

---

Water Sensitive Cities Australia

# WSUD Life cycle costing

## Context analysis report

July 2024

---

## **WSUD Life cycle costing – Context analysis report**

Benny Penhallurick (E2DesignLab), Dr Dale Browne (E2DesignLab), Sally Boer (E2DesignLab) and Kym Whiteoak (Canopy Economics and Policy)

© 2024 Water Sensitive Cities Australia

This work is copyright. Apart from any use permitted under the *Copyright Act 1968*, no part of it may be reproduced by any process without written permission from the publisher. Requests and inquiries concerning reproduction rights should be directed to the publisher.

### **Publisher**

Water Sensitive Cities Australia  
8 Scenic Blvd, Clayton Campus  
Monash University  
Clayton, VIC 3800

**e.** [info@wscaustralia.org.au](mailto:info@wscaustralia.org.au)

**w.** [www.wscaustralia.org.au](http://www.wscaustralia.org.au)

**Date of publication:** July 2024

### **An appropriate citation for this document is:**

B Penhallurick, D Browne, S Boer and K Whiteoak (2024). *WSUD Life cycle costing – context analysis report*. Melbourne, Australia: Water Sensitive Cities Australia.

### **Disclaimer**

Water Sensitive Cities Australia has endeavoured to ensure that all information in this publication is correct. It makes no warranty with regard to the accuracy of the information provided and will not be liable if the information is inaccurate, incomplete or out of date nor be liable for any direct or indirect damages arising from its use. The contents of this publication should not be used as a substitute for seeking independent professional advice.

---

## CONTENTS

---

1. Introduction .....	3
1.1 Scope of investigation.....	4
2. Review Findings .....	5
2.1 WSUD LCC literature review .....	5
2.2 WSUD literature review .....	7
2.3 LCC literature review .....	8
2.4 Stakeholder survey .....	10
2.5 Expert interview .....	11
3. Process & Tool Concept.....	13
3.1 LCC process .....	13
3.2 LCC tool .....	15
4. Next steps .....	16
4.1 This project .....	16
4.2 Future projects .....	19
References .....	20

### List of Figures

Context analysis stage .....	3
Context analysis stage tasks and associated reporting .....	4
LCC tool.....	15
Specification stage .....	16
Specification stage tasks .....	17

### List of Tables

LCC process.....	13
Specification stage tasks .....	17

---

# 1. Introduction

---

Water Sensitive Cities Australia (WSCA) is undertaking a project to develop a life cycle costing (LCC) tool for water sensitive urban design (WSUD) and similar assets in Australia. The project responds to the unmet LCC needs of WSUD stakeholders and longstanding and pervasive issues affecting the planning, design, construction and ongoing management of WSUD assets arising from a lack of reliable cost information (see Taylor & Wong, 2002; Taylor, 2003; Taylor et al., 2010; Manning, 2023). The project focuses on biofilters or bioretention systems, passively watered solutions (e.g., tree pits) and permeable or porous paving. Other types of WSUD assets are likely to be included in future WSCA projects. A Project Steering Group (PSG) comprising financial members of WSCA from South Australia (SA), Victoria (VIC) and Western Australia (WA) provided input into this and future projects.

WSCA engaged E2Designlab and Canopy Economics and Policy for the project. This document summarises our findings from the context analysis phase of the project (Figure 1).

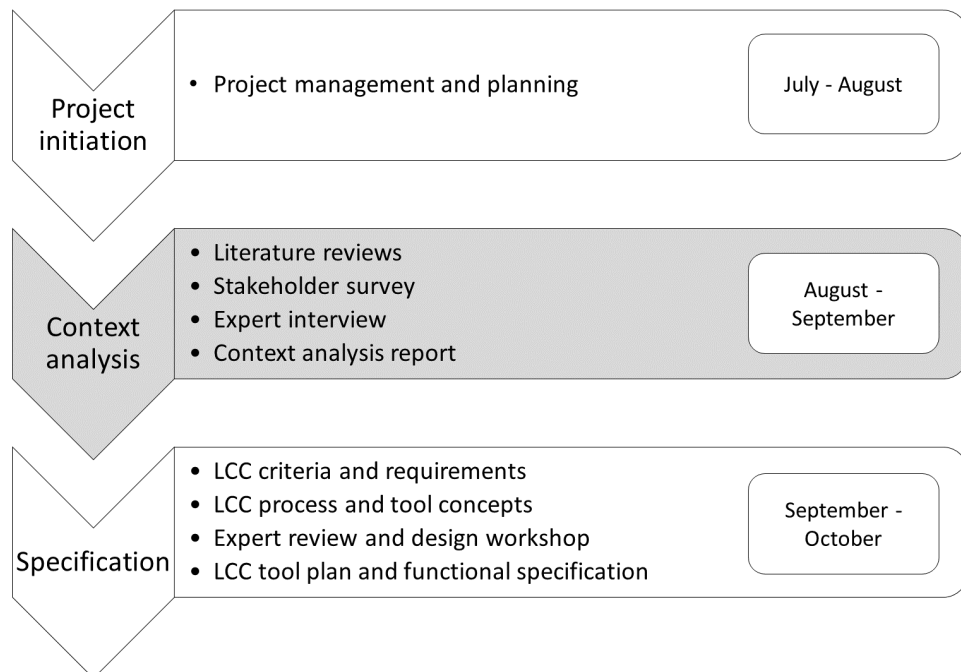


Figure 1  
Context analysis stage (2023)

## 1.1 Scope of investigation

The context analysis involved several investigations into the LCC of WSUD assets including literature reviews and stakeholder surveys (Figure 2).

This report summarises these investigations including the approach taken, key findings and recommendations. This report also outlines:

- a general process to develop and apply a LCC tool that complies with relevant Australian guidelines and standards for LCC and the findings of this stage
- a conceptual diagram for a LCC tool that incorporates some of the steps in the process.

This report is supported by 2 standalone supplementary reports that detail the literature review and stakeholder surveys undertaken, and provide the empirical and theoretical foundations for the development of the LCC tool:

- *WSUD Life cycle costing – Supplementary report 1: Life cycle costing standards and learnings*
- *WSUD Life cycle costing – Supplementary report 2: Stakeholder consultation.*

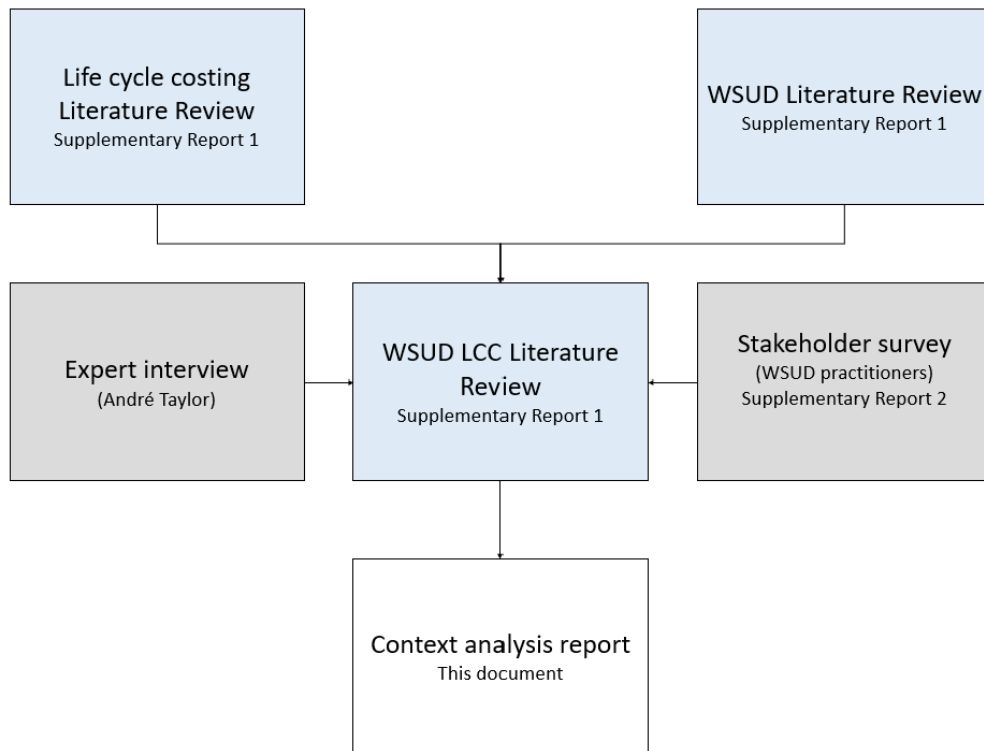


Figure 2

Context analysis stage tasks and associated reporting (2023)

---

## 2. Review findings

---

### 2.1 WSUD LCC literature review

#### 2.1.1 Approach

We collected literature reporting on industry projects and research undertaken on the LCC of WSUD assets in Australia over the past 3 decades to:

- understand the history of work on WSUD LCC in Australia
- understand how the LCC process has been applied to WSUD assets in Australia
- identify the LCC needs of stakeholders and longstanding and pervasive issues that this and future projects need to address
- collect reported cost data and estimates that may be useful for this and future projects
- identify if and how to transfer cost data and estimates to contexts where this information is not available but is still required for decision making.

Via an internet search of Australian WSUD LCC literature, we collected documents that:

- reported on projects involving or addressing the LCC of WSUD assets in Australia
- contained Australian cost data or estimates, particularly for the focal assets
- were authored by an authoritative source (e.g., an industry association or group)
- were published in the past 3 decades.

#### 2.1.2 Key findings

Several noteworthy projects have been undertaken to improve the LCC of WSUD assets in Australia over the past 3 decades (e.g., Taylor & Wong, 2002; Taylor, 2003, 2005; Taylor et al., 2010; Manning, 2023), but most recommendations have not been implemented. Apart from this project, there appears to be no national level, coordinated effort to improve LCC for WSUD assets in Australia, and this has been the case for the past 20 odd years.

Some previous projects (e.g., Taylor 2003, 2005; Taylor et al., 2010; Manning, 2023) provide a useful understanding of the LCC needs of stakeholders as well as longstanding and pervasive issues that should be addressed in this and future projects. All highlighted the need for appropriate and long-term funding, governance and management of a national-level LCC process and tool for WSUD assets. Taylor (2003), Taylor et al. (2010) and Manning (2023) recommended developing the following components of an LCC process and tool for WSUD assets:

- **Cost database:** a database including cost data and estimates for input into a LCC model to support decision making across the life of assets (e.g., planning, design, construction and other operational phases). This includes rates for construction and operational phase works items like those in Rawlinson's Australian Construction Handbook. Cost estimates should also be formatted for integration into common asset planning, design and management processes and tools (e.g., Assetic, Predictor, INFFEWS, MUSIC)
- **Cost data recording templates:** a set of standardised templates for recording cost data for programmed upload into the cost database and integration into common asset planning, design and management processes and tools
- **LCC model template:** an Excel-based tool for estimating the total costs, or part thereof, incurred over user specified planning intervals (e.g., 10 or 20 years). The tool would use default cost estimates drawn from the database but also allow users to use their own cost data or estimates.
- **Guideline:** a guideline or manual including descriptions of the LCC tool, its components and how to use them
- **Training video:** a freely available tutorial video providing a quick overview of the same guidance found in the guideline
- **National website:** a national-level website to host the above.

Some projects provide parametric cost estimates for the focal assets, but their usefulness is limited due to high variability likely owing to uncertainties in their costing basis (e.g., design, construction, operational phases and how these are influenced by local conditions, constraints and policy and other requirements). Notwithstanding the above, several drivers affect asset life cycle costs that must be accounted for when transferring estimates from one context to another. When accounted for, it may be possible to develop rules of thumb for transferring cost estimates, but given the lack of easily accessible, high-quality cost data in Australia, this is not recommended for this stage of the project.

### 2.1.3 Recommendations

- Develop and apply a LCC tool based on the recommendations of Taylor (2003), Taylor et al. (2010) and Manning (2003). The tool should address the LCC needs of stakeholders as well as longstanding and pervasive issues affecting the LCC of WSUD assets in Australia as identified in the literature. Criteria or requirements should be identified to develop and apply the tool to address these needs and issues.

Additional information on the literature review can be found in *WSUD Life cycle costing – Supplementary report 1: LCC standards and learnings*.

## 2.2 WSUD literature review

### 2.2.1 Approach

We collected and reviewed best practice guidelines, standard drawings and similar documents for the focal assets from around Australia to identify a consistent basis for LCC in terms of design and life cycle activities. This task recognised the high variability and limited usefulness of previously collected cost estimates, reflecting their inconsistent cost bases (e.g., Taylor 2005; Taylor et al., 2010).

We drew on:

- a literature review of WSUD guidelines, standard drawings and similar documents undertaken by Project Team members for Blacktown City Council in 2021 and Water by Design in 2022
- the Project Team's knowledge of industry developments including their experience co-authoring recently published guidelines (e.g., Water by Design's Guidelines for the construction and establishment of bioretention systems and constructed wetlands)
- PSG member websites and meetings.

We collected documents that:

- represented best practice as judged by the Project Team
- were authored by an authoritative source (e.g., an industry association or group)
- were published in the past 15 years
- were accepted and used by stakeholders in SA, VIC or WA.

Best practice documents published by authoritative sources outside of SA, VIC, or WA were also included but viewed as less applicable for PSG members (e.g., guidelines from Water by Design in QLD).

### 2.2.2 Key findings

Guidelines, standard drawings and similar documents for the focal assets are often specific to a local government or regional area. These documents use slightly different language for the focal assets and their components; however, some terms are used interchangeably across the country (e.g., biofilter and bioretention system, permeable and porous paving, sediment forebay and sedimentation forebay).

Documents provide slightly different guidance for the design and life cycle activities of the focal assets (e.g., construction and maintenance), reflecting the lack of national standardisation, specific areas embracing specific language (e.g., biofilter versus bioretention system), and the need for guidance that responds to context-specific



conditions, constraints and policy and other requirements. Consequently, the literature does not identify a consistent basis for the LCC of the focal assets.

### 2.2.3 Recommendations

- Work with PSG members to establish a common and consistent language for WSUD assets and their life cycle activities that can be used for the LCC tool.
- Work with PSG members to develop a consistent costing basis for the focal assets that can be used for the LCC tool.

Costing bases may need to be developed at the local government or regional area level depending on the scale at which differences in the design and life cycle activities of assets affect their costs. These may take the form of short documents describing the design and life cycle activities of assets and how they differ by local government or regional area to reflect area-specific conditions, constraints and policy and other requirements (e.g., local climatic, environmental and market conditions and constraints, and specific design, construction, establishment and handover requirements). New costing bases will need to be developed as required to ensure they reflect how the design and life cycle activities of assets change over time. Older costing bases reflecting obsolete asset designs should not be removed from the LCC tool because they will allow costs to be recorded and estimated for existing assets as they progress into their operational life cycle phases.

## 2.3 LCC literature review

### 2.3.1 Approach

We collected and reviewed industry accepted guidelines and standards for LCC in Australia to understand what it is and why, when and how it should be done. This task involved an internet search for Australian LCC guidelines and standards. We collected documents that were:

- authored by an authoritative source (e.g., an industry association or group)
- accepted or used in the industry.

### 2.3.2 Key findings

Several LCC guidelines and standards exist in Australia (e.g., Standards Australia, 1999; Australian National Audit Office [ANAO], 2001; Australian Institute of Quantity Surveyors [AIQS], 2022; New South Wales [NSW] Government, 2018). While these documents use different language and focus on different things (e.g., facilities, infrastructure assets, projects), guidance is consistent.

Generally, the documents prescribe a LCC process that can be adapted for WSUD assets and a nationally applicable LCC tool:<sup>1</sup>

- **Prepare a LCC plan** that outlines the objectives, scope (i.e., decision to be made and asset options and life cycle scenarios to be considered), assumptions and limitations, and required resources for the analysis (ANAO, 2001; Taylor, 2003; NSW Government, 2018).
- **Develop a LCC model** that allows users to input key information (e.g., cost elements, discount rate, span of analysis) and extract desired information (e.g., life cycle cost, present and net present values). The model should support sensitivity analysis and may be simple (e.g., Excel-based) or more sophisticated (e.g., a modelling software) (NSW Government, 2018; AIQS, 2022).
- **Undertake LCC analysis** by identifying cost drivers (i.e., cost elements that significantly affect life cycle cost), undertaking sensitivity analysis to explore the impact of assumptions and uncertainties, and comparing outputs against historical cost information (if available) and the objectives of the LCC plan (Taylor, 2003).
- **Report on LCC analysis** by documenting information that is relevant for the decision making audience and detailed enough to be reviewed by an independent analyst or economist (Taylor, 2003; NSW Government, 2018).
- **Review LCC analysis** by engaging an independent analyst or economist to review the report to ensure objectivity and rigour (NSW Government, 2018; AIQS, 2022).
- **Monitor and update LCC analysis** with real cost data as it is collected over an asset's life. Repeat the steps as required to support improve decision making for the asset or similar assets in the future (Taylor, 2003; NSW Government, 2018; AIQS, 2022).

Generally, this process results in the development and continual improvement of a LCC plan, model and report, which may be considered the components or deliverables of the LCC analysis process.

Most documents draw on the Australian Standard for LCC (AS/NZS 4536:1999 Life Cycle Costing – An Application Guide), however this is identified as being “Withdrawn” on the Standards Australia website. Standards Australia advised this means the document is “*no longer relevant, or its designation has changed*” and that they “*will not undertake any review or revision work for this Standard indefinitely*”. However, they also advised that “*Withdrawn publications can still be used within an industry... when there are no replacement documents readily available*” which appears to be the case for this Standard. AS/NZS IEC 60300.3.3:2019 Dependability management, Part 3.3: Application guide —

---

<sup>1</sup> The process outlined the guidance documents is commonly applied to new commercial products (e.g., air conditioning units, fridges, washing machines) (Taylor, 2003).

Life cycle costing may replace AS/NZS 4536:1999, but Standards Australia has not confirmed this.

### 2.3.3 Recommendations

- Develop and apply a LCC tool for WSUD assets that complies with industry accepted guidelines and standards for LCC in Australia. This task should follow a LCC analysis process adapted from these guidelines and standards and identify criteria or requirements to ensure compliance with these guidelines and standards.

## 2.4 Stakeholder survey

### 2.4.1 Approach

We surveyed WSUD practitioners from around Australia to obtain information needed to deliver a LCC tool for WSUD assets that meets the needs of end users.

We developed a draft survey questionnaire observing guidance from Rea & Parker (2014), sought feedback from PSG members and then revised the survey questionnaire based on their feedback. The questionnaire included background information on the project, definitions of relevant terms and photos of WSUD assets to ensure a consistent understanding between respondents.

Survey respondents included PSG members and WSUD practitioners from around Australia that the Project Team felt had the knowledge and experience to answer the survey in full and likely had access to cost data or estimates from within their organisations. Identified respondents had 2 weeks to provide responses.

### 2.4.2 Key findings

15 respondents from NSW, QLD, SA, VIC, and WA completed the survey – 2 worked at a water utility and 13 worked at a local government. Key findings are summarised below:

- Some indicated their organisations record cost data for the focal assets, but most indicated the information wasn't recorded or they were unsure.
- For the cost data that was being recorded, most indicated it has a medium to low quality. This was a subjective rating.
- Most indicated they needed cost estimates for the operational phases of the focal assets (i.e., operation and maintenance, and renewal, upgrade or decommissioning).
- Most indicated their organisations either weren't undertaking LCC analysis for the focal assets or they were unsure.
- Most indicated their organisations either didn't have a tool for undertaking LCC analysis for the focal assets or they were unsure.

- Most indicated their organisations didn't follow any guidelines or standards for LCC analysis or they were unsure.
- Respondents were split as to having, not having, or being unsure about issues with the approach their organisations currently undertake for LCC analysis on the focal assets.
- All indicated they would consider using a LCC tool developed by WSCA for the focal and other WSUD assets their organisations own.
- 8 indicated they would be willing and able to share their cost data or estimates and 7 were unsure.
- Most indicated they wanted future stages to focus on (in order of priority) constructed wetlands, naturalised channels, sediment basins, grass or vegetated swales, gross pollutant traps and stormwater harvesting systems.
- Most indicated they would be willing to participate in a brief meeting to clarify their responses.

### 2.4.3 Recommendations

- Collect cost data or estimates from willing survey respondents who can share it. If possible, use this data to develop, test and refine the tool concepts in this and future stages.
- Briefly meet with willing respondents to clarify their responses including their LCC needs and issues for WSUD assets (this may be combined with the above recommendation).
- Ensure the design of the tool allows other asset types to be added in future including (in order of priority) constructed wetlands, naturalised channels, sediment basins, grass or vegetated swales, gross pollutant traps and stormwater harvesting systems.

Additional information on the stakeholder surveys can be found in *WSUD Life cycle costing – Supplementary report 2: Stakeholder consultation*.

## 2.5 Expert interview

### 2.5.1 Approach

We consulted an expert in WSUD LCC to understand previous projects including their perceptions of what worked, what didn't work, and what we can learn.

We met with Dr Andre Taylor (25 August 2023), who led the seminal work on the LCC of WSUD assets in Australia (see Taylor & Wong, 2003; Taylor, 2003; Taylor et al., 2010).

Dr Taylor offered the following insights:

- Previous work had been driven by capacity building organisations from around Australia despite no national governance or leadership.

- These organisations and their champions often had short-term funding and consequently could not provide the long-term support required to progress the work (e.g., some organisations and champions are no longer active in the industry).
- Other organisations were not interested in supporting further work at the time because they had other priorities, but this might be different now.
- Lack of funding, governance, leadership and ownership were the biggest issues affecting previous projects.
- A user pays model could help provide long-term funding to develop, maintain and improve a LCC tool, provided value could be demonstrated to users.
- The tool would need to accommodate local differences in design and life cycle activities (i.e., the costing basis) to allow for the recording and use of data to estimate costs that reliably inform decision making around Australia.
- Regional workshops with PSG members may be used to develop the costing basis with costs then collected by a quantity surveyor or similar.

### **2.5.2 Recommendations**

- Consider a user pays model for a WSCA owned and managed LCC tool like the INFFEWS Value Tool.

The above recommendations may be undertaken with willing PSG members as part of a champion-driven pilot in a future stage..

## 3. Process & Tool Concept

### 3.1 LCC process

A key recommendation is to adapt a process from relevant LCC guidelines and standards to guide the development and application of a LCC tool. An early concept is presented in Table 1. This process needs to be refined based on the LCC criteria and requirements identified in the next stage.

Table 1

LCC process

#	Step	Description	Comments
1	Plan	Prepare a plan for the development and application of the LCC tool. The plan should observe the structure and content prescribed in relevant LCC guidelines and standards (e.g., AS/NZS 4536:1999) but be adapted for WSUD assets and the LCC tool. The plan should be long term and updated as required based on the monitor and update step of this process (see below).	WSCA is already applying some elements of this plan (e.g., this project involves developing concepts and specifications for a LCC tool). The plan should guide future projects including their scopes, budgets and timelines. We propose to develop an early version of this plan in the next stage of this project (see below).
2	Develop	Follow the plan to develop the tool. This may involve following the recommendations included in this report such as undertaking a champion-driven pilot with PSG members. The pilot may involve establishing a common and consistent language for WSUD assets and their life cycle activities, developing costing bases for focal assets and developing and refining online or offline tool components including the cost data recording templates, cost database and LCC analysis model. After the pilot, these components may guide the development of a national website with web-based functionality for the LCC tool.	This step should also involve developing a guideline or manual and video tutorial providing an overview of the LCC tool, its components and how to use them. This guideline or manual may satisfy the reporting requirements of AS/NZS 4536:1999 (see below). It may be appropriate at this stage to promote the tool and seek subscriptions or similar from end users as per the recommendation from Taylor et al. (2010).
3	Apply	Follow the plan to apply the tool. This may involve the programmed collection,	Pilot champions should use the cost data recording

#	Step	Description	Comments
		review and upload of qualifying cost data recorded by pilot champions and other end users to the online or offline cost database linked the LCC analysis model. The LCC analysis model may be (sensitivity) tested and refined for the focal assets and their cost bases, with outputs compared against real cost data and plan objectives. When objectives are achieved, the model can be finalised and used by end users to analyse the LCC, or part thereof, of focal assets via an online or offline (downloaded) LCC analysis model and cost database.	templates to record data either as a standalone spreadsheet or through their asset information management systems (AIMS). The latter would likely require champions to modify their processes and systems to integrate the cost data recording attributes and specifications into their AIMS. Flexibility should be afforded for both options.
4	Report	Prepare a document reporting on the above steps. The report may be reviewed with each significant update of the tool (e.g., an update of the LCC analysis model based on the programmed collection and upload of cost data or the development of a new cost basis).	The report should be prepared for end users and decision makers and be sufficiently detailed to be reviewed by an independent analyst or economist (Taylor, 2003; NSW Government, 2018). This reporting requirement may be met by updating the guideline or manual with relevant information, thereby requiring only one document to be developed and maintained for the LCC tool.
5	Review	Engage an independent analyst or economist to review the objectivity and rigour of the guideline or report and LCC tool.	
6	Monitor and update	Collect and review real cost data from end users on a programmed basis (e.g., every year) and upload qualifying data to the cost database linked to the LCC analysis model. Return to previous steps to update components as required. This should improve the reliability of cost data, cost estimates and LCC analysis for WSUD assets, and decision making across the life cycle of assets.	Cost bases should be monitored and updated if and when asset design and life cycle activities in specific areas change enough to affect costs. Criteria for qualifying data should be identified. This may include all attribute fields being completed, evidence of costs being uploaded and the cost data or estimate not being a statistical outlier as evaluated through automated exploratory data analysis (e.g., box and whisker plots) in the cost database.

### 3.2 LCC tool

A conceptual diagram indicating how end users, tool administrators and independent analysts may engage with a LCC tool based on the above process is presented in Figure 3. This concept needs to be refined based on the LCC criteria and requirements identified in the next stage of the project. It is likely that some activities may be automated or simplified through the development of a web-based LCC tool.

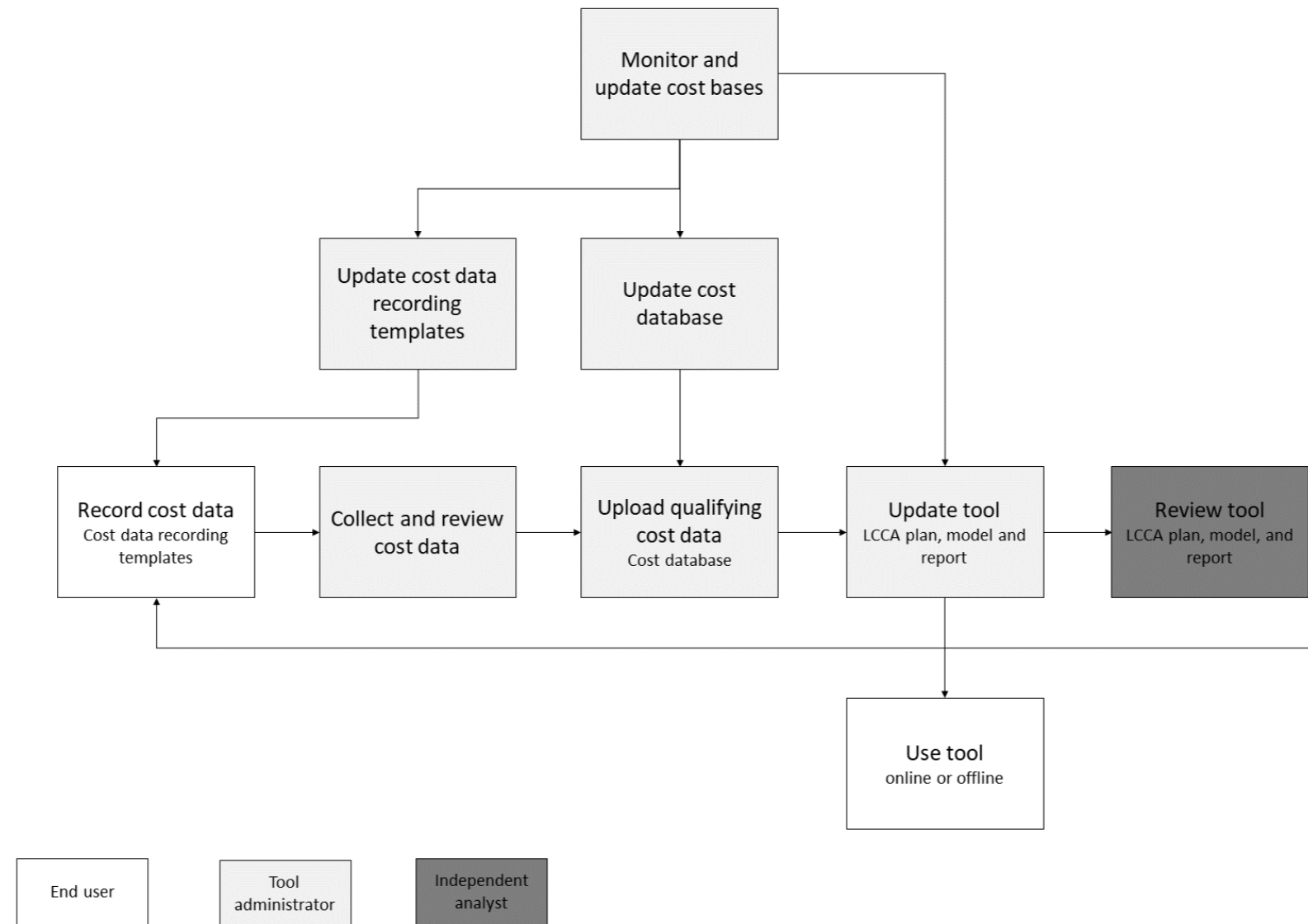


Figure 3  
LCC tool



---

## 4. Next steps

---

### 4.1 This project

The next stage of this project will involve developing concepts and a plan for the LCC tool to guide future stages (Figure 4).

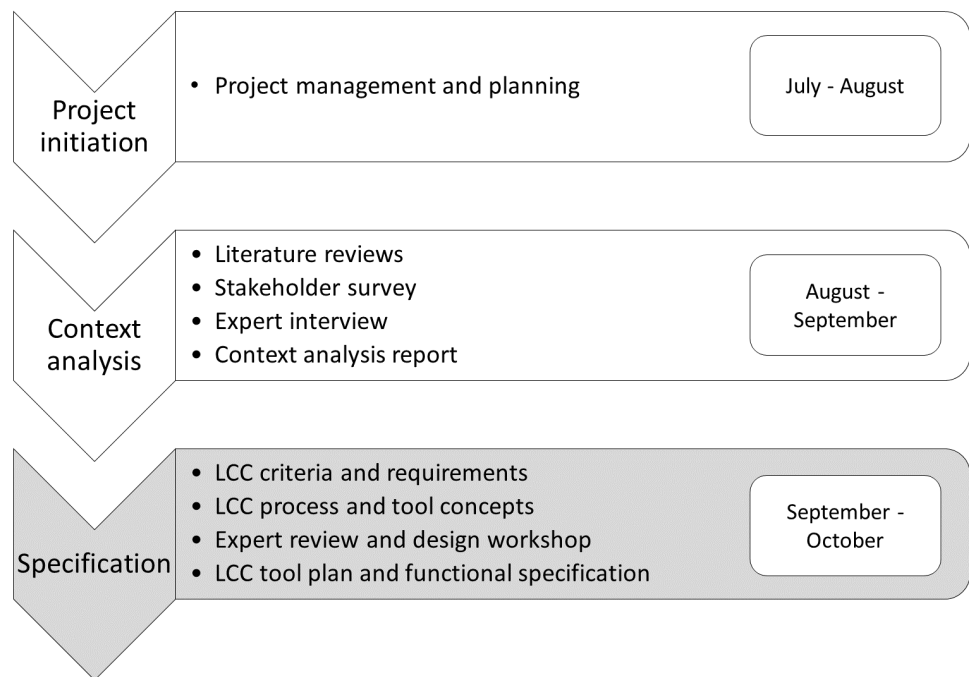


Figure 4  
Specification stage (2023)

The next stage will include the following tasks (Figure 5).

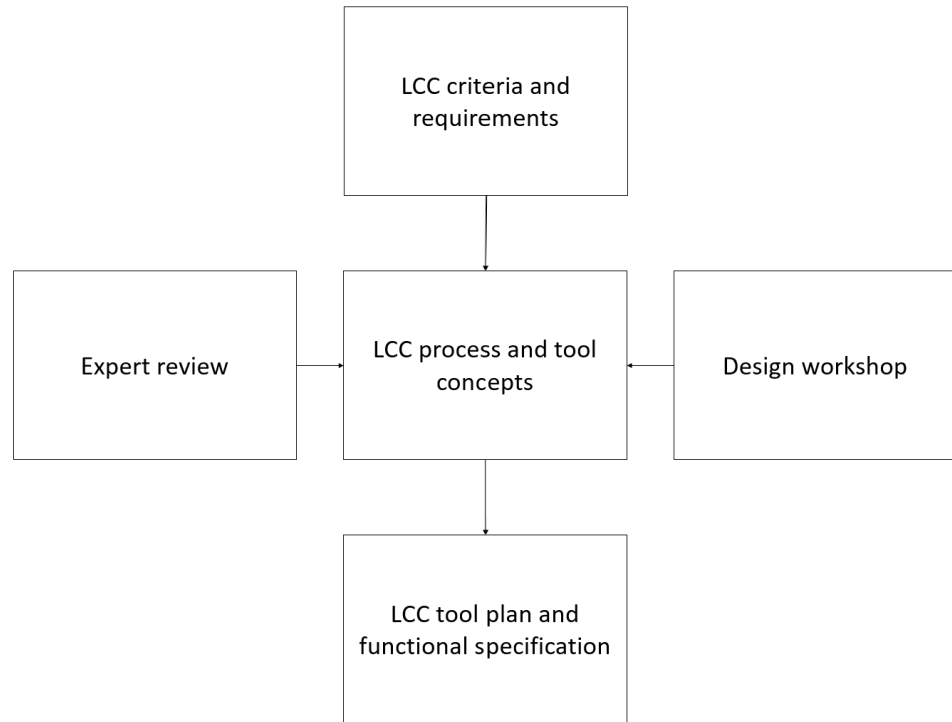


Figure 5  
Specification stage tasks

Table 2 provides a high-level summary of these tasks including the approach to be taken and expected deliverables.

Table 2  
Specification stage tasks

Task	Approach	Deliverable	Comments
LCC criteria and requirements	We will identify criteria or requirements to develop and apply the tool so it complies with relevant LCC guidelines and standards, addresses the LCC needs of stakeholders and responds to longstanding and pervasive issues affecting the LCC of WSUD assets	List of criteria or requirements to develop and apply the LCC tool (e.g., functionality, funding, governance, management).	Criteria or requirements will likely apply to the LCC process and tool and will be drawn from the findings of context analysis tasks, including the in-depth, standalone reports. They will be useful when designing the LCC process and tool and to refer to in a

Task	Approach	Deliverable	Comments
	identified in the literature.		design workshop with the PSG (see below).
LCC process and tool concepts	Observing the criteria and requirements identified in the previous task, we will document a LCC process and develop a concept, Excel-based LCC tool.	LCC process, cost data recording templates, cost database template, and LCC analysis model template	A worked example will be provided for 1 conceptual costing basis for a biofilter or bioretention system, tree pit, and permeable or porous paving asset. These examples will provide a proof of concept for the LCC functionality of offline components which can be used to develop an online tool in a future project.
Expert review	Brightly, the owners of the Assetic AIMS, will review the LCC process and tool concepts to ensure they align with industry accepted asset and financial management processes, standards, and software.	Brief report	Brightly will assess offline tool components and provide feedback relating to their integration into the Assetic, Predictor and other software. This software is used by over 100 local authorities around Australia which presents a unique opportunity to mainstream LCC for WSUD assets.
Design workshop	We will hold a 2 to 3-hour virtual workshop with the PSG and others as determined by PSG, to present and obtain end user feedback on the process and tool concepts.	NA	A part of this workshop will be dedicated to brainstorming funding, governance and management options for the tool. Currently, this workshop is to be confirmed by WSCA.
LCC tool plan and	Based on the expert review and design workshop, we will	LCC tool plan and functional	

Task	Approach	Deliverable	Comments
functional specification	finalise the LCC process and tool concepts. We will also prepare a draft plan to develop and apply the tool and develop a functional specification diagram for an online tool in a future project.	specification diagram	

## 4.2 Future stages

This is the first of potentially several stages to a LCC tool. The plan to be developed in this project should provide a strong basis for these stages including their scopes, budgets and timelines. While the plan has not yet been developed, we anticipate several tasks may need to be completed in these stages including, but not limited to, the following.

- building a prototype of the LCC tool
- piloting, testing and refining the LCC tool with champions and end users
- developing cost transfer functionality (provided the tool supported the collection of high-quality cost data with a consistent and comparable cost basis)
- developing a guideline and training video for the end user
- further testing and refining the LCC tool to respond to monitoring and continual improvement processes including end user and other stakeholder feedback
- updating the guideline and training video to respond to refinements or updates to the LCC tool and stakeholder feedback
- including more WSUD asset types to the LCC tool
- having an independent analyst review the LCC tool and its online and offline components.

---

## References

---

Australian National Audit Office [ANAO]. (2001). Life cycle costing better practice guide.

Australian Institute of Quantity Surveyors [AIQS]. 2022. Life cycle cost analysis information paper.

Manning, C. (2023). Life cycle costs database: Needs analysis. Water Sensitive Cities Australia, Melbourne, Victoria.

New South Wales Government. (2018). Total asset management life cycle costing guide.

Rea, L. M. & Parker, R. A. (2014). Designing and conducting survey research: A comprehensive guide. John Wiley & Sons.

Standards Australia. (1999). AS/NZS 4536:1999 Life Cycle Costing – An Application Guide

Taylor, A. (2003). An introduction to life cycle costing involving structural stormwater quality management measures. Cooperative Research Centre for Catchment Hydrology. Melbourne, Victoria.

Taylor, A. (2005). Structural stormwater quality BMP cost/size relationship information from the literature. Cooperative Research Centre for Catchment Hydrology. Melbourne, Victoria.

Taylor, A., Leinster, S. & Robinson, A. (2010). National needs analysis: Life cycle costing data and tools for water sensitive urban design assets. Prepared for Sydney Metropolitan Catchment Management Authority. Sydney, New South Wales.

Taylor, A. & Wong, T. (2002). A Literature Review of Their Value and Life cycle Costs. Cooperative Research Centre for Catchment Hydrology. Melbourne, Victoria.



## Water Sensitive Cities Australia



Monash University  
8 Scenic Blvd, Clayton VIC 3168  
[wscaustralia.org.au](http://wscaustralia.org.au)



**MONASH**  
University

MONASH  
SUSTAINABLE  
DEVELOPMENT  
INSTITUTE

**Water Sensitive Cities**  
Australia