 - indicative CBA results – 20% decrease in capital and operating costs

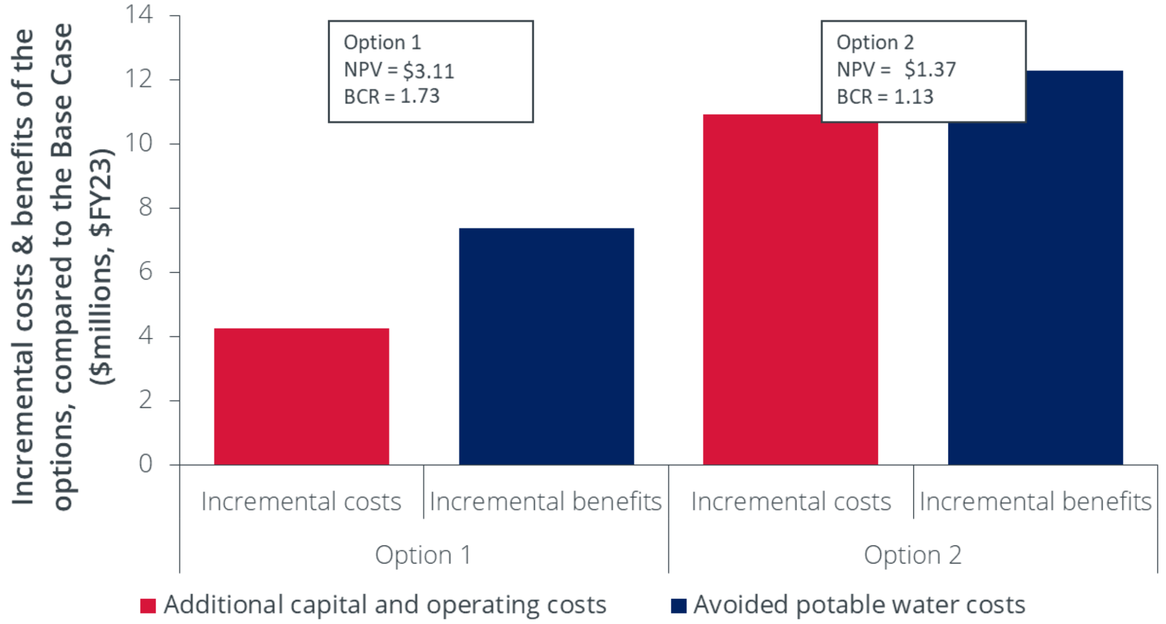


Figure 24. Case study 1 - indicative CBA results – 10% discount rate

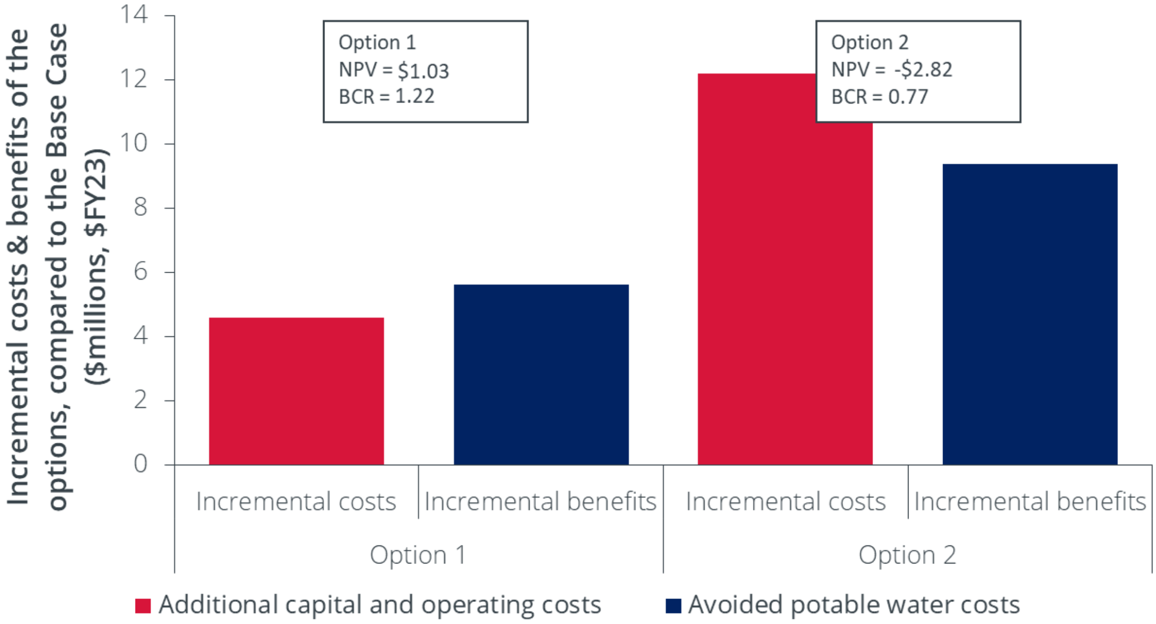
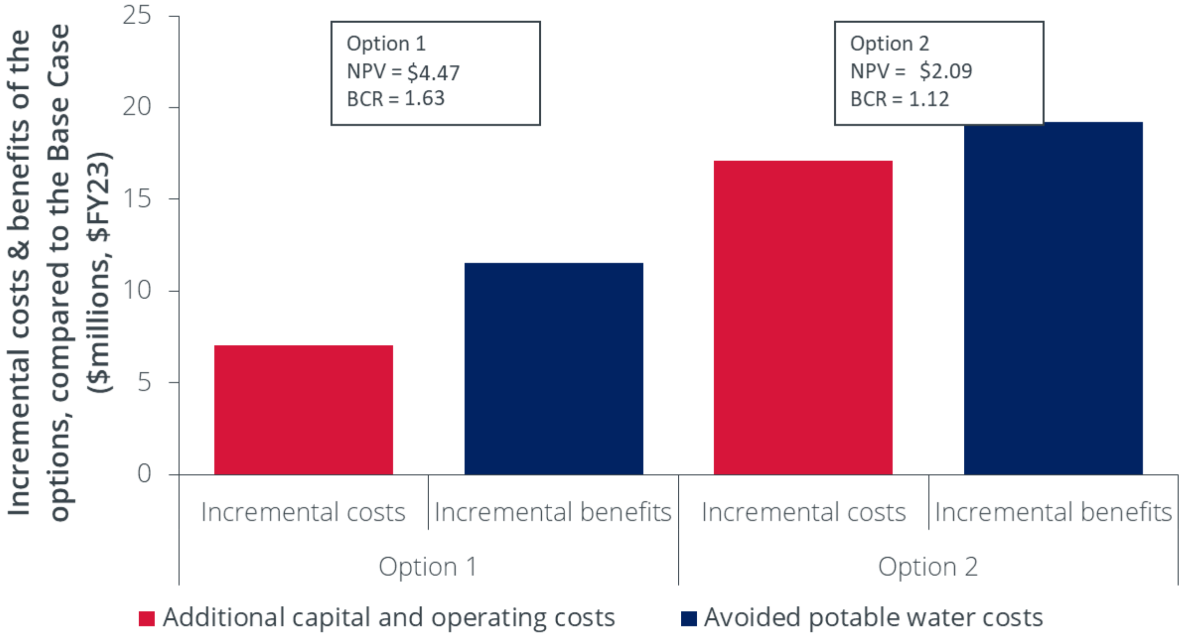


Figure 25. Case study 1 – indicative CBA results - 3% discount rate



Case study: real options decision tree

Figure 26 presents an example decision tree that maps options and their expected NPVs, in the face of uncertainty. In this case, the utility is faced with the initial option of building a relatively small supply augmentation or building a larger augmentation (for example, a large dam).

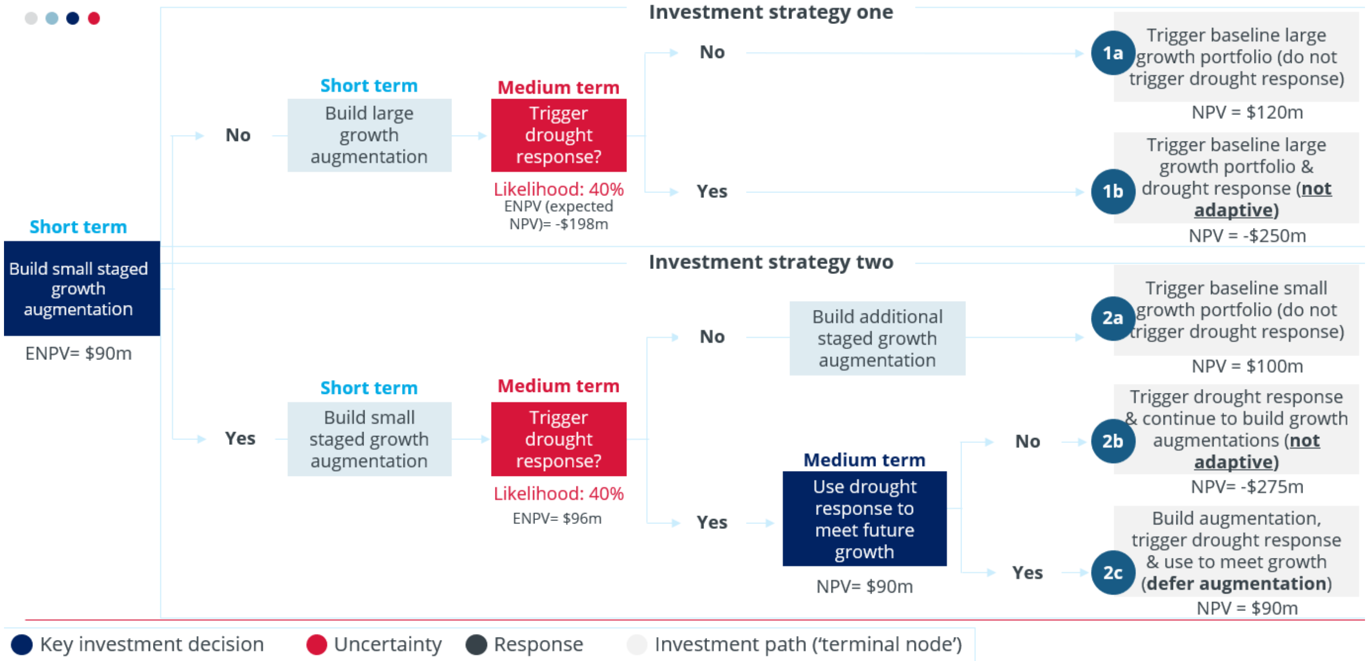
If the utility elects to initially build a large supply augmentation and drought does not hit, the utility will not need to augment again for the foreseeable future and the dam will yield an NPV of $120m.

However, if drought does hit, it may still need to invest in drought-response or drought-resilient measures, such as a desalination plant. In total, this would result in a negative NPV of $250m.

Alternatively, if the utility initially elects to build a smaller augmentation (under a stage approach), if drought does not hit at some stage, it will require further augmentation (but, in a staged way, at an NPV of $100m). And if drought does hit, it will need to invest in further supply capacity in response, but this can also play a role in meeting growth (at an NPV of $90m).

Under this scenario, the option of building smaller, staged supply capacity has a higher expected NPV (ENPV) than the option of initially building larger capacity.

Figure 26. Real options decision tree

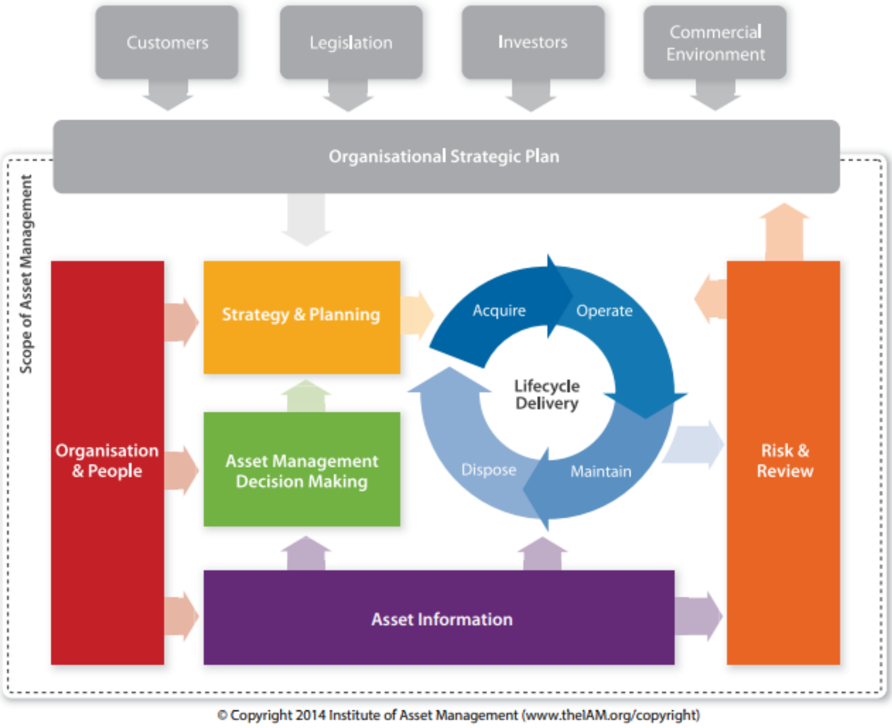


Managing assets over their life cycle

Asset management system

There are many models for asset management systems, and most will adhere to the general principles outlined in ISO55001. A popular model is that from the Institute of Asset Management (IAM), outlined in Figure 27.

Figure 27. The IAM's Conceptual Asset Management model



The IAM model outlines the key components of an asset management system required to adequately inform the evaluation of viable asset investment options aimed at ensuring service levels are met.

- **Strategy and planning** set the context in which the utility operates, the asset management strategy, alignment with the utility's organisational strategy, legislative requirements, stakeholder requirements, asset management roles, and the long-term asset plans (for example, the SAMP).
- **Asset management decision** making defines the framework and policies with the aim of optimising the utility's plans in a structured, co-ordinated, consistent, and directed manner.
- **Life cycle delivery** covers the practical, day-to-day aspects of managing assets throughout their life cycle, covering the planning, acquisition (design, procurement, construction), operation, maintenance/renewal, and disposal stages.
- **Asset information** highlights the need to collect appropriate asset data and information, to guide decisions and actions related to each asset. Appropriate IT systems are required to manage asset information and provide a 'single source of truth'.

- **Organisation and people** raise awareness within the utility regarding the asset management objectives and alignment of everyone's contribution to this common goal.
- **Risk and reviews** identifies current and future risks related to safety, environment, reputation, compliance, reliability, and setting the utility's tolerance for these risks. This forms the basis for rational, sound, and defendable investment decision making. It also includes a performance-monitoring function where both leading (overdue maintenance works, overdue corrective works, poor asset health), lagging (in-service failures, safety incidents, condition-based failures), and other (maintenance cost per asset, capital cost per asset) performance measures are used to direct investment decision making.

These key asset management components are interconnected. Together they equip the utility to adequately manage assets over their life cycle to ensure service levels are met.

Strategic Asset Management Plan

A Strategic Asset Management Plan (SAMP) is a common industry tool.

ISO 55000 defines a SAMP as the:

> '… documented information that specifies how organisational objectives are to be converted into asset management objectives, the approach for developing asset management plans, and the role of the Asset Management System (AMS) in supporting achievement of the asset management objectives.'

Senior management should drive the SAMP to reflect the local water utility's asset management policy, framework, and objectives.

To ensure the strategic asset management planning process reflect the utility's operating environment and objectives, the utility should ensure:

- there is clarity in terms of internal responsibility and accountability for managing assets, including outsourced services
- asset management information systems (AMIS) are maintained at a level that meets decision-making and reporting requirements
- an effective performance evaluation/reporting and continuous improvement program is in place.

A SAMP provides the framework to present the utility's overarching strategy and the associated processes for asset management planning. The SAMP can be structured to demonstrate and align asset portfolio/operational planning with higher-level strategic service delivery objectives and governance arrangements. This enables prudent and efficient decision-making in response to a changing operating context.

A SAMP aims to provide a logical, understandable, and structured hierarchy of asset-related actions from strategy to planning and delivery. It can drive associated or consequential improvements across all areas of the asset life cycle to secure value for money from the overall asset investment. It:

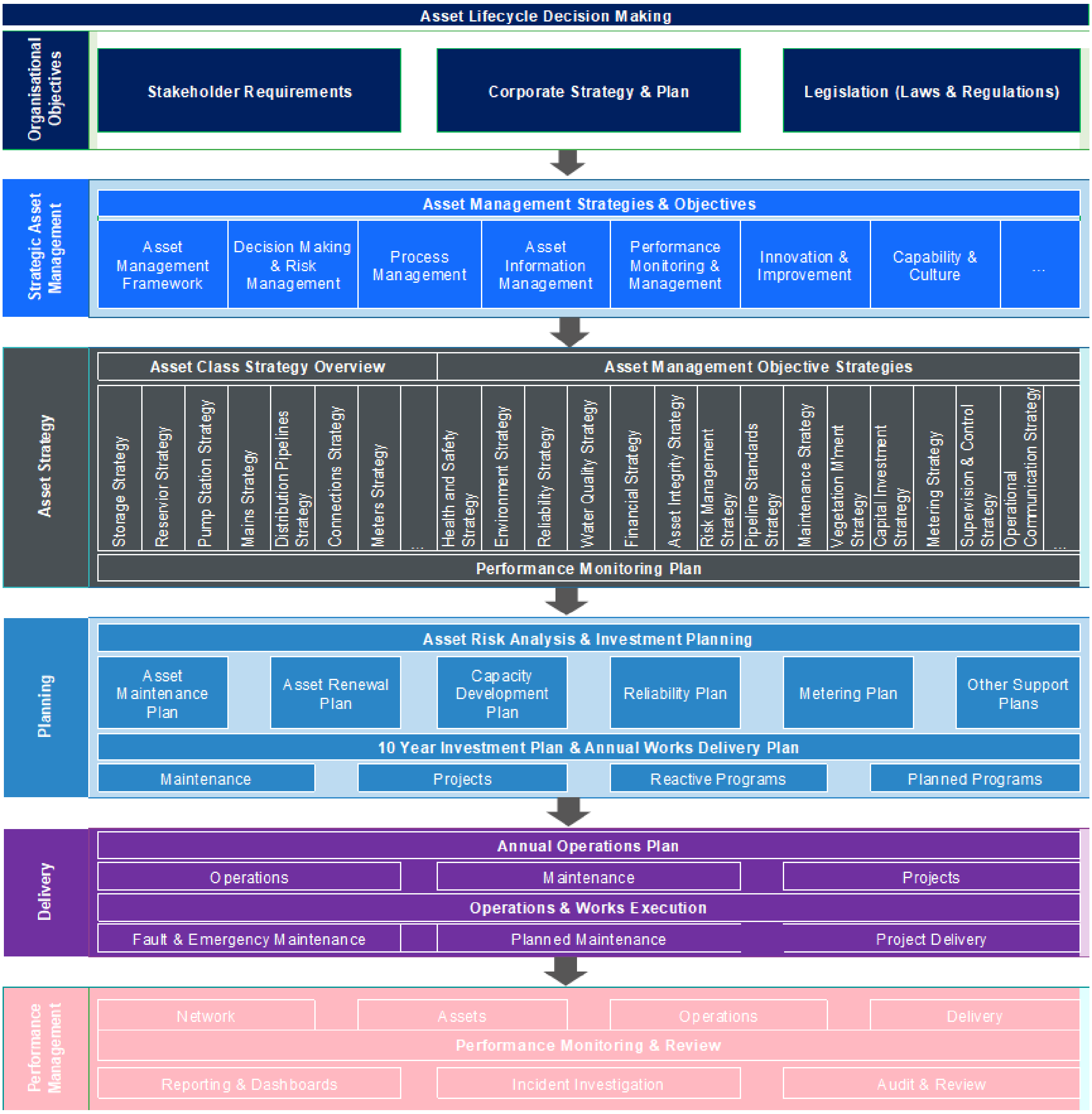
- offers a strategic perspective to rethink the way physical assets facilitate the delivery of services
- sets out guidance for developing asset management objectives, supports alignment across levels of service, and contributes to desired strategic outcomes within a constrained budget
- incorporates stakeholders' expectations into planning to ensure external requirements are met
- improves asset management skills and maturity within the utility
- integrates with other management systems (risk management, financial management, information management)
- links asset management systems with long-term funding requirements through a long-term financial plan
- supports funding submissions by providing demonstrable links to department and state strategies.

A utility should tailor its SAMP to reflect its specific objectives, operating environment, and circumstances.

A sample asset life cycle decision-making framework

Figure 28 provides a sample asset life cycle decision-making framework that can be applied towards a utility meeting its service levels. The sample is based on popular asset management models and is only one of many permutations that could be applied by the utility.

Figure 28. Sample asset life cycle decision making framework



Other asset management tools

Other asset management tools include:

- NSW Government framework for SAMPs: https://www.treasury.nsw.gov.au/finance-resource/asset-management-policy
- Industry good practice sources such as "International Infrastructure Management manual" https://www.ipwea.org/westernaustralia/publications/bookshop-old/ipweabookshop/iimm
- Asset Management – An Anatomy – IAM (UK) https://theiam.org/knowledge-library/asset-management-an-anatomy

- Framework for Asset Management, Second Edition – Asset Management Council (AUS) https://www.amcouncil.com.au/component/content/article.html?id=1124:building-an-asset-management-system-framework
- Pathway to Excellence – Maturity Scale and Guidance – https://theiam.org/shop/products/38230.