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Water Sensitive Cities Australia

# WSUD Life cycle costing

## Supplementary report 2: Stakeholder consultation

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## **WSUD Life cycle costing – Supplementary report 1: Stakeholder consultation**

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# 1. Introduction

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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.

This document summarises the outcomes of stakeholder consultations concerning LCC for WSUD assets in Australia and is one of 2 supplementary reports which support, and should be read in conjunction with, the following reports:

- *WSUD Life cycle costing – Context analysis report* summarises stage 1 investigations, including the approach taken, key findings and recommendations
- *Supplementary Report 1 – Life cycle costing standards and learnings* summarises the literature sources and findings of the review into WSUD LCC, LCC standards and WSUD guidelines, fact sheets and design drawings.

This report synthesises insights from a survey of WSUD practitioners nationwide as well as consultation with an expert in WSUD life cycle costing.

The survey had 2 objectives:

1. Gather information necessary to develop a LCC system that meets the needs of end users. This task included identifying WSUD assets owned by organisations, assessing the availability and confidence in existing LCC data, understanding the specific needs for cost data across different life cycle phases, and evaluating current practices and tools for life cycle cost analysis.
2. Gain insights from previous projects, exploring what methodologies were effective, what challenges were encountered, and how lessons from past endeavours can inform the current project.

Survey design and refinement followed established methodologies, incorporating feedback from both the Project Team and industry experts. The survey included background information, definitions and visual aids to ensure clarity and consistency in respondent understanding. Targeted respondents, including members of the Project Steering Group (PSG) and WSUD practitioners, were identified collaboratively and administered the survey within a defined timeframe. Aggregate survey results, presented in this document, offer valuable insights into the landscape of WSUD asset management practices and highlight areas for potential support and intervention by WSCA in future projects.

Key findings and individual survey responses offer a foundation for WSCA to deliver tailored assistance to stakeholders, contingent on further clarifying their requirements and challenges. This document is a pivotal supplementary resource in developing and implementing effective LCC strategies for WSUD assets, contributing to sustainable urban water management practices in Australia.

## 1.1 Survey purpose

The stakeholder survey aimed to obtain information needed to deliver a LCC tool for WSUD assets that meets the needs of end users.

## 1.2 Methods

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.

## 1.3 Limitations

There were several limitations to the survey:

1. **Sampling bias:** The survey respondents were primarily WSUD practitioners and PSG members. This could introduce bias as their perspectives may not represent the broader range of stakeholders who might interact with or have insights about WSUD assets.
2. **Limited response rate:** Only 15 respondents completed the survey, which might not be representative of the entire population of WSUD practitioners in Australia. A higher response rate would provide more robust data.
3. **Subjective nature of responses:** Several responses were subjective and could lead to inconsistencies and unreliable data. Objective measures for assessing data quality could provide more reliable insights.

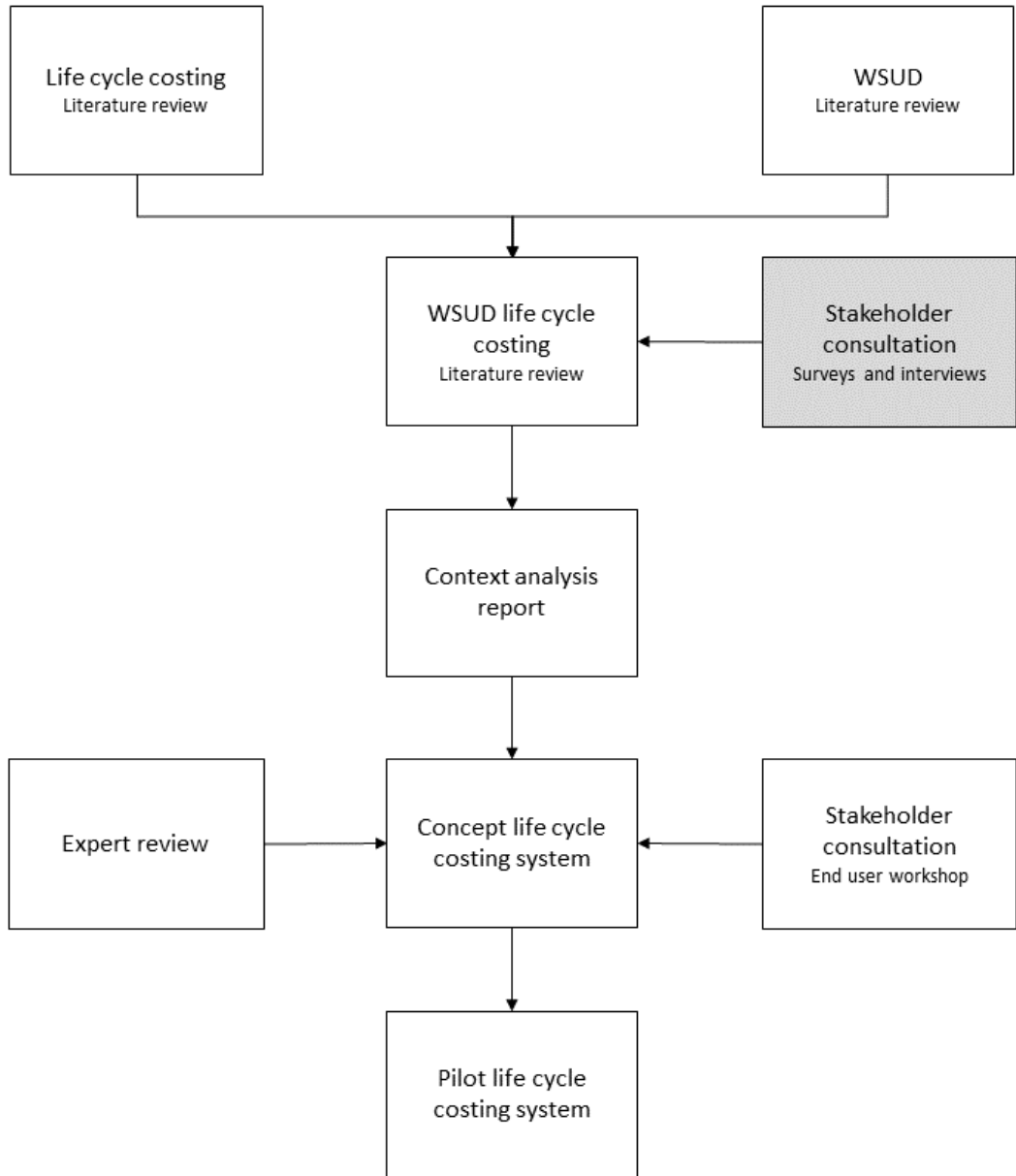


Figure 1  
Project activities

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## 2. Results

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The following chapter details the aggregated results of the survey. 15 respondents completed the survey from NSW, QLD, SA, VIC and WA. Of these, 2 worked at a water utility and 13 worked at a local government. The chapter structure matches the section headings of the survey questions. These responses may allow WSCA to provide targeted support to stakeholders in future projects pending further clarification of their issues and needs.

### 2.1 Survey responses

#### 2.1.1 Respondent information

Figure 2 illustrates the geographical distribution of respondents' workplaces across Australia.

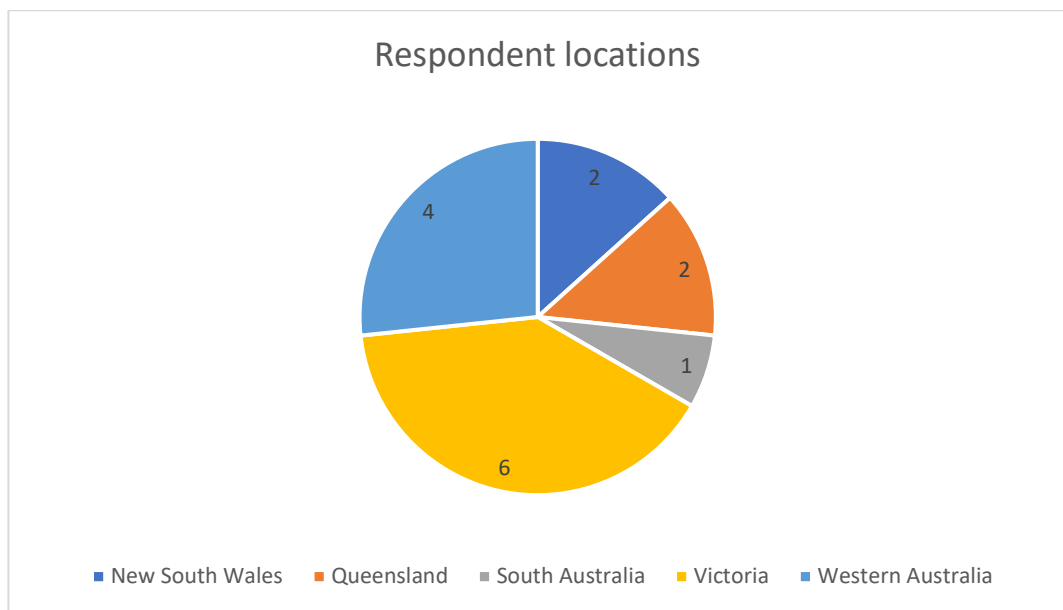


Figure 2  
Respondent locations

Figure 3 displays the organisations that respondents were affiliated with.

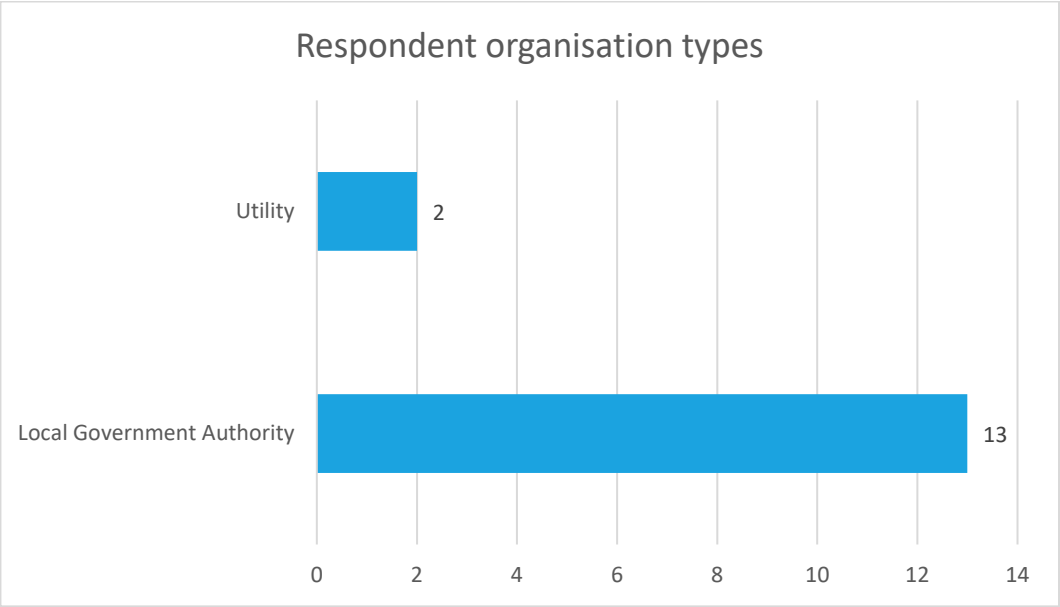


Figure 3  
Respondent organisation types

Table 1 presents respondent information including job title, organisation and location.



Table 1  
Respondent information

Organisation	Location
Blacktown City Council	New South Wales
Logan Council	Queensland
City of Greater Geelong	Victoria
City of Canning	Western Australia
City of Melbourne	Victoria
City of Canning	Western Australia
Melbourne Water	Victoria
City of Canning	Western Australia
City of Port Phillip	Victoria
Ipswich City Council	Queensland
City of Mitcham	South Australia
City of Casey	Victoria
Midcoast Council	New South Wales
City of Mandurah	Western Australia
Melbourne Water	Victoria

### 2.1.2 WSUD assets

What types of WSUD assets does your organisation own?

Figure 4 illustrates the array of WSUD assets owned by respondent organisations. It includes an additional asset category identified by one practitioner: Solar production bores.

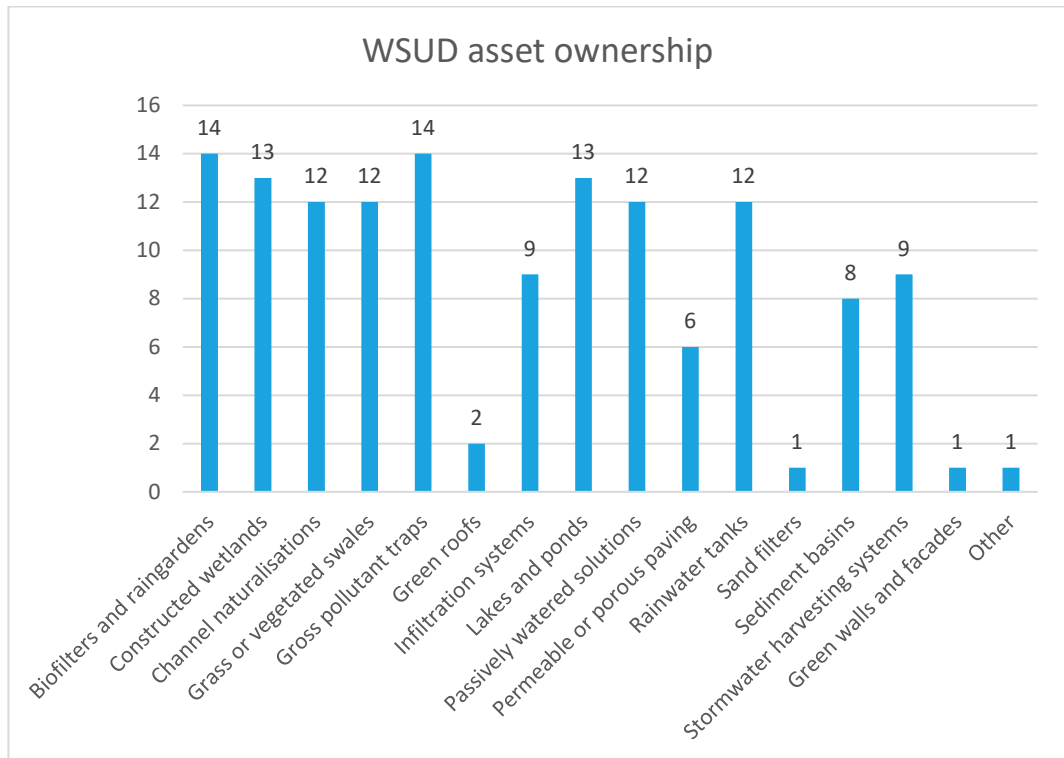


Figure 4  
 WSUD asset ownership indicating number of respondents with ownership of each asset type

### 2.1.3 Life cycle cost data

Several questions covered what data is being collected.

Does your organisation collect life cycle cost data for biofilters or raingardens?

Figure 5 indicates if respondent organisations collected biofilter cost data.

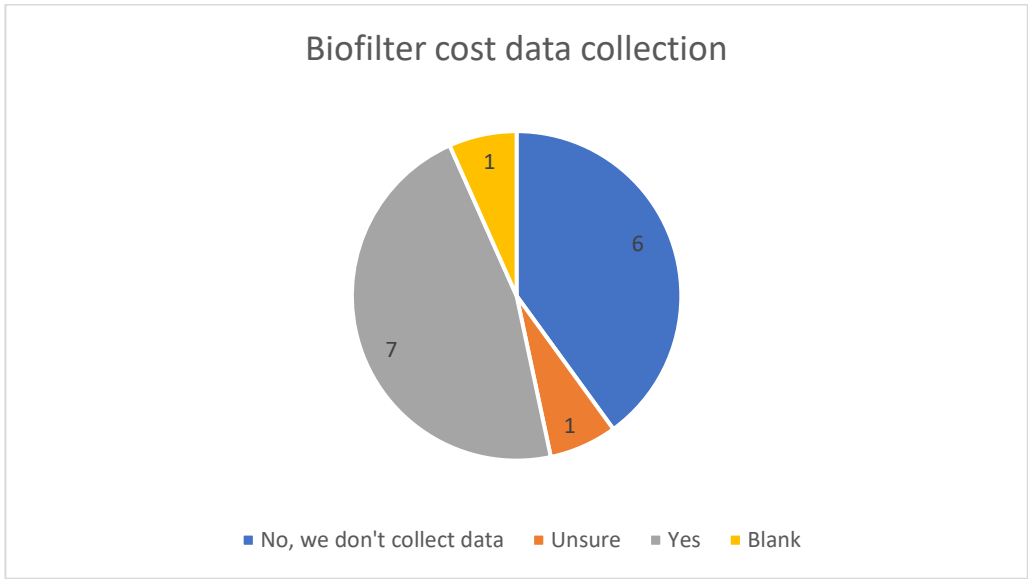


Figure 5  
[Biofilter cost data collection](#)

What LCC data is being collected for these assets?

Figure 6 indicates the life cycle phases for which cost data is collected for biofilters and raingardens. The response from one respondent suggested data may exist but not in a readily accessible form: “In theory we could extract cost data based on bonds provided through the development process, but it is not captured as part of any database”.

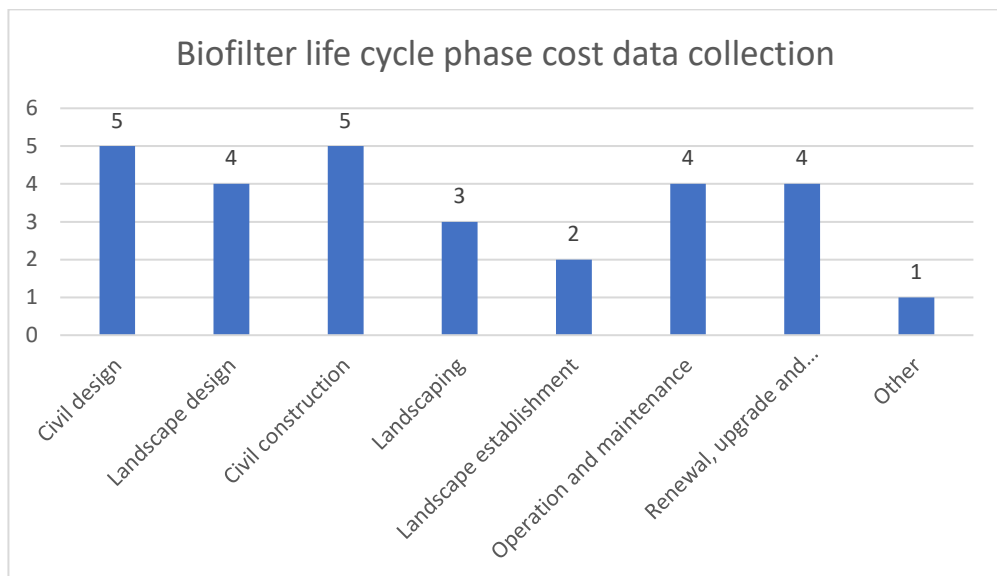


Figure 6  
[Biofilter life cycle phase cost data collection](#)

How confident are you in the quality of this data?

Figure 5 indicates most respondents had medium confidence in the quality of the cost data their organisations collect for biofilters.

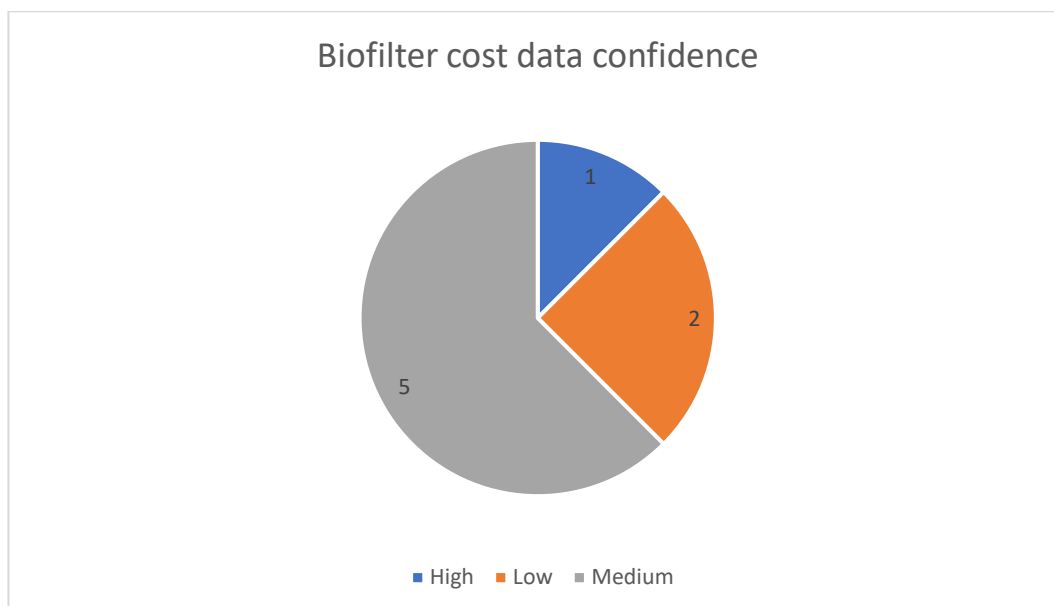


Figure 6  
Biofilter cost data confidence

Table 2 presents explanatory comments for the responses above. They identify opportunities and challenges associated with the data and being able to access it in a usable way.

Table 2  
Biofilter cost data comments

Organisation	Comments
Logan City Council	Some components of the life cycle do not have a large amount of data collected at this point in time.
City of Greater Geelong	I assume we have costs we spend on maintenance and renewal of some of our larger bioretention systems. We use cost estimates from developers to derive bonds which infer some construction, establishment and maintenance costs.
City of Canning	We would be able to extract procurement costs for contractors to undertake the above items, but we aren't collating it to track LCC. Anything in house e.g., maintenance, no cost data available.
City of Mandurah	The capital cost data for the raingardens and watered solutions has been collected. There are still large developments within our catchment where these assets have

	not been handed over and this life cycle cost data is not available.
Melbourne Water	Melbourne Water only own and operate assets which have catchments >60ha. We do provide guidance on design and maintenance standards to achieve waterway health objectives.

Does your organisation collect LCC data for passively irrigated or watered solutions (e.g., WaterWise or passively irrigated tree pits)?

Figure 7 illustrates whether respondent organisations collect data on passively watered solutions.

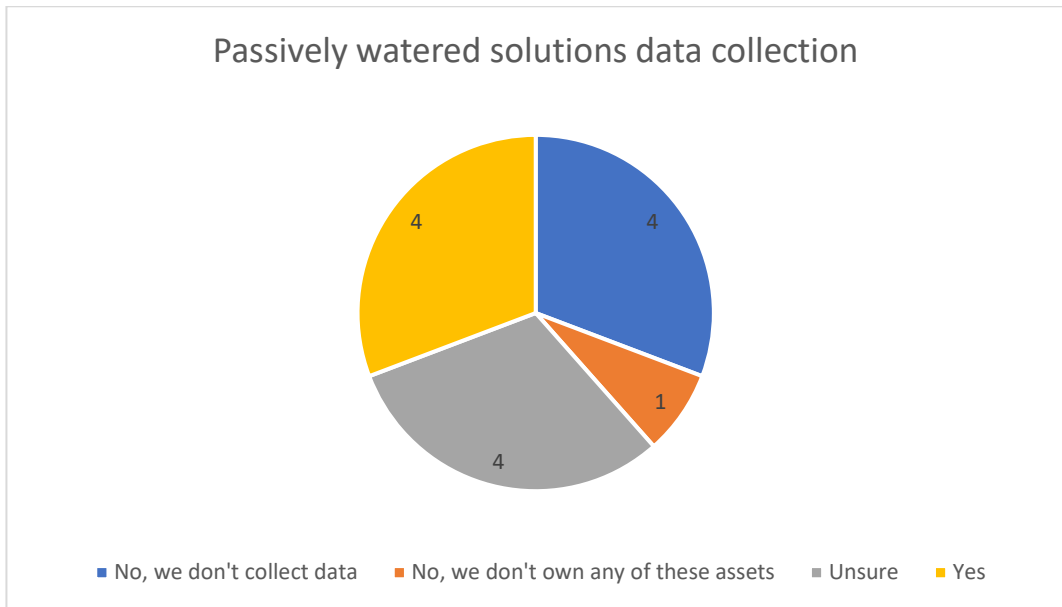


Figure 7  
Passively watered solutions cost data collection

What LCC data is being collected for these assets?

Figure 8 indicates the life cycle phases for which cost data is collected for passively watered solutions.

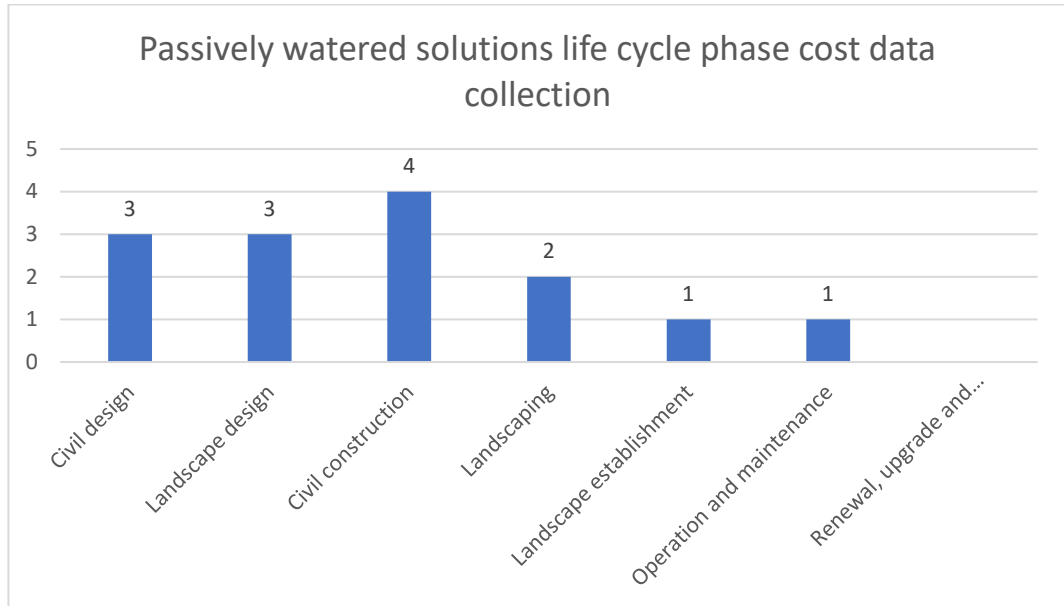


Figure 8  
Passively watered solutions life cycle phase cost data collection

How confident are you in the quality of this data?

Figure 9 indicates 3 of 5 respondents had medium confidence in the quality of the cost data their organisations collect for passively watered solutions.

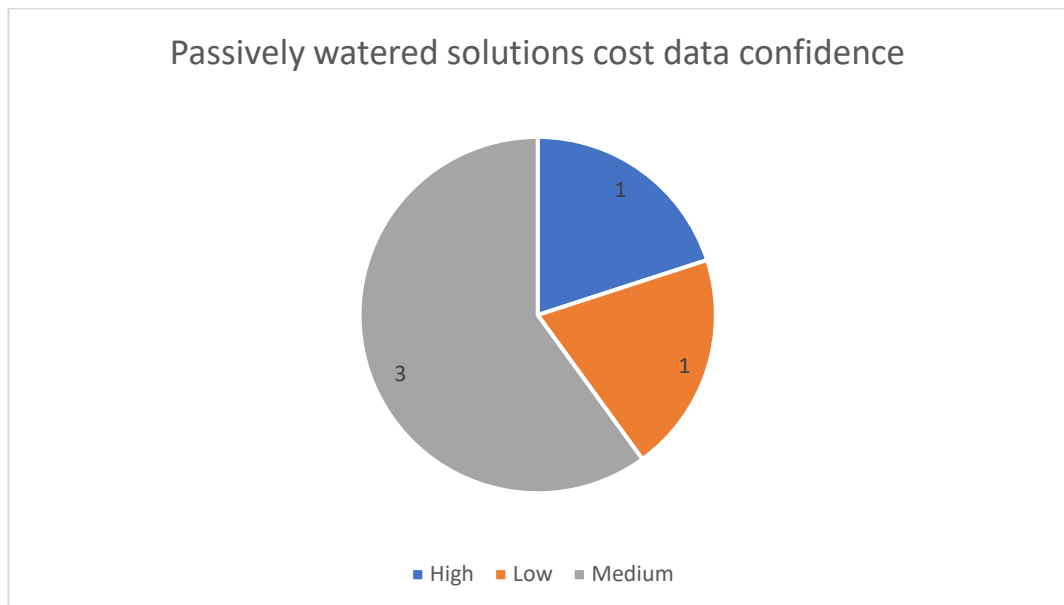


Figure 9  
Passively watered solutions cost data confidence

Table 3 presents explanatory comments for the responses above.

Table 3  
Passively watered solutions cost data comments

Organisation	Comments
Blacktown City Council	We are currently trialling the use of passively watered street trees and have some early but limited data.
City of Canning	We would be able to extract procurement costs for contractors to undertake the above items, but we aren't collating it to track LCC. Anything in house e.g., maintenance, no cost data available.
City of Mitcham	Costs are constantly changing but for some examples we do have recent construction costs to go from. And we are not so much 'collecting' the data, but we have access to it recent costs.

Does your organisation collect LCC data for permeable or porous paving?

Figure 10 indicates if respondent organisations collected permeable paving.

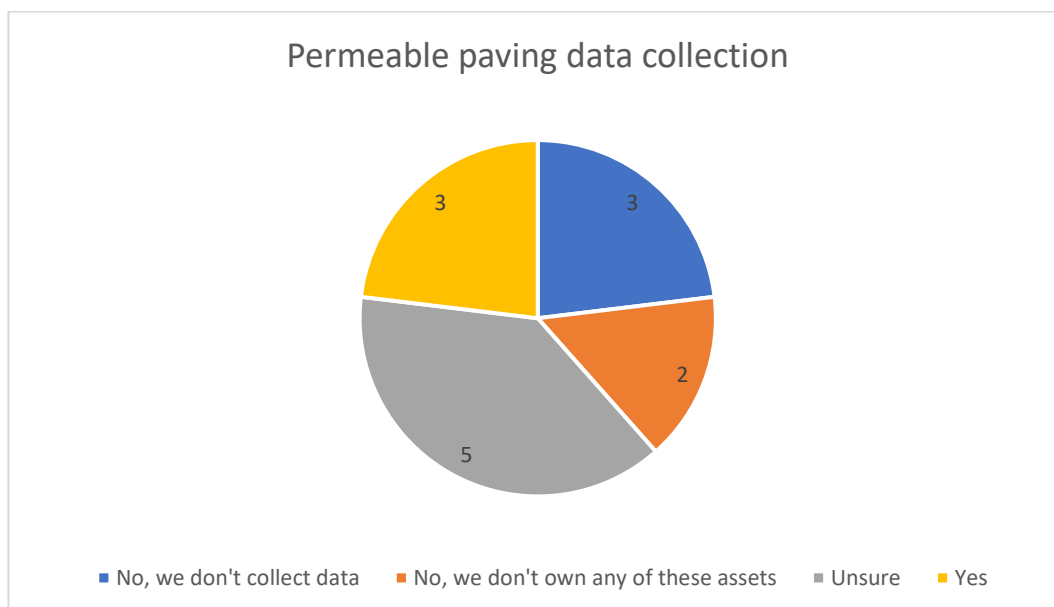


Figure 10  
Permeable paving cost data collection

What LCC data is being collected for these assets?

Figure 11 indicates the life cycle phases for which cost data is collected for permeable paving. The results suggest less data is collected for these assets: it is collected for only 1 or 2 stages by any given organisation, with no-one collecting maintenance and operation.

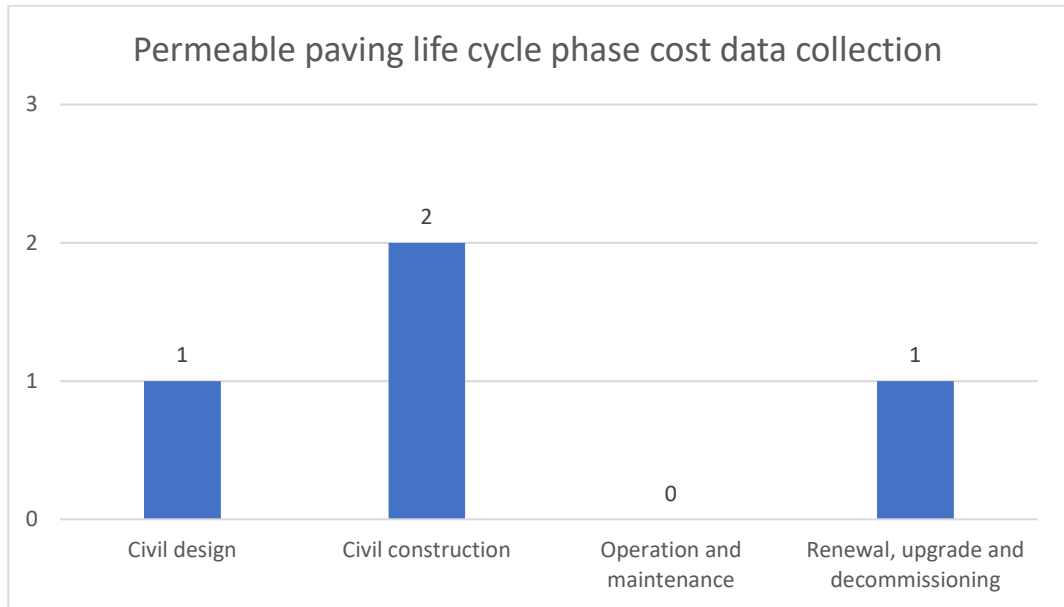


Figure 11  
Permeable paving life cycle phase cost data collection

How confident are you in the quality of this data?

Figure 12 indicates how confident respondents are in the quality of the cost data their organisations collect for permeable paving.



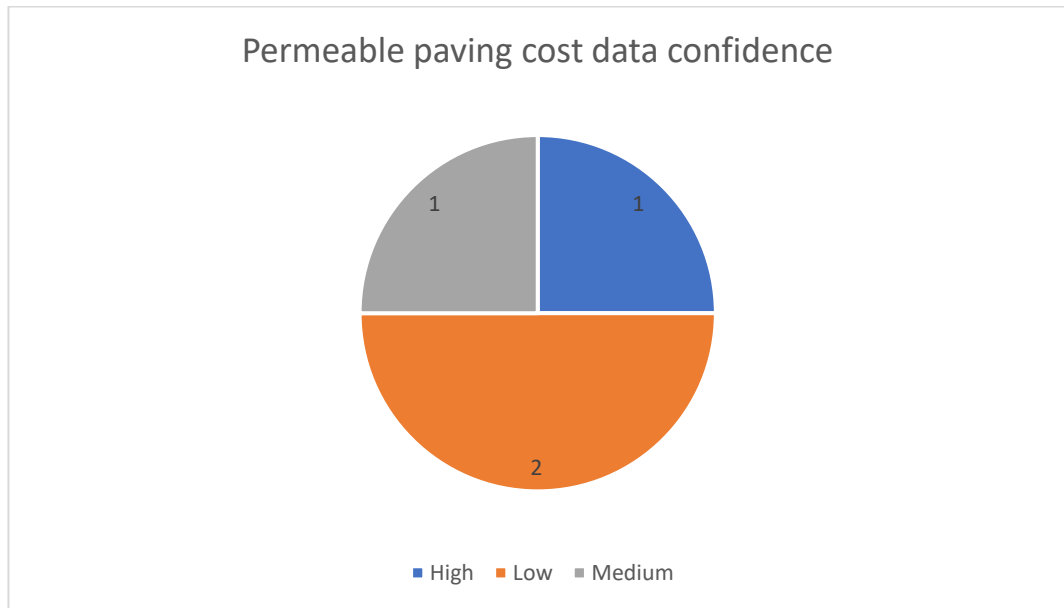


Figure 12  
Permeable paving cost data confidence

Table 4 presents explanatory comments for the responses above.

Table 4  
Permeable paving cost data comments

Organisation	Comments
City of Greater Geelong	We have porous pavements around street trees; I am not sure what sort of data we have on that.
City of Canning	We would be able to extract procurement costs for contractors to undertake the above items, but we aren't collating it to track LCC. Anything in house e.g., maintenance, no cost data available.
City of Mitcham	Costs are constantly changing but for some examples we do have recent construction costs to go from. And we are not so much 'collecting' the data, but we have access to recent costs.
City of Mandurah	Porous paving is now considered in renewal projects, however it is new technology that requires further investigation, depending on the works (i.e. roads, carparks).
Melbourne Water	The Flood strategy team is conducting research into impact porous paving may reduce nuisance flooding in specific urban areas.

## 2.1.4 Life cycle cost data needs

For biofilters or raingardens, passively irrigated or watered solutions (e.g., WaterWise or passively irrigated tree pits), and permeable or porous paving, what lifecycle stages does your organisation need cost data for most?

Figure 12 indicates the life cycle phases for which respondents most need cost data.

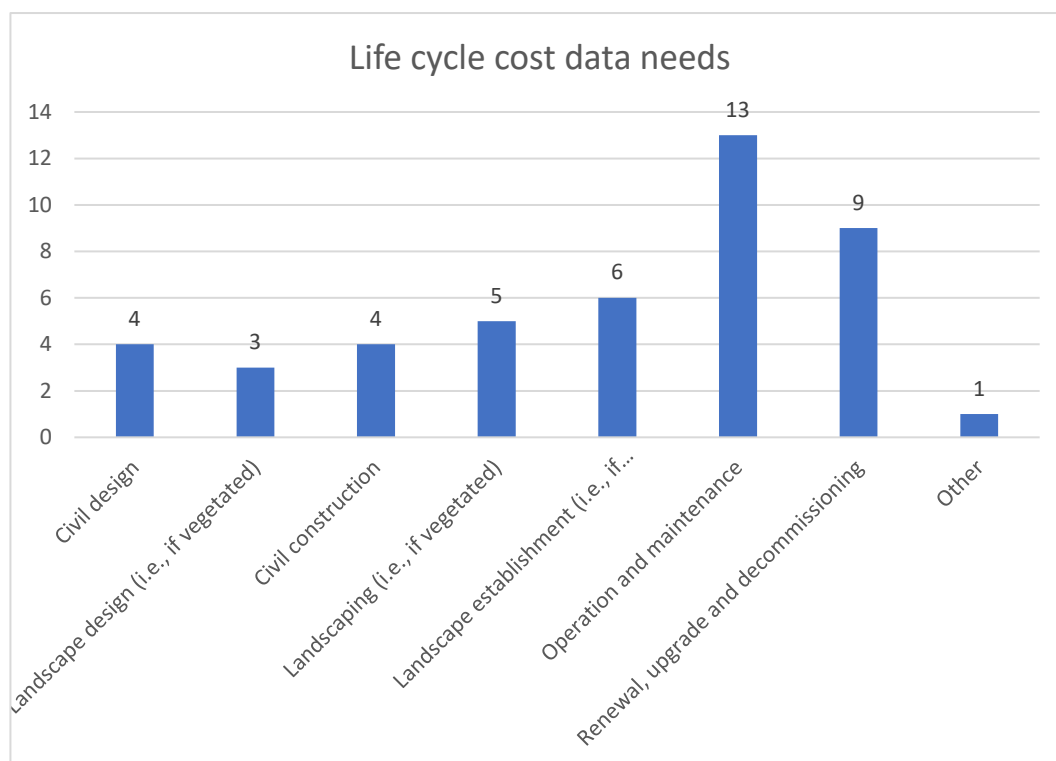


Figure 13

[Life cycle cost data needs](#)

Please briefly describe why your organisation needs cost data for these lifecycle stages.

Table 5 presents explanatory comments for the responses above.

Table 5  
Life cycle cost data needs comments

Organisation	Comments
Logan Council	Generally most of our assets are contributed from development. A very small percentage will be built by us and require the early life cycle stage costings. We own and maintain and renew these assets so require good understanding of these costs.
City of Greater Geelong	As mentioned in your project brief, this information can be used to evaluate different design approaches, estimating future maintenance obligations, breakdown barriers regarding perceptions of maintenance burdens etc.
City of Canning	We know how much it costs to build; establishment and maintenance costs are sometimes not as clear, though depends on the system.
City of Melbourne	To assist with allocating budgets for ongoing maintenance.
City of Canning	To be able to support business cases and also advocate for support for continued implementation of WSUD across the city.
Melbourne Water	We have a number of bioretention systems that we don't actively maintain but are reaching the end of their operating life and need to determine costs to undertake maintenance on the assets or to renew them.
City of Canning	To ensure these assets continue to function at their optimum so that they can operate as per their intention.
City of Mitcham	The operation, maintenance and renewal are the biggest unknowns and the hardest to quantify for our operations team. This information would help to make sure we are adequately supporting the investment in new assets and the appropriate management of those devices.
City of Mandurah	My organisation needs life cycle costs for all stages, so the capital cost are known to renew the assets and the operational costs are known to ensure ongoing correct operation of all WSUD infrastructure.
Melbourne Water	We publish WSUD asset guidance including design and operations/maintenance which is used by developers and councils for assets which are owned and managed by Councils.

Please provide any further explanatory comments on your responses to questions in this section, if desired.

Table 6 presents explanatory comments for all responses provided in this section.

Table 6

Life cycle cost data needs comments

Organisation	Response
City of Greater Geelong	Some information on different types of batters would also be useful to help assess the ongoing maintenance and renewal costs associated with different assets. It would be good to validate assumptions around cost of maintaining an earthen grassed batter versus steeper vegetated versus a retaining wall.
City of Canning	We can extract contractor costs from our procurement system, but costs for internal works e.g., maintenance would be unknown. Where people have to guess or make assumptions, it is likely to be inflated, or not even considered.
Melbourne Water	Bioretention assets are generally better suited to small catchments. We have a number of legacy assets that are downstream of a wetland cell and which are not maintained but we would benefit from having an understanding of maintenance costs so that we can determine an appropriate maintenance approach.
Ipswich City Council	While we are not actively collecting LCC data (e.g., collating in database) we would have access to limited amount of data related to the design and construction of various projects completed in recent years (e.g., bioretention basins, channel naturalisation, constructed wetlands).

### 2.1.5 Life cycle cost analysis needs

Does your organisation undertake life cycle cost analysis for biofilters or raingardens, passively irrigated or watered solutions (e.g., WaterWise or passively irrigated tree pits), and permeable or porous paving? If no or unsure, skip this section.

Figure 14 indicates if respondent organisations undertake life cycle cost analysis for any of the suggested asset types.

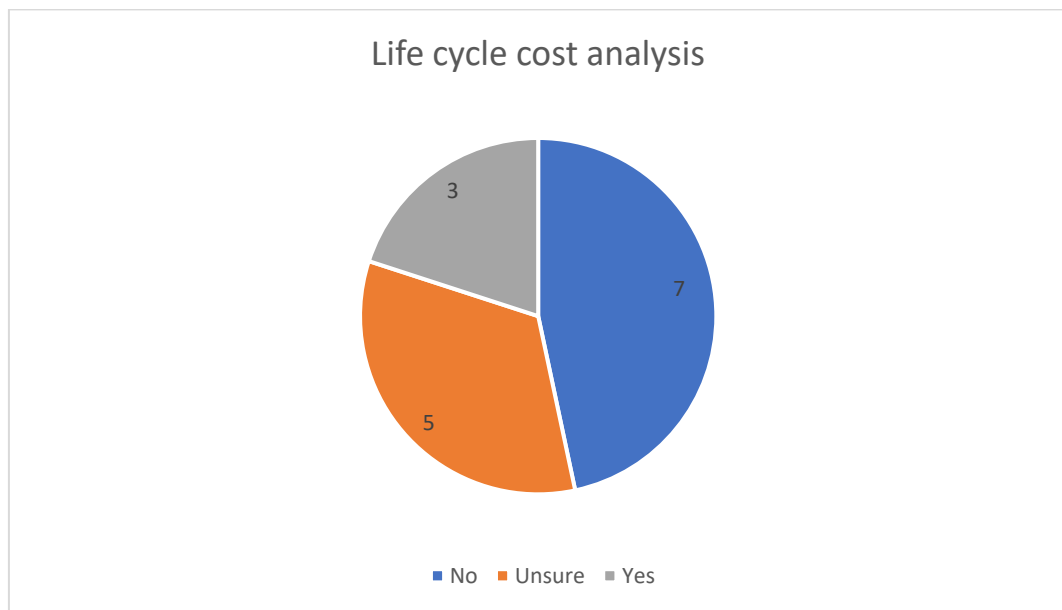


Figure 14  
Life cycle cost analysis

Please briefly describe why your organisation undertakes life cycle cost analysis for these assets.

Table 7 presents comments on why respondents' organisations undertake life cycle cost analysis for these assets.

Table 7  
Life cycle cost analysis comments

Organisation	Comments
Logan Council	We have started this process so do not have comprehensive data but are in the process of gathering and analysing what we do have.
City of Mandurah	Capital costs of the biofilters, raingardens and watered solutions, with a probable life expectancy of the assets within our internal assets register.
Melbourne Water	We are involved with research projects to develop and establish new and improved solutions but I'm not aware if lifecycle cost analysis is included in any of this work.

Does your organisation use a life cycle cost analysis tool for these assets? If no or unsure, skip to question 26.

Figure 15 indicates if respondents' organisations use a lifecycle cost analysis tool for the assets.

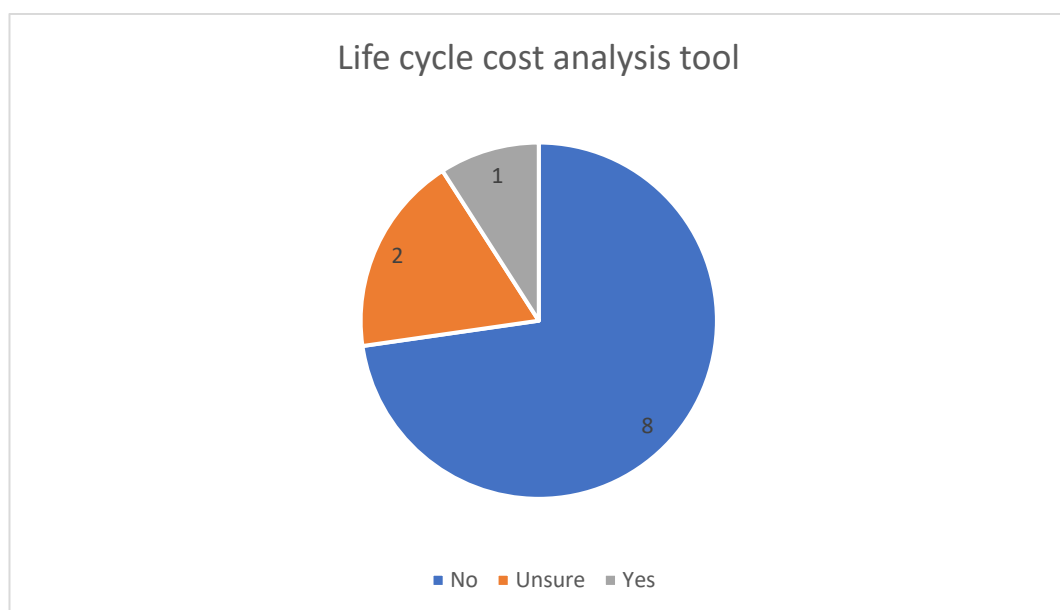


Figure 15  
Life cycle cost analysis tool

Please indicate what the tool is.

Table 7 presents respondents' comments on what lifecycle cost analysis tool their organisations use.

Table 8  
Life cycle analysis tool comments

Organisation	Comments
Logan Council	Generally NAMS+ but also allot of the behind the scenes data capture too
City of Mandurah	Public Open Space assets register

If your organisation doesn't use a life cycle cost analysis tool, please briefly describe how it undertakes life cycle cost analysis for these assets.

Table 9 presents comments from respondents on how their organisations conduct life cycle cost analysis.

Table 9  
Life cycle cost analysis process comments

Organisation	Comments
City of Canning	It undertakes costs analysis based on construction costs per project.
City of Canning	Best guess. Based on hourly rate and treatment type.
Ipswich City Council	Currently not undertaking any life cycle cost analysis but need to in support of asset management plan that is currently being developed.
City of Mandurah	Public Open Space assets register

Does your organisation follow guidelines, standards or similar when collecting, storing, maintaining and analysing LCC data? If no or unsure, skip to question 29.

Figure 16 indicates if the respondent's organisation follows guidelines, standards or similar.

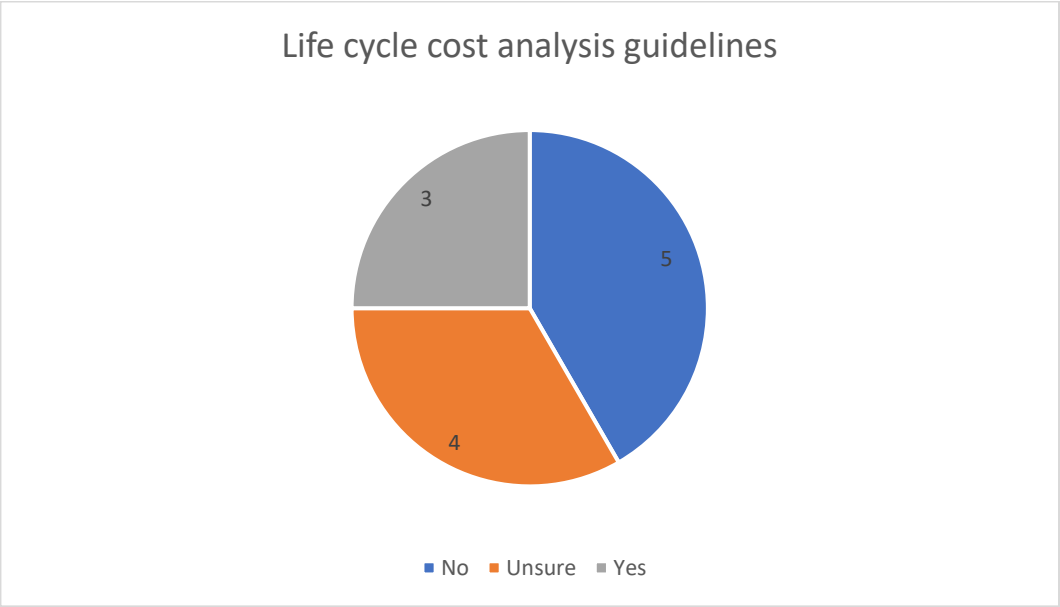


Figure 16  
[Life cycle cost analysis guidelines](#)

Please indicate what the guidelines, standards or similar are.

Table 10 presents the guidelines, standards or similar respondents' organisations use.

Table 10  
[Life cycle cost analysis guidelines comments](#)

Organisation	Comments
Logan Council	IPWEA has been used as a general basis
City of Port Phillip	Institute of Public Works Engineering
City of Mandurah	Assets register guidelines



Do you have any issues with the approach your organisation uses to undertake life cycle cost analysis for these assets? If no or unsure, skip to question 31.

Figure 17 indicates if respondent's had issues with the approach their organisation uses.

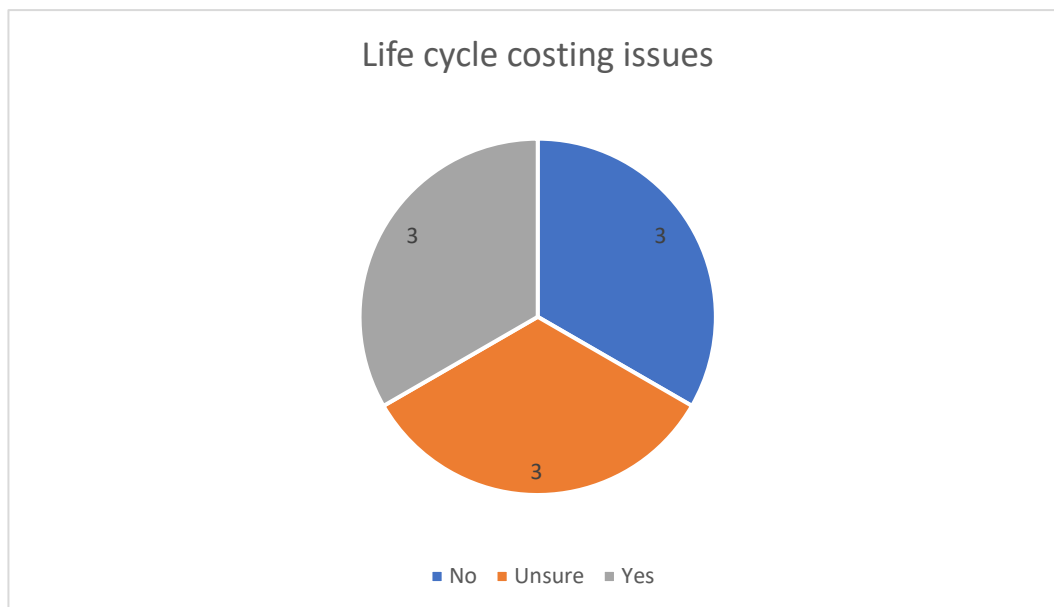


Figure 17  
Life cycle costing issues

Please briefly describe what these issues are.

Table 11 identifies the issues respondents have with life cycle costing.

Table 11  
Life cycle cost analysis issues comments

Organisation	Comments
City of Port Phillip	Not specific to WSUD
Midcoast Council	Lack of life cycle cost analysis structure established
City of Mandurah	A WSUD asset that is under \$5,000 is not included in the life cycle cost analysis, however there are multiple assets under \$5,000 that should be considered to ensure accurate future replacement costs.

Please provide any further explanatory comments on your responses to questions in this section, if desired.

Table 12 presents further comments on issues regarding life cycle costing.

Table 12  
Additional life cycle cost analysis comments

Organisation	Comments
City of Canning	We don't collect this data
Melbourne Water	I work in the policy and strategy area of the business and am not across our asset management processes, including lifecycle management and costing.

### 2.1.6 Final questions

Would you consider using a LCC database and life cycle analysis tool developed by WSCA for these assets and other WSUD assets your organisation owns? If yes, skip to question 34.

All survey respondents answered yes.

If no or unsure, please briefly describe why.

One respondent said, "It really depends on its alignment with our systems and other asset management options as well".

Would you be willing and able to share LCC data for the WSUD assets your organisation owns for the purposes of this project? We recognise that this may require preparing and signing a data sharing agreement.

Figure 18 presents the respondents' willingness to share LCC data for the WSUD assets in their organisation.

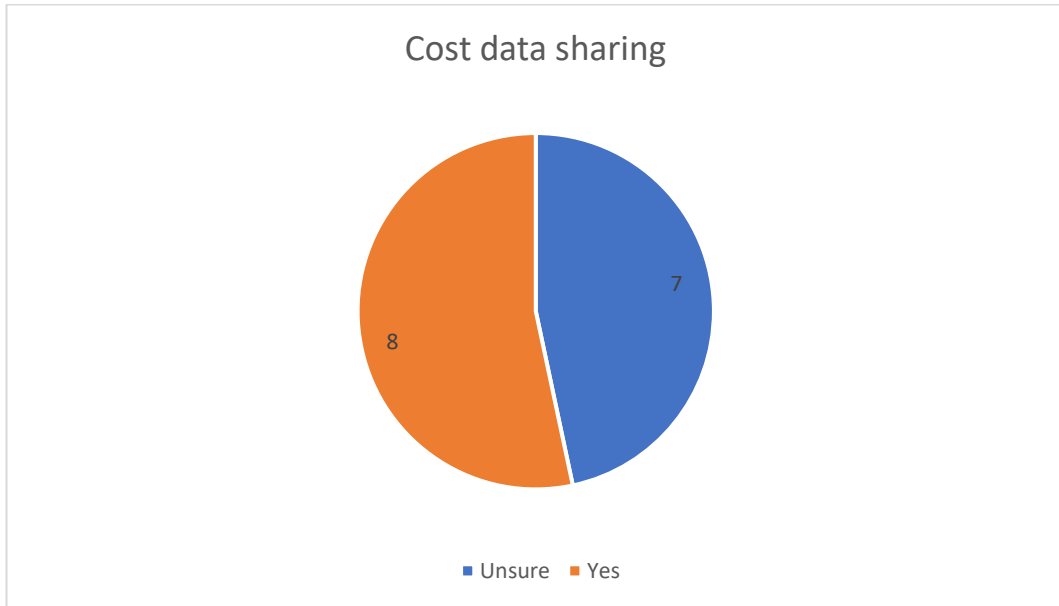


Figure 18  
 Cost data sharing

What WSUD assets would you like us to focus on in future stages of the project?

Figure 19 presents respondent preferences for WSUD assets in future stages. One respondent stated, “Water recycling systems, water tertiary treatment, water desalination, water nutrient removal and packaged filtration plants to ensure fit-for-purpose water”.

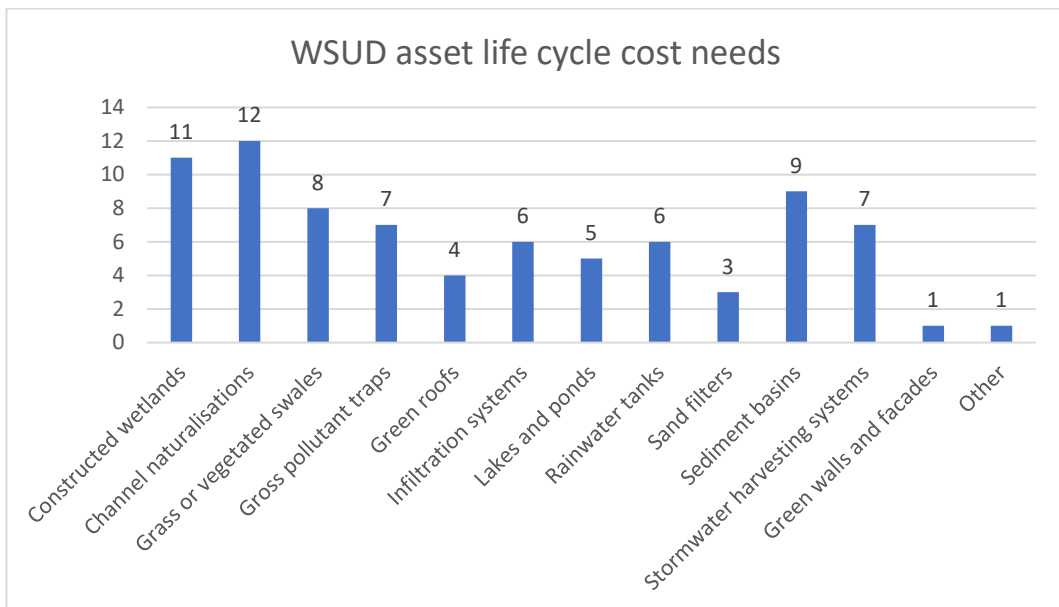


Figure 19  
 WSUD asset life cycle cost needs

Please briefly describe why you'd like us to focus on these assets in the future.

Table 13 presents comments on focus areas for assets in the future.

Table 13

WSUD asset life cycle cost needs comments

Organisation	Comments
Blacktown City Council	These are some key assets that we need data for to allocate appropriate operation and maintenance budgets.
Logan Council	These assets are important to understand in a drying climate as we will rely on them more.
City of Greater Geelong	We have these assets within our network and it would be good to have some life cycle costing data for them. It would be good to be able to use it to compare different treatment approaches, bioretention versus wetlands for example. Some data on stormwater harvesting would be good to help promote more of these systems.
City of Canning	We need a greater uptake of these systems and LCC data will assist in this, in particular relation to developing project business cases.
City of Melbourne	
City of Canning	Most commonly proposed or delivered assets in the City
Melbourne Water	These are the assets that MW own and actively maintain (although lakes are not currently maintained other than for amenity purposes).
City of Canning	
City of Port Phillip	Costing not well established, standardised approach to comparing infrastructure options
Ipswich City Council	These are some of the main WSUDs we are actively installing across Ipswich.
City of Mitcham	These are assets that we have, but we don't have to regularly clean or maintain and have little information about how much it might cost to do so.

City of Casey	These are the types of WSUD we own.
Midcoast Council	These are the predominate assets currently owned.
City of Mandurah	These assets are best to focus on, in the future, as they help support our constructed and natural environment, provide much needed water quality improvements in a catchment and assist with water security.
Melbourne Water	Melbourne Water's Healthy Waterways Strategy (2018), and EPA (Vic) guidance on urban stormwater management (publication 1739.1) have set ambitious stormwater harvesting/ evapotranspiration and infiltration targets across the greater Melbourne region to protect waterway health. We are grappling with infiltration and harvesting systems that can deliver on these significant targets (80GL Harvested & 20GL Infiltrated per year by 2050).

Would you be willing to have a brief virtual meeting or phone call to discuss your survey responses (maximum 30 minutes)?

Figure 20 presents respondents' willingness to have a virtual meeting to discuss survey responses.

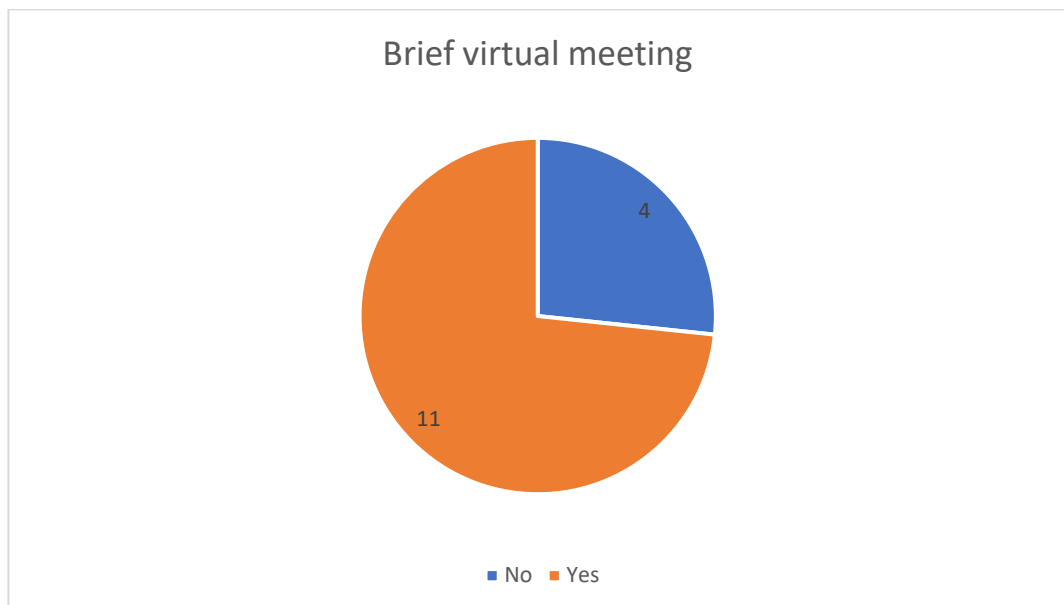


Figure 20  
Brief virtual meeting

Please provide any further feedback on this survey or the project.

Table 14 presents a summary of additional feedback of the survey by respondents.

Table 14

#### Summary of further feedback

Organisation	Comments
City of Greater Geelong	Thanks for the opportunity to participate. I think life cycle information that is more up to date than information from Melbourne Water and Water by Design. Ideally based on a larger sample size. This information assists in determining the most effect
Ipswich City Council	Was involved in this tool in previous job – may be of some help to see how others have approached development of a life cycle cost tool – <a href="https://sustainabletechnologies.ca/lid-lcct/">https://sustainabletechnologies.ca/lid-lcct/</a>  Fully support developing a life cycle cost tool, but also need to ensure resources available in the long run to keep updated. Thanks.
City of Mitcham	I believe we are likely to be willing to share our LCC data (refer Q.34) but it would possibly depend on the data, and I would need to confirm with our assets team to be certain we had the information available, and with management so that an agreement could be reached.

### 3. Conclusion

The stakeholder survey of WSUD practitioners across Australia highlighted key insights crucial for developing a tailored LCC tool. While most organizations lack formal LCCA processes or tools, there is a clear willingness to adopt a tool developed by WSCA. Moving forward, collaboration with willing respondents is recommended to refine cost data and address specific LCC needs, ensuring the tool's adaptability for various WSUD asset types outlined in the report. A summary of key findings and recommendations are outlined for reference in the context analysis report.

## 4. References

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

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# Appendices

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## Appendix A: Survey content

### A.1 Project background

The following background information was provided on the survey landing page.

Water Sensitive Cities Australia (WSCA) is undertaking a project to develop a lifecycle costing tool for water sensitive assets in Australia, otherwise known as water sensitive urban design (WSUD) assets. The project will focus initially on biofilters or raingardens, passively irrigated or watered solutions (e.g., WaterWise or passively irrigated tree pits), and permeable or porous paving only. Future stages may seek to expand the application of the lifecycle costing tool to other WSUD assets.

The development of the tool seeks to ensure the planning, design, construction, operation and maintenance and ongoing management of these assets is informed by an accurate and up to date understanding of whole of lifecycle costs. This recognises that poor quality and limited cost information is a significant barrier to the adoption of these assets as compared with more traditional infrastructure assets in Australia. Additionally, it recognises concerns around funding for the ongoing maintenance of these assets once established and operational.

We have prepared a short survey to obtain the information needed to develop a lifecycle cost tool, including a lifecycle cost database and lifecycle cost analysis tool, that meets the needs of end users including decision makers and practitioners. We are reaching out to you to complete the survey as you have been identified by the Project Team as a person with significant knowledge and experience with WSUD assets in Australia.

The survey should take approximately 10 minutes to complete. Your responses to survey questions will be de-identified, only used for the purposes of the project and not shared with anyone outside of the Project Team without your prior written permission.

Should you have any comments, concerns or questions about the survey or the project, please reach out to Chris Manning (Project Manager) at [chris@wscaustralia.org.au](mailto:chris@wscaustralia.org.au).



## A.2 Definitions

The following definitions were provided on the survey landing page.

Before you begin the survey, it's important that we clarify what we mean by WSUD, a WSUD asset, lifecycle costs, lifecycle cost database and a lifecycle cost analysis tool.

### **What is WSUD?**

WSUD is an approach to the planning and design of urban areas that aims to minimise the impacts of urban development on receiving waters and maximise economically, environmentally, and socially beneficial outcomes for communities. These outcomes include, but aren't limited to, the following.

- Improving the quality and reducing the quantity of stormwater running off urban areas.
- Improving the sustainability, use and reuse of water including through groundwater recharge.
- Improving local biodiversity.
- Cooling and shading urban areas.
- Improving recreational and visual amenity and opportunities.

### **What is a WSUD asset?**

A WSUD asset is a physical device or system used to achieve the aims of WSUD. Examples of WSUD assets include, but aren't limited to, the following.

- Biofilters or raingardens (otherwise known as bioretention systems).
- Constructed or artificial wetlands.
- Creek or drain naturalisations and living streams.
- Grass or vegetated swales.
- Green roofs.
- Green walls and facades.
- Gross pollutant traps and other pollution control devices (e.g., targeting hydrocarbons or sediments).
- Infiltration systems, including devices designed for groundwater recharge (e.g., soakwells).
- Lakes and ponds.
- Passively irrigated or watered solutions (e.g., WaterWise or passively irrigated tree pits).
- Permeable or porous paving.
- Rainwater tanks.
- Sand filters.
- Sediment basins.
- Stormwater harvesting systems.

WSUD assets used to manage stormwater are often configured in a treatment train to provide primary treatment (e.g., gross pollutant traps and sediment basins), secondary treatment (e.g., grass or vegetated swales), and tertiary treatment and reuse (e.g., biofilters and stormwater harvesting systems) of runoff being discharged to drainage networks or waterways.

### **What do we mean by lifecycle costs?**

Lifecycle costs are the costs associated with all activities involved in the planning, design, construction, establishment (i.e., if vegetated), operation and maintenance, and renewal, upgrade and decommissioning of WSUD assets. These costs are often specific to each WSUD asset and its design configuration, surrounding environment, and the local industry supplying products and services across the above lifecycle stages.

**What do we mean by a lifecycle cost database?**

A lifecycle cost database is a centralised location for the collection, storage and maintenance of lifecycle cost data. A database provides a structured collection of high quality and useful data that can be accessed efficiently by end users.

**What do we mean by a lifecycle cost analysis tool?**

A lifecycle cost analysis tool is a tool used to analyse lifecycle cost data to provide information that is useful for the management of assets. For end users, the outputs of analyses often informs budgets for the planning, design, construction, and establishment of new assets as well as the ongoing operation and maintenance or renewal, upgrade and decommissioning of existing assets. This information is also critical for informing asset management planning so the often large portfolios or networks of assets owned by end users can be managed sustainably and to meet desired or expected levels of service now and into the future.

**A.3 WSUD asset photos**

Presented below are photos of WSUD assets that were used in the survey and their sources.

**Biofilters or raingardens (otherwise known as bioretention systems)**



Source: E2Designlab

**Constructed or artificial wetlands**



Source: E2Designlab

**Channel or drain naturalisation and living streams**



Source: E2Designlab

**Grass or vegetated swales**



Source: Derwent Estuary Program

**Green roofs**



Source: Green Roofs Australia

**Green walls and facades**



Source: Green Roofs Australia



**Gross pollutant traps and other pollution control devices (e.g., targeting hydrocarbons or sediments)**



Source: Stormwater Sydney

**Infiltration systems, including devices designed for groundwater recharge (e.g., soakwells)**



Source: Perth Soakwells

**Lakes and ponds**



Source: E2Designlab

**Passively irrigated or watered solutions (e.g., WaterWise or passively irrigated tree pits)**



Source: Water by Design

**Permeable or porous paving**



Source: E2Designlab

**Rainwater tanks**



Source: E2Designlab

**Sand filters**



Source: Derwent Estuary Program

**Sediment basins**



Source: Derwent Estuary Program

**Stormwater harvesting systems**



Source: WSCA

## Appendix B: Survey response types

The table below presents the types of responses for the questions included in the survey.

Table B.1

### Survey question types

Question type	Description
Multiple choice	Select one or more from a list of custom options.
Fixed choice	Select one from a list of custom options.
Picture choice	Select one or more images from a list of custom options. Upload images or use Google image search (PNG, JPEG, GIF only.)
Like/dislike	Quickly gather input as a thumbs up / thumbs down, or series of emojis.
Rating	Rate custom options on a customizable scale.
Ranking	Rate several options. Respondents can drag the options to reorder them.
Slider	Define response on a spectrum.
Multiple choice and rating grid	As a question with multiple items.
Form	Ask respondents to enter specific information, such as name, email address, or phone number.
Short answer	Provide a text field for open-ended questions without character limits.
Image upload	Let respondents upload images from a mobile device or desktop computer.
Section break	Add instructions or information, or provide an area where no answer is needed.



## Appendix C: Survey questions

The table below presents the questions included in the survey as well as response types and options.

Table C.1

### Survey questions

Section heading	Section description	#	Question	Response type	Response options
Respondent information	Please provide your information. This information will only be used by the Project Team to follow up with you to clarify your responses, if required.	1	What is your full name?	Form	
		2	What is your job title?	Form	
		3	What organisation do you work for?	Form	
		4	What is your email address?	Form	
		5	What is your preferred contact number?	Form	

Section heading	Section description	#	Question	Response type	Response options
WSUD assets	Please provide information on the WSUD assets your organisation owns.	6	What types of WSUD assets does your organisation own?	Multiple choice	Biofilters or raingardens (otherwise known as bioretention systems); Constructed or artificial wetlands; Creek or drain naturalisations and living streams; Grass or vegetated swales; Green roofs; Green walls and facades; Gross pollutant traps and other pollution control devices (e.g., targeting hydrocarbons or sediments); Infiltration systems, including devices designed for groundwater recharge; Lakes and ponds; Passively irrigated or watered solutions (e.g., WaterWise or passively irrigated tree pits); Permeable or porous paving; Rainwater tanks; Sand filters; Sediment basins; Stormwater harvesting systems; Other
Lifecycle costs	Please provide information for biofilters or raingardens, passively irrigated or watered solutions (e.g., WaterWise or passively irrigated tree pits), and permeable or porous paving. This first stage of the project is focusing on these asset types only. Future stages may seek to expand the application of the lifecycle costing database and lifecycle cost	7	Does your organisation collect lifecycle cost (LCC) data for biofilters or raingardens? If no or unsure, skip to question 11.	Fixed choice	Yes; No, we don't collect data; No, we don't own any of these assets; Unsure



Section heading	Section description	#	Question	Response type	Response options
	analysis tool to other WSUD assets.				
		8	What LCC data is being collected for these assets?	Multiple Choice	Civil design; Landscape design; Civil construction; Landscaping; Landscape establishment; Operation and maintenance; Renewal, upgrade or decommissioning; Other
		9	How confident are you in the quality of this data?	Rating	Low; Medium; High
		10	If desired, briefly provide any explanatory comments on your responses.	Form	
		11	Does your organisation collect LCC data for passively irrigated or watered solutions (e.g., WaterWise or passively irrigated tree pits)? If no or unsure, skip to question 15.	Fixed choice	Yes; No, we don't collect data; No, we don't own any of these assets; Unsure
		12	What LCC data is being collected for these assets?	Multiple Choice	Civil design; Landscape design; Civil construction; Landscaping; Landscape establishment; Operation and maintenance; Renewal, upgrade or decommissioning; Other
		13	How confident are you in the quality of this data?	Rating	Low; Medium; High

Section heading	Section description	#	Question	Response type	Response options
		14	If desired, briefly provide any explanatory comments on your responses.	Form	
		15	Does your organisation collect LCC data for permeable or porous paving? If no or unsure, skip to question 19.	Fixed choice	Yes; No, we don't collect data; No, we don't own any of these assets; Unsure
		16	What LCC data is being collected for these assets?	Multiple Choice	Civil design; Landscape design; Civil construction; Operation and maintenance; Renewal, upgrade or decommissioning; Other
		17	How confident are you in the quality of this data?	Rating	Low; Medium; High
		18	If desired, briefly provide any explanatory comments on your responses.	Form	
		19	For biofilters or raingardens, passively irrigated or watered solutions (e.g., WaterWise or passively irrigated tree pits), and permeable or porous paving, what lifecycle stages does your organisation need cost data for most?	Multiple Choice	Civil design; Landscape design; Civil construction; Landscaping (i.e., if vegetated); Landscape establishment (i.e., if vegetated); Operation and maintenance; Renewal, upgrade or decommissioning; Other

Section heading	Section description	#	Question	Response type	Response options
		20	Please briefly describe why your organisation need cost data for these lifecycle stages?	Form	
		21	Please provide any further explanatory comments on your responses to questions in this section, if desired.	Form	
Lifecycle cost analysis	Please provide information for biofilters or raingardens, passively irrigated or watered solutions (e.g., WaterWise or passively irrigated tree pits), and permeable or porous paving. This first stage of the project is focusing on these asset types only. Future stages may seek to expand the application of the lifecycle costing database and lifecycle cost analysis tool to other WSUD assets.	22	Does your organisation undertake lifecycle cost analysis (LCA) for biofilters or raingardens, passively irrigated or watered solutions (e.g., WaterWise or passively irrigated tree pits), and permeable or porous paving? If no or unsure, skip this section.	Fixed choice	Yes; No; Unsure
		23	Please briefly describe why your organisation undertakes LCA for these assets.	Form	
		24	Does your organisation use a LCA tool for these assets? If no or unsure, skip to question 26.	Fixed choice	Yes; No; Unsure

Section heading	Section description	#	Question	Response type	Response options
		25	Please indicate what the tool is.	Form	
		26	If your organisation doesn't use a LCA tool, please briefly describe how it undertakes LCA for these assets?	Form	
		27	Does your organisation follow guidelines, standards or similar when collecting, storing, maintaining and analysing LCC data? If no or unsure, skip to question 29.	Fixed choice	Yes; No; Unsure
		28	Please indicate what the guidelines, standards or similar are.	Form	
		29	Do you have any issues with the approach your organisation uses to undertake LCA for these assets? If no or unsure, skip to the next section.	Fixed choice	Yes; No; Unsure
		30	Please briefly describe what these issues are.	Form	
Some final questions	You're almost there! Please provide information that will help the Project Team deliver the very best lifecycle costing tool we can.	31	Would you consider using a LCC database and LCA tool developed by WSCA for these assets and other WSUD assets your	Fixed choice	Yes; No; Unsure

Section heading	Section description	#	Question	Response type	Response options
			organisation owns? If yes, skip to question 33.		
		32	If no or unsure, please briefly describe why.	Form	
		33	Would you be willing and able to share LCC data for the WSUD assets your organisation owns for the purposes of this project? We recognise that this may require preparing and signing a data sharing agreement. Please note that data you share with us will be de-identified, only used for the purposes of the project and not shared with anyone outside of the Project Team without your prior written permission.	Fixed choice	Yes; No; Unsure
		34	What WSUD assets would you like us to focus on in future stages of the project?	Multiple choice	Constructed or artificial wetlands; Creek or drain naturalisations and living streams; Grass or vegetated swales; Green roofs; Green walls and facades; Gross pollutant traps and other pollution control devices (e.g., targeting hydrocarbons or sediments); Infiltration systems, including devices designed for groundwater recharge; Lakes and ponds; Rainwater tanks; Sand filters;

Section heading	Section description	#	Question	Response type	Response options
					Sediment basins; Stormwater harvesting systems; Other
		35	Please briefly describe why you'd like us to focus on these assets in the future.	Form	
		36	Would you be willing to have a brief virtual meeting or phone call to discuss your survey responses (maximum 30 minutes)?	Fixed choice	Yes; No
		37	Please provide any further feedback on this survey or the project.	Form	





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