CRC for
Water Sensitive Cities

INFFEWS Benefit: Cost Analysis Tool: User Guide

David J. Pannell

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INFFEWS Benefit: Cost Analysis Tool: User Guide

Comprehensive economic evaluation framework (IRP2)
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Author
David J. Pannell, University of Western Australia

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Cooperative Research Centre for Water Sensitive Cities
Level 1, 8 Scenic Blvd, Clayton Campus
Monash University
Clayton, VIC 3800

p. +61 3 9902 4985
e. admin@crcwsc.org.au
w. www.watersensitivecities.org.au

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Executive Summary

The INFFEWS BCA Tool provides a sophisticated and user-friendly platform for conducting high-quality Benefit: Cost Analysis (BCA) in Microsoft Excel. It was developed for the evaluation of projects related to urban water and green infrastructure. It is used jointly with the INFFEWS Value Tool, a database of relevant results from research that quantifies non-market (intangible) values resulting from urban water and green infrastructure projects. The BCA Tool is consistent with standard guidelines and can be used to evaluate other type of projects as well.

Features of the BCA Tool include the following.

Inputs

- Supports specification of a detailed project logic
- Is flexible, providing multiple approaches for entering costs and benefits of different types
- Allows additional sheets to be inserted for calculations that can be linked into the BCA Tool
- Includes options for discount rates that are constant or dynamic over time
- Accounts for the effect of incomplete behaviour change resulting from the project
- Allows for the probability of project failure
- Provides facilities for recording data sources and comments by independent reviewers

Outputs

- Provides 14 graphs and 12 tables depicting different aspects of the BCA results
- Conducts Monte Carlo analysis to provide probability distributions of results
- Conducts break-even analysis and a sensitivity index to indicate key variables
- Provides sensitivity analysis of discount rates and the excess burden of taxation
- Provides all standard BCA decision criteria: NPV, BCR, IRR and MIRR
- Provides advice on which BCA decision criteria to use in different contexts
- Reports on who benefits and who pays across up to eight stakeholders
- Provides detailed results for the project overall and for the project's lead organisation

Advantages

- Is a reliable, fully tested and widely used framework
- Includes a user guide and context sensitive video help
- Includes a checklist of steps for Quality Assurance of the BCA
- Automatically transfers existing data to new versions of the BCA Tool when released
- Will continue to be maintained, updated and improved

Contents

Introduction

The INFFEWS BCA Tool for conducting Benefit: Cost Analysis (BCA) consists of a set of guidelines and spreadsheets. This is the User Guide for the BCA Tool spreadsheet. It provides step-by-step support for completing a BCA using the spreadsheet tool.

For each project to be assessed, users complete one copy of the spreadsheet in Microsoft Excel. The spreadsheet captures both contextual and quantitative information about the project and calculates the BCA results. It also generates a summary report of the BCA which can be provided to decision makers, and automatically conducts five types of sensitivity analysis.

We assume that the user of the BCA Tool already has a specific project in mind and wishes to evaluate that project. The project may have already been defined in detail, or only in general terms. If it has only been defined generally, the BCA tool leads you through a process of defining it more specifically. The project needs to be defined specifically in order for a BCA to be conducted.

Box 1. Resources included in the INFFEWS BCA Tool

The BCA Tool is a package consisting of the following components. This is the recommended order for accessing the components (apart from the training resources).

INFFEWS BCA Tool: Benefit: Cost Analysis and Strategic Decision Making. Provides guidance on: BCA basics; strategic issues related to BCAs; whether to conduct a BCA; use of economic information, including BCAs, in strategic decision making.

INFFEWS BCA Tool: Rough BCA Tool. Guidelines and a spreadsheet for a “Rough” BCA, useful as a first step towards a full BCA, and a test of whether a BCA is feasible.

INFFEWS BCA Tool: Guidelines. Explains key concepts behind BCA, and pitfalls to avoid when doing a BCA.

INFFEWS BCA Tool: User Guide. Provides detailed step-by-step instructions and advice for completing a BCA in the spreadsheet tool.

INFFEWS BCA Tool Spreadsheet. Captures the qualitative and quantitative information, calculates BCA results and conducts a sensitivity analysis to test the robustness of results.

INFFEWS BCA Tool: Comparison Tool. Makes it easy to compare the results from BCAs for multiple projects, or different versions of the same project.

INFFEWS BCA Tool Training Resources. Videos and slide sets used in training courses.

Expertise needed

It is expected that users of spreadsheet tool already have training in BCA. They may have a degree in economics, or they may have received specific training in the use of this BCA Tool. For inexperienced users, we recommend that they seek additional support from an experienced economist or an expert in this BCA Tool. Experience shows that inexperienced users of BCA are prone to make errors which result in inaccurate results. See the Guidelines section on “Pitfalls and errors to avoid”.

In addition, the person who leads the process of completing a BCA needs access to information about the project. They need to be able to access people who are able to provide information about aspects such as:

- The specific actions that will be undertaken in the project
- Which benefits will be generated and how large they will be
- Behaviour change required for the project to succeed
- Risks that could jeopardise project success
- The costs of the project
- The timing of benefits and costs

Experienced users of BCA should be able to complete the spreadsheet without any additional support.

Inexperienced users should complete a training course before attempting to use the Tool, and should carefully study the BCA Tool Guidelines and BCA Tool User Guide prior to using the spreadsheet tool.

A third group consists of people who wish to be sufficiently informed about BCA to be able to be able to make sound decisions about which BCAs to commission, how to commission them, and how to interpret and use the results from BCAs, but not to conduct a BCA themselves. For this group, the BCA Tool provides the document titled “Benefit: Cost Analysis and Strategic Decision Making for Water-Sensitive Cities”, as well as guide and template for conducting a “Rough BCA”.

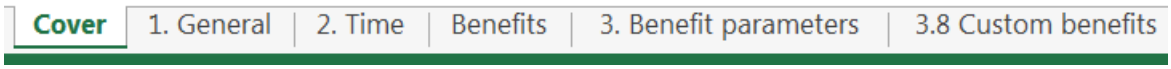
Compatibility

The spreadsheet is compatible with the 2013 version of Excel and later. It is not recommended for use in versions of Excel prior to 2013.

Compatibility between Excel for Windows and Mac can sometimes be a problem. A professional Excel programmer helped us modify the code to increase its Mac compatibility, and has advised that it should work in Excel for Mac 2016 and later. It does not work in Excel for Mac 2011 or earlier versions.

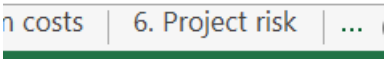
Using the spreadsheet

Click on the tabs at the bottom of the screen to move between sections of the spreadsheet.



There are more tabs than can be displayed in the available space. To see additional tabs, you have three options:

- click on one of the arrows that are next to the tabs 
- click on the … to the left of the tabs 

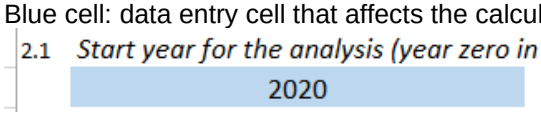
- click on the … to the right of the tabs 

When using the BCA Tool spreadsheet, a brief video provides background and advice about each of the questions. To access these videos, click on the relevant 

button.

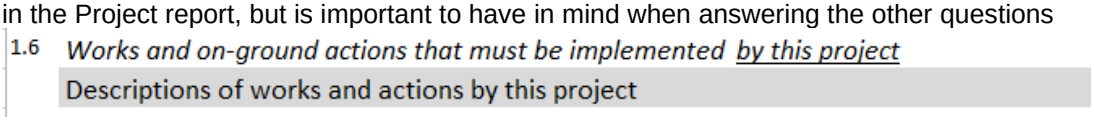
There are different colours for different types of cells in the spreadsheet

- Blue cell: data entry cell that affects the calculations of the BCA

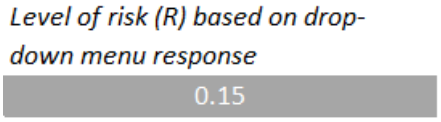


- Grey cell with blue border: cell for entering text information that does not affect the calculations of the BCA, but is included in the Project report

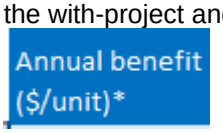
- Grey cell: for text information that does not affect the calculations in the BCA and is not included in the Project report, but is important to have in mind when answering the other questions



- Darker grey cell with white writing: cell containing a formula that you cannot edit



- Intense blue with white writing: a heading for numbers that depend on the difference between the with-project and without-project scenarios



Note that cut/paste is switched off in the INFFEWS BCA Tool to protect the formulas of the spreadsheet. Copy/paste still works. For the same reason, drag/drop is switched off while the BCA Tool is running. If drag/drop was switched on before the BCA Tool was loaded, it will be switched on again when the Tool is shut down.

1. General sheet

1.1 Name of project

Provide a brief name for the project.

Purpose. To allow the project to be easily recognised when alternative projects are discussed.

Example. “Greening the Pipeline” project, Melbourne

1.2 Project summary

Provide brief information (up to 150 words) about the project, including its location, scale, activities and goal.

Purpose. This summary is provided in the BCA Report that is generated for decision makers.

It is recommended that you revisit this summary after the rest of the BCA has been completed, and update it if necessary. Often the process of completing the BCA leads to refinement or at least clarification of the project.

1.3 Names of people responsible for completing this BCA

Purpose. So that it is clear who should be consulted if any questions or issues arise.

1.4 Date when this form was last updated

Purpose. To help with version control.

1.5 Goal or target for the project

Outline the goal or target for this project (25-50 words). Preferably it should be a SMART goal: Specific, Measurable, Achievable, Relevant and Time-bound. The S, M and T parts of this acronym are important to facilitate later evaluation of the project, if it is implemented.

Purpose: The goal informs judgements about the on-ground actions and works that will be needed (1.6, 1.7, 1.8) and other activities needed to deliver the project (1.10 to 1.13).

Example. To encourage householders in North Melbourne to install rainwater tanks. The target is 25% of householders by 2025.

The next three questions (1.6, 1.7 and 1.8) relates specifically to on-ground works or actions that directly affect the project outcomes, not to planning, public education, monitoring, investigations, payments to landholders, etc. that may deliver outcomes indirectly. Such indirect actions will be captured in Questions 1.10 to 1.13.

In most cases, the responses to questions 1.6, 1.7 and 1.8 will be physical works or on-ground actions, but for some projects it may be changes in behaviour that do not involve physical works. An example of the latter would be a project that seeks to change the behaviour of visitors to a park or recreational users of a water body.

Later on, you will need to identify what difference these works and actions would make to the outcomes that matter to people; i.e., what benefits they generate, relative to the base-case scenario.

1.6 Works and on-ground actions that must be implemented by this project

This question relates to works that the organisation responsible for the project (the “project organisation”) needs to do itself. Examples could include engineering works on public land, establishment of vegetation, or installation of rain gardens. The question does not relate to indirect actions, like planning, extension, monitoring, payments to landholders, etc. even though these may be important to the project. These indirect actions are captured in 1.10 to 1.13.

Purpose. Costs to the project from undertaking these works and actions will need to be included in the Costs section of the BCA.

Benefits generated by these works and actions (together with those in 1.7 and 1.8) need to be identified, quantified and included in the Benefits section of the BCA. The types and levels of benefits depend on the specific works and actions undertaken in the project.

Example. Install and maintain 30 rain gardens in the City of Nedlands.

Example. In some projects there may be no on-ground actions to be implemented by the project itself, because all of the works must be implemented by private citizens. The project encourages practice change by private citizens (using delivery mechanisms documented in 1.12) but does not implement works itself.

1.7 Works and on-ground actions that must be implemented by private citizens or businesses

The relevant private citizens may include, for example, home owners, renters, private businesses, river users, or park users. Relevant businesses could include those that emit water pollutants, design urban developments, or are responsible for water provision.

Provide specific details of the required works and actions, and who will need to implement them. Go into sufficient detail to inform later questions about the works' impacts, their likely adoption by the relevant people, and their costs. Give **areas, lengths, volumes,** and **locations** as appropriate. A mistake that some users make is to provide too little specific information about the works and actions. Sufficient detail is needed to be able to cost them, and estimate their benefits.

In some cases, the physical actions required may be to not take certain actions: e.g. to not clear native vegetation, to not switch to a new management practice that is environmentally damaging in some way.

Purpose. Benefits generated by these works and actions (together with those in 1.6 and 1.8) need to be identified, quantified and included in the Benefits section of the BCA. The types and levels of benefits depend on the specific works and actions undertaken in the project.

Related questions. 1.12 identifies the project activities that will be undertaken to ensure that private citizens or businesses do take up the works and actions that you specify here in 1.7.

4.1 to 4.3 are concerned with the extent to which these works and actions are likely to be adopted by private citizens or businesses, given the project activities specified in 1.7.

Example. 25% of householders in North Melbourne to install rainwater tanks by 2025.

1.8 Works and on-ground actions that must be implemented by other organisations

This question relates to works that other organisations need to do to deliver the goal(s) of the project. "Other organisations" are those that are not ultimately responsible for the project but agree to contribute to it as partners. Relevant other organisation may include, for example, local governments, state government agencies, national government departments, community groups or environmental non-government organisations (NGOs).

Purpose. Benefits generated by these works and actions (together with those in 1.6 and 1.7) need to be identified, quantified and included in the Benefits section of the BCA. The types and levels of benefits depend on the specific works and actions undertaken in the project.

Related question. 1.13 identifies the project activities that will be undertaken to ensure that the other organisations undertake the works and actions that you specify here in 1.8.

Example. In a project to be implemented by Brisbane City Council, the state government Department of Transport will manage stormwater from roads in way designed to benefit vegetation by the Brisbane River.

1.9 Briefly outline the causal links between the above works/actions and outcomes for the project

Explain how the works/actions would deliver the intended outcomes of the project. The causal chain should be outlined. Also outline the available evidence for believing that these works/actions will work.

Purpose. To prepare you to make realistic judgements about the types and levels of benefits that will be generated by the project (specified in 3.1 to 3.8).

Example. The three constructed wetlands will strip nutrients and reduce nutrient concentration in the adjoining stream. Evidence from monitoring of a similar project in the neighbouring suburb in 2012 showed ongoing reductions in nitrogen concentration of 50 percent, which exceeds the 40 percent target set for this project.

The next four questions (1.10, 1.11, 1.12 and 1.13) Questions 1.5, 1.6 and 1.7 are where you specify everything your organisation needs to do to achieve the project goal (beyond the on-ground actions that you have already specified in 1.6). In projects were the works or actions will be implemented by private citizens or businesses, the role of the project organisation is to encourage, support or regulate those citizens or businesses, and this is captured in 1.12. Alternatively, your organisation may be responsible for encouraging or commissioning other organisations to do the works or actions (1.13).

1.10 Investigations (data collection, research, analysis) that will be done in the project

Revisit this question after the rest of the BCA has been completed to see whether there are any knowledge gaps that should be filled during the project. If so, describe the key knowledge gaps and outline how they will be filled.

Purpose. Costs to the project from undertaking these investigations will be reflected in the project budget in the Costs section.

Example. Undertake hydrological modelling to help with design of a proposed wetland.

Example. Install four additional bores to monitor groundwater levels adjacent to Perry Lakes.

Example. Engage technical specialists (hydrogeology, ecology) to advise on the design and location of works required for managed aquifer recharge.

1.11 Management arrangements for the project

Who will be responsible for the implementation of the project? Who will provide oversight?

Purpose. Costs to the project from implementing these management arrangements will be reflected in the project budget in the Costs section.

Example. The project will be managed by Ms Charlene Bloggs of the City of Canning. There will be a steering committee consisting of Ms Bloggs, the chief engineer and the environment officer. Quarterly reports will be provided to the CEO.

1.12 Delivery mechanisms used in this project to encourage private citizens or businesses to undertake the works and on-ground actions

If the project does not require works or actions to be implemented by private citizens or businesses, go to 1.13.

The relevant private citizens or businesses were documented in 1.7, together with the works and actions they would need to undertake. For this question, describe the actions that will be taken in the project to influence those citizens or businesses, not the actions required of private citizens or businesses. In other words, in 1.7 we documented what works have to happen and who has to do them, while this question is asking how the project will make those works come about.

The activities listed here need to be sufficient to cause private citizens or businesses to implement all of the works and actions listed in 1.7. If they are not sufficient, then you will be exaggerating the project benefits and/or under-estimating the project costs.

Options could include:

- Payment mechanisms (e.g. stewardship payments, incentive payments, conservation tenders, reverse auctions, subsidies for particular technologies.)
- Regulation
- Planning restrictions
- Information provision and persuasion (e.g., education, training, awareness raising, marketing or promotion campaign, build community networks or social capital.)
- Covenants
- Voluntary agreements

Provide details such as:

- Which mechanisms will be used (e.g. covenants, codes of practice, research, incentive payments, economic instruments, regulation, technology development, awareness campaign, …)
- Design of any payment mechanisms (level, frequency, who is eligible, scale)
- Numbers of staff employed under the project to engage with private citizens
- Details of covenants or voluntary agreements
- Monitoring and enforcement of actions
- Staff to be appointed to deliver these activities

Purpose. Costs to the project from implementing these delivery mechanisms will be reflected in the project budget in the Costs section.

Example. The City of Melbourne to provide subsidies of $500 for each rainwater tank installed. One full time staff member will be appointed to implement the program.

1.13 Delivery mechanisms used in this project to encourage other organisations to undertake all required measures

Describe all delivery mechanisms to be used in this project to encourage other organisations to undertake all measures required for this project to achieve its goal(s). The relevant actions you are trying to encourage the other organisations to adopt were described in 1.8. This question is about how you will encourage the other organisation to implement those actions.

Include mechanisms to encourage the other organisations to implement (i) works and on-ground actions (e.g. engineering works), and (ii) indirect actions (e.g. enforcement of regulations, planning changes).

The activities listed here need to be sufficient to cause the other organisations to implement all of the works and actions listed in 1.8. If they are not sufficient, then you will be exaggerating the project benefits and/or under-estimating the project costs.

Provide details such as:

- Communication methods to be used
- Committees or steering groups to be formed
- Individuals or committees to be targeted for communications
- Advice or training to be provided
- Agreements to be established
- Monitoring of actions by other organisations
- Staff to be appointed to deliver these activities

Purpose. Costs to the project from implementing these delivery mechanisms will be reflected in the project budget in the Costs section.

Example. Conduct meetings with the Department of Sustainability and Environment to request stronger enforcement of existing regulations to prevent water pollution.

Example. Negotiate a contract with the Department of Transport for them to implement different arrangements for stormwater management.

The next two questions are amongst the most important in the BCA. A clear understanding of the with-project and without project scenarios is essential for accurate estimation of the benefits of the project.

1.14 Describe the “with project” scenario

In broad terms, how will the outcomes evolve over time in the presence of the project? What difference will the project make, relative to the without-project scenario? The difference to outcomes to be identified here is the difference resulting from all of the on-ground works and actions that will be conducted by the project (as indicated in 1.6) plus all the works and actions that the project will cause to be undertaken by private citizens or businesses (1.7) and other organisations (1.8).

1.15 Describe the “without project” scenario

This represents the baseline or business-as-usual scenario. In broad terms, how will the outcomes evolve over time in the absence of the project? This should reflect that, even without the project, things may change. They may worsen or they may improve, but we need to anticipate what they would do without the project, so that we can use this as the baseline for assessing the benefits of the project. The description should help the reader understand how the outcomes that are relevant to this project (benefits and costs) would unfold if the project is **not** implemented.

Purpose. The estimation of benefits must be based on the difference between the with-project and without-project scenarios.

Example. Refer to the section on “The with-versus-without principle” in the INFFEWS BCA Guidelines for a detailed discussion of this issue.

Box 2. Checklist to guide thinking about with-project and without-project scenarios

This checklist of questions is provided to help BCA practitioners test whether their thinking about the with- and without-project scenarios is sufficiently clear and comprehensive. Think about the questions on this checklist prior to quantifying the project’s benefits on the *Benefit parameters* sheet or the *Custom benefits* sheet.

1. Type of impacts

What conditions or outcomes are likely to change as a result of the project? (e.g., availability of a public good, sales of a commercial product, probability of a risky event, severity of a risky event if it does occur, delay or reduction in a cost)

What is the chain of events between the project and the outcomes?

Example1. Subsidies for water-conserving technologies → increased purchases of water conserving technologies → save water → reduce costs

Example 2. Project engages with local governments → their support for managed aquifer recharge (MAR) increases → implementation of MAR → water table rises → water present in local lake → benefits to local residents from aesthetics and recreation

Example 3. Promotion of rainwater tanks → increased installations of tanks → reduced flood risk and save water → reduce costs

2. Effectiveness of project at delivering changes in behaviour or management

What barriers prevent the desired changes in behaviour or management? To what extent does the project address these barriers?

Given the mechanisms used in the project (e.g. education, information, subsidies, regulation), how many people or businesses will adopt the desired changes in behaviour or management?

What is the chance that the desired behaviour change would occur anyway, without the project?

To what extent will essential partner organisations come on board with the project?

3. Effectiveness of changes in behaviour or management at delivering benefits

What difference will the actions resulting from the project (including changes in behaviour or management) make to the desired outcomes?

How responsive is the benefit to the actions being promoted. For example, if one of the benefits is increased urban wildlife making use of new habitat, to what extent with the new habitat result in increased populations of wildlife?

Would the project generate new benefits that would not have otherwise occurred, or does it bring forward in time benefits that would have occurred eventually? Or some combination?

Will conditions get worse before the benefits from the project start to emerge?

4. Second-round effects

Will the project create incentives or opportunities that lead to second-round effects?

Example 1. Availability of a new park may reduce crowing or congestion at other heavily used parks that are nearby.

Example 2. Subsidies for water-conserving technologies → increased purchases of water conserving technologies → reduction in perceived cost of having a longer shower → people take longer showers

If you create a new resource or opportunity, would new businesses arise to add value? Their profits would become part of the benefits of the project.

5. Without-project scenario

What is the current trajectory of change, and how would that evolve without the project? Would it stay on the same trajectory or not? Things that may change in the without-project scenario include income, population, government policy, technology, other facilities or infrastructure, climate, developments, demand for recreation, or demand for water.

To what extent would the desired changes happen anyway, even without the project? The extent to which changes would have happened anyway needs to be specified as part of the without-project scenario.

What would people do without the project? How does this affect the benefits of the project?

Is there a probability distribution of possible outcomes in the without-project scenario? The riskiness of the with-project scenario should be judged relative to that without-project distribution (see Appendix A of the BCA Tool Guidelines).

Example 1. One potential benefit of reduced urban heat is a reduction in mortality, but only if people are exposed to the higher heat in the without-project scenario. If most people and businesses in the area have air conditioning, the likely loss of lives due to heat is low.

Example 2. One potential benefit of increased green space is greater physical recreation, with benefits for physical health and mental health. However, what if people are already doing physical recreation without the project. The full benefits of greater physical recreation are only generated to the extent that physical recreation is actually increased as a result of the new green space. For those people who are already recreating, there might be a benefit in terms of recreation quality, if the new green space is more attractive or has better facilities.

1.16 Labels for the project organisation and up to seven other stakeholders

The BCA Tool can be used to investigate benefits and costs for society as a whole, for the project organisation (the organisation responsible for the project) and for up to seven specific stakeholders. Generic labels for the project organisation and the stakeholders are provided, but in these questions they can be made more specific here.

Allocating the benefits and costs to different stakeholders is optional. It will be useful for some users but not others.

Purpose. These labels are used as headings in the benefits section and the costs section, where the overall benefits and costs can be allocated to each stakeholder. They are used in the reports generated for decision makers.

Note. The BCA Tool is flexible in terms of whose benefits and costs are considered. For a government agency, results for society as a whole will be of primary interest and the other categories may be ignored. Or the distribution of benefits among different groups may be of interest in considering who should pay. If the project organisation is a business, such as a water utility, there will be a focus on benefits and costs to the project organisation.

Box 3. Spatial aspects of projects

Water-related projects are inherently spatial, in a number of respects. Here's how spatial aspects should be captured in the BCA Tool.

Spatial scale. Water-related projects vary widely in the scale at which their works and actions are undertaken, ranging from a small localised scale up to a state-wide or even national scale. In the BCA Tool, the location and scale should be specified in summary in 1.2. Then the various works and actions are defined in 1.6, 1.7 and 1.8. In defining the works and actions, be clear about the spatial scales and locations of each action.

Spatial heterogeneity. When an action is implemented over a broad scale, its effectiveness and benefits can vary depending on the local physical or biological context, or the values it generates can vary depending on the local social or economic context. For example, the monetary-equivalent value of establishing green infrastructure may vary from suburb to suburb depending on the existing amount of green infrastructure, and the income levels of residents. In the BCA Tool, this would be reflected in the specification of the benefits that will be generated. One option is specify benefits in aggregate across all relevant areas, in which case benefits per unit need to be specified as averages. The other option is to enter benefits separately for each context (e.g. each suburb) and leave it to the BCA Tool to add them up.

Spatial connections. For some projects, works and actions in one location generate benefits in another location. An example is a project to reduce water pollution in a river, which has benefits in all down-stream locations. In the BCA Tool, the benefits do not have to be in the same location as the works or actions. In the with-project scenario (1.14), would should specify the locations where the benefits will be generated, and they can be different from the locations of works and actions as specified in 1.6, 1.7 and 1.8.

1.20 Source of video help

By default, the help videos for the BCA Tool are stored on YouTube. **For Windows computers only**, there is the option of downloading the help videos to your computer and accessing them from there. This is useful if you cannot access YouTube (e.g. your employer has a restrictive firewall, or you will be working without internet access). The help video files occupy 960MB, so they are not provided as the default option. If you change this setting to Computer without having downloaded and installing the help video files, it will not work.

If you wish to access help videos from your computer, you need to download the videos from the web site of the CRC for Water Sensitive Cities (IRP2 project page), put them in a folder on your main disk, and enter the path for that folder into the indicated cell of the spreadsheet. The spreadsheet contains advice on how to obtain the path.

1.24 BCR setting

Results for two versions of the Benefit: Cost Ratio (BCR) formula are calculated: (a) **BCR for constrained budget** (has constrained costs in the denominator and unconstrained costs subtracted from the numerator). (b) **BCR for unconstrained budget** (has both constrained and unconstrained costs in the denominator). For more advice on which of these to use, see Box 8 and the *14. Criteria* sheet.

Both versions of the BCR are provided on the *8. Report* sheet. However only one version is provided in the summary at the top of each page (see the blue section above) and in the first section of the sensitivity analysis. This sub-section provides a drop-down menu where you can specify which BCR version you prefer to be used for these purposes.

2. Time sheet

2.1 Start year for the analysis (year zero in the BCA)

Purpose. It is used to determine when the “present” is when calculating Net Present Value. The same start year for analysis must be used for all projects that are going to be compared.

Example. 2019

2.2 Start year for the project

For many projects there is a project phase and a maintenance phase, although in some cases the project continues throughout the whole planning horizon. This year is the start of the project phase. It can be later (but not earlier) than the start year for the analysis (2.1).

Purpose. This is when costs begin to be incurred. For most benefit types, the commencement time for benefits is specified relative to this start time for the project.

Example. 2020

2.3 Length of the analysis (years)

For how long after the start year for the analysis (2.1) should benefits and costs be included in the BCA calculations? INFFEWS BCA Tool can conduct analyses for up to 50 years. The start year for the analysis (2.1(a)) is considered to be year zero, and is not counted in the length of the analysis.

Purpose. This is the number of years used to calculate the Net Present Value and Benefit: Cost Ratio. The same length of analysis must be used for all projects that are going to be compared.

Example. 30

2.4 Discount rate

Users can specify whether they wish to use a discount rate that is constant over time or one that varies. Click on the relevant button in Question 2.4.

Constant discount rate

Provide the default discount rate to be used to convert future benefits and costs into present values. Normal practice in economics is for this to be the "real" discount rate, meaning the rate with inflation factored out. Many organisations have a standard real discount rate that they use for evaluating all of their investments. For government agencies, there is usually a rate specified by the Department of Treasury and Finance, or equivalent.

If you use a real discount rate (which is usual practice), then it implies that all benefits and costs must be specified in real terms as well – with inflation factored out. You can also enter lower and higher discount rates for use in sensitivity analysis, as recommended in most BCA guidelines prepared by government treasury departments.

Purpose. The discount rate is used to convert future benefits and costs to present values. It is required in the calculation of Net Present Value and Benefit: Cost Ratio. Standard results in the BCA Tool are calculated using the default discount rate. In the Sensitivity Analysis section, results are shown for a specified low discount rate and a high discount rate.

Examples. Although most published government guidelines in Australia specify a real discount rate for public investments of 7%, with sensitivity analysis using 4% and 10%, the record low interest rates since 2019 indicate the need for modifications to these rates. As of version 2020-04 of the BCA Tool, the default real discount rate in INFFEWS has been altered to 4%, with 2% and 6% used in sensitivity analysis. Users can alter these rates if desired.

Variable discount rate

Although the great majority of BCAs are conducted using a constant discount rate, there has been increasing interest in the potential for them to vary over time. Even if the expected discount rate is constant, uncertainty about the discount rate affects the maths of discounting in a way that is equivalent to a declining discount rate (Weitzman, 1998). To account for this, the UK Government's BCA guidelines explicitly recommend using a discount rate that declines slowly over time (HM Treasury (2018). Doing so probably makes little difference to the BCA results unless the length of the analysis is somewhat more than 50 years, but the option is included in the INFFEWS BCA Tool.

Perhaps a more relevant consideration in the short term is the fact that discount rates are at record low levels. If it is judged that they may rise in future (perhaps before declining again due to discount-rate uncertainty), this can be represented in the tool.

To select a variable discount rate, click on the button for "Discount rate varies over time" and then enter low, default and high discount rates for each decade of the analysis.

2.5 Finance rates for calculation of MIRR

The BCA Tool includes calculation of the Modified Internal Rate of Return (MIRR). MIRR results for the project overall and for the Project Organisation are provide on the *8. Report* sheet. Calculation of the MIRR requires input of two parameters: the external cost of capital (interest rate) used to pay for the project, and the rate of return on benefits from the project that are reinvested.

MIRR should be viewed as an optional extra rather than a core output of the BCA. As shown in the *14. Criteria* sheet, MIRR is only suitable to use in two contexts (out of 12 shown) and in those contexts NPV and BCR are equally applicable. They can be used instead of MIRR.

Purpose. By accounting for these two parameters, the MIRR overcomes a known limitation of the Internal Rate of Return (IRR), that it assumes that finance is obtained at the IRR and benefits are reinvested at the IRR.

Example. External cost of capital: 4%, Reinvestment rate of return: 4%. For a public investment, the recommended discount rate could be used for both.

Benefits sheet

The BCA Tool is very flexible in its ability to represent benefits of different types. This includes the possibility of entering negative benefits for a particular benefit type, if a project is expected to have adverse consequences for that benefit type. Negative benefits are entered into the BCA Tool's benefit tables, but as negative numbers.

There are three sheets devoted to benefits, plus the INFFEWS Benefit Transfer Tool for estimating non-market values generated by water and green-infrastructure projects.

On the first of these sheets, called "Benefits", we provide a table of 20 diverse benefit types to serve as a checklist (Table 1). The user can consider the various types of benefits listed here, and for those that are relevant to the project being assessed, a benefit can be added to one of the tables on the *Benefit parameters* sheet, ready for the numbers to be entered.

Purpose. The list of 20 benefit types serves as a check list to remind users of benefits that may be relevant to their project.

Some projects generate multiple types of benefits. For example, a project that reduces extreme heat may reduce mortality, reduce recurring heating costs, and increase work productivity. Identify the individual benefit types and enter information about each of them individually. They will be aggregated in the BCA.

To include an additional benefit type in the BCA: (a) select a benefit category for that benefit type from the drop-down menu to the right of the main table, (b) click on the "Add benefit" button to generate a row in the relevant benefit category table (on the next sheet) and (c) enter the required numbers in that row. Clicking on the "Add benefit" button only adds one benefit types to one benefit category on the *Benefit parameters* sheet. To add multiple benefit types, repeat the process for each benefit type.

Before doing this, it is important to understand the different benefit categories that are available on the *Benefit parameters* sheet. These benefit categories represent different ways of calculating benefits (e.g. per person, per unit of pollution abatement, per year that an infrastructure cost is deferred). We will go through these in detail when we describe the next sheet.

The benefit types included on the *Benefits* sheet are very diverse. The following sections go briefly through each of the 20 benefit types and provide comments about each of them. Each benefit type is part of one or more broad benefit groups. These broad benefit groups contain groups of benefits that are broadly similar in nature.

Reduced water consumption

Market benefit. This benefit could be generated, for example, by water-saving technologies in the home (e.g., low-flow shower heads, water-efficient washing equipment), by installation of rainwater tanks, or by water-recycling systems. From the perspective of the community as a whole, the benefit is the marginal cost of providing a unit of water. This depends on what the source of water would be in the absence of the water saving. This may or may not equal the price that people are actually charged for the water. Thus, the benefits to one of the stakeholder groups may differ from the benefit to society as a whole.

Table 1. Water-related benefit types included in the BCA Tool.

	Benefit	**Broad benefit group**
1	Reduced water consumption	Market
2	Reduced or delayed investment in infrastructure (e.g. water-treatment plant)	Cost savings
3	Reduced recurring costs (e.g. energy for cooling)	Cost savings
4	Improved management of waste-water	Market or cost savings
5	Increased business profits (e.g. from sewer mining)	Market
6	Increased work productivity (e.g. from less extreme heat)	Market
7	Increased tourism	Market and non-market
8	Improved aesthetics	Non-market
9	Improved opportunities for recreation	Market and non-market
10	Reduced crime, increased community cohesion	Market and non-market
11	Reduced mortality (e.g. from reduced extreme heat)	Non-market and market (health system costs)
12	Reduced morbidity, improved health (e.g. from reduced extreme heat)	Non-market and market (health system costs)
13	Reduced greenhouse gas emissions, increased CO_2 sequestration	Market and non-market
14	Groundwater recharge (e.g. for potable extraction or wetland enhancement)	Market and non-market
15	Ecological improvement, biodiversity	Non-market
16	Improved air quality	Non-market
17	Enhancing water quality in a water body	Market and non-market
18	Reduced flood risk	Risk reduction
19	Reduced risk of poor water quality due to fire	Risk reduction
20	Improved security of water supply	Non-market

Like most of the benefits, this benefit can potentially be calculated in a variety of ways, such as per person, per household, or per year in aggregate. For this reason, several INFFEWS benefit categories are suggested as being potentially relevant: categories 1, 2, 4, 8 (Details of the various categories are provided below, under the *Benefit parameters* sheet).

Potential units of measure: KL, ML, GL (for very large projects).

Number of relevant values included in the INFFEWS Value Tool: nil

Reduced or delayed investment in infrastructure

Cost savings. A project may reduce the cost of a particular investment, or delay the time when it will be necessary. It may also affect the maintenance costs following the investment. For example, a project to exclude livestock from a water-resource catchment may mean that, when an existing water treatment plant is replaced, a cheaper replacement plant may be sufficient, relative to what would be required without the project. Or it may be that the same water-treatment plant is needed, but its installation can be delayed by 10 years, which would generate large savings in interest costs. If the project results in different infrastructure, then it may also result in different maintenance costs.

INFFEWS benefit category 5 is designed to do the calculations for this type of benefit.

Potential units of measure: $ of cost savings.

Number of relevant values included in the INFFEWS Value Tool: 4

Reduced recurring costs

Cost savings. Although this is another type of cost saving, this is different in nature. The previous benefit type (reduced or delayed investment in infrastructure) related to one large expenditure item, such as infrastructure, whereas this benefit type relates to regular ongoing costs. An example is that reductions in temperature through a project that increases the extent of vegetation in a city could lead to reduced cooling costs.

Potential INFFEWS benefit categories: The cost reduction could be expressed on a per-head basis (category 1), or on some other basis (e.g., categories 2, 4 or 8).

Potential units of measure: $ of cost savings per person, per household or per business.

Number of relevant values included in the INFFEWS Value Tool: 65

Improved management of waste-water

Market or cost savings. This could include investment in improved systems, processes or technologies for treatment or recycling of waste-water. It could result in increased water availability, or reduced cost of providing a given amount of water. Most Australian water utilities have the objective of increasing their recycling of waste-water. For example, The Water Corporation of Western Australia has a target of recycling 30% of waste-water by 2030.

Potential INFFEWS benefit categories: 2, 4, 5, 8

Potential units of measure: $ of cost savings or market benefits.

Number of relevant values included in the INFFEWS Value Tool: 27

Increased business profits

Market. A project or policy may result in new or increased opportunities for private benefits to operate and generate profits. These profits count as a benefit in a BCA of the project or policy. As an example, there could be business opportunities from mining valuable resources out of sewers. Another example is a private water supplier that makes a profit.

Potential INFFEWS benefit categories: 2, 4, 5, 8

Potential units of measure: $ of market benefits for particular businesses.

Number of relevant values included in the INFFEWS Value Tool: nil

Increased work productivity

Market. Reduced temperatures resulting from investment in green infrastructure could result in increased work productivity, generating financial benefits for employers. Assessing this requires clear definition of the with- and without-project scenarios. For example, if air conditioning is used in the without-project scenario, there would probably be no improvement in work productivity from the project, but there may be reduced cooling cost.

Potential INFFEWS benefit categories: 1, 3, 4, 8

Potential units of measure: $ per person per unit of worktime, such as per hour, per week or per year.

Number of relevant values included in the INFFEWS Value Tool: 86

Increased tourism

Market and non-market. Some tourism is supported by commercial activities, and so provides a market benefit. This could include a range of tourism service providers, such as tour guides or travel agents. Other tourism benefits arise from non-commercial recreation, generating non-market benefits. Water-related projects that enhance landscape or water-scape aesthetics may contribute to increased tourism benefits of either of these types. For example, greening of a regional city centre might contribute to increased tourism to the city. In assessing the resulting benefits, you would need to make judgements about what the additional tourists would have been doing otherwise. Perhaps they would still have been tourists but to a different regional city, in which case the new tourism-related benefits would be partly or fully offset by losses of tourism elsewhere.

Potential INFFEWS benefit categories: 1, 4, 8

Potential units of measure: $ of market benefits for suppliers of tourism services (“producer surplus), $ of market benefits for consumers of tourism services (“consumer surplus”), $ of non-market benefits per tourist.

Number of relevant values included in the INFFEWS Value Tool: 8

Improved aesthetics

Non-market. Apart from their contribution to tourism, projects that enhance visual amenity can generate non-market benefits in the form of an appreciation of the beauty of the landscape or waterscape. “The

extent to which GI [green infrastructure] delivers local improvements in environmental and aesthetic quality is linked to both the standard of environmental quality maintained on site (e.g. cleanliness and site management) and its design (i.e. how well it integrates into and enhances the local landscape)." (Forest Research, undated).

Potential INFFEWS benefit categories: 1, 2, 4, 8

Potential units of measure: $ of non-market benefits per person or per household.

Number of relevant values included in the INFFEWS Value Tool: 101

Improved opportunities for recreation

Market and non-market. Similarly to tourism, recreation is partly commercial and partly not. Even recreational activities that don't have a commercial aspect, such as walking or jogging through a green area, generate non-market benefits for the community. For example, a study of urban stream corridors in Texas identified a variety of recreational benefits for residents, including walking, running, bicycling and playing (Shafer et al., 2013). "Proximity of stream corridors to local residents, the level of pedestrian access available and tree cover were the best predictors of recreational use while the presence of water, fish or other wildlife were not significant predictors" (Shafer et al., 2013, p.478).

Potential INFFEWS benefit categories: 1, 2, 4, 8

Potential units of measure: $ of market benefits for suppliers of recreation services ("producer surplus), $ of market benefits for consumers of recreation services ("consumer surplus"), $ of non-market benefits per person who recreates.

Number of relevant values included in the INFFEWS Value Tool: 417

Reduced crime, increased community cohesion

Market and non-market. There is some evidence that provision of urban green space can enhance various measures of social cohesion (Kaźmierczak, 2013; Kendal et al., 2016). Mechanisms may include provision of an environment that fosters greater interaction between community members (Peters et al., 2010), and bringing people together to participate in projects that establish or enhance green space (Westphal, 2003).

Provision of high-quality green space can also contribute to reduced local crime in some cases (e.g., Kuo and Sullivan, 2001), although this is a complex issue and the outcome can be an increase in crime. Green spaces are more likely to be crime-prone if they are located in neighbourhoods with relatively high crime levels, and if they are located close to schools (Kimpton et al., 2017). Provision of amenities within the green space can attract criminals to the location, but can also attract non-criminals who provide a level of surveillance that helps to reduce crime (Kimpton et al., 2017). Changes in expectations about crime may contribute to a reduction in investments to avert crime, while changes in the incidence of crime influence the psychological distress caused to victims of crime. Overall, it seems difficult to be confident about what the impacts of a given green space on crime levels will be. If the impacts of green space on crime are judged to be adverse, negative benefits can be entered as negative numbers into benefit tables in the BCA Tool.

Potential INFFEWS benefit categories: 1, 2, 4, 8

Potential units of measure: $ of cost savings from reduced need for policing and legal processes, $ of non-market benefits for people who would have been victims of crime, reduced damage to property, $ of non-market benefits from wellbeing due to increased community cohesion.

Number of relevant values included in the INFFEWS Value Tool: 13

Reduced mortality

Non-market and market. A number of studies have estimated the “value of a statistical life” (VSL). These are based on the expenditures that people are willing to make to reduce their own risk of dying. One VSL is equivalent to the value of one life saved. Lives could be saved, for example, through mitigating extreme heat, or through providing recreational opportunities that improve health. The main benefit of reduced mortality is clearly a non-market benefit, but there could be reduced health-care costs associated with this, which is a market benefit.

Potential INFFEWS benefit categories: 1, 7, 8

Potential units of measure: $ value per statistical life.

Number of relevant values included in the INFFEWS Value Tool: 20

Reduced morbidity, improved health

Non-market and market. Similarly to reduced mortality, some water-sensitive projects can contribute to improved health. Examples include reduced incidence of extreme heat, and improved recreation opportunities that enhance health. Some of these benefits relate to improved well-being, which is a non-market benefits, but some could relate to reduced health-care costs, which would be a market benefit.

Potential INFFEWS benefit categories: 1, 8

Potential units of measure: $ value per QALY (Quality-Adjusted Life Years), $ of non-market value (willingness to pay) for avoidance of ill-health, savings in medical treatment costs.

Number of relevant values included in the INFFEWS Value Tool: 293

Reduced greenhouse gas emissions, increased CO_2 sequestration

Market and non-market. CO_2 emissions may be reduced by projects that reduce energy consumption (e.g. due to heat mitigation). Projects that result in increased vegetation contribute to CO_2 sequestration.

This is one of the most complex benefit types to quantify. If there had been a cap on emissions (as was previously planned in Australia) and the emissions being evaluated in the project were counted as part of that cap, then there would have been no need to count emissions reductions as a benefit, as they would have been offset by increases elsewhere in the economy to get back to the cap. In the absence of a cap, inclusion of benefits related to CO_2 emissions or sequestrations depends on whether the project organisation wishes to define the scope of the analysis as including international benefits. If so, it makes sense to count emissions reductions as a benefit.

Even if it is clear that these benefits should be included, quantifying them is difficult, due to uncertainty. Most commonly, researchers argue for using the Social Cost of Carbon (SCC), which is the total present value of all future market and non-market costs from emitting one extra tonne of CO_2. The value to use for the Social Cost of Carbon is subject to debate, with widely varying proposals having been put forward, ranging from a few dollars to a few hundred dollars. It depends in part on the discount rate assumed, with higher discount rates resulting in a lower SCC.

There is no standard value for the Social Cost of Carbon specified in any of the Australian BCA Guidelines. According to Johnson et al. (2013), the US Government at that time used SCC values of US$11, US$33 and US$52 per tonne of CO2-e, based on discount rates of 5, 3 and 2.5% respectively. Note that the higher discount rates recommended by all Australian Departments of Treasury and Finance (7% in most cases) would result in a SCC below US$11.

An alternative approach, advocated by Mandell (2011) for example, is to use the shadow price of carbon emission as a result of government policies. In other words, we would use the carbon tax, or the price of carbon in a carbon market or a carbon emissions permit auction, as the price of CO_2 in our BCA.

In the absence of clear guidelines from government, this latter approach is perhaps the simplest and most practical. It implies using a value for CO2-e of around A$25 per tonne (based on the carbon tax that was previously in place) or perhaps of A$14 (based on the results of reverse auctions under the Emissions Reduction Fund policy – see https://theconversation.com/infographic-emissions-reduction-auction-results-at-a-glance-40728).

When valuing carbon that has been sequestered, it is also necessary to account for the fact that sequestration may be temporary and somewhat insecure. This means that the value of sequestered carbon should be reduced to some extent.

Potential INFFEWS benefit categories: 2, 3, 8

Potential units of measure: The social cost of CO_2 emissions ($).

Number of relevant values included in the INFFEWS Value Tool: 16

Groundwater recharge

Market and non-market. A project to undertake groundwater recharge (manages aquifer recharge) may generate benefits through providing a source from which water can later be extracted for potable use. It may also raise water tables locally. In the vicinity of wetlands and lakes that are connected to the water table, a higher water table can increase the depth or duration of water in the wetlands or lakes, which can be valuable to local residents. For example, Tapsuwan et al. (2009) found that a 20 ha wetland surrounded by uniform-density housing in the western suburbs of Perth would increase the value of surrounding houses by around AU$140 million.

Potential INFFEWS benefit categories: 1, 2, 4, 6, 8

Potential units of measure: Reduced cost of water treatment ($/ML), $ of non-market value of wetland improvement.

Number of relevant values included in the INFFEWS Value Tool: 18

Ecological improvement, biodiversity

Non-market. Water-sensitive projects can contribute to environmental health in a variety of ways, including: through improving water quality in a water body; through establishing vegetation that provides habitat for wildlife; or creating a wetland or lake that provides habitat for freshwater fauna or flora. Many community members ascribe a “passive use” value to resulting biodiversity improvements. For example, Rudd et al. (2016) found that households in southern Ontario hold passive-use values for little-known aquatic species worth about Can$10-$25 per species per year.

Potential INFFEWS benefit categories: 1, 2, 3, 4, 6, 8

Potential units of measure: $ of non-market values, which could be per hectare of vegetation, for a particular water body, or a particular species.

Number of relevant values included in the INFFEWS Value Tool: 405

Improved air quality

Non-market. Air quality may be improved as a results of deposition of pollutants on to leaves. In a recent review, Sara Janhäll (2015) reported the following findings.

> "The effect of vegetation on urban air quality depends on vegetation design and on level of air pollution in the area. This review identified the following vegetation design considerations based on air quality arguments:
>
> 1. Dilution of emissions with clean air from aloft is crucial; the vegetation should thus preferably be low and/or close to surfaces.
> 2. Proximity to the pollution source increases concentrations of air pollutants and thus deposition; vegetation should be close to the source.
> 3. Air passing above, and not through, vegetation is not filtered; barriers should be high enough and porous enough to let the air through, but solid enough to allow the air to pass close to the surface.
>
> Other interesting findings are that the deposition of coarse particles is more efficient at high wind speeds, while the opposite is true for ultrafine particles; and that vegetation density often changes due to strong winds. To improve deposition, the vegetation should be hairy and have a large leaf area index, but still be possible to penetrate." (Janhäll, 2015, p.135).

On the other hand, vegetation can also make air quality worse. "Some plant species emit biogenic volatile organic compounds (BVOCs), planting of some cultivars increase ozone and particulate matter ambient concentration and hence deteriorate air quality." (Leung et al., 2011, p. 173.) Therefore, careful planning is needed to ensure that the air-quality impacts of urban vegetation are positive overall.

Potential INFFEWS benefit categories: 1, 2, 3, 4, 8

Potential units of measure: Same as for reduced morbidity, $ value per QALY (Quality-Adjusted Life Years), $ of non-market value (willingness to pay) for avoidance of ill-health, savings in treatment costs.

Number of relevant values included in the INFFEWS Value Tool: 28

Enhancing water quality in a water body

Market and non-market. Benefits from enhanced water quality can include: enhancement of amenity values, recreation values, tourism, or ecological values. The benefits could result from reduced levels of pollutants being delivered into water bodies, or from strategies that reduce the adverse impacts of pollutants once they are in the water. An example of the latter is use of Phoslock™, which removes phosphorus from the water column.

Another example is where a potable water body is protected. For example, a project could reduce the risk of a fire in the catchment area for a dam.

Potential INFFEWS benefit categories: 2, 3, 4, 6, 8

Potential units of measure: $ of non-market value per person who is concerned about the water body, or per kg of pollutant.

Number of relevant values included in the INFFEWS Value Tool: 34

Reduced flood risk

Risk reduction. Reduced flood risk may occur, for example, by reducing the area of hard surfaces, installing holding tanks for stormwater, enhanced drainage, or infiltration basins. In simulation studies for Melbourne, Löwe et al. (2017) found that developing and applying a “master plan” for water-sensitive cities was an efficient approach to flood mitigation, and that rainwater capture using rainwater tanks could be efficient in certain cases. Both were preferred over expansion of pipe capacity due to its high cost.

Potential INFFEWS benefit categories: 7, 8

Potential units of measure: $ value of the change in consequence of flood, which may include changes in the frequency of floods of particular severities, and changes in the costs that are incurred per flood of a given severity.

Number of relevant values included in the INFFEWS Value Tool: 13

Reduced risk of poor water quality due to fire

Risk reduction. In vegetated water catchments, there is a risk of water-quality reductions if a fire event is followed by a rain storm. The absence of vegetation and potential changes in soils following an intense fire increase the chance that sediment and other pollutants will be washed into water bodies in runoff. As a result, there may be a loss of water for human or agricultural purposes, or increased costs of water treatment. In addition, there may be ecological impacts. “The entire local food chain may be adversely affected by the loss of riparian vegetation after fire as it can lead to increased light availability, higher water temperatures, loss of habitat, and reduced protection from predators for in-stream biota. When combined with increased contaminant loading, the increased water temperature can trigger greater breakdown of organic matter by bacteria, which may deplete oxygen levels in the water. Fish suffocation is a common after-effect of fires as a result of this sudden depletion of dissolved oxygen.” (http://www.agriculture.gov.au/water/quality/bushfires-and-water-quality, accessed 29 May 2018).

Potential INFFEWS benefit categories: 7, 8

Potential units of measure: $ cost of increased treatment of affected water, $ cost of replacing water from the next cheapest source of an equivalent quality. Costs also depend on the expected frequency of impacts.

Number of relevant values included in the INFFEWS Value Tool: nil

Improved security of water supply

Non-market. Studies have found that residents place a value on having greater security of water supply. For example, they would pay a premium for their water it there was a lower probability of water restrictions due to drought. (Cooper et al., 2018). Two Australian studies, both based on Canberra, found that the willingness to pay to avoid mandatory water restrictions was $150 per year (Gordon et al., 2001) or $240 per year (Hensher et al., 2006). Cooper et al. (2018) found that the willingness to pay varied significantly between different cities in Victoria and New South Wales. They also found that willingness to pay varied over time, being lower at times when water restrictions are not actively in place.

Potential INFFEWS benefit categories: 1, 2, 4, 8

Potential units of measure: $ of non-market benefits per person or per household.

Number of relevant values included in the INFFEWS Value Tool: 358

3. Benefit parameters sheet

The BCA Tool identifies benefits in a range of categories. These categories reflect the various ways in which the benefits can be calculated. They are used to simplify the process of calculating benefits, and to make clear what information is needed to calculated each type of benefit. However, when results are presented, they are broken down by individual benefits rather than benefit categories (except in the case of the Comparison tool.)

There can potentially be multiple benefits within a project, and these different benefits can be from the same category or different categories. If a benefit type could potentially be included under more than one category, include it in the category that best reflects the way that the information about it will be available. Each benefit should be included in only one benefit category, to avoid double counting.

Aspects common to different benefit categories

Before we look at the distinctive aspects of each benefit category, we will look at several things that most of them have in common.

The benefit parameters to be entered in this sheet are the values that are judged to be most relevant to the project you are evaluating. Judgements about the numbers should be all-things-considered judgements, based on all the available evidence, on the specifics of this project, and on the knowledge of relevant experts.

In all cases, the benefits reflect a difference between the with-project scenario and the without-project scenario. This is highlighted in the descriptions of the benefit categories below. In the Benefit parameters sheet, parameters that vary between the with- and without-project scenarios are highlighted as white text on a blue background.

The monetary benefits depend on both a value and a quantity. For example, we need to know the benefit per person and the number of people affected. Advice from experts other than economists is probably needed to quantity the change that occurs due to the project.

For each benefit type, indicate whether it will be measured in monetary or monetary-equivalent terms, quantitatively but in non-monetary terms, or described qualitatively. If benefits are measured in non-monetary terms, enter a description in words of the benefits (the tables for doing so are to the right of the numerical tables). These descriptions will be included in the Project report but the benefits they describe will not factored into the BCA in monetary terms.

Expressing the benefits in non-monetary terms is not about the nature of the benefits (monetary vs non-monetary) but rather about how the benefits will be measured in this analysis. You may decide to describe a monetary benefit in words rather than numbers because of a lack of information about it. Conversely, non-market or unpriced benefits can be expressed in monetary-equivalent terms using one of the non-market valuation approaches developed by economists for this purpose. To estimate non-market values, refer to the INFFEWS Value Tool.

For each benefit flagged for monetary estimates, complete the required information in the tables provided. The information required is somewhat different for each benefit category, as outlined below, so a different table is provided for each.

For benefit categories 1 to 4, you specify a Start year, a Plateau year and an End year for the benefit. These settings determine the pattern of benefits over time. To indicate that benefits ramp up, specify a Start year (the last year when benefits = zero) and a later Plateau year (after which benefits level off).

You can also specify a growth rate (% per year) representing annual compound growth in benefits between the Plateau and End years.

If Start year is blank, it is automatically set equal to Plateau year and benefits start suddenly in that year. If Plateau year is blank, it is automatically set equal to Start year. If both Start year and Plateau year are blank, they are both set equal to Analysis Start year (2. Time sheet).

Benefits end suddenly after the End year. If End year is blank, it is set equal to Analysis End year (= Analysis Start year + Length of analysis: see *2. Time* sheet).

Start year must be less than or equal to Plateau year which must be less than or equal to End year. If either of these rules is violated, the offending years are highlighted in red text with pink background.

If you want to enter a benefit that lasts for a single year, specify that the End year is the same as the Start year. (Either leave Plateau year blank or make it the same as Start year.) Sometimes you may want to enter a multi-year benefit where the stream of benefits has already been discounted back to a single value at a particular point in time. Enter this as if it was a benefit that only lasted for one year, with the same Start year and End year.

For each benefit category other than categories 5 and 6, you can specify an annual growth rate for that benefit. This may reflect population growth or economic growth, for example. The growth is cumulative and occurs at a constant relative rate between the Plateau year and the End year. The growth rate can be negative if relevant. Growth is assumed to commence at the Plateau year for the benefit, not at the start year for the whole analysis (as specified on the *2. Time* sheet).

For each benefit category, the proportion of the total benefits that flow to the project organisation and to up to seven other stakeholders can be specified. The proportions given in the table must not exceed 1 for any one benefit type.

Allocating the benefits and costs to different stakeholders is optional. It will be useful for some users but not others.

We saw earlier how to add a benefit type to the BCA, using one of the “Add benefit” buttons on the *Benefits* sheet. Note that an alternative approach is to enter a benefit directly into one of the benefit category tables on the *Benefit parameters* sheet. Just type in a suitable label for the benefit and enter the required numbers.

For benefit categories 1 to 7, up to 10 individual benefit types can be specified, while for benefit category 8 there is room for up to 20 benefit types.

If the project would have an adverse impact on a benefit type, capture this in the relevant benefit category table. For example, enter a negative annual benefit per person or a negative improvement in asset value. This could be relevant, for example, if a commercially beneficial project has an adverse effect on others through a loss of visual amenity, or emission of a pollutant. These are examples of “negative externalities” – adverse impacts on other people who are not involved in the project. In some cases, the negative effects might be felt by the same people who are receiving the benefits. In that case they may not be externalities, but the positive and negative benefits can still be captured separately in the BCA Tool.

When estimating the magnitudes of benefits generated, consider the availability of substitutes for the benefits generated. For example, if a project provides additional greenspace in an area where there is a lot of green space already, the benefits are likely to be less than they would be in an area that lacks green space.

Where delivery of a benefit depends on the adoption of new behaviours, practices or technologies by private citizens or businesses, it is recommended that the benefits specified in section 3 be based on an assumption that the people do fully adopt. In other words, assume that people or businesses do take up the new behaviours, practices or technologies sufficiently to achieve the goals of the project. The benefits based on this assumption will then be scaled down in section 4, where you will specify the proportion of

the desired adoption that will actually be generated by the project. See Section 4 for more about adoption.

Note that the behaviour of people or businesses in the base case is also relevant to the estimation of benefits from the project. For examples, if the project aims to encourage adoption of a new technology, and the new technology is highly attractive to the target audience, there is a good chance that the technology would be adopted by most of the target audience even without the project. The potential benefit of the project (the difference between the with-project and without-project scenarios) would therefore be small, even if 100% adoption is achieved. The main benefit might be to bring adoption sooner, rather than to increase the amount of adoption.

3.1 Category 1. Benefit per person (on average) for a population

For benefits in this category, you specify an average benefit per person, and the number of people affected.

With versus without. In most cases, the benefit per person reflects the difference between the with-project scenario and the without-project scenario. In some cases, it is the number of people affected that varies between the with- and without-project scenarios.

Annual versus one-off benefits. If the benefit is specified as an annual benefit, the Start year and End year should represent the range of years over which this annual benefit occurs. If the benefit is specified as a one-off benefit, the Start year and the End year should be the same year – the year when the one-off benefit occurs.

Example. Reduced mortality from a project to reduce extreme heat in a city generates benefits of $7 million per life saved, and saves five lives per year on average. The with- versus without-project difference is the number of lives lost due to extreme heat. There are five fewer lives lost per year with the project. This is an annual benefit, so the Start year and End year should represent the range of years over which this annual benefit occurs (with an option for benefit to ramp up between the Start year and the Plateau year).

Example. Ecological benefits from improved water quality in the Swan River are valued at $100 per head per year for a sub-population of 50,000 and $40 per year for a sub-population of 200,000 and zero for the remainder of the population. This would be entered as two benefits, one for each sub-population. The with- versus without-project difference is in the annual benefit per person. It is $100 for one sub-population and $40 for the other, reflecting the difference in water quality, with versus without the project. This is an annual benefit, so the Start year and End year should represent the range of years over which this annual benefit occurs (with an option for benefit to ramp up between the Start year and the Plateau year).

Like all the benefit categories, Category 1 benefits are adjusted for discounting, partial adoption/participation, and project risks.

3.2 Category 2. Benefit per user-specified unit

Specify the unit to be used to measure this benefit (e.g. hectares or households), the annual benefit per unit, and the number of units affected.

With versus without. In most cases, the benefit per unit reflects the difference between the with-project scenario and the without-project scenario. In some cases, it is the number of units affected that varies between the with- and without-project scenarios.

Annual versus one-off benefits. If the benefit is specified as an annual benefit, the Start year and End year should represent the range of years over which this annual benefit occurs. If the benefit is specified as a one-off benefit, The Start year and the End year should be the same year – the year when the one-off benefit occurs.

Example. Adoption of water-conserving shower heads generate water savings worth $100 per household per year for 5,000 households. In this case, the with- versus without-project difference can be thought about in either of two ways. Firstly, we could view it as a gain of $100 per household for a fixed population of 5,000 households. Secondly we could view it as an increase of 5,000 in the population of households that are benefiting from water-conserving shower heads. Either way, the overall benefit comes out to be $100 times 5,000, so think about it whichever way makes the most sense to you. This is an annual benefit, so the Start year and End year should represent the range of years over which this annual benefit occurs (with an option for benefit to ramp up between the Start year and the Plateau year).

Example. Establishment of a living stream is valued at $800 per household per year, for 500 households close to the stream. The benefit of $800 per household reflects the annual gain in amenity and other benefits for these 500 households, with versus without the project. This is an annual benefit, so the Start year and End year should represent the range of years over which this annual benefit occurs (with an option for benefit to ramp up between the Start year and the Plateau year).

Example. Establishment of a living stream has benefits of $18,000 per household, for 500 households close to the stream. This $18,000 represents the present value of a stream of future annual benefits (with versus without the project). To include it in the BCA Tool, you could either convert it to an annual stream of benefits (as in the previous example – with the Start year and End year representing the relevant range of years), or include it as a one-off benefit (with the Start year and End year being the same, representing the base year for which the present value was calculated). In the latter case, if the benefit has been estimated as an increase in house prices, use the year at which the house prices are expected to reach their maximum increase as the year.

3.3 Category 3. Benefit per unit of abatement

Specify the unit to be used to measure abatement (e.g. tonnes of CO_2-e), the benefit per unit, and the number of units of abatement.

With versus without. The number of units of abatement is the difference in emissions between the with- and without-project scenarios.

Annual versus one-off benefits. In most cases, the level of abatement will be specified as an annual amount. The Start year and End year should then represent the range of years over which this annual abatement benefit occurs (with an option for benefit to ramp up between the Start year and the Plateau year). It would be possible for abatement to occur as a one-off event – a reduction in emissions in a single year. The Start year and the End year would then both be set to the year when the one-off abatement occurs.

Example. Cooling of a suburb due to establishment of vegetation reduces demand for electricity for cooling, resulting in reduced emissions of 100 tonnes per year of CO_2-e, valued at $25 per tonne. The with- versus without-project difference is the reduction in annual emissions. This is an annual benefit, so the Start year and End year should represent the range of years over which this annual benefit occurs.

3.4 Category 4. Benefit per year in aggregate

Specify the aggregate benefit per year in dollars. You have flexibility in how this annual benefit is calculated. It will be treated by the BCA Tool as being constant between the Plateau year and the End

year, apart from any Growth rate specified. There can also be a ramp up of benefits between the Start year and the Plateau year.

With versus without. The aggregate benefit must reflect the difference between the with- and without-project scenarios.

Annual versus one-off benefits. The aggregate benefit could be either annual (Start year and End year set to the range of years over which this annual benefit occurs) or one-off (Start year and the End year both set to the year when the one-off benefit occurs).

Example. A project results in reduced urban heat, leading to reduced costs of air conditioning. The total cost saving per year for the area is $120,000. This is an annual benefit, so the Start year and End year should represent the range of years over which this annual benefit occurs.

Example. The benefit to surrounding households of maintaining water in a large lake using managed aquifer recharge is estimated at $5 million per year in aggregate. With the project there is water in the lake, without the project there is no water, and the difference is estimated to be worth $5 million per year. This is an annual benefit, so the Start year and End year should represent the range of years over which this annual benefit occurs.

3.5 Category 5. Delay or reduction in cost

This benefit category is for projects that result in a delay or reduction in a discrete investment, such as investment in a new water treatment plant. In this case, the with-project and without-project scenarios are explicitly built into the way the data are entered.

The best way to explain this category is with an example. Suppose there is currently a water treatment plant producing potable water from a particular stream. There is a project to modify land use in the catchment (watershed) to improve water quality in the stream. We are doing a BCA on this catchment project. Without the project, the water treatment plant would need to be replaced and upgraded in five years' time (at a one-off cost of $15 million). With the catchment project in place, the plant won't need to be replaced for 15 years, and the required capacity of the plant at that time would be reduced (cost reduced to $10 million). Without the project, following replacement of the plant in five years' time, operating and maintenance costs for the plant would be a little less than they are now (down from $1 million per year to $800,000 per year). With the project, following replacement of the plant in 15 years' time, operating and maintenance costs for the plant would be much less than they are now (down by 50% to $500,000 per year). All of these complexities can be represented in benefit category 5.

The first two required numbers are (a) the cost of the future investment if there is no project ($15 million in the above example), and (b) the cost of the future investment if the project is implemented ($10 million). If (b) is less than (a), this is a benefit. However, (b) doesn't necessarily have to be less than (a). The benefit could be in the timing of investment costs rather than the amount.

The next three numbers relate to maintenance costs: (c) annual maintenance costs prior to the investment ($1 million in the above example), (d) annual maintenance cost after the investment if there is no project ($800,000), and (e) annual maintenance cost after the investment if the project is implemented (500,000). Again, these maintenance costs don't have to be different. It may be that the project reduces future maintenance costs, meaning that (e) is less than (d). Or the three maintenance costs might all be the same, or (d) and (e) might be the same, or they might all be different.

The next two numbers are (f) the year of the investment if there is no project (after 5 years in the example) and (g) the year of the investment if the project is implemented (after 15 years). If the project delays the year when the investment will be required, this is a benefit in terms of reduced interest costs (reflected in a higher discount factor for costs that occur further in the future).

The final required number is the life of the investment, in years. Handling the life of the infrastructure can add to the complexity of the analysis. In the BCA Tool it is handled simply by assuming that beyond the first round of investment, there is no difference between the with- and without-project scenarios (i.e. no enduring benefits in later rounds of infrastructure investment).

Note that if maintenance costs vary with and without the investment, it is essential to include a value for the life of the investment, because maintenance costs are only calculated for the life of the investment.

A potential complication with this benefit category is that the year of the discrete investment (e.g. the water treatment plant) with the project might fall after the end date of the analysis. In the above example, if the length of the timeframe for the BCA is only 10 years (unusual, but not unknown), the delayed investment in the water treatment plant would be after the final year of the analysis. This means that the cost of the delayed investment would not be captured by the analysis, which is equivalent to saying that the cost is delayed forever (i.e. avoided entirely). This is a logical outcome of specifying an end date for the analysis – a year after which you don't care about the benefits and costs. If it seems unreasonable to ignore the delayed investment cost beyond the analysis end date, you are effectively saying that the length of the analysis is not long enough. This is easily fixed on the *2. Time* sheet, although remember that all BCAs that you are going to compare should have the same start and end years for the analysis (on the *2. Time* sheet).

Note that in this example, the cost of the project in the BCA (sheets *5. Costs* or *5.6 Custom costs*) is the cost of the activities that modify land use in the catchment. It does not include the cost of the water treatment plant. The two costs of the water treatment plants (with and without the catchment project) get included in the benefits part of the BCA, not the cost part. If the two costs are different, that can be a benefit, and if they occur at different times, that can be a benefit.

With versus without. In this case, the with-project and without-project scenarios are explicitly built into data requirements.

Annual versus one-off benefits. The benefits in this category are inherently one-off, as they relate to a particular investment at a point in time.

Example. See the above example.

3.6 Category 6. Improve an environmental or community asset

This benefit category is used for projects that affect the condition or value of a discrete asset – often an environmental asset, but potentially a different type of community asset. It requires three pieces of information: the total value of the asset if it was in good condition, the improvement in the asset value as a result of the project (as a proportion of the value of the asset in good condition), and the year by which the majority of the benefits would be delivered.

With versus without. The second piece of information - the improvement in the asset value as a result of the project – is based on the difference between the with- and without-project scenarios.

Annual versus one-off benefits. This category estimates the change in asset value at a particular point in time. An asset value encompasses a stream of annual values in subsequent years, but those annual values are not expressed explicitly. In the BCA calculations this is treated as a one-off benefit, although in reality annual benefits lie behind it.

Example. The total value of Perry Lakes to surrounding households, if they were in good condition, is estimated as $150 million (the present value of a stream of future annual benefits). In their current condition, they are dry most of the time, and have a value of $30 million (again, a present value). The project being assessed would result in water in one of the lakes 30% of the time, and in the other lake 20% of the time. The estimated value following the project is $45 million. The proportional increase in value is ($45 million − $30 million)/$150 million = 0.1.

3.7 Category 7. Reduced consequence of a risky event

This is the most complex of the benefit categories, in terms of the number of parameters for which information is required. It is designed for projects that reduce the risk of particular adverse events, such as a flood, or loss of water quality following a fire.

The first two pieces of information required are (a) the expected or average cost of the risky event if it does occur in a year and the project was not implemented, and (b) the expected or average cost of the risky event if it does occur in a year and the project was implemented. It is possible that the project may reduce the cost of a risky event such as a flood by flood proofing particular buildings in some way. In this case, the probability of a flood is not altered, but its consequences are.

The next two pieces of information are (c) the annual probability of the risky event if there is no project, and (d) the annual probability of the risky event if the project is implemented. The project may alter the probability of a risky event, such as by improved drainage reducing the probability of a flood.

Next we account for the fact that there may be a change in the probability of a repeat of the risky event for a period after the risky event occurs. Two pieces of information are required: (e) the multiplier for the probability of the risky event during the residual period, and (f) the duration of the residual period. For example, suppose that, following a flood event, the probability of an additional flood in this area is increased by 20% for the next 3 years. Then the “Multiplier for probability of risky event during residual period” is 1.2, and the “Duration of residual effect” is 3.

Even with these six parameters, this approach is highly simplified. For example, a fully detailed approach could examine changes in probability distributions, not just in expected outcomes. If the analyst wishes to base the analysis on a more complex representation of the risk category (or any of the other categories), this can be calculated separately and the year-by-year results included in category 8.

With versus without. The category accounts for the with- and without-project scenarios in two ways. If the cost of the risky event is reduced by the project, this is reflected as the difference between (b) and (a). If the probability of the risky event is reduced by the project, this is reflected as the difference between (d) and (c).

Annual versus one-off benefits. This category calculates benefits on an annual basis, reflecting the annual reduction in the expected cost and probability of the risky event.

Example. Suppose that a proposed project would reduce the severity of flooding in a suburb by 25%. Long-run expected annual losses at the moment are $4 million per year, but would be reduced to $3 million if the project is implemented. (This provides (a) and (b): $4 million and $3 million.) The project also reduces the probability of a flood in any particular year from 0.1 to 0.05. (This provides the numbers for (c) and (d): 0.1 and 0.05) If there is a flood, the probability of an additional flood in this area is increased by 20% for the next 3 years. (This provides the numbers for (e) and (f): 1.2 and 3).

Box 4. Negative benefits

As well as the costs of implementing a project, there can sometimes be negative outcomes from the project. For example, a project to establish new wetlands in an urban area, if not designed and implemented well, could result in an increase in mosquito numbers.

There are three ways that negative benefits can be captured in the BCA Tool.

Firstly, if it is possible to quantify the negative impacts, they can be entered as negative benefits in parts 3.1 to 3.8. For example, there could be a negative annual benefit per person from increased mosquito numbers in 3.1. **Secondly**, if quantification is too difficult, the negative impacts can be recorded in words,

either as a non-monetary negative benefit in *3.1 Benefit parameters*, or in *6.4 Negative and positive spinoffs from the project*. The descriptions entered in both those places are included in the Report that presents the BCA results. **Thirdly**, a negative impact on somebody who is being asked to implement the works and actions needs to be considered in parts 4.1 or 4.3 when you weigh up the likely adoption of the works. The greater the negative impact on the potential adopter, the less likely it is that he or she will adopt the works and actions.

Negative benefits that are entered quantitatively into parts 3.1 to 3.8 of the BCA Tool reduce the overall benefits of the project. They offset some of the positive benefits. In that way they have a similar effect on the analysis as a cost. They are not necessarily a financial cost (although they could be). Negative benefits are deducted from the numerator of the BCR rather than being added to the denominator.

3.8 Custom benefits sheet

This sheet includes only one benefit category. It is included on its own sheet because it needs space for up to 50 years of benefits, whereas the other benefit categories calculate up to 50 years of benefit based on a much smaller number of parameters. For the other categories, the calculations are done on a separate hidden sheet, but for this category the estimated benefits are shown for each year. Adjustments for partial adoption and project risk are made to the numbers provided on this sheet. If the numbers provided already allow for partial adoption and project risk, set adoption to 1 (100%) on the *4. Adoption* sheet and set project risks to zero on the *6. Project risk* sheet.

3.8 Category 8. Custom benefits

This category provides complete flexibility in the calculation of benefits. If none of the other seven benefit categories is suitable for a particular benefit type, it can be calculated separately and the results entered here.

With versus without. The benefits entered in this category must all be based on the difference between the with-project and without-project scenarios.

Annual versus one-off benefits. This category is completely flexible regarding the timing and frequency of benefits.

Example. A particular benefit type from one of the other benefit categories may have benefits that are expected to vary in a predictable way that cannot be captured by the other categories. For example, a benefit may be generated ever second year, or may be expected to have a low period in between two high periods.

Box 5. Benefit categories for each broad benefit group

In the BCA Tool Guidelines, project benefits are described in four broad benefit groups: market benefits, non-market benefits, cost savings and cost delays, and risk reductions. Benefits from these broad groups can potentially be entered in the BCA Tool in various benefit categories, as follows.

Market benefits

Category 4. Total or aggregate benefit per year. Benefits are entered as a total value per year for each benefit type, with each benefit type entered in a separate row in the Category 4 table. If you are calculating benefits as the total consumer surplus plus producer surplus, and it is reasonable to assume

that the annual benefit is constant (or growing constantly) between the start year and the end year, this is the category to use. You could enter consumer surplus in one row of the table and producer surplus in another, or put the total surplus in one row. If you enter them in separate rows, the BCA Tool will add them up.

Category 8. Custom benefits. This category gives you complete control over the pattern of benefits over time. As with Category 4, you could enter consumer surplus and producer surplus in separate rows of the table, or combine them in a single row for the total surplus.

If you are trying to estimate market benefits without using a supply and demand model, it may be that it is more convenient to enter them in category 1 or category 2.

Category 1. Benefit per person. For entering benefits in category 1, the benefits need to be expressed as an average per head. The size of the relevant population is also entered. If there are multiple sub-groups within the population and you know the benefit per head for each, you can enter separate rows in the Category 1 table for each sub-group.

Category 2. Benefit per user-specified unit (e.g., unit of action or area). If you are calculating the benefits as the average consumer surplus per unit of a product or average profit per unit of a product, this is the category to use.

Non-market benefits

Category 1. Benefit per person. For the survey-based non-market valuation techniques, Category 1 (benefit per person) is particularly relevant. Some surveys (e.g. some surveys of peoples' willingness to pay for certain outcomes) provide estimates of benefits for different segments of the community. These could be entered separately into the BCA Tool Category 1 table, one population segment per line.

Category 2. Benefit per user-specified unit. Some non-market valuation results are presented per household or per residential property. These can be entered in Category 2.

Category 3. Benefit per unit of abatement. If you are calculating the benefits per unit of pollution reduction, this is the category to use.

Category 4. Total or aggregate benefit per year. If you have evidence about total consumer surplus for the population, you could use this category.

Category 6. Improved condition of an environmental or community asset. This category is relevant to projects that aim to protect or enhance an environmental asset.

Category 8. Custom benefits.

Cost savings and cost delays

Category 5. Delay or reduction in cost. The with-project and without-project scenarios are explicitly built into the Category 5 table.

For annual cost savings by private citizens, businesses, government agencies or other organisations, use **Category 1** if benefits are expressed per head or **Category 2** if they are expressed in other units.

Category 8. Custom benefits.

Risk reductions

Category 7. This category is set up to calculate the benefits of a change in the annual consequence (cost times probability) of a risky event, such as a flood. The approach to calculating the benefit of a risk reduction is a simplification. In reality, there is a probability distribution of costs if the risky event (like a flood) occurs. The approach used in the BCA Tool is summarise the distribution down to an annual average.

Category 8. Custom benefits.

Box 6. When is a benefit too small to bother with?

Where a project generates multiple different benefits, it is common that one or two of the benefits provide most of the overall benefits, with others making little difference to the overall result. If a benefit type makes a small contribution to the overall benefits, and it is not a simple matter to estimate its magnitude, a reasonable judgement can be made to exclude it from the quantitative analysis, perhaps including it in words, either as a non-monetary benefit in *3.1 Benefit parameters*, or in *6.4 Negative and positive spinoffs from the project*. How small the benefits should be before they can be overlooked is a matter of judgement for the analyst. A suggested rule of thumb is that if a benefits type is expected to be not more than 5 to 10% of the total benefit, it could be excluded. If the BCR is close to the threshold at which the project would be accepted, the temptation would be to include relatively small benefit types in the calculations. Or if a project generates many small benefits and no large ones, you will not want to exclude any of the small ones.

4. Adoption sheet

This section asks about the adoption of the required works and actions by the relevant people or businesses.

Purpose. The lower the level of adoption of required works and actions by private citizens and businesses, the lower the level of benefits that will be delivered. If adoption is below the required level, benefits are scaled down accordingly. For simplicity, benefits are scaled down linearly as adoption falls.

At the top of the sheet there are two buttons where you can select to “Use one adoption parameter for whole project” or “Use separate adoption parameters for each benefit”. If you select the first option, sections 4.1, 4.2 and 4.3 are displayed. If you select the second option, section 4.4 is displayed.

4.1 Attractiveness of the works and actions to private citizens and businesses

If any works or actions are required of private citizens or businesses, they should have been specified in 1.7. If no such works or actions are required, select “Not applicable” from the drop-down menu and go to the next sheet.

This section is about the extent to which those works or actions (the ones specified in 1.7) will be adopted and implemented by the relevant private citizens or businesses.

Important definition: The following text refers to **“adoption”**. By adoption we mean the uptake and usage of particular new practices or behaviours by the relevant private citizens or businesses. Back in question 1.7 you specified the level of adoption that would be needed to achieve the goals of the project. This section is about the extent to which the necessary level of adoption will actually be achieved.

In the drop-down menu, select the most appropriate option from the following list.

☐ Highly attractive. Even without this project, the works/actions would probably be adopted at the required scale within a decade. The benefit of this project is to speed up adoption, not to increase the final level of adoption. This should already have been reflected in the with-versus-without

scenarios that you used to define the potential project benefits, and then reflected in the potential benefits defined in section 3. (See below for more explanation.)

☐ Slightly attractive. Without this project, the works/actions would probably be adopted to some extent, but at less than the required scale, and reaching peak adoption would take more than a decade.

☐ Neutral. There is currently little or no adoption of the works/actions, and it is unlikely that they would proceed to higher levels of adoption without a project to push them. However, it is expected that this project would be sufficient to prompt long-term adoption by some people (or by all people in particularly favourable adoption circumstances).

☐ Slightly negative. The works/actions would not be adopted without strong support or encouragement from a project, such as moderate ongoing payments or regulation.

☐ Highly negative. The works/actions would not be adopted without large ongoing payments or strongly-enforced regulation.

☐ Not applicable. No private adoption needed.

Note that the question refers to full adoption, not partial adoption. “Full adoption” means that all of the works and actions specified in 1.7 would be adopted at the necessary scale.

Be realistic about adoption levels that are likely. For example, history shows that even in areas with strong social networks and well-informed people, voluntary adoption of conservation practices is often well below the levels required to achieve strong resource conservation goals.

Earlier on in Section 3, at the end of the sub-section called “Aspects common to different benefit categories”, I explained how behaviour is also relevant to the without-project (base-case) scenario. If a new practice or technology is highly attractive to people, it will probably be adopted widely even without the project, in which case the benefit of the project itself will be modest. This thinking should influence the specification of the potential benefits in *3. Benefit parameters* or *3.8 Custom benefits*. On the other hand, selection of “Highly attractive” in 4.1 results in a high adoption multiplier (0.9 or 1.0, depending on the response in 4.2). This may seem like a contradiction, but it is logical. The adoption multiplier specified in section 4 gives the proportion of the *potential* benefits (from section 3) that will be generated once adoption of new practices is accounted for. If a new practice is highly attractive, then the level of potential benefits will be relatively low, but the proportion of those potential benefits that are actually delivered by adoption will be high.

4.2 The adoption circumstances

How favourable are the circumstances of this project for adoption of the desired works/actions by the relevant private citizens or businesses?

☐ Very favourable adoption circumstances. For example, small target audience for adoption, with excellent links to the organisation running the project.

☐ Less favourable adoption circumstances. For example, a larger and more diverse target audience for adoption, with varying strengths of linkage to the organisation running the project.

A is defined as the proportion of adoption achieved by the project, relative to the level needed to fully deliver the specific targets of the project (as specified in 1.5). By default, the BCA Tool estimates the value of A from your earlier responses (see Table 2 below) for use in calculations in the Benefit: Cost

Analysis later. If you have better evidence, you can over-ride the standard method for estimating *A* in section 4.3 below.

The *A* values given in Table 2 are judgements based on observations of adoption levels in past projects, and extensive review of the research literature on adoption of innovations by farmers (Pannell et al., 2006). They represent the proportion of target adoption that is expected to occur as a result of this project. ("Target" adoption means full adoption of the works and on-ground action specified in 1.7.) For example, under less favourable adoption circumstances, with slightly attractive works/actions, it is estimated that, even with the project in place, only 80% of the target adoption level will be achieved.

Note that the adoption proportions are not evenly spaced. The numbers tend to be nearer to 1 than to zero, especially in the "favourable adoption" column. This reflects that the project aims to encourage adoption of the works, and is likely to succeed to some extent, depending on the circumstances. If projects always succeeded in achieving full adoption, all the numbers in the table would be 1.0. Realistically, of course, projects often fall short of this ideal, and the numbers in the table reflect this.

This bunching of *A* values towards 1 means that the relationship between response categories and *A* is non-linear. Going from "Highly attractive" to "Slightly attractive", the reduction in likely adoption is zero (or relatively low in the right column), since "Slightly attractive" is judged to be sufficient to lead to full adoption (or high adoption in the right column). Going from "Slightly negative" to "Highly negative", adoption is assumed to drop off more rapidly, since practices with highly negative adoption characteristics are likely to be much harder to get adopted than practices with slightly negative characteristics.

4.3 Custom value for adoption (*A*)

By default, the BCA Tool estimates the value of A from your earlier responses (see Table 2) for use in calculations in the Benefit: Cost Analysis later. However, you can over-ride the standard method for estimating A and provide your own value if you have grounds for believing that the standard value is inappropriate for this project.

Consistency check 1

A common mistake is to over-estimate the adoption that would really occur. Are the responses to 4.1, 4.2 and 4.3 consistent with observed adoption behaviour for these practices or similar ones in the region(s) of this project?

☐ Yes: continue

☐ No: modify the responses to 4.1, 4.2 or 4.3

Table 2. Values of *A* based on responses to 4.1 and 4.2. Rationales are provided.

Average score	**Very favourable adoption circumstances**	**Less favourable adoption circumstances**
Highly attractive	1.0: Given the very favourable circumstances, the project interventions are likely to be fully successful at prompting full adoption.	0.9: The works are highly attractive, so adoption will be high, but given the many challenges involved, full adoption is still not assured.
Slightly attractive	1.0: Given the very favourable circumstances, the project interventions are likely to be fully successful at prompting full adoption.	0.8: The project would be highly successful at prompting adoption, but not fully successful.
Neutral	1.0: Given the very favourable circumstances, the project interventions are likely to be fully successful at prompting full adoption.	0.7: Potential adopters consider that positive and negative aspects of the works are approximately in balance. With an intensive intervention, there should be better than 50% of the desired level of adoption.
Slightly negative	0.8: The project would be highly successful at prompting adoption, but not fully successful.	0.6: Relatively poor adoption even with the project in place.
Highly negative	0.6: Given that the works/actions are highly unattractive to the target audience, there is limited adoption, even with the project in place.	0.4: The works are highly unattractive to potential adopters, and even with substantial and costly policy interventions, adoption well below the target level is the most likely outcome.
Not relevant	1.0: No private adoption required.	1.0: No private adoption required.

4.4 Separate adoption parameters for each benefit

Starting with version 2020-01 of the BCA Tool, users have the option of specifying one adoption parameter for the whole project, or separate adoption parameters for each benefit. If you select one adoption parameter, you are presented with the questions in 4.1, 4.2 and 4.3. If you instead select to provide separate adoption parameters, a row is displayed for each benefit that has a non-zero value, based on the entries on sheets *3. Benefit parameters* and *3.8 Custom benefits*. You are able to enter the adoption parameter (a number between zero and one) directly into the table provided – the questions from 4.1 and 4.2 are not asked for each individual benefit. However, you may find it helpful to study Table 2 before providing adoption parameters for each individual benefit.

5. Costs sheet

There are several categories of costs that should be captured for your economic analysis of the project:

- Capital expenses (Capex) or the cost of establishing and implementing the project. Typically, projects have an establishment or implementation phase, followed by a maintenance or

operations phase, although in some cases, expenditure continues in a similar way and at a similar level more-or-less indefinitely (e.g. an ongoing community education program).

- Maintenance or operating costs after the project has been established.

- Monitoring, reporting, evaluation and administration costs.

- Private costs. If the project involves mechanisms that force businesses or private citizens to undertake actions that they would not otherwise agree to do, there are likely to be costs to them that should be considered in the overall BCA. Also, private entities may bear some of the costs of the project. If the benefits being captured by those private entities are included in the BCA, their costs should be as well. If the private benefits that are driving their participation are not included, then the private costs should be omitted too.

A more detailed "Checklist of cost types for water-sensitive projects" is available via a button near the top of the *5. Costs* sheet. This checklist is reproduced in Appendix B of this document.

Just like the benefits, costs need to be based on the difference between the "with project" and "without project" scenarios. Only *additional* costs, beyond those that would have been incurred under the "without project" scenario, should be included as costs in the Benefit: Cost Analysis.

For the first three of the above cost categories, the costs would predominantly be those associated with the project activities outlined in 1.6, 1.10, 1.11, 1.12 and 1.13 (assuming that these activities would not have occurred without the project).

If cost to private citizens are included (for activities listed at 1.7), care is needed. You need to (a) also include private benefits, (b) assign one of the stakeholders in the spreadsheet to private citizens, and (c) indicate in the spreadsheet the share of total costs that is attributed to the private citizens' stakeholder group. (b) and (c) are necessary to ensure that private costs are treated correctly when the BCR is calculated. Following these instructions will ensure that they are deducted from project benefits, rather than added to project costs.

Similarly, if costs to other organisations are included (for activities listed at 1.8), follow a similar procedure to that for private citizens' costs: (a) also include the other organisations' benefits, if there are any (beware of double counting), (b) assign one of the stakeholders in the spreadsheet to the other organisations, and (c) indicate in the spreadsheet the share of total costs that is attributed to the other organisations' stakeholder group.

Assuming that the discount rate specified in 2.4 is a real discount rate (inflation removed - which is how discount rates are normally specified), it is important that costs over time also be specified in real terms (inflation factored out). Beyond inflation, though, there are other things that may change over time, such as the size of the population that is affected by a project, or their real income. These can influence the size of benefits and, potentially, costs.

There are three options for quantitatively specifying project costs, as follows.

a. Stylised pattern of costs over time, broken into an establishment phase and a maintenance phase. This is a simplified approach, but one that can still be realistic for most projects.

b. A detailed costing template in which you specify all of the individual costs and how they occur over time. This provides maximum detail and support, but can become somewhat large and complex.

c. A simple time series of costs, specified separately for each year. This provides complete flexibility in the inclusion of costs, but requires you to prepare a detailed budget separately, with only the aggregate year-by-year costs being entered into the INFFEWS BCA Tool. You can insert a blank sheet in the spreadsheet to create that budget and link the results into the BCA Tool using formulas on the cost sheets.

You can use the same approach (stylised, detailed, time series) for all costs, or you can use different approaches for different costs. You must not enter the same costs twice using two different approaches. That will double the costs as all the costs you enter will be added up across the three approaches.

5.1 Stylised pattern of costs

Data for this system are entered at the top of the *Costs* sheet. In this system, it is assumed that there are two phases with different annual cost levels. The first phase, project establishment and implementation, begins in the specified Start year, and lasts until the specified End year. The second phase, project operation and maintenance, also has specified Start and End years. In each case, if no start year is specified for the costs, it is assumed to be the start year for the analysis and if no end year is specified, it is assumed to be the start year for the analysis plus the duration of the analysis (*2. Time* sheet).

Usually costs are higher in the first phase, but this does not have to be the case. Within each of the two phases, it is assumed that costs are the same each year. If this is too unrealistic, you can use one of the other cost systems, which are outlined below.

In this costing system, INFFEWS BCA Tool does not require you to provide a detailed budget, just the average annual costs in each of the two phases. However, you will probably need to prepare a budget to come up with those annual costs.

As a reminder, the activities that you need to cost out are those outlined in 1.6, 1.10, 1.11, 1.12 and 1.13 (assuming that these activities would not have occurred without the project). Also see the notes above about how to include costs for activities in 1.7 and 1.8.

Purpose. The data entered is used to generate a budget for up to 50-years. These costs are deducted from the benefits to calculate the Net Present Value of the project, or divided into the benefits to calculate the Benefit: Cost Ratio.

Enter the proportion of the costs that are funded from taxes.

Purpose. This is used to calculate the excess burden of taxation, as required or suggested in the BCA guidelines of most state governments.

Indicate the proportions of the costs that are attributed to the project organisation and up to seven other stakeholders.

Purpose. If desired, you can obtain information about the net benefits to the project organisation and to each stakeholder.

The next system gives you the opportunity to break down the budget into individual elements. You can enter some costs in one system (e.g. stylised) and some in another (e.g. detailed) and the Tool will add them up. Don’t enter the same costs in two systems or there will be double counting.

In each of the following four cost categories, you are asked to specify the year when the cost starts and the year when it ends. The cost is the same each year within that range. If no start year is specified for the costs, it is assumed to be the start year for the analysis and if no end year is specified, it is assumed to be the start year for the analysis plus the duration of the analysis (*2. Time* sheet).

5.2 Detailed costing: Capital costs

This includes planning, design and construction of capital works. Like each of the cost groups in the detailed costing system, you can enter up to 10 individual cost types. For each cost type, enter the annual cost between the specified Start and End year, a contingency proportion in case of cost blowouts.

As with the stylised system, also enter the proportion of funds that are obtained from taxes, and the breakdown of costs between the project organisation and up to seven other stakeholders. The difference from the stylised approach is that you can do this separately for each cost item.

If there are costs of disposal or restoration at the end of the life of the project, they could be included here, by using one of the rows in the table for this purpose.

Purpose. See 5.1 Stylised pattern of costs

5.3 Detailed costing: Operating costs

This includes factors such as travel, meetings, payments to private citizens or businesses, legal costs, operations and maintenance. Include any of the various costs required, other than capital costs (which go into 5.2) and salary costs (5.4).

The information requirements are the same as for capital costs except that there is no requirement for a contingency proportion. For each of up to 10 cost items, enter annual costs, their start and end dates, the proportion of funds obtained from taxes, and the proportions of costs attributable to the project organisation and other stakeholders.

Purpose. See 5.1 Stylised pattern of costs

5.4 Detailed costing: Salary and in-kind costs

This includes salary and in-kind costs for all project-related activities, including project management, coordination, project officers/field officers, administration, investigation, research, technical support, monitoring, and evaluation.

The information requirements for each cost item are the same as for capital costs except that there is no requirement for a contingency proportion. For each of up to 10 cost items, enter annual costs, their start and end dates, the proportion of funds obtained from taxes, and the proportions attributable to the project organisation and other stakeholders.

Purpose. See 5.1 Stylised pattern of costs

5.5 Detailed costing: Other costs

Any costs not captured elsewhere can be specified here. For each of up to 10 cost items, enter annual costs, their start and end dates, the proportions funded from taxes, and the proportions attributable to stakeholders.

Purpose. See 5.1 Stylised pattern of costs

Box 7. Financial risk and maintenance costs

One of the risks that can affect a project is the risk of maintenance costs not being provided. The effect of this on project benefits is captured in the *Project risk* sheet. However, if this risk is realised, it also results in a saving in maintenance costs on the *Costs* sheet or the *Custom costs* sheet. If this is relevant to your project, you should scale down the maintenance costs to reflect the probability that maintenance costs will not be provided. For example, if it is judged that there is a 10% probability of maintenance costs not being provided, the project risk factor on the *Project risk* sheet should include a 10% component for this risk, and maintenance costs on the *Costs* sheet should be reduced by 10%.

5.6 Custom costs sheet

5.6 Simple time series of costs

In this system, for up to 10 cost items, you provide the aggregate project cost for each year, the proportion of funds obtained from taxes, and the proportions of costs that is attributable to the project organisation and up to seven other stakeholders.

You are not required to provide a detailed budget here, just the aggregate cost for each year. However, you will need to prepare a budget to come up with those year-by-year costs.

The two project phases that were used in the stylised cost system are not used in this system, as you enter a separate cost for each individual year. Whether you are in the implementation phase or the maintenance phase will affect the costs, but you don't have to specify which phase any particular year is in.

As a reminder, the activities that you need to cost out are those outlined in 1.6, 1.10, 1.11, 1.12 and 1.13 (assuming that these activities would not have occurred without the project). You also need to factor in costs to other stakeholders, including private citizens and businesses (1.7) and other organisations (1.8).

Consistency check 2

(a) Are the items listed in the budget consistent with the project activities provided in 1.6, 1.10, 1.11, 1.12 and 1.13? Have you factored in costs to other stakeholders, including private citizens and businesses (1.7) and other organisations (1.8)?

☐ Yes: continue.

☐ No: Modify the budget or the project activities. If you have to scale down the project activities, consider whether you also need to scale down the project's specific goal(s).

Box 8. Costs, negative benefits and the BCR

The INFFEWS BCA Tool provides the results for two versions of the BCR.

(a). **BCR for constrained budget** (has constrained costs in the denominator and unconstrained costs subtracted from the numerator). If you are ranking independent projects to help decide how to allocate a limited budget (a pool of funds), this version of the BCR gives the best result - the highest overall NPV from the funded portfolio of projects. To allow INFFEWS to calculate this BCR, on the *5. Costs* and *5.6 Custom* costs sheets it asks whether each cost item is constrained (drawn from a limited budget).

For example, suppose an agency has a budget of $20 million dollars for new projects. It is considering 30 possible new projects. To do all 30 projects, it would need to spend $50 million, so it will need to rank the projects and choose the best ones it can afford, up to a total cost of $20 million. In addition, the projects would require financial inputs from other organisations and businesses – a total of $25 million for all 30 projects. Each project involves some cost from the agency's $20 million budget, and some other costs from other organisations and businesses. When entering these costs into the BCA Tool, the costs from the agency's limited budget are "constrained" and the other costs are "unconstrained".

In many cases, it is likely that the project organisation's funds for the project's construction and implementation phase will be constrained in this sense, and other costs (operations, maintenance, other organisations' costs) may not be. However, the BCA Tool is completely flexible in which costs can be flagged as "constrained". In some cases, the budget to be allocated for projects might be drawn from more than one organisation.

The questions about this are to the right of the table of stakeholders for each cost. Answer "Yes" if the cost is drawn from a limited budget and "No" if it is not.

(b). **BCR for unconstrained budget** (has both constrained and unconstrained costs in the denominator). The questions about whether each cost is constrained have no effect on the calculation of this BCR.

If you are making a yes/no decision about a single project, either version of the BCR formula can be used. They are consistent in terms of whether the BCR is greater than or less than one. Version (b) is provided because some people prefer it, although for yes/no decisions either version works equally well. Note: the version with all costs in the denominator should not be used to rank projects when there is a funding constraint, nor to select from a set of mutually exclusive projects.

In Question 1.24, you can specify which of these two versions of the BCA you wish to display at the top of each screen and use for Monte Carlo analysis. Both versions are presented on the *8. Results* sheet.

Further advice on which BCA decision criteria to use in different contexts is provided on the *14. Criteria* sheet.

Another type of "cost" is a negative benefit. This is an adverse result from the project, which might be internal or external to the project organisation. For example, a project may generate income but cause pollution as a side effect. The monetary-equivalent impacts of the pollution can be entered as a negative benefit. Enter negative benefits on the *3. Benefit parameters* sheet or the *3.8 Custom benefits* sheet by entering negative values in the cells where you are asked to enter benefits. Negative benefits are deducted from the numerator in either version of the BCR.

The excess burden of taxation is always treated as an unconstrained cost.

5.7 Marginal excess burden of taxation

The excess burden of taxation is the cost to society of collecting taxation to spend on this project. See the Guidelines for details and for values recommended in different jurisdictions.

Enter the Marginal Excess Burden of Taxation as a percentage (not a proportion)

As one of the sensitivity analyses generated on the Sensitivity sheet, the BCA Tool follows the suggested approach of the Australian Government and NSW Treasury of comparing results with and without the excess burden of taxation as a sensitivity analysis. The standard results all include the Excess Burden of Taxation at whatever rate is specified on the *5.6 Custom costs* sheet. If you don't wish to include the Excess Burden of Taxation, set the value to zero.

In order to calculate the Excess Burden of Taxation, it is necessary to know how much of the budget spent on the project is sourced from taxation. Questions about this are included in each part of the Cost sections.

6. Project risk sheet

There are a number of risk factors that may mean that the project fails to deliver its intended benefits:

- Technical risk. Assuming that the works and actions specified in 1.6, 1.7 and 1.8 were fully implemented, what is the risk that the actual benefits would be significantly less than the benefits predicted in 3.1 to 3.8)
- Non-cooperation by other organisations whose support and cooperation you would need. This encompasses considerations such as whether the direct costs to the other organisation will discourage their cooperation, the capacity of the other organisation, the priorities of the other organisation, and the likely effectiveness of delivery mechanisms used in this project to try to influence the other organisation.
- Social, administrative or political constraints. Consider whether the project will be supported or obstructed by social, administrative or political factors, including support or opposition by local community groups and networks, likely resistance to the project at the political level, bureaucratic approvals that would be needed, support or opposition by local government, etc.
- Non-provision of essential maintenance funding. Most projects require some maintenance funds for the benefits to be continued. How likely is it that this will not be available or will be prematurely curtailed?
- Poor project management or poor project implementation. These risks might arise from poor governance arrangements, poor relationships with partners, poor capacity of staff in the organisation, poor specification of milestones and timelines, or poor project leadership.

It is suggested that these project risks should be explicitly accounted for in the BCA, to reduce the chances of over-stating the expected benefits. The suggested approach in the INFFEWS BCA Tool is to enter benefits on the *3. Benefit parameters* and *3.8 Custom benefits* sheets on the assumption that they are not affected by these project risks. Then specify the project risks on the *6. Project risk* sheet. The original benefits will be scaled down accordingly.

If the initial entered benefits are already scaled down to account for project risk, the risks specified on the *6. Project risk* sheet should be zero.

6.1 One risk or separate risks?

You can either specify one value of project risk which applies to all categories of benefits, or a separate risk value for each benefit. Select your choice by clicking on the relevant button.

6.2 One risk for whole project

In the drop-down menu, select the overall probability that the project will substantially fail to deliver its intended benefits. (Referred to below as *R* for risk)

		Value of *R*
☐	0-5% Very low risk of long-term project failure	0.03
☐	6-25%	0.15
☐	26-50%	0.38
☐	51-75%	0.63
☐	76-100% Very high risk of long-term project failure	0.88

6.3 Separate risks for each benefit

A separate drop-down menu is provided for each benefit. For each benefit presented (which will be all of the benefits with non-zero benefits, based on the information you have provided in 3.1 to 3.8), select the overall probability that the project will substantially fail to deliver the intended benefit.

Purpose. The probability that the project fails to deliver benefits is used in calculating the expected NPV and BCR, the main economic outputs of the BCA. Expected benefits are scaled down according to the probability of success (= 1 – *R*).

See Box 9 (in the section below on the *9. Distribution sheet*) for advice about the relationship between project risk and the probability distributions specified for the sensitivity analysis.

Consistency check 3

Considering the answer(s) to 6.2 or 6.3, is there a sufficiently high probability of achieving the project's target(s) (2.5)?

☐ Yes: continue

☐ No: Modify the target(s), such that there is a lower probability of failing to achieve the target(s), or modify the project actions to increase the probability of success.

You cannot legitimately put forward a goal that is known to have a high probability of failure. To do so distorts the decision-making process to favour projects with exaggerated goals.

A less demanding goal may increase feasibility and/or reduce costs, but of course a less demanding goal is in itself less attractive than a more demanding goal (assuming both can be achieved).

Modifying the project actions may increase the probability of success, but is likely to be more expensive. It would require changes throughout the BCA.

6.4 Negative or positive spin-offs from the project

Note in words any negative or positive spin-offs that are not captured elsewhere in the analysis (e.g. on the Benefit parameters sheet). The idea is that if they have not been quantified, they can at least be described. These spinoffs are effects that the project has for other public assets or for people other than those implementing the works and actions. Indicate the nature, severity, location and timing of the impacts.

As noted in Box 4, there are three ways in which negative impacts from a project can enter the BCA: as a negative benefit in parts 3.1 to 3.8, as an influence on the adoption parameters in 4.1 or 4.3, or as a qualitative statement here in part 6.4.

There may sometimes be positive impacts of a project that cannot be quantified in the BCA. These, too, can be described here.

The text that is entered in this section is included in the Project report.

Purpose. These are negative or positive aspects of the project that may need to be considered when decisions about supporting the project are being made, but which have not been captured quantitatively in the BCA.

Example. Installation of constructed wetlands may increase mosquitos for residents in surrounding area, generating discomfort and potentially disease. You don't have quantitative information about this, so you provide a description of the issue.

Example. A series of rain gardens in a suburban area may be considered unsightly by local residents, and may reduce the availability of parking. You don't have quantitative information about this, so you provide a description of the issue.

7. Information sheet

This sheet allows you to capture two important aspects of the information used in this BCA.

7.1 Information sources and peer review

In the "Information sources and peer review" section (8.1), you can record where the information for each component of the BCA was obtained. Indicate the publication, report, data set, expert, committee, community group, or any other source of the information.

Purpose. It provides information that decision makers can use to help them assess the quality and reliability of the BCA. It also provides a reminder to the analyst of where the information was obtained, so that it can be followed up or confirmed if necessary.

To the right of the information sources there are two columns, for "Peer-review comments", and "Replies" to those peer-review comments by the BCA analysts.

Purpose. These columns are to facilitate the process of peer review of the BCA. A reviewer can enter comments about any of the sections of the BCA. Peer review should be conducted for any important BCA. The analysts should reply to each comment, describing what changes they have made in response to the comment, or explaining why they have not made a change. In this way, the analysis can be

improved, and the analysts are accountable for the decisions they make about the analysis. Decision makers who are considering the project may seek to view the peer-review comments and replies as part of the process of forming judgements about the reliability of the results.

It is also possible to embed comments anywhere in the spreadsheet using the standard Excel facility to "Insert Comment". This can be useful to record reminders or comments about any aspect of the analysis.

7.2 Information quality

In the "Information quality" section (8.2), you can provide a subjective assessment of the quality of the information used in each of the five main sections: general, benefits, adoption, costs and project risks. You select a score on a simple five-point scale, from "very poor" to "very good".

Purpose. To assist decision makers to assess the quality and reliability of the BCA. To prompt the analysts to think about obtaining better information if some of the information is poor or very poor.

8. Report sheet

This report provides a summary of the project and the results of the Benefit: Cost Analysis. It draws together key information from the various sheets. This brief report may be provided to decision makers in the organisation to support strategic decision making about prioritisation of projects, or to external funders. Results are shown for society as a whole, and for the project organisation.

Results presented include:

- The present value of benefits (before and after they are adjusted to account for incomplete adoption and project risk)
- The present value of costs, broken down into the Project Organisation, other stakeholders, and the excess burden of taxation
- Net Present Value
- Benefit: Cost Ratio, calculated in two ways: (a) (Benefits − Other stakeholder costs − Excess burden)/Project organisation costs [for ranking independent projects when there is a budget constraint] and (b) Benefits/All costs [for use when there is no budget constraint].
- Other common decision criteria: the equivalent annual value (EAV), the internal rate of return (IRR) and the modified IRR (MIRR).
- Breakdown of results by individual benefits
- Negative spinoffs from the project (in text)
- Benefits expressed in non-monetary terms (if any were entered in the *3. Benefit parameters* sheet)

At the bottom of the *8. Report* sheet there are four graphs depicting net benefits over time (undiscounted) and cumulative net benefits (discounted) for the project overall and for the project organisation. If you click on one of these graphs, it will be copied into the clipboard and can then be pasted into another documents, such as a Word document.

9. Distribution

9.1 Ranges for sensitivity analysis (percentage changes)

For each of the variables offered, indicate the percentage changes to be used for the sensitivity analyses: a low level (a negative percentage change) and a high level (a positive percentage change).

When specifying these ranges, try to reflect realistically wide ranges for each variable. A common error is to use the same narrow range (e.g. +/− 20%) for each variable. Preferably, provide ranges that reflect the 75% confidence interval for each variable and consider how the ranges are likely to vary for different variables. Where uncertainty about a variable is higher, the range should be wider.

9.2 Probabilities used for robustness calculations

For each of the main variables, indicate the probability distribution for the low, default and high values. If the ranges provided in the previous table reflect 75% confidence intervals, then reasonable probabilities to include here are 0.25, 0.5 and 0.25, respectively. The three probabilities must add up to 1.

Box 9. The relationship between project risk and the sensitivity analysis

The *9. Distribution* sheet shows probability distributions for each benefit, for use in the sensitivity analysis. They are simple, discrete distributions with three levels. The high and low values used in the distributions should represent realistic confidence intervals for each variable. Specifying them as 75% confidence intervals is suggested, meaning that there is a 75% probability that the true value will fall within that range.

In most cases, the 75% confidence interval specified for the sensitivity analysis probably does not include zero. However, there is often a realistic possibility of failure to deliver a particular benefit at all, meaning that it would take the value zero, or something close to it. The probability of this occurring is what I refer to as the project risk. It is the probability of a relatively extreme outcome, usually beyond the range specified for the sensitivity analysis. It is included as a separate parameter, rather than being built into the sensitivity analysis, because there is a well-documented tendency for people to neglect the risk of project failure. By making it explicit in the analysis, it is more likely to be accounted for appropriately in the BCA.

10. Sensitivity sheet

Good sensitivity analysis (SA) is crucial for getting the best value from a BCA. SA can help you to (a) judge how robust the results of a BCA are, including the probability that the project will have a favourable BCR, (b) identify the variables to which the results are most sensitive (and hence potentially worth investigating further), and (c) estimate how much a variable would need to change to achieve a favourable BCR.

The BCA Tool includes five different sensitivity analyses automatically, including the above three, plus two others that are recommended in governments' BCA guidelines: sensitivity to the discount rate, and sensitivity to exclusion of the excess burden of taxation from the cost calculations. In summary, the SAs provided are:

- BCA robustness, based on 1000 simulations. Shows probability that NPV > 0 and BCR > 1; and probability distributions for NPV and BCR; for both society as a whole and the project organisation.
- Sensitivity index for up to eight individual benefits (the eight with the highest calculated benefit values), adoption, costs and project risks, based on 1000 simulations. An index that shows the sensitivity of the BCR to each of the factors, when they are varied over the ranges specified in 9.1, with the probabilities specified in 9.2. This indicates whether uncertainty about a factor is important in the sense that it has a big effect on the results. It is similar to a coefficient of variation in statistics, as it expresses the range of results relative to the mean.
- Break-even analysis for the same individual factors (% change to break even), based on 1000 simulations. For each main variable, this indicates how much the variable would need to change in order to change the BCA result. Changing the BCA result means switching from BCR >1 to BCR < 1 or vice versa. If the break-even percentage change is within the range of values specified for sensitivity analysis (see below), it is highlighted with a pink background. If the break-even percentage change is greater than 100% or less than −100%, this is indicated in text, rather than showing the precise result. This is done because the extreme results can be highly sensitive to the results of the 1000 simulations.
- Sensitivity to discount rate. Most government guidelines recommend including this SA. It shows how much difference to results is made by alterations in the discount rate. It uses the default discount rate, the low rate and the high rate specified in 2.4.
- Sensitivity to excluding the excess burden of taxation. Some government guidelines recommend including this SA. Given that guidelines vary in whether they recommend the inclusion of the excess burden of taxation in BCAs, this SA shows how much difference to results is made by its exclusion.

The probability distributions for all the variables are specified in Tables 9.1 and 9.2 on the *9. Distribution* sheet. Together, these tables define a discrete probability distribution for each variable. In forming the joint probability distribution for the Monte Carlo simulations, it is assumed that each variable is distributed independently from every other variable (i.e. they are uncorrelated).

11. Stakeholders sheet

This table provides a breakdown of benefits, for each benefit type, across the project organisation and up to seven other stakeholders. It shows the aggregate present values of benefits and costs, and the Net Present Value for each stakeholder. Benefit: Cost Ratios are not shown because it is assumed that the other organisations are not deciding on the rank of projects. Also, it is sometimes the case that a stakeholder bears none of the project costs, in which case their BCA is not defined.

As well as the table, the *11. Stakeholders* sheet also shows 6 graphs that depict the results in various ways. If you click on one of these graphs, it will be copied into the clipboard and can then be pasted into another documents, such as a Word document.

12. Detailed results

This sheet shows the year-by-year benefits and costs for each individual category of benefit and cost. It is to help analysts get inside the black box. The benefits shown here have been adjusted down for less-than-full adoption, and for project risks. The numbers have not been discounted (i.e., they are future values, not present values), apart from those in the "Present value" column. They are aggregate values, across all stakeholders.

13. Quality assurance checklist

This sheet provides a checklist of steps to be undertaken to ensure a high-quality BCA. It is recommended that users of the BCA Tool should record information about whether and how they have accomplished each of the steps. This information can then be presented to decision makers, along with the BCA results, to help them form judgements about the level of confidence they can have in the results.

14. Decision criteria

This sheet provides advice on the decision rules that should be applied to the BCA results in a range of different circumstances: should decisions be based on NPV, BCR, IRR, MIRR or something else? Should you rank projects, or make a yes/no decision about each individual project, or build an optimisation model? Importantly, the advice is different in different contexts (Table 3). It depends on whether the projects being evaluated are independent of each other, dependent on each other, or mutually exclusive. It also depends on whether there is a limited budget available for allocation to projects, or multiple constraints on the projects (e.g. one constraint on funds available for project implementation and a different constraint on funds for maintenance), or no constraint on which projects can be done.

This information is provided in the BCA Tool because the advice provided in many BCA text books and guidelines is poor. They often fail to recognise that the advice should be different in different contexts. Some of them advise against the use of BCR even though BCR is the correct criterion to use in certain contexts.

Table 3. Recommended decision criteria for BCA in different contexts.

	Project costs subject to one constraint (from a limited budget)	*Projects subject to more than one constraint (e.g. two pools of funds)*	*Funding unconstrained*
All projects independent (the benefits and costs of each project are not affected by which other projects are done)	Linearly scalable projects: (See note 2 below.) Rank projects by BCR. Calculate BCR with constrained costs in the denominator and unconstrained costs subtracted from the numerator. (See Note 3 below.) Non-linearly scalable projects: (See note 2 below.) Constrained optimisation, OR treat projects of different scales as a set of mutually exclusive projects (select highest NPV). Binary (lumpy) projects: Constrained optimisation using integer programming, to maximise total NPV.	Constrained optimisation model to maximise total NPV. (See Note 4 below for further advice on constrained optimisation.)	Fund all projects with NPV > 0, BCR > 1, IRR > discount rate, or MIRR > discount rate. No ranking required. (See Note 5 below regarding IRR and MIRR.)
Projects dependent (a project affects the benefits or costs of another project)	Enumerate all possible combinations and treat the full set as mutually exclusive (choose highest NPV), OR constrained optimisation to maximise total NPV.	Constrained optimisation model to maximise total NPV.	Enumerate all possible combinations of dependent projects and treat the full set as mutually exclusive (choose highest NPV).
All projects mutually exclusive (e.g. different versions of the project) (See Note 6 regarding projects of different timeframes)	Select the project with the highest NPV that is feasible (the funding constraint is not violated).	Select the project with the highest NPV that is feasible (none of the funding constraints are violated).	Choose the project with the highest NPV.
A mix of projects that are independent, dependent, and mutually exclusive	Constrained optimisation model to maximise total NPV.	Constrained optimisation model to maximise total NPV.	For each set of dependent projects, identify all possible combinations and treat the full set as mutually exclusive. Within each set of mutually exclusive projects, select the one with the highest NPV and eliminate the others. Fund all remaining projects with NPV > 0, BCR > 1, IRR > disc. rate, or MIRR > disc. rate. (See Note 5 re IRR and MIRR.)

Notes on Table 3.

1. Many textbooks and guidelines do not recognise that different advice on decision criteria is needed in different decision contexts. For example, some advise against the use of BCR in general, failing to recognise that in some contexts it is equivalent to NPV and in one context it is the single best criterion.
2. For a linearly scalable project, if you halve the costs, you halve the benefits. For a non-linearly scalable project, if you halve the costs, the benefits reduce but not by half.
3. BCR calculation. Even amongst BCA experts, many are unaware of the correct rule for calculating BCR when funding is constrained, projects are independent and the marginal project is linearly scalable. (The rule is: constrained costs go in the denominator and unconstrained costs are subtracted from the numerator - see Box 8 for more explanation.) In INFFEWS, users specify whether each cost is constrained, and this determines whether the cost is placed in the denominator or subtracted from the numerator. INFFEWS also presents a version of BCR with all costs in the denominator, but that is not to be used to rank projects, only for yes/no decisions about individual projects.
4. Constrained optimisation. In some contexts, there is no simple decision criterion (like NPV or BCR) that results in selection of the optimal portfolio of investments. In these cases, the advice in the table is to use constrained optimisation. This involves building an optimisation model where the objective is to maximise overall NPV and the decision options are the available projects. This can be done using Solver in Excel. For an example, see this video: https://youtu.be/a_WHNA16MVs
5. IRR and MIRR. Internal Rate of Return (IRR) is potentially problematic because (a) there can be more than one IRR value for a stream of net benefits, and (b) it implicitly assumes that finance is obtained at the IRR and benefits are reinvested at the IRR. To use IRR safely for decision making requires a high level of expertise. For most people, the best advice is to avoid using it. Modified IRR (MIRR) only has one value for a given income stream and allows you to specify the finance and reinvestment rates (2. Time sheet.) However, IRR and MIRR are only suitable in two contexts in the table and in those contexts NPV and BCR are equally applicable, so IRR and MIRR are never needed.
6. Projects of different lifespans. To compare mutually exclusive projects using NPV, the timeframes of the BCAs must be the same. If the projects have different lifespans, a strategy that some recommend is to compare them using the Equivalent Annual Value (EAV) = an annuity. This assumes that shorter projects can be repeated with identical benefits and costs. A more generally applicable approach is to think through what is really likely to happen following the shorter projects and enter benefits and costs for later years to bring all the BCAs to the same timeframe.

Comparison sheet

It is often useful to be able to compare the results from different projects, or from different versions of the same project. The BCA Tool includes a separate spreadsheet to facilitate this.

Once you are happy with the numbers in the BCA you are working on and you want copy the results into the comparison tool, go to the *Comparison* sheet. Then follow the instructions that are provided below and at the top of the *Comparison* sheet.

1. Make sure that the project has a distinctive title in cell A15, so that you can easily identify it from a list of projects.

2. Click button labelled “Copy the BCA results to clipboard” to select and copy the two rows of grey cells below the instructions, which contain the main BCA results.

3. Go to the INFFEWS BCA Comparison spreadsheet and select a cell in column A where you want to paste these results. The two rows (headings and numbers) from the *Comparison* sheet in the BCA Tool will be copied in.

4. In the Comparison spreadsheet, click on the button labelled “Paste the BCA results from clipboard”.

5. Once you have results from multiple project BCAs in the BCA Comparison spreadsheet, you can readily compare their results.

Due to changes in the Tool over time, use only the latest version of the Comparison spreadsheet.

Upgrade sheet

The INFFEWS BCA Tool includes the facility to efficiently transfer the data for a BCA from an old version to a new version of the Tool. This means that if you want to re-examine an existing BCA in a later version of the tool, you don't need to re-enter all the data manually, one number at a time.

The *Upgrade* sheet is normally hidden. To access the *Upgrade* sheet, go to the *Cover* sheet, page down to the bottom of the sheet, and click on the button labelled "Unhide upgrade sheet".

Note: Upgrading from 2019 versions is problematic because in those versions copy/paste was blocked, and copy/paste is used in the upgrade process. A decision was made to block cut/paste to protect the integrity of formulae in the spreadsheet, but in the process, copy/paste was also blocked. It is now possible to upgrade from a 2019 version. Contact David.Pannell@uwa.edu.au for advice on how to do so.

Once you are on the *Upgrade* sheet, follow the step-by-step instructions that are provided below and at the top of the sheet.

1. Go to the new spreadsheet and click on the "Unhide upgrade sheet" button on the *Cover* sheet.

2. Come back to the old spreadsheet. Click on the "Backup to upgrade" button below the instructions, to copy all entered values from the various sheets to the sheet below the instructions.

2. Click on the "Copy ready to transfer" button below the instructions, to copy the data to the clipboard to prepare to transfer it to the new version of the BCA Tool.

4. Go straight to the *Upgrade* sheet in the new version of the spreadsheet. Don't copy anything else until after the next step.

5. Click on the "Paste to transfer data" button in the new version, to paste the data from the clipboard into the *Upgrade* sheet.

6. Click on the "Upgrade from backup" button in the new version, to copy all the values from the *Upgrade* sheet to the various sheets of the tool.

7. Check out the "Checklist of changes from old versions needing additional data". There is a button to click, which will take you to a web page that alerts you to any important changes in the new version from the old version you were using. It is also reproduced in Appendix A of this document. If there are any additional data required, it will tell you, and you will need to provide these in the new version of the Tool.

8. In the new spreadsheet, click on the "Hide upgrade sheet" button on the *Cover* sheet.

In data entry cells, it is possible to enter a formula rather than a fixed value. Including some formulas in cells can help to make transparent where a number comes from. When upgrading from a version of the BCA Tool earlier than 2021.03, the process converts formulas to values. If you wish to upgrade and retain the formulas you have entered in data entry cells, contact the developer David Pannell for assistance. In future, when updating from version 2021.03 or later to subsequent versions, you will have the option of retaining formulas automatically.

A limitation of the upgrade process when it is copying formulas to a new spreadsheet is that any cell references in a formula that gets copied will continue to refer to the original file. If there are cell references in your formulas, then after upgrading you will need to manually remove the references to the original file. For example, if the original file was called “INFFEWS BCA Tool 2021.01 Manchester.xlsm” then in the new upgraded version of the file, do a search and replace to replace “[INFFEWS BCA Tool 2021.01 Manchester.xlsm]” with “” (without the quote marks). Repeat this on each sheet in the new file that includes formulas with cell references.

If you have added extra sheets to the BCA Tool, the automated upgrade facility does not copy the extra sheets into the new version. You can copy them across manually. If your main data entry cells in the BCA Tool include formulas that look at extra sheets you have added, it is recommended that you (a) copy the extra sheets across before running the automatic upgrade facility, and (b) when you do so, make sure to use exactly the same name for the sheets, so that the formulas can find the data in the new spreadsheet. You also need to do the search-and-replace process described in the previous paragraph.

Structure of the BCA tool

The information is collected in a logical order. The three main sections of information build towards the overall economic assessment of the project being evaluated (Figure 1)

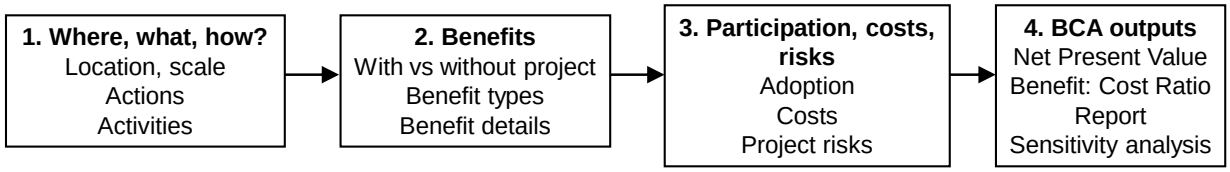


Figure 1. Logical flow of information collected to produce BCA outputs.

The information collected in the spreadsheet is integrated in a very precise way to evaluate the Net Present Value (NPV) and Benefit: Cost Ratio (BCR) for each project. The questions are designed in a particular way to feed into the calculations of the BCA. The answers to later questions often depend on the answers to questions earlier in the spreadsheet (Figure 2).

For some questions, you have the option of responding to a simplified five-point scale, or of providing a specific numerical response. The choice depends on the quality and detail of information available to you.

Limitations and known weaknesses

The art of developing a tool like the INFFEWS BCA Tool is judging which simplifications to make. Every simplification means there is a limitation to the flexibility or accuracy of the tool. Key limitations to the current version of the Tool include the following.

- The maximum time frame for calculating benefits and costs is 50 years.
- Market benefits, depending on a traditional supply and demand model, must be calculated outside the Tool (or on an inserted sheet) and then included in one of the benefit categories.
- Benefits are assumed to be linearly related to adoption.
- The maximum number of stakeholders amongst which benefits and costs can be distributed is eight (the project organisation and seven others).
- Project risks are represented as a simple binary distribution, where the project is either successful (to the extent specified in the other parameters) or not successful at all.

- The inclusion of risk in the base case is not transparent. Users need to be conscious of risk in the base case and specify project risk as the marginal additional risk introduced by the project.
- Sensitivity analysis is done for combinations of individual benefits, but only for up to eight benefits. The eight largest benefits are analysed, and any additional benefits are assumed to be known with certainty.
- In the sensitivity analysis, a simple probability distribution is used for each benefit category, with three possible values: low, default and high.
- In the sensitivity analysis, each variable is assumed to be distributed independently from the other variables.
- Even if separate adoption parameters are specified for each benefit, the sensitivity analysis treats them jointly. They are assumed to be perfectly correlated.
- Even if separate project risks are specified for each benefit, the sensitivity analysis treats them jointly. They are assumed to be perfectly correlated.

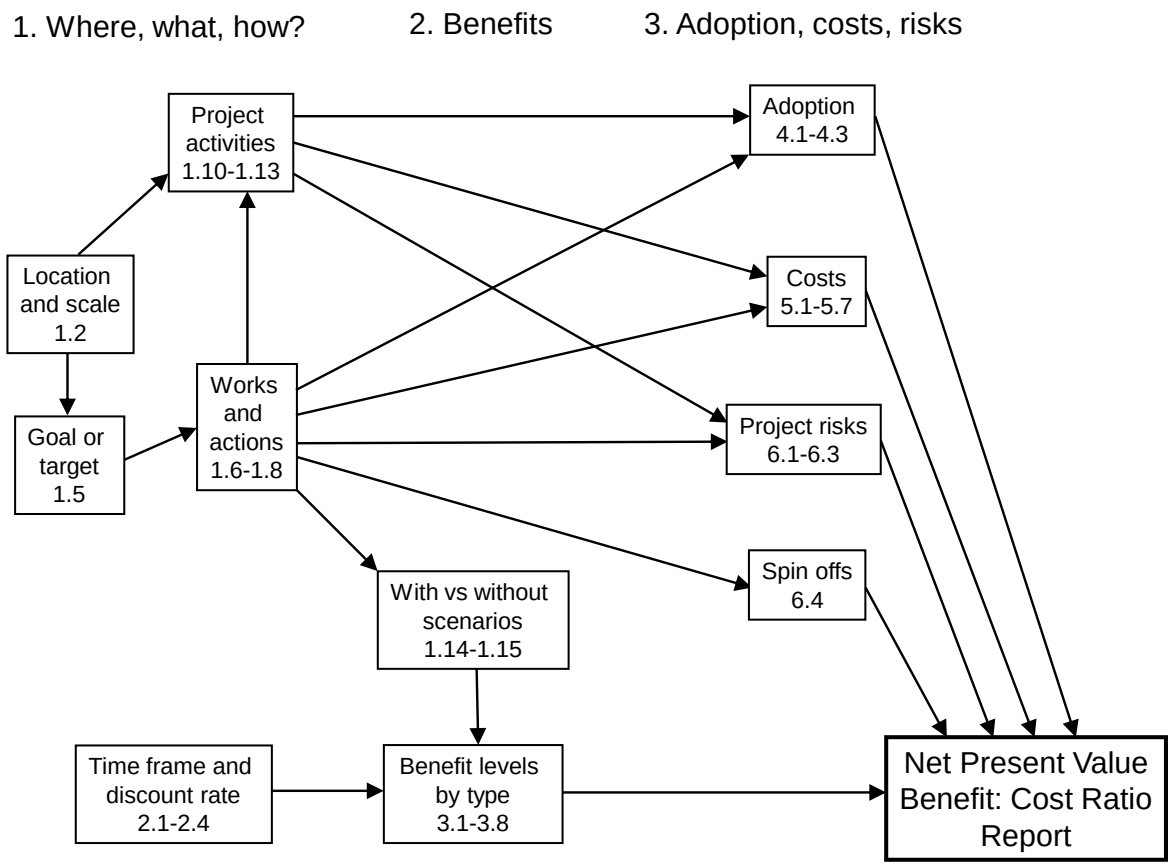


Figure 2. Connections between parts of the BCA tool. An arrow indicates that the box being pointed at depends on the box from which the arrow comes.

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Appendix A. Checklist of changes from old versions

The INFFEWS BCA Tool includes the “Upgrade” facility to efficiently transfer the data for a BCA from an old version to a new version of the Tool.

Upgraded versions of the tool have included changes to the data requirements, such that when you upgrade from an old version, not all the data required for the new version is provided, because it didn’t exist in the old version. The checklist below allows you to identify what additional data you will need to provide following an upgrade. You may also need to adjust a few numbers that were transferred, as instructed in the table below.

You need to know the version of the Tool that you are upgrading from. This is shown on the *Cover* sheet in cell B4.

You also need to know the version of the Tool that you are upgrading to. It is probably the latest version, but just to be sure, check on the *Cover* sheet, near the top. If you find that you are not using the latest version (as indicated below), it is essential that you do switch to the latest version. The instructions below are only for upgrades to the latest version, not for intermediate versions.

Even when all the data is correctly transferred from an old version to the latest version, the results (NPV and BCR) may be a little different due to changes in the way the tool works, and the correction of three small bugs in the initial release.

Previous versions	**Additional data required in the latest version (2021.01) if you upgrade from this previous version to the latest version**
2018.15 Beta and 2018.16 Beta	This was the first publicly-released version. Additional data required if upgrading from this version to the latest version are as follows: *1. General* sheet, names of additional stakeholders 5 to 8. *1. General* sheet, Source of video help. *2. Time* sheet, reduce discount rates by a factor of 100. The format changed to percentage. *3. Benefit parameters* sheet, proportions of each benefit captured by stakeholders 5 to 8. *3.8 Custom benefit* sheet, proportions of each benefit captured by stakeholders 5 to 8. *4. Adoption*. Now includes option to specify separate adoption parameter for each benefit. *5. Costs* sheet, proportions of each cost borne by stakeholders 5 to 8. Compliance costs now dropped - included within other costs. In 5.5., provide proportion of costs funded from taxes. *5.6 Cost time series* sheet (now renamed "*Custom costs*"). This is now expanded out to 20 rows of costs. The one original row will not be transferred. *6. Project risk*. Now includes separate project-risk parameter for each benefit instead of for each benefit category. *9. Sensitivity* sheet, Tables 9.1 and 9.2 (the original version did not copy these parameters for the upgrade process, so check that the values in the latest version are the values you want). They are now included on a separate sheet "*9. Distribution*", with this sheet renamed to "*10. Sensitivity*". The new versions of Tables 9.1 and 9.2 include separate rows for each benefit, rather than for each benefit category. In 2.4, if you select to use a discount rate that varies over time (introduced in version 2021.01), you will need to provide low, default and high discount rates for each decade. If you use the Modified Internal Rate of Return (a new output on the “*7. Report*” sheet), you may wish to adjust the two required input parameters in section 2.5 on sheet “*2. Time*”. On the *5. Costs* and *5.6 Custom costs* sheets, if you wish to use the version of the BCR that is optimised for ranking independent projects under a constrained budget,

	you need to specify whether each cost item is constrained or unconstrained. (Constrained means that it is paid from a limited pool of funds.) The number of custom benefits and the number of custom costs have each been increased from 10 to 20. If you add in a custom benefit beyond the initial 10 (e.g. you add an 11th custom benefit, you may need to provide additional inputs for adoption (if it is set to use a separate adoption parameter for each benefit), project risk (if it is set to use a separate risk parameter for each benefit), and the distributions (Tables 9.1 and 9.2).
2019.1 to 2019.3	Note that the 2019 versions disallowed cut/paste and copy/paste (to protect the integrity of formulae in the spreadsheet), but this means that the Upgrade facility ceased to work. It is possible to overcome this to upgrade to the latest version. Contact David.Pannell@uwa.edu.au for advice. This problem goes away in 2020 versions and later, which only disallow cut/paste, not copy/paste. Once David helps you switch copy/paste back on in your 2019 version, you'll be able to use the Upgrade system. Additional data required if upgrading from this version to the latest are as follows: *4. Adoption*. Latest version now includes option to specify separate adoption parameter for each benefit. *5. Costs* sheet. Compliance costs now dropped - included within other costs. In 5.5., provide proportion of costs funded from taxes. *5.6 Custom costs* sheet. This is now expanded out to 20 rows of costs. The one original row of custom costs will not be transferred. *6. Project risk*. Now includes separate project-risk parameter for each benefit instead of for each benefit category. *9. Sensitivity* sheet. Tables 9.1 and 9.2 are now included on a separate sheet "*9. Distribution*", with this sheet renamed to "*10. Sensitivity*". The new versions of Tables 9.1 and 9.2 include separate rows for each benefit, rather than for each benefit category. In 2.4, if you select to use a discount rate that varies over time (introduced in version 2021.01), you will need to provide low, default and high discount rates for each decade. If you use the Modified Internal Rate of Return (a new output on the "*7. Report*" sheet), you may wish to adjust the two required input parameters in section 2.5 on sheet "*2. Time*". On the *5. Costs* and *5.6 Custom costs* sheets, if you wish to use the version of the BCR that is optimised for ranking independent projects under a constrained budget, you need to specify whether each cost item is constrained or unconstrained. (Constrained means that it is paid from a limited pool of funds.) The number of custom benefits and the number of custom costs have each been increased from 10 to 20. If you add in a custom benefit beyond the initial 10 (e.g. you add an 11th custom benefit, you may need to provide additional inputs for adoption (if it is set to use a separate adoption parameter for each benefit), project risk (if it is set to use a separate risk parameter for each benefit), and the distributions (Tables 9.1 and 9.2).
2020.1 to 2020.6	In 2.4, if you select to use a discount rate that varies over time (introduced in version 2021.01), you will need to provide low, default and high discount rates for each decade. If you use the Modified Internal Rate of Return (a new output on the "*7. Report*" sheet), you may wish to adjust the two required input parameters in section 2.5 on sheet "*2. Time*". On the *5. Costs* and *5.6 Custom costs* sheets, if you wish to use the version of the BCR that is optimised for ranking independent projects under a constrained budget, you need to specify whether each cost item is constrained or unconstrained. (Constrained means that it is paid from a limited pool of funds.) The number of custom benefits and the number of custom costs have each been increased from 10 to 20. If you add in a custom benefit beyond the initial 10 (e.g. you add an 11th custom benefit, you may need to provide additional inputs for adoption (if it is set to use a separate adoption parameter for each benefit), project risk (if it is set to

	use a separate risk parameter for each benefit), and the distributions (Tables 9.1 and 9.2).
2021.01	Latest version

Changes in outputs resulting from upgrades

Two changes were made in version 2020.1 that cause outputs to be altered relative to earlier versions, even for the same data (almost certainly only slightly).

- From version 2020.1 on, the growth rate on benefits doesn't begin to take effect until the start year for the benefit. In previous versions it started in the first year of the analysis irrespective of when benefits started.
- From version 2020.1 on, in the overall BCR, the excess burden is now subtracted from benefits. In previous version it was included in costs.

If you use a dynamic discount rate (the option introduced in version 2021.01), that too will change outputs from earlier versions.

The calculation of the BCR constrained budget version (introduced in version 2021.01) is likely to be different from previous versions, depending on which items are specified as being constrained. The BCR unconstrained budget version is new in version 2021.01 and will likely be different from the BCR calculated in previous versions, which was an approximation of the constrained budget version.

Appendix B. Checklist of cost types for projects related to water and green infrastructure

The INFFEWS BCA Tool includes three different systems for entering project costs, on the *5. Costs* and *5.6 Custom costs* sheets. See the User Guide for details.

To help with identifying relevant costs, this page provides a checklist of of the various types of costs that may be relevant. Quantitative information about the relevant costs will be required to be entered into the spreadsheet.

Cost category	Specific cost
Project costs	Physical materials: pipes, pumps, concrete, bricks, slabs, ... Machinery and equipment The time of people employed to implement the project or provide support to the project Cars (purchase or depreciation or hire, fuel, repairs, servicing, etc., or capture all that with a per kilometre cost such as the standard rates specified by the Australian Tax Office) Office space and other office costs (telephones, printers, computers, internet, ...) Insurance Publicity and communications Design and printing Costs of obtaining required permits and permissions Legal Costs Payments to people to encourage behaviour change Costs of research, data collection, analysises, etc. undertaken as part of the project In-kind costs, for items such as project staff salaries, administrative support, office space, stationary, and telephone calls
Maintenance costs	Maintain, repair, or replace equipment or structures Pay the wages of people responsible for ongoing education, training, awareness raising, or ongoing management of the project Continuing payments to people to ensure ongoing adoption of improved practices Inspecting and enforcing compliance Monitoring, analysing and reporting outcomes from the project

Compliance costs	Loss of profits such as through changing land use from commercial to non-commercial purposes Additional expenses to implement works and actions Legal and administrative costs required for compliance
Disposal or restoration costs	At the end of the life of some types of projects, there may be costs involved in removal of structures, disposal of materials or restoration of the site.
Excess burden of taxation	The 'deadweight loss' from efficiency costs and admin costs involved in collecting and dispersing money through the tax system. The information you need to provide for this are (a) the proportion of costs that are collected through the tax system, and (b) the marginal excess burden (a proportion) for each taxed dollar. See the *BCA Tool Guidelines* for more information.

Cooperative Research Centre for Water Sensitive Cities

Level 1, 8 Scenic Boulevard
Monash University
Clayton VIC 3800

info@crcwsc.org.au

www.watersensitivecities.org.au