CRC for
Water Sensitive Cities

INFFEWS worked example: Princes Park Stormwater Harvesting

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1. Introduction

This document presents a worked example of using the INFFEWS tools to develop a business case for a water sensitive project, specifically the Benefit Cost Analysis Tool and the Value Tool.

1.1. Introducing the INFFEWS package

The Cooperative Research Centre for Water Sensitive Cities (CRCWSC) developed a package of economic tools and resources, known as INFFEWS (Investment Framework For Economics of Water Sensitive cities). The package provides an economic evaluation framework to identify and quantify economic, environmental and community values of investments in water sensitive practices and systems. It seeks to support business case development and decision making at multiple levels in public and private sector organisations.

The INFFEWS Benefit Cost Analysis Tool

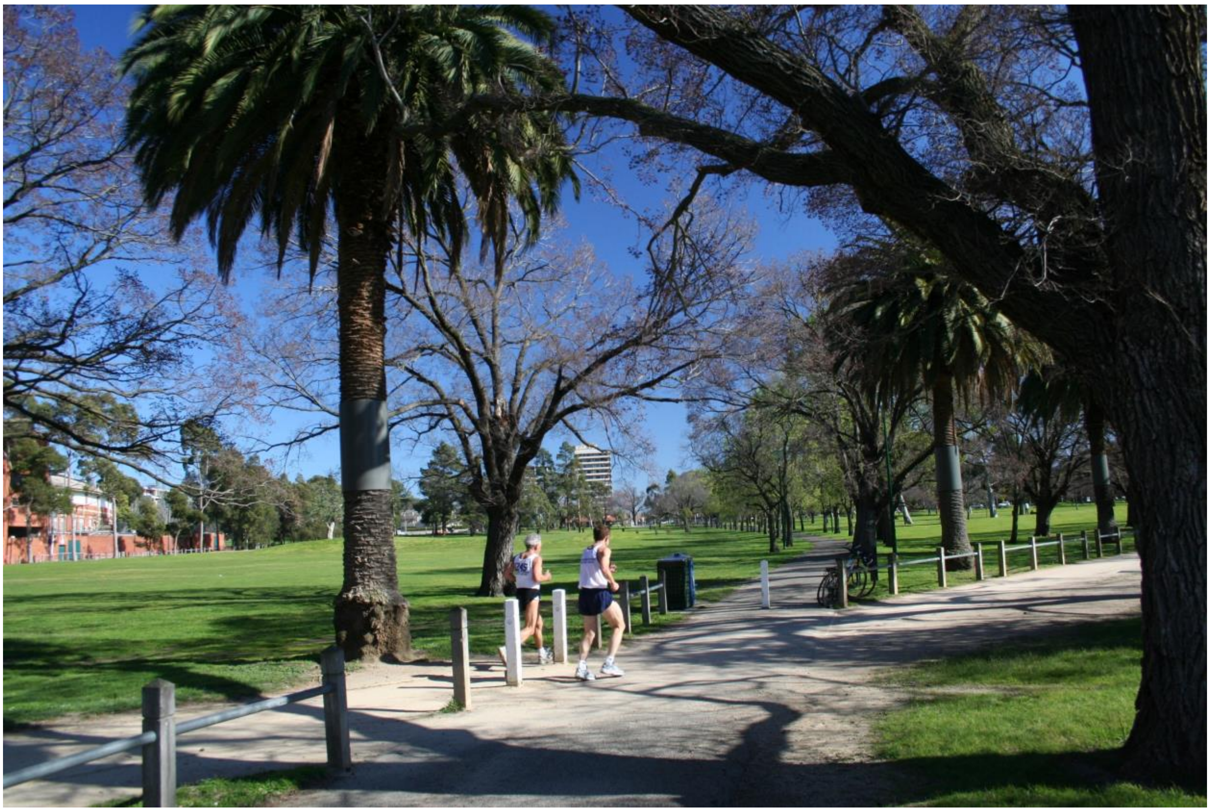
The INFFEWS Benefit Cost Analysis Tool (BCA Tool) is an Excel-based framework that allows the user to develop a benefit–cost analysis. It was developed in response to industry feedback that developing holistic business case was an important factor in delivering water sensitive investments. Accordingly, the BCA tool is tailored specifically to assessing investments for water sensitive cities. Its contents, framework and assumptions are based on sound economics and the tool is fully consistent with guidelines prepared by Australian state and national governments.

The INFFEWS Value Tool

Another important component of INFFEWS is the Value Tool which provides information about monetary-equivalent values of non-financial benefits generated by investments in water sensitive cities. The Values Tool is a comprehensive database of existing non-market values of water sensitive systems and practices that will be used to underpin various benefit transfer methods. The Values Tool complements the BCA Tool, by providing reference data to identify possible monetary values for common benefits of water sensitive projects. This custom-built, Excel-based database uses values from Australian studies that can be easily and efficiently accessed. Its design and functionality reflects consultation with the industry partners and non-market value experts, ensuring it would be easy to maintain into the future.

1.2. Introducing the worked example project: Princes Park Stormwater Harvesting

The worked example is a benefit–cost analysis (BCA) of a proposed stormwater harvesting scheme in the City of Melbourne municipality in Victoria, Australia. Princes Park is a major metropolitan parkland in Melbourne’s inner north. It includes various types of sports grounds and passive recreational spaces, and is home to many mature trees of historical significance. The park is heavily used by the local community, and it attracts users from a much wider area given its prominence for sports events and recreation.



Joggers in Princes Park

The park and its trees are currently supported by irrigation using the potable mains water supply, with a typical annual water demand amounting to 73 ML/year. City of Melbourne identified Princes Park as a major water user, and is working to reduce potable water use and increase alternative water supplies as part of its Municipal Integrated Water Management Plan. A stormwater harvesting concept[1] had been developed, which considered extracting urban stormwater from Moonee Ponds Creek, which would then be pumped to a large underground storage before being used to irrigate parkland and trees (figure 1). The stormwater harvesting scheme is expected to significantly reduce potable water use for park irrigation, with modelling predicting a 77% reduction. A successful stormwater harvesting scheme is already servicing the adjacent Royal Park area, but the treatment system and storage are at capacity. So a new system is being considered.

[1] Stormy Water Solutions (2019), *Mooney Ponds Creek harvesting for irrigation investigation*. City of Melbourne.

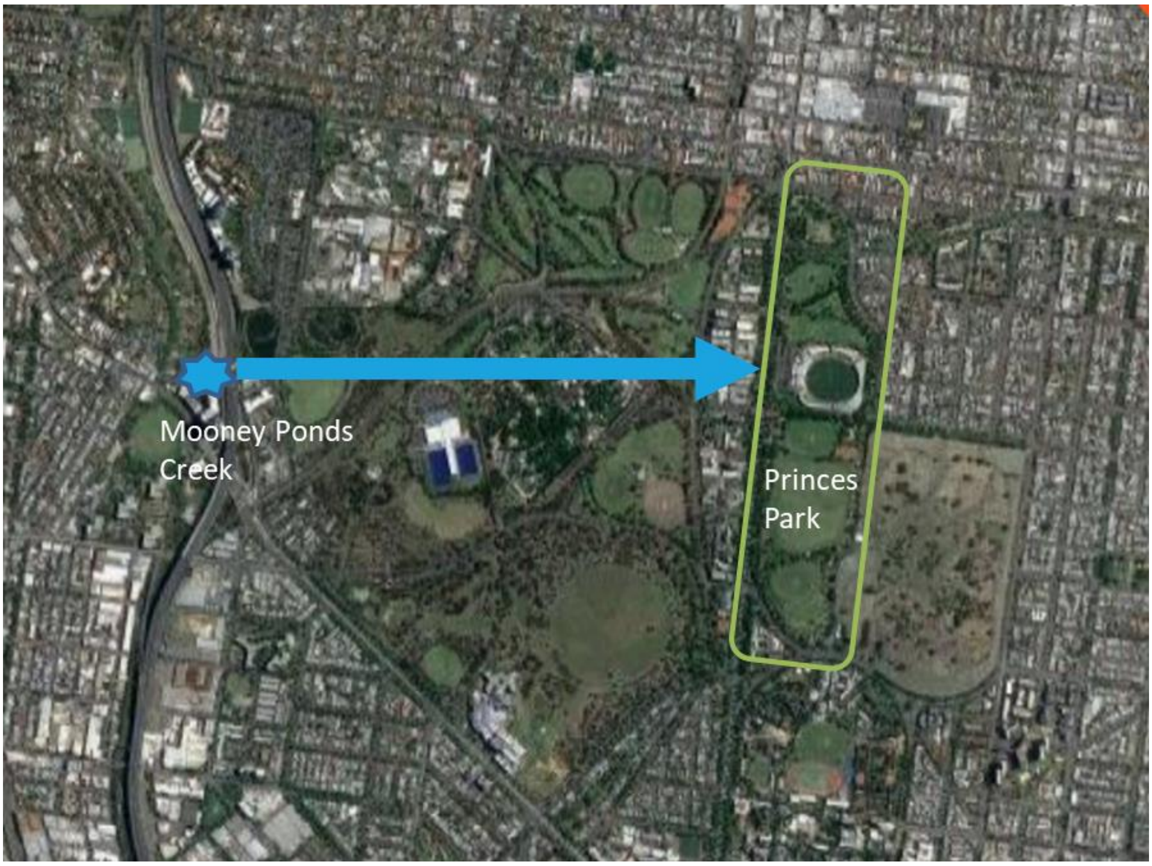


Figure 1: Location of Princes Park in relation to stormwater extraction from Mooney Ponds Creek

The BCA process

Consultants E2Designlab conducted a six-step process for City of Melbourne, to prepare and undertake the BCA for the Princes Park project using the INFFEWS toolkit:

Step 1: Understand why a BCA is needed and how it will be used

Step 2: Define the 'with project' and 'without project' scenarios

Step 3: Identify costs

Step 4: Identify potential benefits using the INFFEWS Values Tool

Step 5: Conduct benefit–cost analysis using the INFFEWS BCA Tool

Step 6: Present a business case summary.

Each of these steps is discussed in the following chapter.

2. Worked example

2.1 Step 1: Understand why a BCA is needed and how it will be used

The first important step in a BCA process is understanding why it is needed and how it will be used by stakeholders. This will often inform the scoping of the analysis, and it could determine what level of detail is needed, i.e. is it a quick 'ready-reckoner' to build confidence in the project or a detailed business case which will be used to underpin financing or final approvals? Is it needed because the project is under scrutiny? Are there aspects of uncertainty or benefits that need to be evaluated?

In this case, the BCA was requested following the completion of an initial concept design for the scheme, to help council decide whether the project had sufficient merit to proceed to detailed design investigations. The concept investigation tested the scheme's feasibility and developed preliminary cost estimates and performance metrics such as the volume of water supplied and the reliability of supply during a drought period. On potable water savings alone, the scheme was not financially viable for the council to invest in. However, the council was also aware of significant benefits that the scheme could offer to the environment and local community, including:

- the continued support of park irrigation during future droughts when potable water supplies may be restricted. In particular, irrigation enabled many of the benefits the park offers, including recreation and health benefits, local cooling, and the provision of amenity and character.
- avoided negative impacts that could occur if water supply is restricted, including tree health impacts and losses and sports field closures
- removal of excess urban stormwater from Mooney Ponds Creek and Port Phillip Bay, reducing pollutants and potentially reducing downstream flood risk
- harnessing stormwater as an alternative resource to support long term sustainability of water resources for the Melbourne region.

A BCA was used to evaluate the business case as a whole, and to present a clear case for council to consider internally whether further investment in the project is worthwhile. The INFFEWS tools were selected to both evaluate benefits and to conduct a BCA.

In this step we determined:

- **Key audience**: Internal stakeholders in council will be the main readers of the BCA.
- **Goal**: The BCA will be used to determine if the project is worthy of further investment from council to complete detailed design. Council wishes to understand the direct monetary benefits and the indirect social and environmental benefits of the scheme.

2.2 Step 2: Define the ‘with project’ and the ‘without project’ scenarios

Perhaps the most crucial aspect in a BCA is defining the costs and benefits that will occur with the project and without the project. Careful definition and framing of the ‘with’ and ‘without’ scenarios will ensure costs and benefits are clearly differentiated between the two scenarios to make a valid comparison. Here, the key question to answer is: what will happen if the project isn’t delivered? And how will this change if it is?

In this worked example, the definition of the with and without scenarios was crucial. In the initial project discussions, stakeholders were keen to point to all of the benefits of parks generally – for amenity, recreation, mental health and biodiversity, and these can all be further enhanced by irrigating the park, keeping it green all year round. However, it was important to recognise these benefits also exist in the ‘without project’ scenario, because the park already exists, and it is already irrigated (with potable water). Accordingly, the key aspect of the ‘with project’ scenario is the new water source. Discussions with stakeholders at this point highlighted that using stormwater in place of potable water could provide additional benefits in times of drought when potable water supplies are restricted. This element of resilience was a key benefit that should be evaluated in the BCA.

Framing the ‘with project’ scenario to consider future climate change

In Melbourne, the water restrictions put in place during the Millennium Drought seriously impacted the health of green spaces and trees. These impacts made lasting impressions on both the community and the local environment. City of Melbourne recorded extensive tree losses and regularly had to cancel sports games in the park because dry conditions made the surfaces dangerous to play on.

A key framing question for the business case was, how often will droughts lead to water restrictions in Melbourne in the future? This is of course, a difficult question to answer definitively because the future can’t be predicted. However, research was undertaken to make sure assumptions were reasonable and based on available evidence to ensure the business case was plausible.

Climate science tells us future droughts are likely to be more frequent and more severe. However, there is no way of predicting exactly when they will occur and for how long. The impact of a drought on the water supply system is also difficult to predict with certainty. Following the Millennium Drought (2002–2008), the Melbourne potable water supply system received significant investment, and a desalination plant was constructed to provide top-up supply when needed (in addition to the predominantly rainfall dependant surface water supplies for the catchment). However, changes in climate along with population growth mean the capacity of the desalination plant is likely to be outstripped in the future. Modelling from Melbourne Water predicted this shortfall could occur as early as 2028[2], under a high growth and high climate change scenario (which is the current trajectory) (figure 2).

[2] Melbourne Water (2017), *Melbourne Water System Strategy*. Melbourne Water.

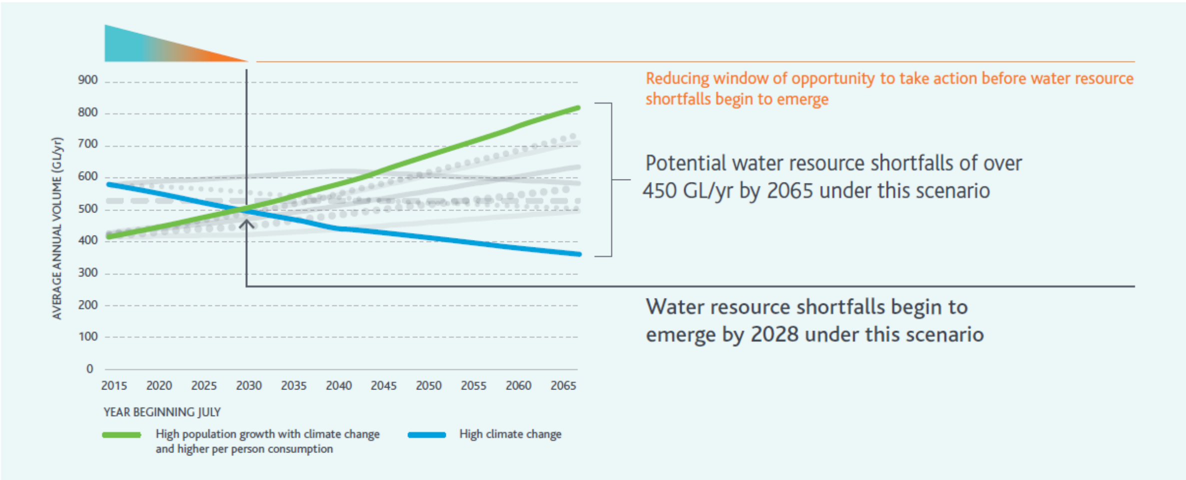


Figure 2: Future water supply and demand projection[3]

For this assessment, it was assumed that another major drought, equivalent in length and severity to the Millennium Drought occurs and requires 7 years of water restrictions from 2032–2038. As was the case in the Millennium Drought, council will be required to truck in recycled water to supply a basic level of service, but the use of sporting grounds will be restricted and mature trees will die prematurely without a supplementary irrigation supply.

Impacts of changing the irrigation water source

It was important to understand the differences in both the costs and benefits between the ‘with’ and ‘without’ project scenario, particularly regarding the reliability of a stormwater harvesting scheme. In ‘normal’ times without water restrictions, the ‘without project’ scenario would use a potable water supply with 100% reliability. The ‘with project’ scenario which pumps stormwater from a large urban catchment, would have a lower reliability, requiring some ‘top-up’ from potable water supply when the storage is empty.

As part of the concept design, extensive modelling was undertaken of stormwater runoff from the catchment to determine the supply reliability for the planned storage. The modelling showed a reliability of 77% during ‘normal’ times and 72% during a drought with the equivalent rainfall pattern to the Millennium Drought.[4] During a future drought, it was assumed water restrictions would be put in place to the same extent. As with the Millennium Drought, council would truck in recycled water for basic irrigation needs, but provide a much lower level of service for the park, resulting in sportsground closures and tree deaths. With the stormwater harvesting in place, it is assumed that a 72% reliability water supply would be sufficient to retain a good level of service.

Summary of ‘with project’ and ‘without project’ scenarios

A summary of the ‘with project’ and ‘without project’ scenarios was developed and agreed with the stakeholders to ensure assumptions for the BCA were transparent. A 50-year analysis timeframe was chosen to provide a long term view, meaning all benefits and costs were examined over that timeframe. This approach also allowed for including a drought once in that timeframe.

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[3] Melbourne Water (2017), *Melbourne Water System Strategy*. Melbourne Water.
[4] Stormy Water Solutions (2019), *Mooney Ponds Creek harvesting for irrigation investigation*. City of Melbourne.

Table 1: Summary of the 'with project' and 'without project' scenarios

Scenario	Without the project	With the project
In normal times 2021–2031, 2039–2070	Irrigation of Princes Park open space and trees with potable water to maintain excellent amenity and recreation value.	Irrigation of Princes Park open space and trees with harvested stormwater (77%) and potable water (23%) to maintain excellent amenity and recreation value.
During a major drought (2032–2038)	No irrigation of Princes Park open space. Emergency irrigation of trees with trucked-in recycled water. Major loss of amenity and recreation value, and premature tree deaths.	Irrigation of Princes Park open space and trees with harvested stormwater (72%) to maintain good amenity and recreation value.

In this step we determined:

- **The 'with project' and 'without project' scenarios**: There were clear points of differentiation around reliability and levels of service in normal times and during a drought.
- **Analysis period**: A 50-year analysis period was selected because stakeholders were interested in taking a long term view to consider future resilience to drought.

2.3 Step 3: Identify costs

Now that the 'with project' and 'without project' scenarios are clear, we can focus on identifying the costs of the 'with project' case compared with the 'without project' case. It is important to identify the capital, operating and replacement costs that will occur over the analysis period, to produce a lifecycle cost. All costs should be 'marginal', meaning that we want to identify the additional costs (and potential savings) compared with the 'without project' case, so that a fair comparison can be made. Accordingly costs that have already been expended, or which would be spent anyway should not be included.

In this worked example, costs were identified by drawing on the cost estimates from the concept design completed by council. Over the 50-year analysis period, these costs included:

- **Capital expenditure**: For the pumped extraction and transfer, filtration and the new storage. Irrigation infrastructure was already in place for the park, so there was no cost included for this.
- **Operating expenditure**: Council assisted in developing an estimate of annual operating costs.
- **Renewal expenditure**: Given the long (50-year) time horizon of the analysis, it was important to consider possible assets that would need to be renewed. The proposed pipe and storage assets were likely to have a long lifetime, but pumps and filters would probably need to be replaced every 10 years. For simplicity and given the high-level nature of the estimates available, these replacement costs were annualised and clumped with the assumed operating expenditure.

It is also important to identify who will bear these costs. In this case, both capital and operating costs will fall to council, although in some cases the costs may be shared by multiple parties. For example, a housebuilder may bear the capital costs of a rainwater tank, while the householder bears the operating costs.

In this step we determined:

- **Capital costs**: Based on the concept design estimate.
- **Operating and renewal costs**: Using a best estimate from council which also considered renewal costs for pumps and filters over a 50-year time horizon.

2.4 Step 4: Identify potential benefits using the INFFEWS Value Tool

Now that the 'with project' and 'without project' scenarios are clear, we can focus on identifying the benefits that each scenario creates and determine if and how these can be monetised for inclusion in the business case. Here there will often be some direct benefits that can be quantified based on their market value, such as potable water savings. However, many of the less tangible social and environmental benefits associated with water sensitive projects will require the use of non-market values, which are estimated values for goods and services that are not traded for money but are valued in terms of what reasonable people should be willing to pay rather than go without them.

Stakeholder workshop

Following an initial review of possible benefits, a stakeholder workshop was held to refine the list of benefits, test the validity of reference evidence for benefit transfers and identify any locally specific evidence that can be used to quantify avoided costs or other benefits to stakeholders.

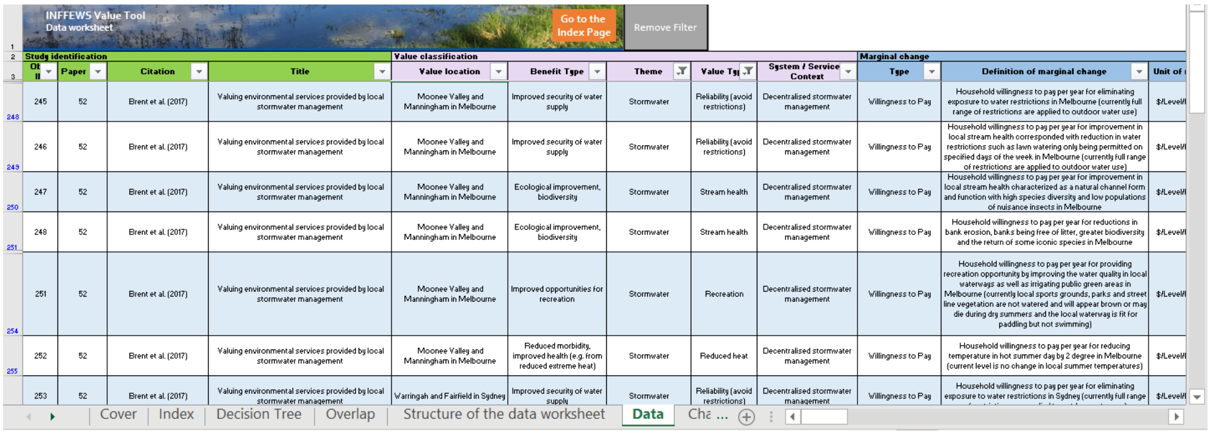
Identification of cost savings and benefits with a market value

In economic terms, it was easiest to firstly discuss possible benefits with a market value which the stakeholders will directly experience in terms of expenditure or savings. Direct discussions with council team members revealed source data on past costs related to the 'without project' scenario which could be avoided in the 'with project' scenario (a benefit). These costs and benefits are listed in Table 2 below, along with a description of the value and how it was derived.

Identification of other benefits and their non-market values

Importantly, the business case must also represent the broader social and environmental benefits of the scheme, where market values did not exist. We used the INFFEWS Value Tool to identify possible non-market values that could be included in the analysis for Princes Park. The Value Tool is a comprehensive database of existing non-market values of water sensitive systems and practices that can underpin various benefit transfer methods (where the value of a benefit in dollar terms has been established through research or community survey for another real or hypothetical project, which can be 'transferred' to represent the benefits of similar projects).

By filtering the database to display reference studies applicable to the stormwater theme and selecting the types of benefits we wanted to quantify, we identified a range of studies and papers that provided potential benefit values to use in this BCA (figure 3).



Study identification				Value classification					Marginal change		
Ob ID	Paper	Citation	Title	Value location	Benefit Type	Theme	Value Ty	System / Service Context	Type	Definition of marginal change	Unit of
245	52	Brent et al. (2017)	Valuing environmental services provided by local stormwater management	Moonee Valley and Manningham in Melbourne	Improved security of water supply	Stormwater	Reliability (avoid restrictions)	Decentralised stormwater management	Willingness to Pay	Household willingness to pay per year for eliminating exposure to water restrictions in Melbourne (currently full range of restrictions are applied to outdoor water use)	$/Level/
246	52	Brent et al. (2017)	Valuing environmental services provided by local stormwater management	Moonee Valley and Manningham in Melbourne	Improved security of water supply	Stormwater	Reliability (avoid restrictions)	Decentralised stormwater management	Willingness to Pay	Household willingness to pay per year for improvement in local stream health corresponded with reduction in water restrictions such as lawn watering only being permitted on specified days of the week in Melbourne (currently full range of restrictions are applied to outdoor water use)	$/Level/
247	52	Brent et al. (2017)	Valuing environmental services provided by local stormwater management	Moonee Valley and Manningham in Melbourne	Ecological improvement, biodiversity	Stormwater	Stream health	Decentralised stormwater management	Willingness to Pay	Household willingness to pay per year for improvement in local stream health characterized as a natural channel form and function with high species diversity and low populations of nuisance insects in Melbourne	$/Level/
248	52	Brent et al. (2017)	Valuing environmental services provided by local stormwater management	Moonee Valley and Manningham in Melbourne	Ecological improvement, biodiversity	Stormwater	Stream health	Decentralised stormwater management	Willingness to Pay	Household willingness to pay per year for reductions in bank erosion, banks being free of litter, greater biodiversity and the return of some iconic species in Melbourne	$/Level/
251	52	Brent et al. (2017)	Valuing environmental services provided by local stormwater management	Moonee Valley and Manningham in Melbourne	Improved opportunities for recreation	Stormwater	Recreation	Decentralised stormwater management	Willingness to Pay	Household willingness to pay per year for providing recreation opportunity by improving the water quality in local waterways as well as irrigating public green areas in Melbourne (currently local sports grounds, parks and street line vegetation are not watered and will appear brown or may die during dry summers and the local waterway is fit for paddling but not swimming)	$/Level/
252	52	Brent et al. (2017)	Valuing environmental services provided by local stormwater management	Moonee Valley and Manningham in Melbourne	Reduced morbidity, improved health (e.g. from reduced extreme heat)	Stormwater	Reduced heat	Decentralised stormwater management	Willingness to Pay	Household willingness to pay per year for reducing temperature in hot summer day by 2 degree in Melbourne (current level is no change in local summer temperatures)	$/Level/
253	52	Brent et al. (2017)	Valuing environmental services provided by local stormwater management	Warringah and Fairfield in Sydney	Improved security of water supply	Stormwater	Reliability (avoid restrictions)	Decentralised stormwater management	Willingness to Pay	Household willingness to pay per year for eliminating exposure to water restrictions in Sydney (currently full range	$/Level/

Figure 3: View of the INFFEWS Value tool, filtered to show 257 potentially relevant citations for a stormwater harvesting scheme

Potential references were identified that showed good alignment with the proposed project, i.e. using stormwater to irrigate open space, a similar scale of project, a similar setting. We favoured references that were more recent and in a close geographic location (hence having a similar community and market context).

In particular, we identified a reference study that was highly relevant, recent, and well-located (in the neighbouring municipality). It was a ‘willingness to pay’ study, where community members were surveyed and asked to nominate how much they would be willing to pay for certain outcomes. The survey determined the value to the local community of providing irrigation through stormwater harvesting to ensure local parks and sports grounds are:

1. green all year round and that mature trees on residential streets are not lost during periods of drought; and
2. 2°C cooler during a hot day compared with the status quo without irrigation.

The study was used to underpin the valuing of these benefits with a high level of confidence relating to relevance. This was very fortunate, and often relevant references will be from another state or country and may require heavy caveating or discounting in the BCA to account for differences in context. The non-market values used are summarised in Table 2.

Table 2: Benefits identified and sources of evidence for market and non-market values

	Benefit identified	Value ($ 2019)	Multiplier	Who benefits?	Basis for value	Notes	Confidence level
	**Potable water savings** The stormwater harvesting scheme will provide stormwater for the majority of irrigation, in place of potable water from the Melbourne mains supply.	**$2,796/ML saved**	**56ML/year** Modelling shows the scheme will result in a 77% reduction in potable water use, which is currently 73 ML/yr.	**Council**	Rates are based on City West Water rates for supply of potable water for non-residential uses (2019-20).	During a drought, potable water would not be available and hence the saving is not accrued during the drought period of the analysis.	**High** Market value
	**Pollution abatement** Stormwater is a major source of pollution to urban waterways and Port Phillip Bay in Melbourne. By harvesting stormwater, pollutants are also removed helping to support healthy ecosystems, increase water quality and improve amenity.	**$7,236/kgTN removed/ year** Applied as a capitalised value (in year 1 only) to represent benefit delivered over the asset lifetime	**200kgTN removed/year** Established by the modelling conducted for the concept design	**Broader Melbourne community**	The monetary value of removing stormwater pollution is derived from the cost of purchasing a nitrogen offset from Melbourne Water[5], which represents the cost of providing stormwater treatment in urban Melbourne by constructing treatment wetlands.	Nitrogen is commonly used as a proxy to represent various types of pollutants that can be removed by stormwater treatment initiatives.	**High** Based on a market value of nitrogen offsets.
	**Maintained recreation and amenity value during periods of drought** The scheme will harvest and store irrigation water which can be used in summer and throughout drought periods when mains supply may be restricted. Modelling of the scheme shows 72% of the water demand could be provided during a major	**$56.60/house hold/year** The average willingness to pay value, adjusted to 2019 dollars.	**24,473 households** Council provided data for local households that benefit from the park based on its classification as a regionally	**Local park users**	A willingness to pay survey[6] was conducted of 1,299 residents of Moonee Valley and Manningham in 2017. The survey determined the value to the community of providing irrigation through stormwater harvesting to ensure	The benefit was only applied for the nominated 7-year drought period during the 50-year analysis.	**High** Non-market value from a highly relevant study Note: Peer review highlighted this

[5] $6,645/kg N + 8.9% admin fee. Sourced: https://www.melbournewater.com.au/planning-and-building/developer-guides-and-resources/drainage-schemes-and-contribution-rates-1-1

[6] Brent, D. A., Gangadharan, L., Lassiter, A., Leroux, A. and Raschky, P. A. 2017. 'Valuing environmental services provided by local stormwater management'. *Water Resources Research* (53): 4907–4921.

	drought, so while irrigation would lessen, a good level of service could be maintained, providing important amenity and recreational value to the community.		significant park.		local parks and sports grounds are green all year round and that mature trees on residential streets are not lost during periods of drought.		value should be reviewed.[7]
	Avoided cost of tree replacement By securing an alternative source of irrigation water, City of Melbourne would avoid the costs of replacing trees when trees die prematurely during a drought.	**$900/tree retained**	**44 trees/year for every year of drought** Council data from the Millennium Drought showed 44 trees died each year during the Millennium Drought in Princes Park.	**Council**	City of Melbourne has well documented evidence of the impact that the Millennium Drought had on its trees. Trees suffered heavily in this period, with high numbers of premature tree deaths, and substantial and long lasting damage to tree health. City of Melbourne incurred both a capital replacement cost and an additional two-year establishment cost for each tree that required replacement.	The benefit was only applied for the nominated 7-year drought period during the 50-year analysis.	**High** Cost saving
	Avoided loss of community benefits provided by mature trees The local community would experience a loss in the	**$26,000/tree retained**	**44 trees/year for every year of drought** Council data from the	**Local park users**	The benefits provided by a tree were determined using the City of Melbourne guidelines for valuing a tree.[8] The	The benefit was only applied for the nominated 7-year drought	**High** Market and non-market value: The tree valuation

[7] Peer review by an independent economist highlighted that the benefit value used for the use of stormwater harvesting to support recreation benefit was not robust. The original research paper cited for the recreation benefit in the INFFEWS Value Tool stated, '*The respondents do not value all the attributes of stormwater management equally. Respondents have statistically significant positive preferences for flood protection, the removal of water restrictions, improved stream health, and cooler temperatures, however the preference for improved recreation is not statistically significant'.* There may be other evidence to support a recreation benefit that could be used in a benefit–cost analysis, however it would be preferable not to use the value from this study. Given the rapid and preliminary nature of the case study BCA, it is recommended that this benefit is examined in more detail at a later stage if the project proceeds to a capital funding decision.

[8] City of Melbourne (2013), *Tree valuations in the City of Melbourne*. The basic monetary value of the tree was taken from the internationally accepted table of values devised by the American Council of Tree and Landscape Appraisers and the International Society of Arboriculture. The basic value was then adjusted according to the factors in the guidance for species, aesthetics, locality and condition (total factor: 1.26). Figure adjusted to present day value.

	benefits that a large mature tree provides – because an older tree would be replaced by a young tree which takes many years to mature. The younger tree would have a small canopy, and be unable to provide the same degree of benefits to the community, such as shade, habitat and amenity.		Millennium Drought showed 44 trees died each year during the Millennium Drought in Princes Park.		guidelines provide values for different sizes of trees. The difference between the average sizes of the 44 trees lost in Princes Park during every year the Millennium Drought (10 small, 10 medium, 17 large and 7 extra-large) and a juvenile tree was used to make the comparison.	period during the 50-year analysis.	system is specific to City of Melbourne and widely used to evaluate (and determine compensation) for mature tree loss.
	Avoided trucking of water from elsewhere during drought During the Millennium Drought, when water restrictions meant potable water was not always available for park and tree irrigation, council trucked in recycled water from elsewhere at an elevated price (10 times normal price) to maintain a very basic level of service (avoid extensive tree damage and maintain integrity of playing fields). With a stormwater harvesting scheme in place, this cost would be avoided.	**$25,000/ML saved**	**12.42ML/year saved**	**Council**	This is a direct saving to council in reduced cost of sourcing recycled water from elsewhere (via truck). Rates are based the costs of trucking in water recorded by City of Moonee Valley during the Millennium Drought. Amount of trucked water is assumed to be 30% of the water demand of trees and 7.5% of the water demand of park irrigation.	Stakeholder feedback confirmed trucked water was available in only small amounts and could not be used to provide the same level of service as a stormwater harvesting scheme. Therefore, the addition of this benefit is not 'double counting' of benefits.	**High** Cost saving
	Avoided sporting ground safety checks during drought When sporting grounds are not irrigated and the weather	**$100/ assessment**	**13 additional assessments per year during drought**	**Council**	This is a direct saving to council in avoided staff time for ground safety checks. Assumptions are based on	The benefit was only applied for the nominated 7-year drought	**High** Cost saving

	is dry and hot, the surfaces can become very hard and unsafe. During the Millennium Drought, council experienced increased call on staff time to visit sporting grounds to test whether surfaces were safe for play. The presence of a water supply that could maintain a good level of service during drought would avoid the need for more regular ground checks.		It is assumed that over the drought period, an additional assessment would be required every week during the summer period.		conversations with council staff regarding experience from the Millennium Drought.	period during the 50-year analysis.	
	**Maintained cooling benefit during periods of drought** With irrigation during drought, the park and its trees will continue to mitigate the urban heat island effect, and provide localised cooling during hot days. Field studies comparing irrigated grassed areas and unirrigated grassed areas show a difference of 3°C on hot days.[9]	**$47.16/house hold/year**	**24,473 households** Council provided data for local households that benefit from the park based on its classification as a regionally significant park.	**Local park users**	A willingness to pay survey[10] was conducted of 1,299 residents of Moonee Valley and Manningham in 2017. The survey determined the value to the community of providing irrigation through stormwater harvesting to ensure local parks and sports grounds are 2°C cooler during a hot day compared with the status quo without irrigation.	The benefit was only applied for the nominated 7-year drought period during the. 50-year analysis.	**High** Non-market value from a highly relevant study

[9] CRC for Water Sensitive Cities (2017), *Adelaide Airport irrigation trials for microclimate*. Available: https://watersensitivecities.org.au/content/adelaide-airport-irrigation-trial/
[10] Brent, D. A., Gangadharan, L., Lassiter, A., Leroux, A. and Raschky, P. A. (2017), 'Valuing environmental services provided by local stormwater management'. *Water Resources Research* (53): 4907–4921.

Other potential benefits

This assessment included only benefits that could be evaluated and monetised with reasonable confidence at this early design stage. Other benefits of the scheme that were not monetised here could include:

- **Avoided closure of sporting grounds**: During a drought, unsafe sporting grounds (due to lack of irrigation) can be closed, resulting in cancelled sports and other activities. The community and the City of Melbourne are likely to experience direct financial losses related to cancellations.
- **Maintained physical and mental health benefits of green space**: During drought, unirrigated open space can become brown and dry. This can impact the local community's physical and mental health. A person who perceives their neighbourhood to be green has 1.37 times higher odds of better physical health and 1.6 times higher odds of better mental health.
- **Improved soil condition**: The City of Melbourne experience showed irrigation with stormwater is preferable to irrigation with potable water, because the chemicals used in potable water treatment can impact soil chemistry over time, increasing operational costs.
- **Reduced flood risk**: Removing urban stormwater (and its sediment load) from Moonee Ponds Creek could help to reduce downstream flood risk.

These benefits were still included and discussed in the business case summary for the project, although they didn't form part of the monetised BCA.

In this step we determined:

- **Benefits with market value**: Working with the stakeholders we identified a range of direct benefits that have a monetary value. These included potable water savings and a range of savings to council expenditure that would occur during a drought in the 'without project' scenario.
- **Benefits with non-market value**: We also identified a series of non-market values for more intangible benefits, including the continued greening of the park in drought, and the resulting amenity and cooling benefits. These were valued using a relevant willingness to pay survey presented in the INFFEWS Value Tool.
- **Benefits that couldn't be valued**: We also identified further benefits that couldn't be valued because sufficient evidence couldn't be identified to underpin a monetary value. These were however noted in the business case to give a holistic picture of the benefit portfolio, and to provide potential to update the business case when new evidence comes to light in the future.

2.5 Step 5: Conduct benefit–cost analysis using the INFFEWS BCA Tool

The steps before this point have prepared us well to conduct a BCA. At this point, the INFFEWS BCA tool was used to compare the 'with project' and 'without project' scenarios. The tool is a spreadsheet, set up with a series of numbered tabs to work through. The key considerations in each tab are described below.

The worked example spreadsheet can be accessed here.

1. General

This is a simple summary tab, providing basic project information that is important for record keeping and to provide a clear definition of the 'with project' and 'without project' scenarios. It is important to list the names of the key stakeholders, who will become the nominated beneficiaries in other parts of the spreadsheet.

2. Time

In this tab we selected:

- **Time of analysis and start year**: As discussed above, a 50-year analysis was undertaken to take a long term view of the impact of possible future droughts. It was assumed the project would be built and become operational in 2020.
- **Discount rate**: The default discount rate of 5% in the INFFEWS BCA Tool was used for the analysis, but a low value of 3% and a high value of 7% were also included to test sensitivity to the discount rate. Arguably, assessments of the value of green infrastructure could use a much lower discount rate to reflect the long term and persistent value delivered by assets like parks.[11] However, in this case the key proposal is to deliver a new irrigation water source, not a new park, and hence a discount rate for more traditional infrastructure is appropriate.

3. Benefit parameters

Working from left to right, for each benefit we included:

- **Benefit value and multiplier**: The previous step includes detailed discussions about the benefit values, which is a crucial part of the BCA. The tool provides guidance on possible types of benefits and how they should be classified. In this example, most of the benefits were market values or direct cost savings, which were recorded with user-specified units (per ML, kgN etc). The non-market values drawn from the willingness to pay survey are expressed per person, and were included in this section. All benefits were listed in Category 2 which accommodates user-defined units (in this case, per household, per tree, per ML, per safety visit and per kg/TN removed).
- **Duration of benefit**: Other than the input of the benefit values, it is important to include the start and end year for each benefit. In this example, a number of benefits would occur only during a drought, so they were only included for the duration of the future drought period (2032–2038).
- **Nominate the beneficiary**: It is also important to place a '1' next to the stakeholder who receives the benefit in the right hand columns. This then transfers to the benefit distribution summary in the tool.

[11] Victoria Institute of Strategic Economic Studies (VISES) (2015), *Green Infrastructure Economic Framework*. Victoria University, Melbourne.

4. Adoption

This tab considers the likelihood of the benefits being adopted, and discounts the benefits where adoption of the project depends on the decision of private citizens or businesses. Given the example project would be fully funded and delivered by the council, the adoption is regarded to be certain (if they choose to invest), so a custom adoption value of ‘1’ was included to ensure that benefits were not factored down.

5. Costs

Costs included here were based on the estimates developed by the concept design of the project. For simplicity, the capital cost ($7 million) was assumed to be completely spent in 2020, and the annual operational costs ($68,000) began in 2021. All of the costs were allocated to council who would be the sole funder of the project.

6. Project risk

This tab considers the likelihood of the benefits being delivered, and discounts the benefits where there are risks that the benefits will not be achieved to their full extent. In this example, we wished to compare the benefits and costs directly, so a custom project risk value of ‘1’ was included to ensure benefits were not factored down.

7. Information

This tab records the key information and assumptions for the purpose of a peer review. It was not used in the worked example.

8. Report

This tab provides the results of the BCA, which are also summarised in the top right hand corner of the spreadsheet, so you can see the impact of benefits and costs as they are added. The benefits and cost are provided as present values, along with the net present value (benefits less cost) and the benefit–cost ratio (benefits divided by cost).

The BCA results of the worked example are presented in Table 3. The project received a benefit–cost ratio greater than 1 overall, meaning the benefits outweighed the costs. However, for council directly, the ratio was only 0.41, meaning the beneficiaries of the majority of the benefits are park users and the wider community and the project would not directly pay itself back in terms of monetary benefits and costs savings accrued by council.

Table 3: Benefit–cost analysis results overall and for the council

	Overall	Council
Benefits (present value)	$16,889,508	$3,398,261
Costs (present value)	$8,900,715	$8,241,403
Net present value (NPV)	$7,988,793	–$4,843,142
Benefit–cost ratio (BCR)	1.90	0.41

9. Sensitivity

This tab includes an automatically generated sensitivity analysis, which tests the impact of changing assumptions and parameters. This is important information to present in the business case to appreciate the inherent variability of the BCA. With a default BCR of 1.90, the project had a minimum BCR of 0.71 and a maximum BCR of 3.54, showing considerable range. Importantly, from all the scenarios examined, the sensitivity analysis provided a probability of 0.97 that the BCR would be greater than 1, providing confidence in a positive BCR.

10. Stakeholders

As mentioned above, the BCA showed the majority of the benefits weren't accrued by the project funder (council). This tab provides the breakdown of who receives the benefits: local park users (72%), council (20%) and the wider Melbourne community (8%). This distributional analysis can help with funding discussions for the project.

In this step we completed:

- **Benefit–cost ratio**: Using the INFFEWS BCA Tool, we entered the benefit values and costs along with key parameters to determine a benefit–cost ratio. The tool provides a full breakdown of the contribution of various factors and assumptions and conducts a sensitivity analysis, which showed the overall business case for the project was fair.
- **How benefits are distributed to stakeholders**: The stakeholder report allowed us to understand who receives most of the benefits.

2.6 Step 6: Create a business case summary

While the results of the BCA were now completed, the final step of the process was an important one. Given the goal of the analysis was to provide a business case for council to support decision making around the future of the project, it was important that the results were presented in a concise yet engaging manner.

Single page results summary

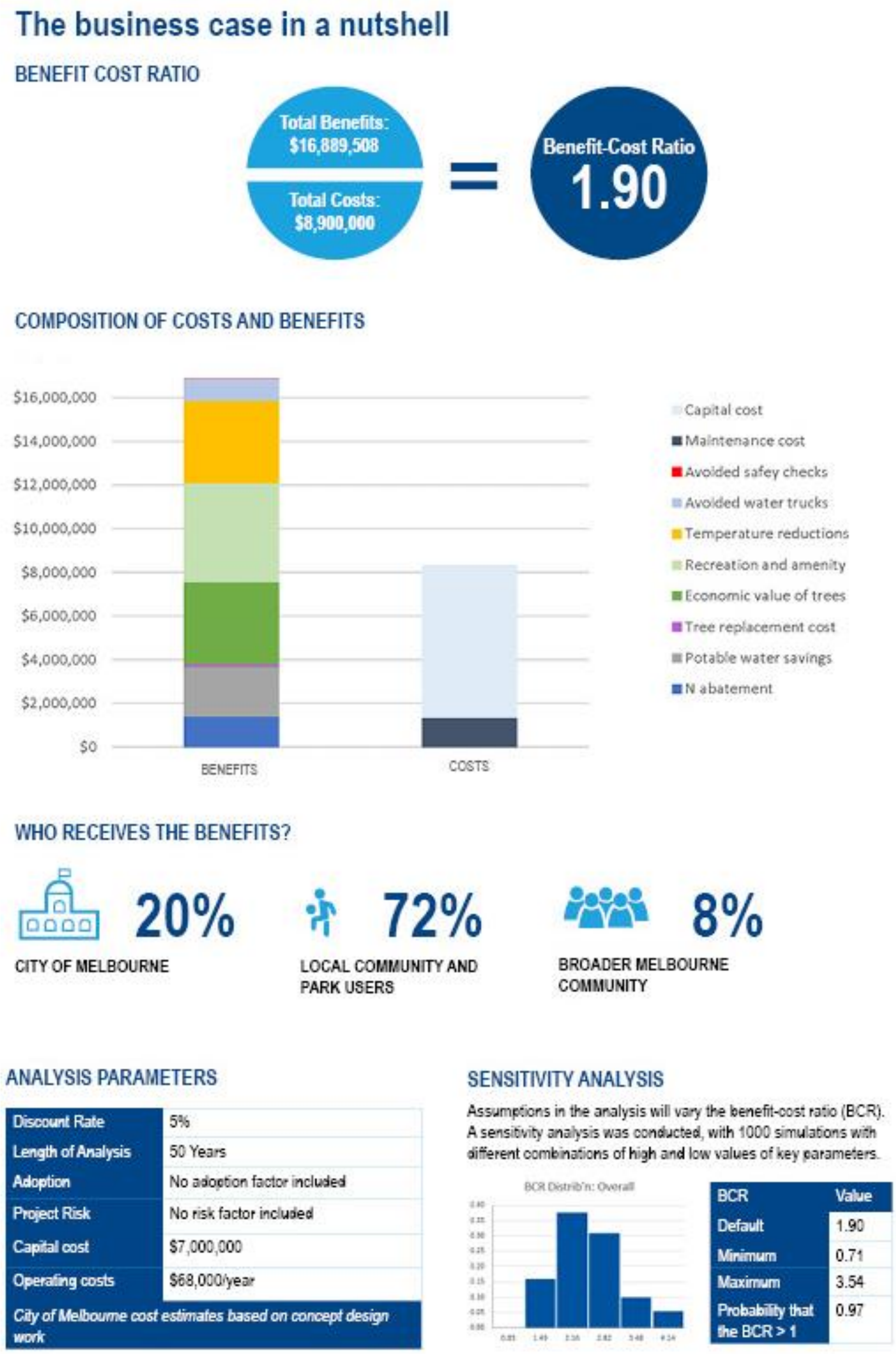
The key results from the tool were used to create simple graphics and a graph of benefits compared with costs as an easy reference page as seen in figure 4. The summary was accompanied by a short booklet which detailed the key benefits and assumptions behind the evaluation.

Stakeholder presentation

At this stage the final results were presented and discussed with the council stakeholder group. This allowed stakeholders to understand the analysis in detail so they could discuss the results internally and decide on the next steps. The BCA showed an overall BCR greater than 1, though the direct benefits to council would not outweigh the costs. Most of the other benefits were gained by the local community. Given council represents the community beneficiaries, and provision of parks and their associated benefits is council's responsibility, the stakeholders felt the business case was still strong. Accordingly, the business case was used to underpin a recommendation to take the project to the detailed design stage.

In this step we completed:

- **A business case summary**: Using the key results to create a graphical comparison of the benefits and costs. It was important to present all key results on one page to provide decision makers with a clear and engaging summary. This was accompanied by a booklet providing background and assumptions for those interested in the details of the analysis.



The business case in a nutshell

BENEFIT COST RATIO

Total Benefits: $16,889,508

Total Costs: $8,900,000

=

Benefit-Cost Ratio 1.90

COMPOSITION OF COSTS AND BENEFITS

WHO RECEIVES THE BENEFITS?

20% CITY OF MELBOURNE

72% LOCAL COMMUNITY AND PARK USERS

8% BROADER MELBOURNE COMMUNITY

ANALYSIS PARAMETERS

Discount Rate	5%
Length of Analysis	50 Years
Adoption	No adoption factor included
Project Risk	No risk factor included
Capital cost	$7,000,000
Operating costs	$68,000/year
City of Melbourne cost estimates based on concept design work	

SENSITIVITY ANALYSIS

Assumptions in the analysis will vary the benefit-cost ratio (BCR). A sensitivity analysis was conducted, with 1000 simulations with different combinations of high and low values of key parameters.

BCR	Value
Default	1.90
Minimum	0.71
Maximum	3.54
Probability that the BCR > 1	0.97

Figure 4: One page business case summary provided to council

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