

Upsoil Collective

Worms at Work Pilot Report

Fishermans Bend Digital Innovation Challenge 2024

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Executive Summary

Worms at Work is a pilot testing whether public furniture can do more than provide seating and instead become living infrastructure that helps cities respond to food waste, food insecurity, energy uncertainty and heat-retaining urban conditions through the everyday power of people, worms and ecological processes.

Cities are moving into a future shaped by tighter resources and less stable supply chains with a growing population, deepening climate uncertainty, and urban systems that still depend heavily on petrol. In that future, infrastructure will need to work harder - it will need to be more efficient, more local, more multi-purpose, and more conscious of the resources it uses. Rather than adding another single-purpose object to the street, the worm bench uses a similar amount of material and space to do several jobs at once: compost local food waste, feed local community, provide seating, reduce transport demand, cool the space, and make local nutrient cycles visible in public life.

To test this, the Worms at Work pilot installed three worm benches within and around Fishermans Bend. This report focuses on the Upsoil Collective installation: a modular system combining tiered worm farms, seating, table use, edible garden beds and IoT sensors. It was tested outside an urban wine bar Susuro (now a wine education company Bacchus Academy), looked after by the business host and supported by designer Zoe Wang and City of Melbourne. The other two benches were designed and installed by Michael Mobbs and are reported separately. The data used in this report covers from 14th Oct 2025 to 6th March 2026.



Photo taken by the City of Melbourne. Worms at Work Launch Event

The pilot was assessed against five refined success criteria

- Clean, safe and publicly endorsed - strongly demonstrated
- Simple to maintain and supported by people - strongly demonstrated
- Clear circular, social and investment Value - promising / demonstrated
- Suitable for real sites - promising / demonstrated
- Useful technology that supports operation - strongly demonstrated

The strongest results were in cleanliness, public endorsement, and maintenance simplicity, which are the first conditions that determine whether this kind of system will be supported by the public. During the reporting period, no smell was reported by people spending time around and on the bench, and no pest issues were recorded. The host reported feeling comfortable putting her hands into the compost and was surprised that it did not feel “icky”, suggesting a positive shift in how food waste was perceived.

The operating model was shown to be workable within a busy urban setting. A single committed host was generally sufficient to keep the system running, with occasional coverage during absences of more than two weeks helping maintain resilience. The tiered worm farm proved beginner-friendly, with a simple top-feed / bottom-harvest logic that could be understood quickly. New users could be introduced to the system in around 10-15 minutes through demonstration, with longer-term hands-on practice available. Support remained light touch, with questions and reminders managed through communication apps and email. In a busy urban context, simplicity matters, because any system that depends on specialist knowledge or high maintenance is unlikely to last.

The pilot also demonstrated circular and social value. At Susuro, where the business primarily operated off site and food scraps were brought in during visits, 35 kg of food waste was diverted from landfill during the reporting period. The system supported 12 types of edible plants in the garden beds. Community and industry interest also emerged beyond the site itself, including enquiries about applications in apartment shared spaces, community greening initiatives, and from property management companies. Research interviews with Monash University FUTURES Hub and What is the Future for Cities Podcast further highlighted the relevance of sustainable and liveable cities. This suggests that the value of the system lies not only in the volume of waste diverted, but also in its ability to integrate waste reduction, urban greening, seating, and public engagement into a single piece of infrastructure for future cities.

The modular, repairable, and user-friendly design enables adaptation to diverse real-world contexts. The system was designed for the most spatially constrained site, making it relevant to many tight urban conditions. At the same time, the pilot showed that thermal performance remains site-dependent in the current design. At Susuro, blocked rear ventilation, narrow air gaps, and surrounding heat retaining materials made heat release more difficult during summer extremes. Simulation across the three sites suggests significantly lower heat stress for the same design where airflow is more open at St Ali and even more so at Yarra's Edge.

The technology layer was also highly useful. Sensor data helped reduce uncertainty, support maintenance, and explain worm and microorganism behaviour. In the Upsoil unit, compost

temperature and odour data were the most useful for flagging operational issues in this project, while ambient temperature, CO₂ and lid-opening data were more useful for understanding design performance, feeding behaviour and waste volume. The dashboard was especially useful during heat events and remote monitoring. For day-to-day record keeping, however, simple text messages or emails appeared easier to adopt than QR-based form, as they took least steps and worked through existing communication channels.

What should happen next

The next step is not simply to expand, but to improve, continue testing, and build a clearer pathway forward.

Priority improvements for the next iteration are to develop a more site-responsive design with better peak temperature performance, simplify the technology package based on learnings, and tailor materials and detailing to future host settings.

Suitable next settings emerged from this pilot include council-supported activation sites, small cafés and hospitality venues, apartment communal areas, and shared workplace. Future testing shall compare different microclimates, host types, composting methods and maintenance schedules.

The next phase should also identify the most suitable integration and collaboration pathway moving forward. This includes testing how the concept may align with existing greening and public-realm programs, and how responsibilities could be shared between hosts, partners, councils and technical support in a way that is sustainable over time.

Overall, the pilot suggests that the worm bench successfully demonstrated how public infrastructure can become more multifunctional and resource-efficient for a circular future. By combining waste processing, urban farming, and public amenity within a single footprint, the system made effective use of both materials and space. Most importantly, it was supported and valued by the community in which it was embedded.

1. Project Background and Concept Development

1.1. Fishermans Bend Digital Innovation Challenge

Worms at Work was developed through the City of Melbourne's Fishermans Bend Digital Innovation Challenge 2024. The Challenge supports innovation and collaboration, with a focus on testing new ideas in the public realm through technology, data and community participation. The challenge sits within the context of Fishermans Bend, Australia's largest urban renewal area. Covering around 480 hectares across the City of Melbourne and the City of Port Phillip, it connects the CBD to the bay and is expected to accommodate around 80,000 residents and 80,000 jobs by 2050. It will also need new ways of thinking about how everyday urban systems work, including waste, greening and participation.



Photo taken by the City of Melbourne. Fishermans Bend Digital Innovation Challenge Pitch Event

The project was funded by the Victorian Government as part of the Gateway to GMH Fishermans Bend funding, with a total project price of \$90,000 ex GST. It was delivered between December 2024 and December 2025, reported in April 2026, and sponsored and owned by the Smart City Incubator within CityLab, led by Laura Pfiester, Nicky Stecca and the support of Mandy O'Toole and Dev Patel.

Within this context, Worms at Work was selected by community and council reviewers to test whether public seats integrated with worm farming, garden beds and sensors could help residents and businesses divert food waste locally in Fishermans Bend, while also

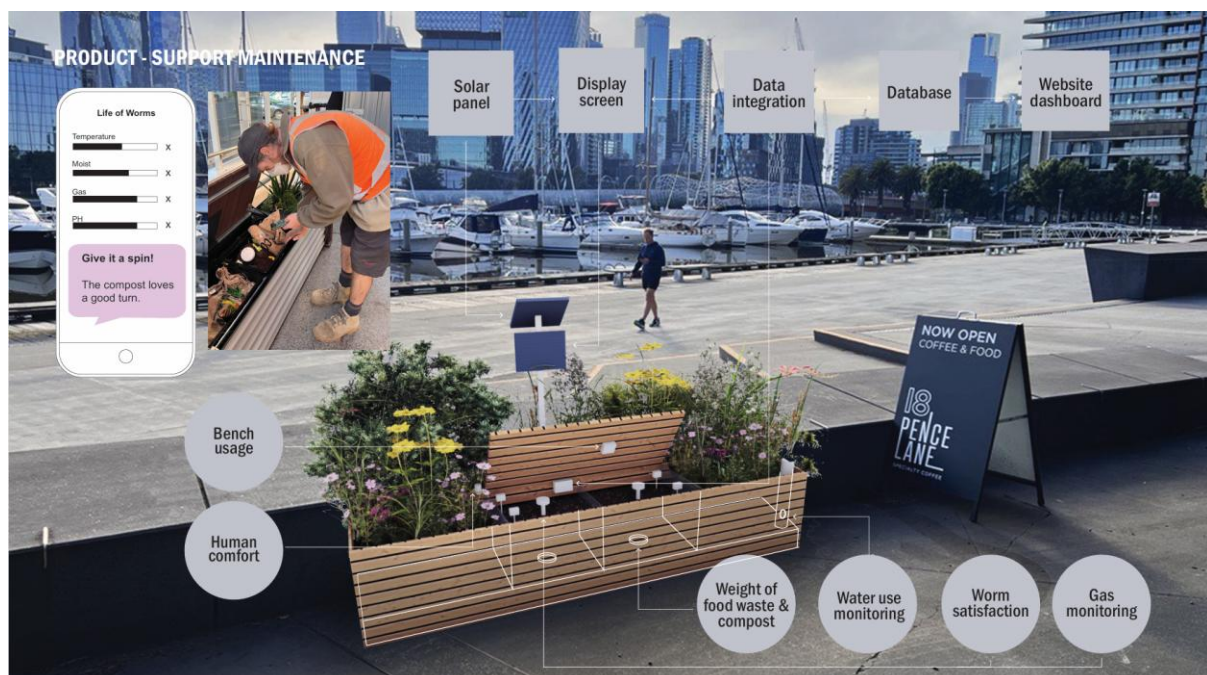
generating broader behavioural, social and environmental value. Zoe Wang and Michael Mobbs won the 2024 Challenge with their joint pitch, and the City of Melbourne subsequently entered into a Collaboration Agreement to develop and deliver the pilot.

Note: This report focuses on the Upsoil Collective installation, specifically the modular worm table and bench unit designed by Zoe Wang and installed at 134/15 Hall St, Port Melbourne, Susuro Urban Winery, in Fishermans Bend. Michael Mobbs developed and installed a separate product, the Coolseat, at two other locations under the same project umbrella, and has produced a separate report for those installations. Design, operational, evaluation and learning content in this report relates specifically to the Upsoil Collective installation unless otherwise stated.

1.2. Vision and Concept Development

The concept began in Zoe Wang's research project, Regenerating Productive Nutrientscape, which imagined a composting-centred Melbourne. Within that work, street composting was one of four components intended to help turn food waste generated within the City of Melbourne municipal boundary into compost and food for a growing city.

The earlier concept explored buried vermicomposting systems in public space as a way of making composting more accessible, visible and socially acceptable in dense urban environments. The intention was to bring part of the nutrient cycle back into public life, rather than keeping food waste as something hidden, removed and managed elsewhere. In response to the Fishermans Bend Digital Innovation Challenge EOI reviewers' comments, particularly around site realities, the concept shifted from an in-ground system towards a more practical above-ground version. This allowed the project to move from a broader research idea into a pilot that could be built, tested and observed in real public conditions.



Graphic created by Zoe Wang. Worms at Work initial pitch concept

The collaboration between Zoe Wang and Michael Mobbs began at the pitch stage. The initial pitch proposal was influenced by Michael Mobbs's earlier design, Coolseat. An early test and demonstration model was installed at Eighteen Pence Lane Café at Yarra's Edge. Following the initial presentation and proposal stage, the collaboration developed into two different design directions. Michael Mobbs continued with a composting bench with basket system arrangement. Zoe Wang explored a direction based on the Tier worm-farming system, shaped by different site conditions and slightly different priorities.

This divergence was valuable to the project as it created a richer testing ground. The two approaches allowed different composting logics, site responses and design priorities to be explored under the same broader project umbrella, generating a wider range of practical learning through the pilot.

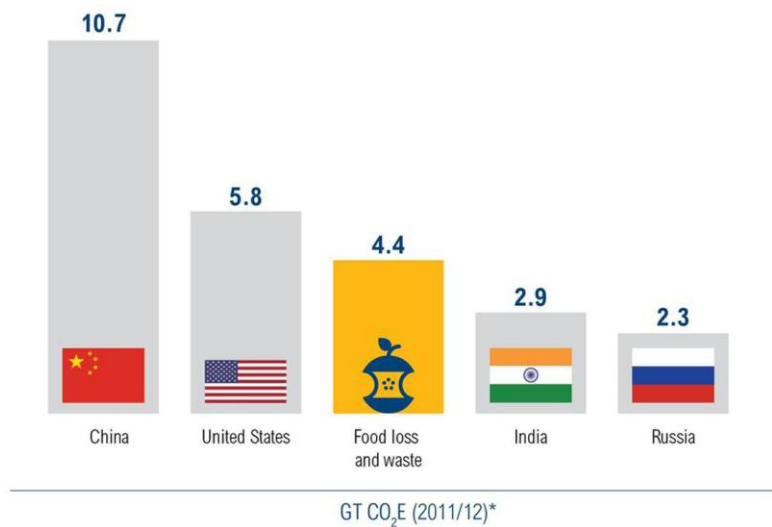
2. Why this project matters

2.1. Urban Food Waste Challenge

Food waste is a major environmental and urban systems challenge. Globally, UNEP reports that 1.05 billion tonnes of food were wasted in 2022, equal to 19% of food available to consumers, while food waste contributes around 8–10% of global greenhouse gas emissions.

In Australia, the Federal Government reports that the country wastes around 7.6 million tonnes of food each year, costing more than \$36.6 billion annually and contributing around 3% of Australia's greenhouse gas emissions. Australia's National Food Waste Strategy aims to halve food waste by 2030.

If Food Loss and Waste Were its own Country,
it Would Be the Third-Largest Greenhouse Gas Emitter



* Figures reflect all six anthropogenic greenhouse gas emissions, including those from land use, land-use change, and forestry (LULUCF). Country data is for 2012 while the food loss and waste data is for 2011 (the most recent data available). To avoid double counting, the food loss and waste emissions figure should not be added to the country figures.

Source: CAIT, 2015; FAO, 2015. *Food wastage footprint & climate change*, Rome: FAO.

 WORLD RESOURCES INSTITUTE

At the City of Melbourne scale, organics are a significant part of the waste stream: the City states that around 40% of landfill-bin contents are organic waste, and its food and garden organics program is intended to capture at least 50% of the food waste currently going to landfill.

The challenge is not only volume. In dense urban areas, food-waste recovery is complicated by limited space, contamination, shared responsibility, odour sensitivity, and servicing logistics. Worms at Work does not replace city-scale organics systems, but it tests whether a decentralised, place-based model can complement them by making food-waste recovery visible, local and easier for people to understand.

2.2. Melbourne Circular Economy Context

The pilot aligns with broader circular economy and regenerative-city directions. The project was framed around keeping food waste local, reducing dependence on collection systems, turning waste into compost, restoring soil, supporting planting and biodiversity, and embedding ecological processes into everyday urban infrastructure.

In this sense, the project sits at the intersection of several city priorities: waste diversion, community education, liveability, greening, regenerative design, and data-enabled innovation. Rather than using separate elements for seating, waste, greening and education, the pilot explores whether one integrated public element can perform several roles at once.

In Australia, food waste goes back to the soil rather than burning for energy.

2.3. Why a decentralised public-facing model matters in this uncertain world

In a world shaped by climate disruption, supply-chain volatility, rising energy costs and resource uncertainty, highly centralised systems can become more fragile, expensive and difficult to adapt. Decentralised systems offer a more resilient strategy. By processing food waste close to where it is generated, they reduce dependence on transport, external inputs and long supply chains, while increasing local capacity to respond to change.



Photo taken by the City of Melbourne. Worms at Work Community Workshop

Nutrients flow in a continuous cycle - from soil to food, to food scraps, then to compost, and back to the soil. A central idea behind Upsoil Collective for Worms at Work is nutrient circularity: keeping nutrients local rather than treating them as waste. In conventional urban systems, food is brought into the city, consumed, discarded, collected, transported and processed elsewhere. This creates multiple losses. Nutrients leave the places as a form of waste where they were used, collection and transport create environmental and financial costs, and people remain missing the opportunity to obtain fertile soil from composting food scraps for new food, biodiversity and urban greening.

The core proposition is to turn food waste into soil where it is generated, keep nutrients in food local, reduce bins and truck pickups, and make the composting process visible and meaningful in everyday urban life. In this project, Upsoil's goal is to turn street furniture into living systems that restore nature, support plant, insect and human life, and let regeneration happen where people live.

Rather than hiding composting behind the door, the system makes them visible and accessible. It invites people to participate in the cycle of care - feeding, observing, learning, and maintaining the living system. Through these simple acts, communities and businesses become active contributors to nutrient cycling, plant growth, biodiversity, and the creation of healthier urban ecosystems. This participatory approach is one of the key strengths of decentralised systems, transforming waste management from an invisible service into a shared community responsibility and learning opportunity.

3. What Success Looks Like

3.1. How Success Was Defined in Scope of Works

Success for the Worms at Work pilot was initially defined in the Scope of Works as the point at which sufficient data and testing had been captured for the idea's feasibility to be assessed on a go / no-go basis. For future scaling, the Scope of Works states that success should be considered through three criteria: desirability, feasibility and viability.

Under this framework, desirability relates to whether the pilot creates meaningful positive impacts through operation, including waste and circular economy impacts, social impacts, and demand from other residents and businesses to see the design in their neighbourhood. Feasibility relates to whether the design, technology and operating model are suitable for successful use in the public realm and capable of being sustained. Viability relates to whether the overall economic impact is justified by the positive outcomes and is comparable with existing public infrastructure.

As the project progressed, these criteria were further clarified and translated into more tangible project priorities through stakeholder input gathered during the workshops, including community workshop, business engagements, City of Melbourne working group discussion. The following refined success criteria were used to assess the pilot in a way that reflects both the original project objectives and the stakeholder needs and drivers identified through the project.

3.2. What else impacts the Success Criteria

1) Working Group Discussion

City of Melbourne working group discussions were held in late 2024 and early 2025, bringing together staff from multiple departments to map project goals, risks, challenges and opportunities for involvement. A further site visit in April 2025 was used to test ideas on site and continue the discussion. Key issues raised through this process included vandalism, graffiti and physical damage, public misuse, the “ick” factor associated with food waste, and the importance of reducing ongoing maintenance requirements for the bench.

2) Community Workshop

A roundtable-style community workshop was held in March 2025 at 18 Pence Lane Café, Yarra's Edge, before the design process began. This timing was important because it allowed community feedback to directly shape the product design, pilot approach and success criteria, rather than being collected after key decisions had already been made.

The workshop attracted 27 participants, with five table hosts facilitating discussion. Held in an informal and accessible setting, it brought community members together to discuss bench design, maintenance and technology in a way that felt grounded and relevant to everyday local life.



Photo taken by the City of Melbourne. Worms at Work Community Workshop

The workshop generated 15 user requirements, which strengthened the design criteria. These included the need for the system to be vermin- and pest-proof, odourless during operation, resistant to vandalism and misuse, and able to remove finished compost easily and without mess. Participants also highlighted the importance of safe and intuitive use, including a lid that would close slowly and safely, clear instructions on what waste can be added, and simple ways to interact with the system, such as being able to scan a QR code to receive live data or report issues. Just as importantly, the feedback reinforced that the bench should feel like a piece of furniture the community feels connected to, rather than a waste unit.

27

Community members
14 Women, 7 Men, 6 Other

18 - 75

Age Range

50%

Residents of Docklands

70%

Have composted before

3

Operators of Community Gardens

107

Feedback Items Collected

Data summarised by the City of Melbourne. Worms at Work Community Workshop

The workshop also helped identify potential champions and confirmed that engagement is most effective when people are invited into the process early, in places where the community already gathers naturally.

3) Business Engagement

Business engagement with Susuro was carried out throughout the design, fabrication, installation and operation phases through online, in-person meetings and communication channels. These discussions identified several practical requirements, including the need for the furniture to be visually appealing and aligned with business branding, able to accommodate a flexible feeding schedule, supported by routine maintenance, and backed by education and remote support. The usefulness of a sensor dashboard and reminder system was also raised through this engagement.

Based on the Scope of Work assessment criteria, together with the issues raised through community engagement, business needs and working group discussion, five shared priority areas emerged. Refer meeting notes and community engagement persona and criteria in appendix.

3.3. Refined Success Criteria

Below are five criteria well suited for a decentralised and community-managed model in urban settings.

1) Clean, Safe and Publicly Endorsed

“Does it smell?”, “Will it attract rats?” “How do we prevent vandalism?” were consistently the first questions people asked. Addressing these concerns was essential to gaining initial trust and getting the potential installation considered in the first place.

- No persistent smell
- No rats, pests or vermin
- No messy compost handling
- Low risk of graffiti or vandalism
- Acceptable in the public realm
- Food waste felt manageable rather than off-putting
- Whether installation caused disruption to community

Sources

- Scope of Works: Feasibility. “does not attract smells, rats and other vermin, graffiti or other undesirable public realm impacts”
- Community workshop: “vermin and pest proof”, “odourless during operation”, “resistant to vandalism and misuse”, “easy to remove vandalism”, “remove finished compost easily and without creating mess”, “a piece of furniture that community members feel connected to”
- Business engagement: “beautiful and represent the business value and branding”

- City of Melbourne working group workshop: “vandalism, graffiti and physical damage”, “public misuse”, “the ‘ick’ factor of food waste”

2) Simple to Maintain and Supported by People

High maintenance requirements are difficult to align with busy lifestyles, and ongoing maintenance costs can place additional financial pressure on the long-term viability of the system. Reducing this burden is therefore a key part of ensuring that ongoing costs remain sustainable.

- Minimal required maintenance
- Clear onboarding and simple instructions for new users to start using it
- Number of people required to operate the system
- Is the system healthy based on the sensor data
- The system remains reasonably stable throughout the year
- Ergonomically comfortable to use
- Support is available when needed
- Operating model can continue beyond the pilot

Sources

- Scope of Works: Feasibility & Desirability. “trialled seat operating models were successful and can be sustained”, “possible to engage local community and onboard them”, “understood how to use it and used it correctly”
- Community workshop: “deposit green waste easily”, “open and close the green waste opening easily”, “mechanism to remain open while the user deposits green waste”, “close in a safe and slow manner”, “clear instructions on how to drop off the correct type of waste”.
- Business engagement: “flexible feeding schedule”, “routine maintenance”, “education and remote support”
- City of Melbourne working group: “reducing maintenance requirements of the bench”

3) Clear Circular, Social and Investment Value

The key value of this pilot lies in its ability to divert food waste, build healthy soil and edible planting, shift how people feel about composting and their relationship with nature, and create meaningful opportunities for people to connect through participation in public space.

- Food waste diverted from landfill
- Compost and planting created
- Community or businesses showing spontaneous engagement
- Sentiment captured from community and business who participate
- Changed community behaviours and attitudes
- Making the space more conducive to socialising, active and safer
- Interest for future rollout is generated
- Cost of manufacture, installation and maintenance is reasonable compared with typical bench or garden bed

Sources

- Scope of Works: Desirability & Viability. “waste and circular economy impacts”, “social impacts”, “demand from other residents and businesses”, “economic impact is perceived by Council to be justified and sustainable”
- Community workshop: “provide at least one learning feature for children”, “learn more about the worm bench trial”

4) Suitable for Real Sites

Space constraints, environmental conditions and user demographics vary across urban public settings, so the ability for the worm bench to suit different sites and locations is important when assessing scalability.

- Suitable for real site conditions
- Suitable for installation in other locations
- Robust enough for ongoing public use
- Repairable and maintainable
- Easy to install

Sources

- Scope of Works: Desirability & Feasibility. “seat design is appropriate to scale and install in other locations”, “design is versatile, robust”
- Community workshop: “furniture-like”, “safe to use in various weather conditions”, “secured to prevent theft, prevent tipping over and support safe use”, “site must be protected from sun and rain”, “earthy and natural colour palette”, “deposit waste whilst someone is sitting on the bench”

5) Useful Technology That Support Operation

Technology plays an important role in reducing system uncertainty and maintenance guesswork, and in translating the living system into information that users can easily understand and act on. It can also help speed up adoption of new ideas by acting as a safety net, giving users more confidence to try, understand and manage an unfamiliar living system.

- Sensor position is optimal and does not disturb composting activity
- Sensor data indicates compost state, maintenance needs, issues, health or efficiency
- Dashboard / QR reporting is useful
- Local weather, UV and external-condition data available for comparison
- Sensor technology works and enables the design to be successful

Sources

- Scope of Works: Feasibility & Viability. “The embedded technology supports operation”, “sensor data used to identify signals or triggers that indicate the state of the compost, the need for maintenance, any issues or general health and efficiency”
- Community workshop: “scan a QR code and receive live data”, “scan a QR code to report any issues”, “scan a QR code to provide feedback”, “scan a QR code to learn

more about the worm bench trial", "scan a QR code to access information on how to use the worm bench"

- Business engagement: "sensor dashboard, reminder"
- City of Melbourne working group: "what data is actually useful", "ensuring to install sensors and the component in right direction to capture correct and continuous data"

4. Pilot Delivery

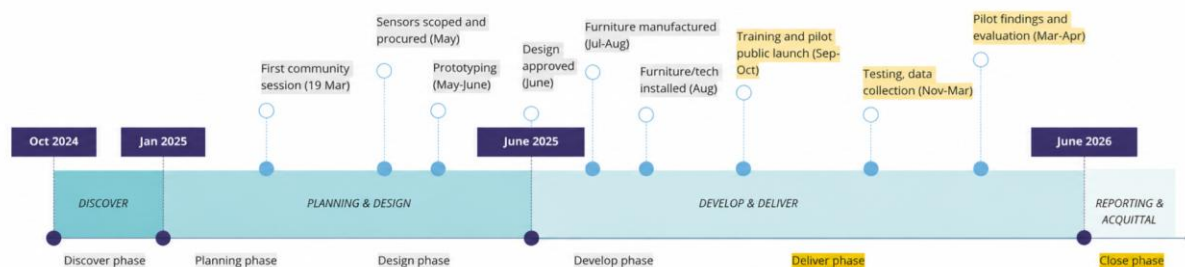
4.1. Project Scope

The scope of works defined the pilot as a staged process including site scoping, community and business engagement, technology requirements and design, dashboard and sensor exploration, worm bench design and approvals, fabrication, installation, launch, feedback collection, community maintainer workshops, maintenance of technology components, data integration and testing, data collection and visualisation, data analysis, qualitative surveys, and evaluation of a community maintenance model etc.

This means the project was broader than fabrication alone. It included design development, technical scoping, engagement, operating guidance, operational testing and evaluation.

All items have been delivered or have been included in this final report. Some additional deliverables have been done without funding through the pilot.

See Activities Delivery Checklist in Appendix 1.



Timeline diagram made by the City of Melbourne based on scope of work

4.2. Key Collaborations

Champion / host stewardship

Champions are key community and business members available to test and trial worm bench function and provide feedback.

Nikki Palun, owner of Susuro (a wine bar and cellar door at 15 Hall St, Port Melbourne, in the Montague precinct of Fishermans Bend) hosted and looked after the bench from mid-Oct 2025 to March 2026: feeding, checking, reporting and caring for it during the pilot. A new tenant Jenny Polack (owner of Bacchus Academy, wine education) has taken over the unit from the beginning of April 2026.

Governance - City of Melbourne / Smart City Incubator & Working Group

Council, the Smart City Incubator (SCI), provided the experience in pilot process, review

input, access to internal expertise, support for site scoping, champion identification, event organisation, signage delivery, technology development and implementation, communications support and more. The SCI functioned to connect Project Managers to internal subject-matter experts across waste and recycling, city design, strategic communications, neighbourhoods and community engagement, water sensitive urban design, climate change and city resilience, food security, infrastructure and assets, parks and city greening, and transport.



Photo taken by the City of Melbourne. Bench installation at Yarra's Edge. Bench designed and made by Michael Mobbs and Mr Fox in a Box

Collaborators - Michael Mobbs & Zoe Wang

Michael and Zoe were named as collaborators and formed part of the core collaboration structure for pilot delivery. They were jointly and severally responsible for the project day-to-day, including community engagement, furniture design and delivery, technology support, and communication review input. During the project, the two collaborators developed separate designs: Zoe created the modular worm table and bench unit (the subject of this report), while Michael adapted his existing Coolseat bench design. Each collaborator produced an independent report for their respective installations.

Fabrication - polynova

polynova is the Melbourne-based manufacturer responsible for the modular fabrication logic and installation of the bench at Susuro. The modular planter-box approach, designed by Zoe and modified to utilise the polynova Ankaa model, strongly shaped the final structure and its adaptability.

Composting operation supporter

Dave from Compostcare Naarm and Kensington Town Hall Composting Hub shared composting knowledge, supplied worms, plants and compost as growing medium, also provided planting arrangement design and species selection.

Technology Supporters

Byron Fisher from International STEAM Education supported the early development of the project's technology concept, lock fob application, and fan system implementation during the pilot phase. His Resoil Network platform was used to visualise site conditions, analyse the existing environment, and simulate unit performance across different placement configurations at three pilot locations. The analysis incorporated machine learning (ML) techniques to support performance assessment and inform design decisions.

Alexis Pang from University of Melbourne supported technology concept design early in the pitching phase.

Design supporters

Susie, Craig, Kate, Matt from Hassell Studio supported review of design and/or pitch content.

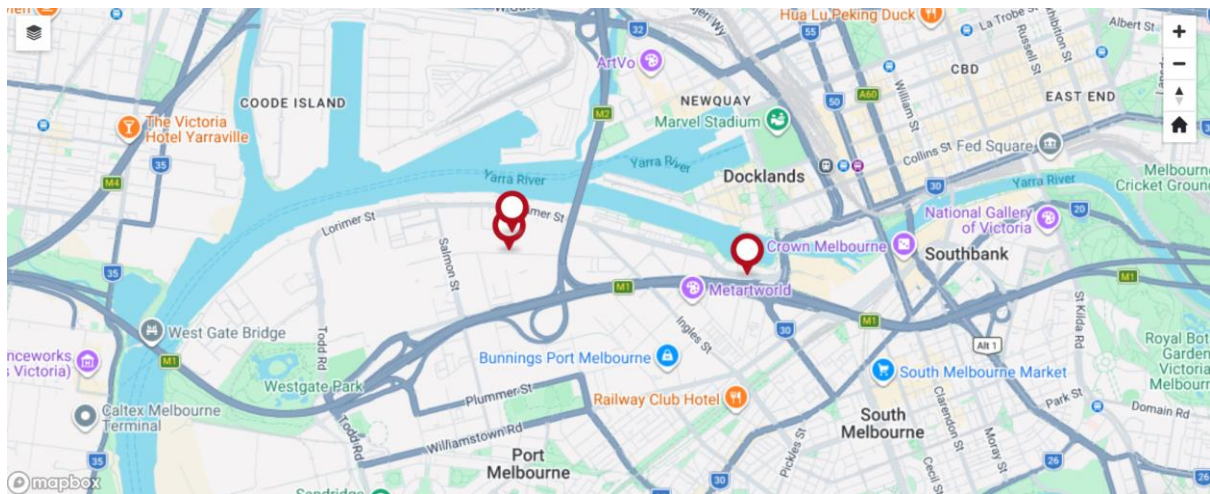


Photo taken by the City of Melbourne. Team photo of bench installation at Susuro. Bench designed by Zoe Wang and Fabricated by polynova

4.3. Site Selection

The site-scoping process considered three different testing contexts: a residential/community-oriented setting at Yarra's Edge, and hospitality-oriented settings represented by Susuro and St Ali. Yarra's Edge and St Ali were subsequently developed as Michael Mobbs's Coolseat installation sites; Susuro became the location for Upsoil Collective's installation, which is the focus of this report.

Ethnographic research based on 11 interviews of Worms at Work participants carried out by Monash University FUTURES Hub describes *“participants drew on their extensive experience with community based composting and gardening to anticipate the sensory and material impacts that composting might have in each of the three locations where benches were installed. This allowed the initial designs to account for factors including: smell, mess, and pathogenic risk; the needs of the worms; and the methods required for composting to thrive in an environment where both weather and paved surfaces made conventional composting difficult.”*



Mapbox on Worms at Work Participate Melbourne Page

5. System Design

5.1. Design Goals

To design, build and test:

- A clean, safe outdoor furniture that support healthy worm farming
- A simple, smart system that supports community-led maintenance model
- An adaptable multi-functional living infrastructure that breathes with nature

5.2. User Types and Site Contexts

The intended users were not specialist or compost managers. They are businesses, community hosts and local participants. The design was created conceptually against three site types, each representing different user behaviours, waste patterns and spatial conditions.

Susuro is an urban business setting with spatial constraints. Nikki, the owner, caters wines and food off-site during the pilot phase. She brings food waste to the site visiting the cellar door or after events somewhere else. The feeding schedule is dependent on her site visits. The site is facing north with direct sun and limited airflow, and is where Upsoil Collective design and this report is mainly focused on. The site provided a valuable context to test where low maintenance, visual quality and operational simplicity are critical.

St Ali represented a café and hospitality business setting, Lucy manages an on-site cafe and coffee roaster company, who has more consistent food waste generated, and relatively predictable maintenance available. The site has strong wind, and facing the west building in front.

Yarra's Edge represented a more residential and community-oriented setting. In this site, the system would rely on shared community stewardship, resident participation and neighbourhood-scale interest. The location is a harbour site along a waterfront path that people from other parts of the city will pass by with an open air, facing north, full sun condition.

5.3. Constraints

The final design was shaped by several practical constraints.

1) Space Constraint

The Susuro site had the narrowest depth available footprint among the three sites. The base unit sizing was therefore developed around this constrained condition so that the system would remain viable in other tight urban sites.

2) Environmental Constraint

The site SUSURO is placed in a challenging thermal environment. It receives direct sun gain 10:30am to 4:30pm during the summer month. The rear of the unit sat 30mm to a glass wall,

10mm above the concrete path, both radiating heat back to the furniture. The glass wall and side concrete walls restrict airflow, which limits cross ventilation and reduced heat escape, particularly in hot weather.



Photo taken by Zoe Wang. Susuro site before bench installation

3) Public-Realm conditions

As a public-facing object, the system is aiming as a pilot MVP, but still needed to manage risk associated with misuse, vandalism, visual acceptance, hygiene concern and ease of access.

4) Operational variability

The pilot needed to be usable by people who were busy, sometimes absent, and not necessarily experienced composters.

5) Timeline and budget

The design phase started late March / early April after a community workshop. Three months until the end of June to conduct research, deliver design, and lock in fabrication and quote from scratch. Due to the integrated nature of the project requiring work around community, design, delivery, technology, the budget for manufacturing was estimated at \$3600 which is

slightly lower than one-off custom furniture in the market, which created a challenge for onboarding a fabricator before the end of the financial year.

5.4. Furniture Design

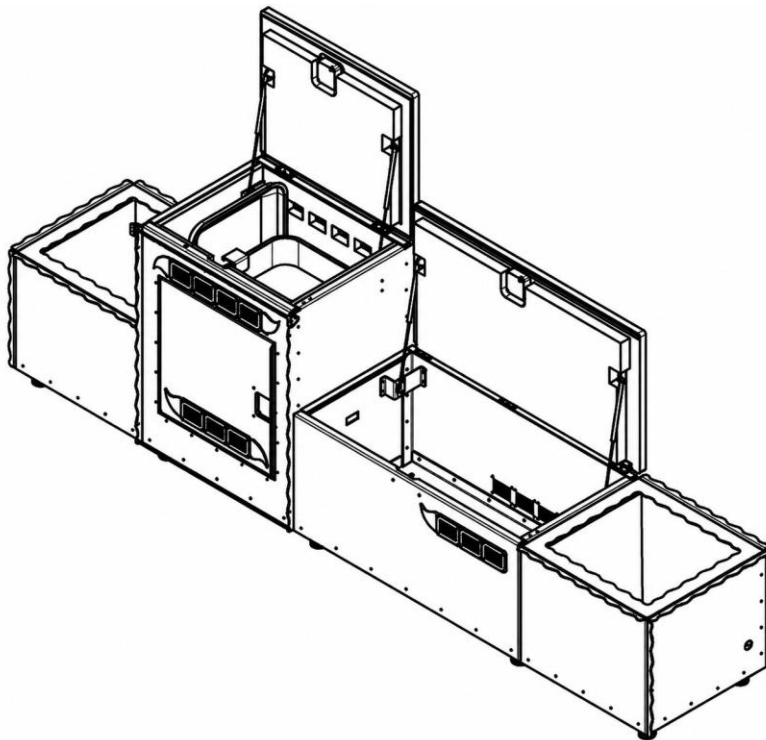
1) Overall configuration

The design evolved from a simple bench concept into an integrated furniture system combining worm farming, seating, table use and planting.

The final configuration includes:

- one main table-height worm farm unit containing one five-tier tray worm farm as the primary composting system, with viewing window cut-outs for visibility into the system; sensor integration points within the main unit
- one bench with worm farms and storage space inside the bench for maintenance tools, supplies and emergency items
- two garden beds positioned on each side
- One bench and one table condition to support sitting, leaning and informal dining
- lockable access points for controlled use
- drainage outlets directing overflow externally

This overall arrangement was designed to support 3 tier worm farms with various size, internal drainage systems, different height for different user accessibility and different furniture use. It allows the furniture to function as a place to sit, gather, lean, dine, observe and maintain, while keeping the worm farming system visible and usable.



Fabrication Drawing produced by polynova. Model made by polynova & Zoe Wang

2) Modular construction

The furniture was designed as a modular panel-based system assembled with mechanical fixings rather than welding. This allows the unit to be dismantled, modified, repaired and relocated more easily over time.

The modular system was developed through integration with the Ankaa planter-box system. To meet design intent, the furniture has adjusted access strategies for the worm farming system, adjustable feet to suit different site conditions, perforations for sensors and drainage pipes, cut-out vents for airflow and ventilation, insulation layer for temperature control, and integration of worm farm, table, bench and planter components into one system.

3) Materiality

The main structure uses 3 mm aluminium panels, they provide a robust frame while still supporting modular assembly and disassembly.

The lids were timber boards, selected as part of the MVP build for a short to medium timeframe. They are suitable for pilot use, but can be replaced with more durable outdoor materials in future versions if required.



Photo taken by the polynova

4) Appearance and identity

Appearance was treated as part of performance. The furniture needed to function well, but it also needed to look appropriate in a visible public-facing business setting.

For the Susuro installation, the design and colour palette were selected to align with the business's branding and interior aesthetic, which the owner particularly appreciated. The finished furniture was considered visually strong enough to be placed in front of the business. This was important because acceptance depended not only on function, but also on whether the unit felt aligned with the business identity and public image.

This confirms that visual quality, branding alignment and furniture-like appearance are critical to the success of this type of living infrastructure in public and semi-public settings.



Photo taken by the City of Melbourne

5.5. Worm Composting System

1) Species Selection

The system uses red wigglers (*Eisenia fetida*), one of the most widely used composting worm species globally. This species was selected because it is commonly available, well proven in composting systems, and more tolerant of practical operating conditions than many other worm species. It is also relatively suitable for beginner-managed systems because it can perform across a broader working range of temperature and moisture conditions.

For this pilot, the target operating range for the worms was approximately: 15–27°C, 80–90% moisture and pH 6–8. These biological requirements informed the design of the enclosure, ventilation, feeding rhythm and maintenance approach.



Photo taken by the City of Melbourne. Worms harvested by Dave Goodman, Kensington Town Hall Composting Hub

2) Worm Count and Establishment

The worms were sourced at Kensington Town Hall Composting Hub, where red wigglers were collected from active composting bays and transferred into the pilot system.



Photo taken by Dave Goodman. Worms harvesting at Kensington Town Hall Composting Hub

Approximately 3,500 worms were introduced across the three worm farms at the Susuro bench. This provided a suitable starting population for the system to establish, begin processing food waste, and allow the worm population to grow over time.



Photo taken by Zoe Wang. Worms harvesting at Kensington Town Hall Composting Hub

3) System Comparison and Tier based logic

Through comparison of multiple worm farming system types to identify a format that could be integrated into public furniture and still remain easy to use, easy to manage, lightweight, beginner-friendly and clean. A range of system types were considered and compared during design development, including grate-based system, drawer system, tray system, chamber system and bag system.

Through this process, the tray-based system emerged as the preferred approach because it offered the clearest balance of simple operation, clean harvesting, low disturbance to worms, beginner-friendly use, suitability for integration into a bench or table setting. Its operating logic is simple and consistent:

- feed from the top
- keep food buried and balanced with carbon
- allow lower trays to mature
- harvest compost from the bottom

4) Worm Liquid Internal Recycling

The system will produce liquid consisting primarily of food-waste leachate and drainage water generated during decomposition. While this liquid can contain nutrients, its composition could vary and may contain contaminants if not further treated. For this reason, the system was designed to direct the liquid into the adjacent garden bed, where it can be further filtered and biologically processed within the planted landscape rather than being collected for public distribution.

5) Clean Harvesting

The system will also produce solid output which is mature vermicompost, we also call it compost in this report. Once fully processed and matured, the compost is stable, easier to handle, and presents a lower risk for the public. This makes it suitable for periodic harvesting and reuse as a soil fertiliser.

The tiered tray system allows mature compost to be harvested from the lower tray without manual shovelling and without disturbing most worms in the upper trays. When maintained well, this makes harvesting cleaner, lower-hassle and more suitable for public-facing use than more manually disturbed systems.

6) Capacity

Capacity in this system is calculated less by overall container volume and more by worm population, feeding surface area, airflow, temperature, moisture and carbon balance. The insulated design was intended to maintain more stable biological conditions through winter and is estimated to improve winter processing capacity by around 50% compared with a non-controlled system.

This bench design provides 0.42 m² of surface feeding area, which can support approximately 4,660 worms when fully established and operating under ideal conditions. Each worm can consume at least around a quarter of its body weight per day. Compost typically matures over 45–90 days, depending on temperature, moisture, and feedstock conditions. Feeding should therefore be paced to match the worms' processing rate and prevent overloading the system.

Without condition-specific calculations, the bench is estimated to process approximately 260 kg of food waste per year, with capacity able to be increased through future design iterations.

5.6. Environmental Control

Environmental control was a core part of the pilot because worm health and composting performance depend on temperature, airflow and moisture balance. The design therefore aimed to protect the system from rain, moderate heat gain, support ventilation, and maintain more stable internal conditions across seasons.

1) Ventilation and Airflow

The furniture was designed with louvre vents at the front, back and additional vents on the table sides to support passive airflow through the worm-farming unit. This was intended to reduce heat build-up and maintain aerobic composting conditions.

A small active fan was also installed at the end of 2025 by Resoil Network to understand whether extra ventilation might be needed in these conditions. This was used for comparison and data gathering rather than as a permanent operating solution.

2) Insulation and Heat Control

Insulation was installed to the sides and top of the table unit, and to the top of the bench, to buffer heat transfer and for a comparison test. During extreme heat events, temporary external shading was tested to reduce heat gain.

3) Rain and Moisture

The table and bench lids were fully covered, and the louvre vents were selected to maintain airflow while preventing rain ingress.

Moisture within the worm farm was managed using carbon material (shredded paper etc) and worm blankets, which absorb excess moisture while retaining sufficient humidity for worm health. This helps maintain a stable composting environment and supports an appropriate balance of food waste, carbon-rich bedding, and moisture.

5.7. Sensor Integration and Data

1) Design Integration

Sensor integration was considered from concept design through to fabrication in collaboration with the technology specialist Dev and fabricator polynova. For the Susuro bench, the main control box was located within the toolbox area to improve protection, reduce vandalism risk, and keep the technology accessible for maintenance. Cables and probes were routed into the table unit and into the second tier of the worm farm. This position was selected as the best balance between data relevance and physical stability,

sitting close to the active composting zone while being less disturbed than the top feeding layer.



Diagram made by Zoe Wang. Sensors are installed in locations that provide maximum support while causing minimal disturbance to composting activities

2) Sensors Used

The pilot included sensors for temperature, moisture, pH, odour, CO2, vibration, lid opening status.



Seat Usage Sensor

What it does: Detects vibrations to sense when someone is sitting on the bench.

Features: Small, accurate movement detection, battery-operated (long-term use), uses LoRaWAN network for wireless data transmission.

Why it's important: Helps us understand how often the bench is used, so we can plan maintenance and ensure it's a welcoming spot for everyone.



Compost Moisture Sensor

What it does: Measures compost moisture levels to keep worms healthy.

Features: Accurate moisture readings, compost temperature readings, Compost conductivity temperature compensation, corrosion-resistant, battery-operated (long-term use), uses LoRaWAN network for wireless data transmission.

Why it's important: Ensures the compost stays at the right moisture level for worms to thrive, preventing it from getting too dry or too wet.



PH Level Sensor

What it does: Checks the compost acidity to support worm health.

Features: Precise pH measurement, compost temperature, battery-operated (long-term use), uses LoRaWAN network for wireless data transmission.

Why it's important: Keeps the compost pH balanced, creating a healthy environment for worms to live and work.



TVOC & CO2e Sensor

What it does: Monitors air quality around the bench.

Features: Measures TVOC, eCO2, temperature and relative humidity, battery-operated (long-term use), uses LoRaWAN network for wireless data transmission.

Why it's important: Ensures the air around the bench is clean and safe, protecting both worms and visitors.

	<p>CO2e Sensor</p> <p>What it does: Monitors air quality around the bench.</p> <p>Features: Measures eCO2, temperature and humidity, battery-operated (long-term use), uses LoRaWAN network for wireless data transmission.</p> <p>Why it's important: Helps monitor air quality and ventilation inside the bench. High CO₂ levels can indicate poor airflow or anaerobic conditions that affect worm health. Ensuring balanced CO₂ levels supports optimal composting and provides valuable data on environmental conditions around installation.</p>
	<p>Seat Status Sensor</p> <p>What it does: Detects when the seat is opened to add food scraps.</p> <p>Features: Uses a Hall effect sensor to detect open/close status, battery-operated long-term use), uses LoRaWAN network for wireless data.</p> <p>Why it's important: Tracks when food scraps are added, helping us monitor feeding schedules and ensure worms have enough food.</p>
	<p>Odour Sensor</p> <p>What it does: Monitors odour levels and air quality inside the worm bench.</p> <p>Features: Measures hydrogen sulfide, ammonia, temperature and relative humidity, battery-operated (long-term use), uses LoRaWAN network for wireless data transmission.</p> <p>Why it's important: Helps identify when the worm farm may be producing unpleasant odours due to overfeeding, excess moisture, or poor aeration.</p>

Sensor Information on Worms at Work Participate Melbourne Page

Additional non-IoT temperature sensors and a small fan were installed in both the table and bench units to compare thermal conditions across different heights, positions and sunlight exposure. This helped build a clearer understanding of heat build-up and airflow behaviour within the furniture.



Photo taken by Resoil Network. Active fan system with temperature sensors integrated

Some technologies considered earlier in the project were not carried through to the pilot, including a solar panel, digital display screen and weight sensor. These were omitted due to budget, power, programming requirements and lower priority relative to the core monitoring needs. Food-waste input was instead tracked through manual weighing and manual logging.

3) Dashboard and Reporting

A dashboard was developed by Dev Patel to translate the worm farm biological behavior into readable information for maintainers. Upsoil has supported in identifying key data trends, healthy operating ranges, alert bands, and the actions users should take if conditions moved

out of range. Environmental data such as Melbourne temperature, rainfall and moisture was also requested and captured to understand factors impacting the worm farm environment.

4) On-Site Reporting

A QR-based reporting form was provided by Upsoil on the table lid so users could log feeding time, feeding quantity, observations and actions taken. This was useful because it helped interpret sensor readings in context. This also aligns with the community workshop identified a strong desire to “scan a QR code to report any issues”, “scan a QR code to provide feedback”, and “scan a QR code to learn more about the worm bench trial.”

Hi worm carer, what did you SEE and DO?

zoe@upsoilcollective.com

Switch accounts

Not shared

WORM TABLE (LEFT)

If you fed today, how much food (kg) did you add?

Your answer

How much carbon (kg) did you add?

Your answer

What did you SEE?

☐ Food mostly gone

☐ Old food still mostly there

☐ Strong smell

☐ Too dry

☐ Too soggy

☐ Blanket uncovered

☐ No carbon visible (paper, leaves, cardboard)

☐ Bedding clumping

☐ Worms clumping

☐ Few or no worms seen

☐ Many new worms outside the farm

☐ Ants

☐ Excessive vinegar flies

☐ Excessive mites

☐ Cockroaches

☐ Rodents

☐ Direct sun heats up the furniture too much

☐ Other:

What did you DO?

☐ Fed worms

☐ Added carbon (paper, leaves, cardboard)

☐ Sprayed water

☐ Buried food with bedding and blanket

☐ Fluffed bedding

☐ Stopped feeding / put "Pause" Sign

☐ Added egg shells or garden lime

☐ Removed problematic food

☐ Added fly-trap

☐ Applied Vaseline, mineral oil or cinnamon powder for ants

☐ Set up a new tray

☐ Emptied worm liquid

☐ Other:

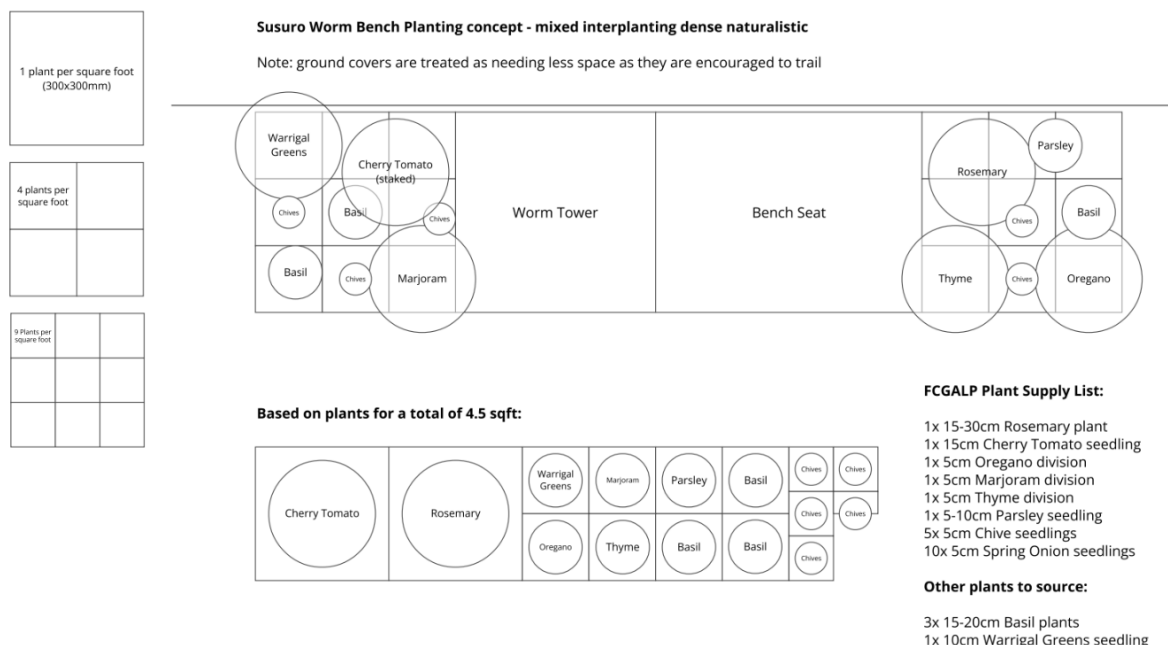
5.8. Integrated Vegetable Garden

1) Purpose

The integrated vegetable garden was designed to make nutrient circularity legible in public space by showing how food waste can be transformed into compost and then into edible planting. In this way, the garden beds are not separate from the worm-farming system, but part of the same cycle linking waste, soil, food and human use.

2) Species selection

Plant selection was developed by Dave Goodman in response to a brief from the business owner, who wanted edible species suitable for pizza-style catering. The planting palette was therefore designed around a “pizza palette” of edible herbs and related species. Plants are supplied by Footscray Community Garden and Learning Place.



Planting Design created by Dave Goodman, Compostcare Naarm

3) Growing Medium

The growing medium used in the garden beds was 100% mature compost sourced from Kensington Town Hall Composting Hub composting bays, providing a biologically rich and nutrient-dense planting base consistent with the project’s circular design intent. Compared with many commercially available garden soils and planting mixes, the mature compost contained higher levels of organic matter and biological activity, supporting plant establishment and ongoing soil health.



Photo taken by Zoe Wang. Installation and planting day with Dave Goodman

6. Maintenance

6.1. Champion

13 Community champions were gathered through community workshops or through word of mouth, and 2 business champions through FB ideas network.

At Susuro, only one person is available for feeding and maintenance. Due to business operations off-site, the champion will be available when visiting occurs.

6.2. Operational Guidelines

Maintenance support was built into the furniture through a QR-linked How to Use Guide and Boss Battle Troubleshooting Guide located on the table unit.

The operational logic described in the guidance documents is simple and repeatable. The troubleshooting guidance identifies common challenges (described in the How-to Guide as “boss battles”). The recommended response is generally to feed less, add carbon, bury and cover food, improve airflow, maintain shade, and respond early.

WORMS AT WORK

CHEAT SHEET

You're not just composting, you are working with a living ecosystem!



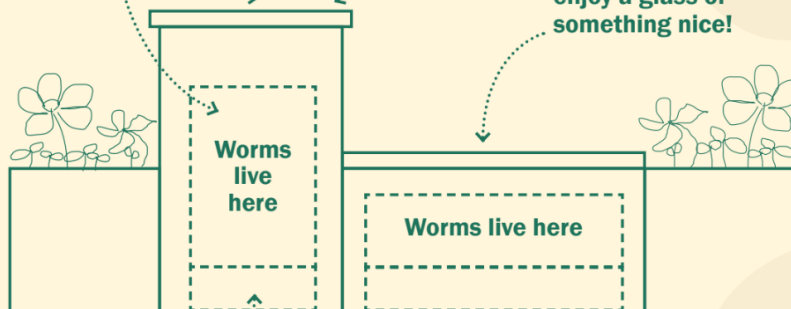
CONTACT US
upsoilcollective.com
hello@upsoilcollective.com

1 Swipe to unlock, lift to access

2 Bury food scraps and carbon in

4 Scan QR code to log what you see and do

5 Sit here and enjoy a glass of something nice!



3 Harvest compost here

Ready to get started?
Take the Living Furniture Quest, with Worms at Work!

Date: 12/04/2026

WORMS AT WORK THE LIVING FURNITURE QUEST

It takes teamwork to keep it balanced, productive, and happy. Every action you take shapes the worms' world in real time. Feed smart, track your data, and grow new life in the soil!



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YOUR FURNITURE



- 1 Worm Table:** One main worm farm with worms and compost sensors.
- 2 Worm Bench:** Two booster worm farms, with the bottom tray of the green one used for carbon storage.
- 3 Edible Gardens:** Where your compost gold becomes plants again.

LEVEL UP PATH

Level 1 - Settling - Observe & learn
Mission: Feed small, and up to 2 kg/week, track how fast worms eat.

Level 2 - Team building - Collaborate
Mission: Work together to split feeding target, and discover the best teamwork rhythm - feed up to 3 kg/week across three farms (about 1.5 kg for the table farm, 1.5 kg for bench worm farms). Practice the Winning Team strategies.

Level 3 - Expansion - Explore feeding potential, and how it relates to compost health and seasonal changes.
Mission: Feed up to 6-12kg/week across the three farms, guided by worms' appetite.

RIGHT FOODS

Power-ups: Fruit, vegetable scraps (chopped is better), blended food, pulverized eggshells, spent coffee grounds, non-plastic tea bags, shredded paper and cardboard, tissues.

Moderate doses: Large amount of citrus, onions, garlic, chilli and ginger can burn worm's skin; Too much melons, squashes can make the farm too moist; too much bread, rice can mold quickly; cooked food can be salty. Too much rotting food can be smelly.

Game overs: Meat, fish, bones, oil, dairy, salt, hot & spicy food, diseased plants, pet poop, processed food, glossy or synthetic paper.

ROLES

WORM FEEDER

Keep the worms fed and happy

Quantity: Split feeding targets between team members.

Top scraps with dry carbon in the caddy.
Log impact: Weigh and record feeding.
Enter the worm world: Open the lids and feed in the top tray when the old food is mostly eaten or about half gone.

Place the feast: Dig a spot, add food scraps - bonus if chopped or thawed.
Balance the meal: Add equal dry carbon (shredded paper or cardboard).

Gold tip - bury the treasure: Cover scraps with bedding and a blanket to speed up composting and prevent pests.
Boss Battles: Carry out "Boss Battles" if needed.

FIELD AGENT

Tackle challenges and track findings

Visit the furniture every 1-2 weeks.

Carry out "Boss Battles" if needed.

Check dashboard data (scan the bench QR code) and take actions to prevent major "Boss Battles".

Water the garden's wicking cells until water level indicator reaches the top, if there isn't heavy rain coming up.

Log what you see and do for analysis.

Inform the Gold Harvester when the top tray is 3/4 full.

GOLD HARVESTER

Celebrate the win

Check maturity: When the top tray is 3/4 full, peek the bottom window. Dark, crumbly means ready! If not, put a "I'm full" sign on the worm farm lid.

Lift: Remove upper trays from top and front openings, keeping in order.

Harvest gold: Collect compost from the bottom tray, weigh and log weight. Fill at least a quarter of the empty tray with mature compost as new bedding.

Stack the trays back: Return trays in the same order as:

Top to Bottom = Immature to Mature.
Data reconnect: Bury sensors in the second tray through sensor slots, surround by compost for tracking.

Set new home: Place the empty tray on top and fill halfway with damp bedding, 50% mature compost + 50% shredded paper + crushed eggshells.

Claim reward: Use compost in the garden or share with the community.

Reset stage: Clean up for the next players.

Date: 12/04/2026

WORMS AT WORK

BOSS

BATTLES

EMBRACE THE ECOLOGY
KEEP THE BOSSES AWAY



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WINNING TEAM

FEED AS NEEDED

Overfeeding is the #1 problem, leading to rot, bad odours, heat, moisture, and pests.
Easy win: Keep the worm world healthy by feeding only after the previous food deposit is mostly or halfway gone. Balance their diet with carbon like shredded paper is also key.
Data: Overfeeding increases pH, moisture, and temperature. It also leads to odours, pests and uneaten food.

BURY & COVER

Exposed food scraps rot, smell and attract flies.
Easy win: Bury scraps and always add same amount of dry carbon (like shredded paper) in bedding, then cover them with a damp worm blanket.
Data: Odour data may rise if food isn't buried or covered properly.

THERMAL COMFORT

When it's too hot or too cold, worms eat less and may try to escape, or even die.
Easy win: Support early - provide protection before temperature rise or drops too far.
Over 32 °C, keep the bench shaded with a cloth, add bottles of ice water on the top tray, and feed thinner layers.
Below 4 °C, Cover with shade cloth, add a thicker blanket or use a heat pad.
Data: Worms are most productive between 15-27 °C.

BOSS BATTLES

ODOUR

Cause: Overfeeding, rotting food, too wet.
Data: Moisture and temperature may rise, NH3 readings may increase.
Easy win: Feed less, add carbon, ensure moisture is below 85%, bury and cover food, avoid oily foods, dairy and meat.

TOO WET OR TOO DRY

Cause: Soggy bedding reduces oxygen, leading to anaerobic and odour. Worms breathe through moist skin, so dryness weakens or kills them.
Data: Maintain 60%-85% moisture, keep bedding wrung-out damp.
When above 90%, add dry carbon (shredded paper); feed less watery food;
When below 60%, spray water, cover with a damp blanket, and feed moist foods.

UNBALANCED pH

Cause: Overfeeding or acidic/alkaline food
Data: Keep pH 6-8.
If above 8, aerate the bedding.
If below 5, remove acidic foods, aerate the bedding and mix in dry carbon; add garden lime or ground eggshells.

VINEGAR FLIES

Cause: Exposed food; Overfeeding, rotting food; fly eggs brought in with fruit scraps.
Easy win: Bury & cover, freeze scraps before feeding, and use a fly trap.
Data: may show low pH.

ANTS

Cause: Bedding too dry.
Data: Low moisture.
Easy win: Moisten bedding slightly, apply Vaseline or mineral oil around the worm farm legs; sprinkle ground cinnamon in the farm where ants are.

EXCESSIVE MITES

Cause: Excessive moisture, overfeeding, or uncovered food.
Data: Low pH, high moisture.
Easy win: Feed less, add dry carbon, remove infested scraps.

RODENTS

Cause: Openings bigger than 6-6.5 mm.
Easy win: Check and ensure openings under 6.5mm with metal mesh, bury and cover scraps, and avoid dairy, oily foods, fish, or meat.

WORMS ESCAPE

Cause: Poor conditions (too wet, too hot, not enough air).
Data: Temperature or moisture too high, or pH too high or too low.
Easy win: Keep moisture and pH balanced, ensure bedding is well-aerated and away from direct sun.

HOLIDAY

Easy win: Add extra bedding before leaving, and ask a teammate or friend to check/feed fortnightly.

Date: 12/04/2026

How to Use Guide created by Zoe Wang

6.3. Business Day-to-Day Use

The maintenance model was tested against real business conditions. In this setting, the tiered worm-farm system was chosen as relatively forgiving of a moderately irregular feeding schedule, provided the system was fed correctly and kept in balance.



Photo taken by Zoe Wang. Planting day with Susuro business owner Nikki Palun

6.4. External Support

External support remained available throughout the pilot as a safety net. Zoe provided ongoing support, and Dave and Byron were available for on-call backup although no on-call support was needed during the pilot. This helped reduce risk during troubleshooting, unusual events, or periods when additional guidance was required.

7. Results and Evaluation

7.1. Evaluation Approach

This chapter evaluates the pilot against the refined success criteria in Section 6.2:

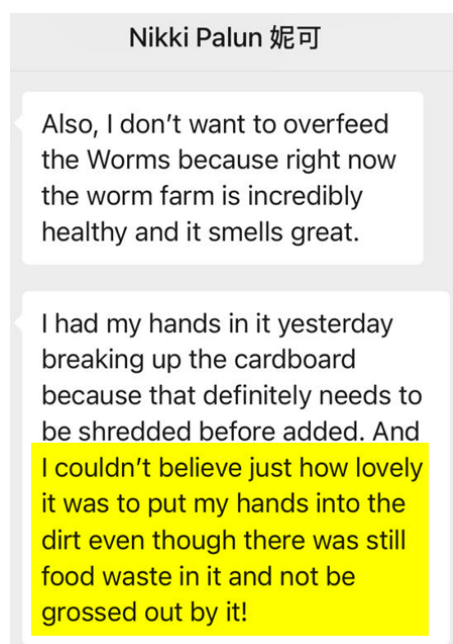
1. Clean, safe and publicly endorsed
2. Simple to Maintain and Supported by people
3. Clear Circular, Social and Investment Value
4. Suitable for Sites
5. Useful Technology That Supports Operation

All evaluation results are based on data, feedback and observations during the operation period from mid-October to end of February for Susuro bench mostly, but include other sites where specifically mentioned.

7.2. Criteria 1. Clean, Safe and Publicly Endorsed

Overall assessment: Strongly demonstrated

Evaluation summary: The design performed strongly on smell control, cleanliness, vandalism, and public acceptance, with no major public-realm issues recorded. No persistent smell, rodent activity, vandalism or disruption was observed during the pilot period. The unit was also positively received as a furniture-like public element rather than as a visible waste facility.

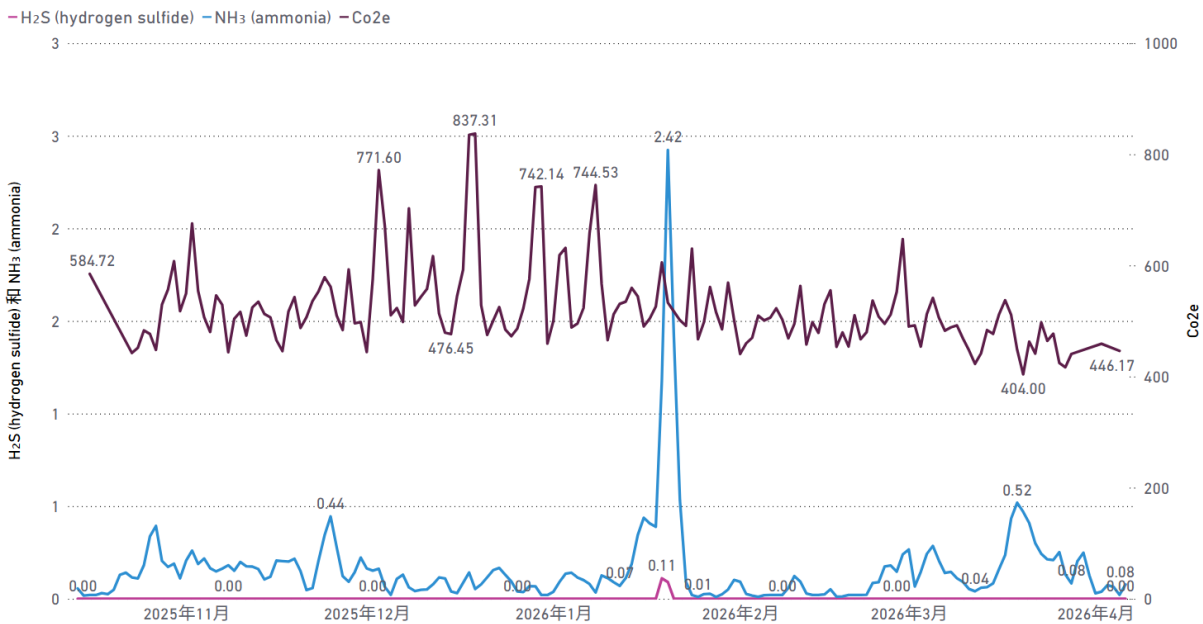


Messages sent by Nikki Palun - business owner and bench host at Susuro

What was evaluated	Result
No persistent smell	No smell was reported by the host business during the pilot. Odour was noticed once on 18th Jan, only when both the table lid and worm farm lid were open at the same time (NH3 detected as 2.42) and was not noticeable when the system was closed (NH3 detected as 0.44). See Figure. Odour sensor data.
No rats, pests or vermin	No rodent issue was recorded. The furniture enclosure openings are under 6-6.5 mm. Feeding avoids meat, dairy and oily foods.
No messy compost handling	The tray system was intentionally selected so compost is separated from worms and could be harvested from the bottom tray.
Low risk of graffiti or vandalism	No graffiti or vandalism was recorded; Lockers were installed for controlled access.
Acceptable in the public realm	<p>The unit was positively received by the business host and placed visibly in front of the cellar-door glass wall next to the entrance after the design was presented. The tenant who succeeded her agreed to keep the bench in place and continue maintenance/use. People from the Department of Defence office nearby and other businesses in Fishermans Ben Business Forum talk about it organically.</p> <p>The garden integration was also one of the most well-received aspects of the concept. The planting softened the metal furniture build and the harder industrial character of the site, helping the unit feel less like a waste facility and more like living public infrastructure.</p> <p>Ethnographic research based on 11 interviews of Worms at Work participants carried out by Monash University FUTURES Hub describes <i>"Prioritising the sensory expectations of potential users - participants adjusted the bench design to safeguard potential users from adverse sensory experiences and to accommodate fine tuning after installation. Prioritising users' sensory expectations in this way made the benches easier and more comfortable to use."</i></p>

Food waste felt manageable rather than off-putting	The worm bench host Nikki at Susuro reported feeling comfortable putting her hands into the compost and was surprised that she did not find the system “icky”. This suggests that the design helped food waste feel contained and manageable in a public setting. See Figure. Food waste felt manageable rather than off-putting.
Whether installation caused disruption	No disruption recorded during installation and operation.

Figure. Odour sensor data in blue



Source: City of Melbourne Participate Melbourne Worms at Work

7.3. Criteria 2. Simple to Maintain and Supported by People

Overall assessment: Strongly demonstrated

Evaluation summary: The system proved manageable to maintain, easy to learn, and workable with light-touch support. One committed person was sufficient to keep it operating during the pilot, with occasional support during absence improving resilience. The main operational issue identified was thermal stress during heat events, rather than user difficulty or maintenance complexity.



Photo taken by Zoe Wang. Business onboard induction

**What was
evaluated**

Result

Realistic
maintenance

Routine maintenance remained low when the worm farms were fed in appropriate amounts and kept balanced with enough carbon. Check-ins by the host generally occurred at feeding time, and every 2 weeks by Zoe. Preventative care and watering plants were needed during extreme weather, particularly before compost temperature rose above 32°C, which typically aligned with Melbourne air temperatures above 36 - 39°C. More frequent lid opening also supported air exchange and helped the system process food more effectively to some extent.

	<p>Tray rotation was needed every month or so once the top feeding tray became full. Each tray weighed approximately 5-7 kg. During the reporting period, tray rotation was undertaken by Zoe, with further user feedback to be gathered after reporting.</p>
<p>Clear onboarding and simple enough for new users to learn and start to use it</p>	<p>The tiered worm farm was beginner friendly. Its top-feed / bottom-harvest logic was easy to understand and remember, and new users could be onboarded in approximately 10-15 minutes. Correct use was supported by in-person walkthroughs and QR-linked how-to and troubleshooting guides. See Image. How-to-Use and Boss Battle Guides</p>
<p>Number of people required to sustain an operating model</p>	<p>One person at Susuro was generally sufficient to keep the system operating during the pilot. However, a second supporter was necessary during absence, particularly during extreme weather or other emergencies, for more than 2 weeks</p>
<p>Is the system healthy based on sensor data</p>	<p>The system remained generally healthy during the pilot. Sensor and observation data suggest that the main challenge was thermal stress during heatwaves due to (the particularly difficult Fishermans Bend) site conditions and limited airflow outside and inside the furniture, rather than basic operation or user error. See Figure. Temperature history.</p>
<p>The system remains reasonably stable throughout the year</p>	<p>The system remained generally stable except for extreme summer days. Worm farming typically slows in cooler weather, however, the insulated bench design is simulated to improve processing speed by around 50% compared with a non-controlled system under cooler conditions.</p>
<p>Ergonomically comfortable to use</p>	<p>The system was comfortable for quick worm feeding and check-ins. The table-height unit with front access was more ergonomic for people with back issues, whilst the bench unit may be more comfortable for wheelchair users and kids, however this hasn't occurred during testing period. Bending was still required for harvesting or swapping trays, which will require rest if long period maintenance is needed.</p>

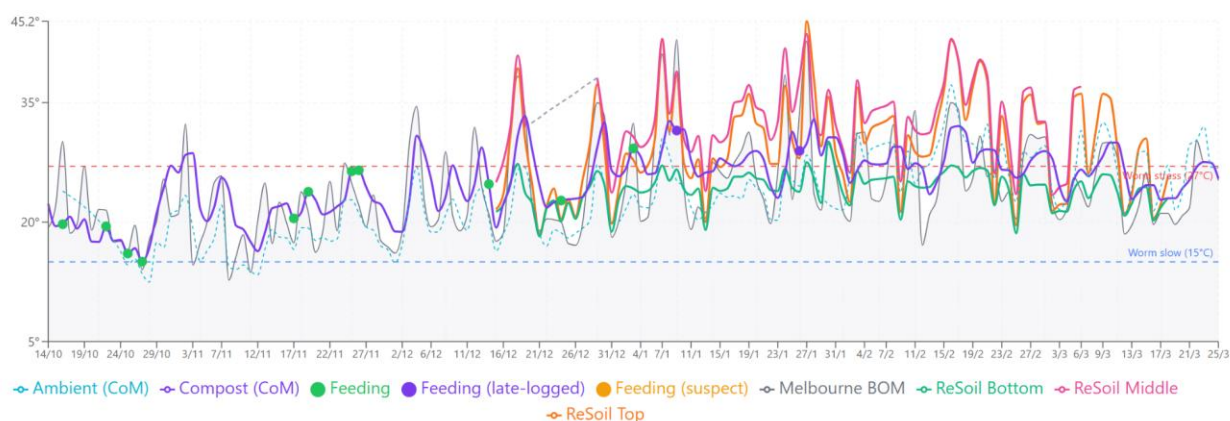
	The bench and table heights were designed to accommodate both the worm-farming system and public-furniture use, making the unit comfortable, practical and easy to interact with.
Support is available when needed	Support was available through a WeChat communication channel for questions and reminders. See Image. Maintenance Support Communication.
Operating model can continue beyond the pilot	The operating model can continue beyond the pilot as long as there is a person available to feed, observe and respond when needed.

Figure. Temperature history

Temperature History

2025-10-14 to 2026-03-25

ReSoil sensors display highest reading of the day, not average. Feeding events verified by ReSoil Machine Learning CO2 response analysis.



Source: Resoil Network

7.4. Criteria 3. Clear Circular, Social and Investment Value

Overall assessment: Promising / Demonstrated

Evaluation summary: The pilot demonstrated clear circular and social value through food-waste diversion, compost production, edible planting, frequent seat use, and positive community interest. The investment case appears promising when compared with the cost of typical council bench and garden-bed infrastructure.

Recommended Development Opportunities for Community Spaces

ExternalInbox x

Chrisentiae Saint-Piaf<chrisentiae@gmail.com>
to info, me, smart.cities, info

Fri, 17 Oct 2025, 08:59

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Fri 17 Oct 2025

cc City of Melbourne (Worms At Work initiative), Zoe Wang from UpSoilCollective, Susuro Urban Winery

NOT PRIVATE AND CONFIDENTIAL - FEEL WELCOME TO SHARE

Hello Housing Choices Australia,

Please direct this to the relevant staff members responsible for the development of the community terrace at 456 Queen Street, Melbourne, as well as other developments nationwide.

I wanted to recommend an innovative approach to seating that relates to a City of Melbourne event I attended yesterday at Susuro Urban Winery. The showcase highlighted cutting-edge technology that transforms food waste into fertile growth by integrating street furniture with public worm-farming and composting systems.

I believe this technology would be suitable for the undeveloped Community Terrace located on level 5 at 456 Queen Street, Melbourne VIC 3000.

In my comment on the "Worms At Work" City of Melbourne YouTube video, per below, I emphasised the importance of deploying this modular design, which not only creates traditional seating but also allows for artistic structures that enhance urban aesthetics. This initiative addresses pressing environmental challenges and has the potential to greatly contribute to healthier, more sustainable public spaces. My full editorial is below.

This innovative approach can be implemented across all Housing Choices Australia properties nationwide, positioning the organisation as a leading proponent in its field.

For further information, please contact the City of Melbourne and the leading team directly:

City of Melbourne "Worms At Work Initiative"
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Zoe Wang "Upsoil Collective"
zoe@upsoilcollective.com

City of Melbourne - Worms At Work
<https://participate.melbourne.vic.gov.au/emerging-tech-testbed/worms-at-work-pilot>

Please acknowledge receipt.

Chrisentiae Saint-Piaf

PS

My comment on the video:

Worms at Work Pilot | City of Melbourne
https://www.youtube.com/watch?v=XFjqArX0_LI

Yesterday's event at Susuro Urban Winery was a significant step forward in exploring innovative sustainability solutions. Located at 134/15 Hall St, Port Melbourne, the showcase highlighted cutting-edge technology designed to promote ecological stewardship through innovative practices.

This groundbreaking approach effectively transforms food waste into fertile growth by integrating street furniture with public worm-farming and composting systems. The versatility of its modular design allows for various structural forms, not only traditional seating benches but also creative sculptures that enhance urban aesthetics.

Deploying this technology now is crucial, as it addresses urgent environmental challenges while simultaneously transforming public spaces into more sustainable and visually appealing environments. As these installations proliferate in community settings, they have the potential to significantly enhance local ecosystems, foster biodiversity, and contribute to a healthier, more resilient environment.

Email sent by community member Chrisentiae Saint-Piaf attended the launch event

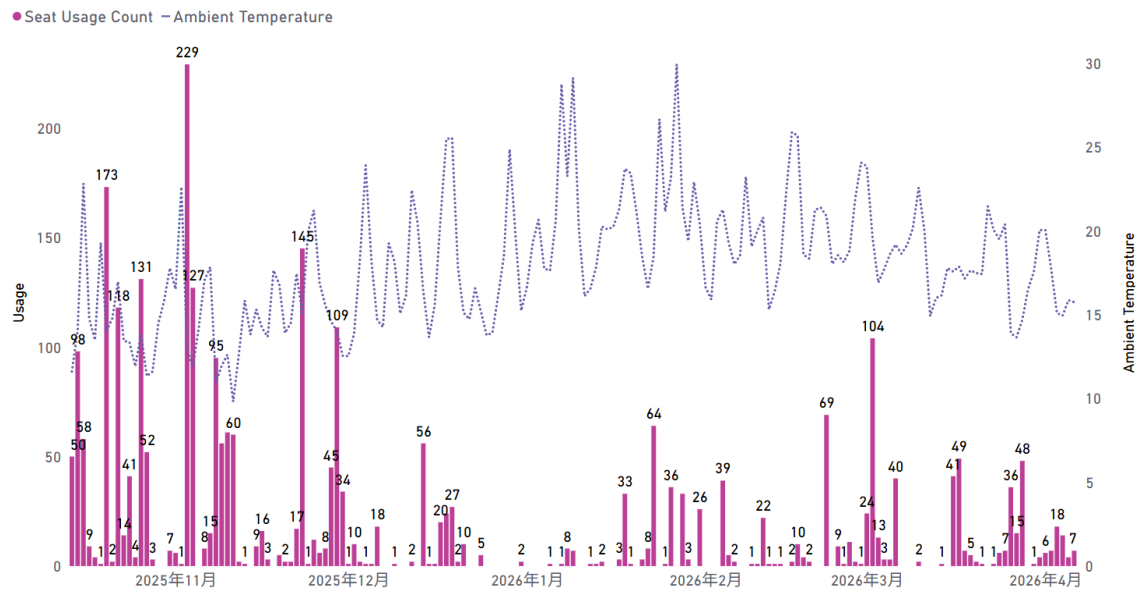
What was evaluated

Result

Food waste diverted from landfill	<p>A total of 35 kg of food waste was diverted from landfill at Susuro during the pilot period, achieving zero vegetable waste at the site. Because the business operated off-site for much of the period and feeding occurred only around once 1-2 weeks, actual diversion was lower than the system's potential.</p> <p>Based on the current design and operating model, potential capacity is approximately 108-300 kg per year depending on environmental and feeding factors. Actuals to be assessed further.</p>
Compost and planting outcomes created	<p>The pilot produced an estimated 15 kg of compost and supported 12 types of edible planting in the garden beds. Compost juice was returned directly to the garden bed rather than distributed more broadly.</p>
Community or business usage	<p>The bench was used by the host and visitors during the pilot, although recorded usage was affected by the host business operating off-site and moving out of the area from mid Jan to March. The seat sensor recorded 2,875 triggers from 14th October 2025 to 6th April 2026, but this includes some false counts from environmental vibration and should therefore be treated with caution.</p>
Sentiment captured from community and business who participate	<p>Sentiment was positive. The host actively gathered food scraps for the worms during events and own cooking, and the pilot generated interest beyond the site, including requests to explore future worm-bench greening opportunities in Community 3008 (newly established Dockland community association).</p>
Changed community behaviours and attitudes	<p>Community attitudes appeared to shift positively when people learned how many champions were involved and also when they were involved in installation and design decision-making. Community workshops are proven effective in gathering thoughts, spreading information, and connecting with champions.</p>
Making the space more social, active and safe	<p>Place activation appeared strongest at Yarra's Edge and St Ali, where there was either closer proximity to the community or a more active on-site business presence.</p> <p>At Susuro, the bench mainly functioned as a meeting point and waiting spot for an internal or existing social circle, reflecting the site's more limited location and business pattern. Observed</p>

	<p>social interaction was approximately 40% higher during maintenance periods than during non-maintenance periods. See Image. Socialising while maintenance.</p>
Interest for future rollout is generated	<p>Interest in future rollout was generated through several channels.</p> <p>After the launch event, a community member, Chrisentiae, contacted Housing Choices Australia to suggest the Susuro bench as a possible model for an apartment courtyard. See Image. An Email from A Community Member.</p> <p>Community 3008 requested exploration of worm-bench greening opportunities in Docklands.</p> <p>The Yarra's Edge bench was well received by the local community, with interest expressed in further installations.</p> <p>Staff from the property management company MCIM, who joined the walking tour, also expressed interest in potential applications in apartment courtyards and in streetside settings for hostile vehicle management purposes.</p>
Cost of manufacture, installation and maintenance is reasonable compared with a typical bench or garden bed	<p>The pilot build cost was approximately \$4,800, including fabrication, installation, the worm farm, soil, plants and basic maintenance tools. Maintenance and bi-weekly check-ins over a six-month period cost \$825, covering ongoing support and data gathering during the pilot. This cost could also be reduced in future as users take on the day-to-day care, leaving only occasional on-site or remote support as needed. See cost breakdown in the Appendix.</p> <p>By comparison, a typical council bench costs around \$4,000-4,500, and a typical garden bed around \$3,000-3,500, excluding maintenance, soil and planting. On this basis, the worm bench appears promising as a multifunctional system, particularly as it combines seating, planting, composting and learning in one piece of infrastructure.</p>

Figure. Seat Usage Count



Graph on Worms at Work Participate Melbourne Page

7.5. Criteria 4. Suitable for Real Sites

Overall assessment: Promising / Demonstrated

Evaluation summary: The strongest design qualities demonstrated in the pilot were modularity, repairability and public-facing usability. The main design limitation was environmental control under extreme heat and more constrained site conditions, where limited airflow made heat release more difficult. This suggests that the concept is adaptable, and future rollout needs stronger site-responsive thermal design.



Photo taken by the City of Melbourne

What was evaluated**Result**

<p>Suitable for real site conditions</p>	<p>The modular system was designed around the most spatially constrained site at Susuro, making it suitable for many tight street-side and public-realm locations. It performed well in heavy rain and proved weatherproof. However, the site also revealed an important limitation: blocked rear ventilation by the glass wall, reduced side airflow and narrow internal air gaps due to 600mm narrow space, made heat escape more difficult, particularly on days above 39°C. External measures such as shade and ice bottles were needed during extreme heat.</p> <p>The insulation provides excellent protection from ambient temperature swings, but the same insulation that shields the composting tiers from outdoor heat also constrains how quickly internally generated heat and CO₂ can exit. Comparison testing of the table and bench with and without insulation also suggested that removing side insulation is more suitable where sufficient internal air gap is not achievable due to site constraints. See Figure. Current Insulation vs Reduced Insulation.</p>
<p>Suitable for installation in other locations</p>	<p>The modular design was intentionally developed to adapt to different space limits, shapes, furniture configurations and composting-capacity needs. The worm farm module and garden bed can be removed separately, and the furniture can be dismantled into parts, allowing easier relocation without moving the full system together with worm farm, soil and plants. This adaptability is one of the concept's main strengths.</p> <p>Site performance is context-dependent based on simulation across three sites. Yarra's Edge benefited from sea-breeze cooling and shade, St Ali had full solar exposure but more open airflow, while the Upsoil table at Susuro sat on concrete against a glass wall in full sun. The simulation results suggested that the Upsoil system at St Ali and Yarra's Edge shows significantly lower heat stress under more open airflow conditions (stress days reduce 28.7% more at Yarra's Edge) See Figure. Upsoil system temperature simulation across three site environmental conditions.</p>

Robust enough for ongoing public use	During the testing period, the unit appeared robust enough for normal seating and leaning use. It is made from 3 mm aluminium panels, a material commonly used in public furniture, and no issues were observed during the pilot. While formal engineering and load testing were not undertaken, the structure appears suitable for the current use case. The timber top was selected for MVP speed and a 12-month pilot life, and can be replaced with more durable materials in future versions.
Repairable and maintainable	The modular system was designed so that individual panels and components can be replaced separately if damaged or worn. This includes the tray system and planters. This makes the unit easier to repair and maintain over time without requiring replacement of the whole system.
Easy to install	The unit uses a modular aluminium panel system fixed together with mechanical fasteners rather than welding. Assembly and repair rely on standard workshop tools rather than specialist welded reconstruction, making the system easier to maintain, modify and repair over time.



Figure. Current Insulation vs Reduced Insulation



Figure. Upsoil system temperature simulation across three site environmental conditions

7.6. Criteria 5. Useful Technology That Supports Operation

Overall assessment: Strongly Demonstrated

Evaluation summary: 174 days of continuous sensor data confirmed technology was useful in reducing uncertainty, supporting maintenance and helping users and designers understand system performance. Temperature and odour sensors gave the clearest data, while moisture, pH and EC added useful context. Dashboard review was useful, especially during heatwaves, although simple text/voice updates proved more practical and saved time for users than QR reporting for day-to-day use.

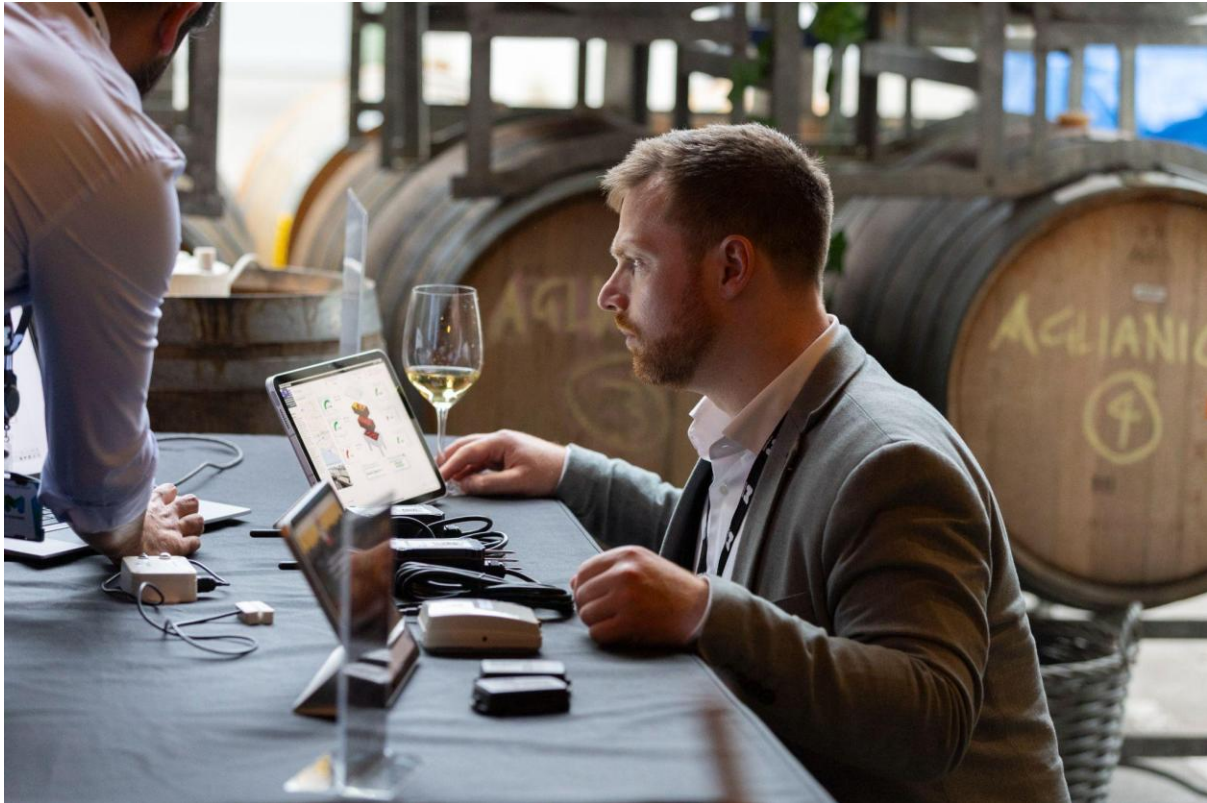


Photo taken by the City of Melbourne

What was evaluated	Result
<p>Sensor data indicates compost state, maintenance needs, issues, health or efficiency</p>	<p>Temperature, CO2 and odour data clearly indicated feeding activity, feeding volume, compost condition and maintenance needs. See Figure. Temperature and CO2 patterns correlate with feeding activity and feeding volume.</p> <p>Moisture readings generally suggested the system stayed in a healthy range, although sensor repositioning and probe cleaning affected accuracy. See Figure. Moisture, pH, humidity and rainfall.</p> <p>pH data supported troubleshooting effectively. However, pH readings were limited to the specific pocket where the sensor was placed.</p> <p>Ambient temperatures were useful data for understanding unit airflow and ventilation.</p> <p>Lid-opening retains high value if noise from wind or other environmental triggers can be filtered out more reliably. See</p>

	<p>Figure. More frequent lid openings and fan purge reduce CO2 buildup.</p>
<p>Dashboard / QR reporting is useful</p>	<p>The dashboard was checked regularly, especially during summer heatwaves, and was useful for identifying patterns and deciding when intervention was needed. QR reporting captured feeding time, feeding weight and maintenance observations, improving understanding of feeding patterns and food-waste diversion. In practice, however, simple text updates through communication platforms were easier and more natural for users than filling in a form.</p> <p>A less expected benefit was the dashboard's value as an education tool. It helped show users what good and problematic feeding looked like in a more immediate way than verbal explanation alone. For example, odour data helped explain the importance of adding enough carbon, while moisture data made it easier to explain why an ice bottle was more suitable than ice cubes, which melt too quickly and can make the system too wet.</p>
<p>Local weather, UV and external-condition data available for comparison</p>	<p>Local weather and environmental data were useful in showing that compost temperature closely tracked external Melbourne temperature. At the same time, the site recorded higher temperatures than general Melbourne weather data due to urban heat island effect and restricted airflow. Additional temperature sensors also showed clear variation within the unit: under direct sun on days above 40°C, the top ambient zone could be up to 15°C hotter than the compost, while the bottom area remained around 2-6°C cooler than the upper trays. See Figure. Temperature history.</p> <p>By contrast, moisture and pH were influenced more strongly by feedstock, compost condition and unit design than by Melbourne weather for the Upsoil system.</p>
<p>Sensor integration is feasible and does not disturb composting activity</p>	<p>Sensor integration into the unit was feasible, however, the active composting zone shifts and is regularly disturbed, so sensor placement remains a technical challenge. At Susuro, probe holes and dedicated sensor spaces helped position sensors closest to</p>

	the active zone, but this still relied on users returning them to the correct position after tray changes.
Sensor technology worked and enabled the design to be successful	The technology helped explain what was happening in the compost, when check-ins were needed, and what a good or problematic feeding pattern looked like.

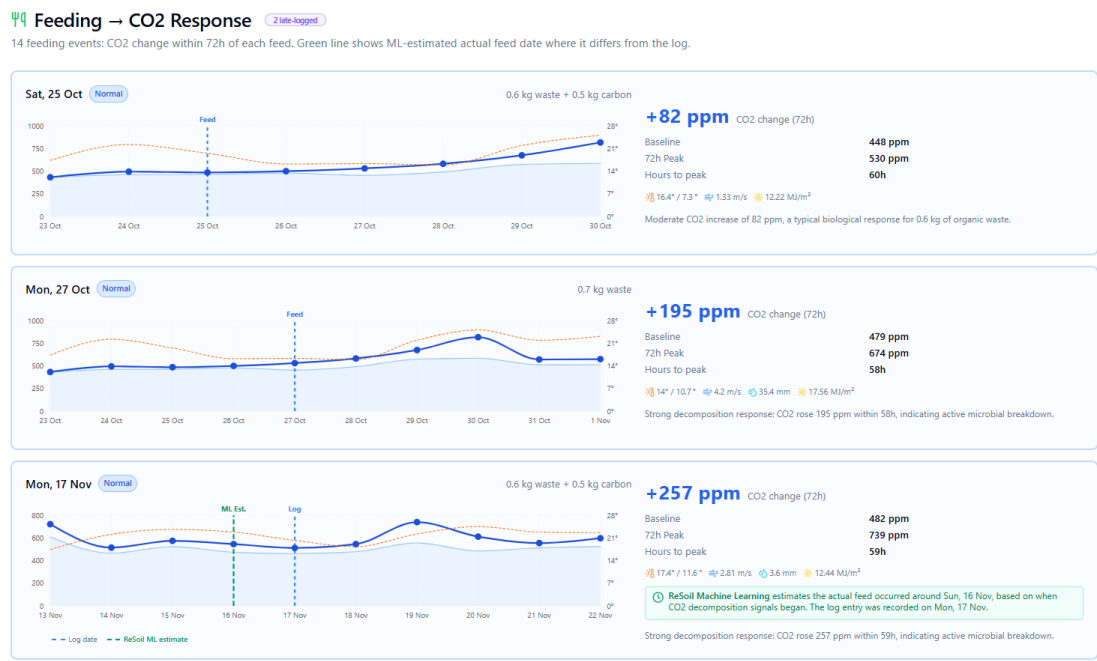


Figure. Temperature and CO₂ patterns correlate with feeding activity and feeding volume. Resoil Network

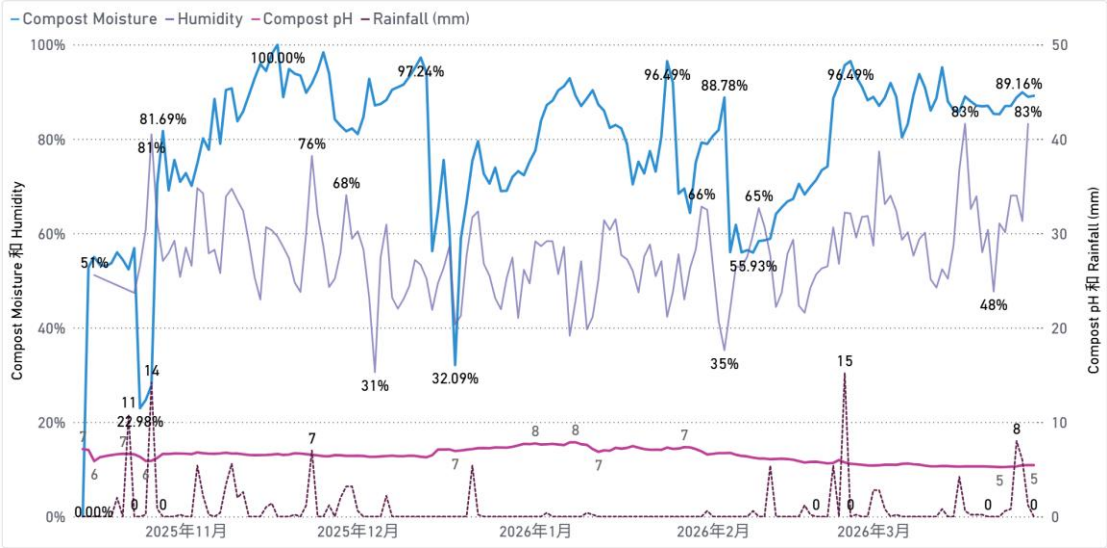


Figure. Moisture, pH, humidity and Rainfall. Source: City of Melbourne Participate Page

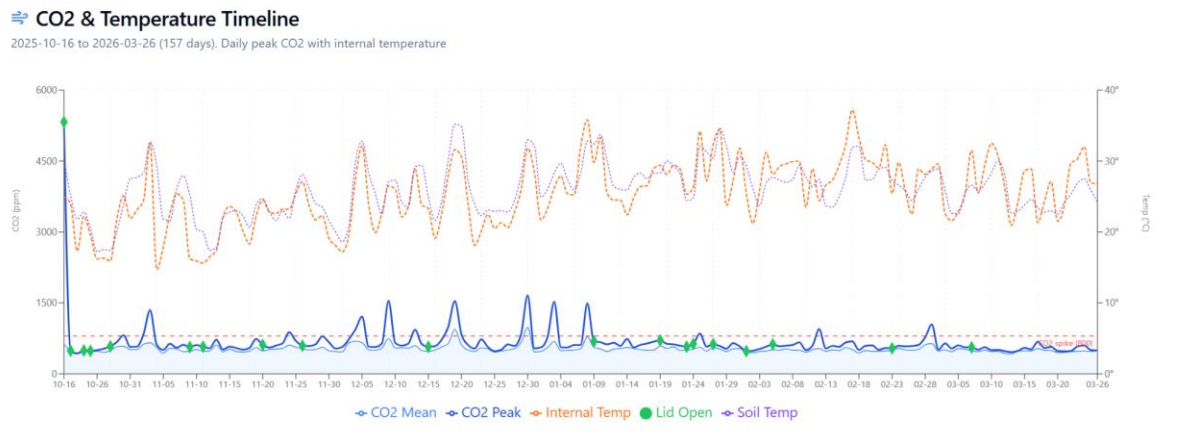


Figure. More frequent lid openings and fan purge reduce CO2 buildup

Source: Resoil Network

8. Five Key lessons

8.1. Public Acceptance Depends on Odour, Pests Control and a Furniture-Like Identity

The pilot reinforced that public trust is the first condition for this type of system. Smell and pests were often the first concerns raised, and they shaped whether people were willing to support the idea at all. The double-enclosed tray-based design appears to have been important in achieving this outcome. Just as importantly, the furniture-like form, colour choices and integrated planting helped the unit feel connected to the site and were repeatedly mentioned by businesses and the community. This suggests that cleanliness, containment and visual identity should remain core design requirements in future versions.

8.2. Site Selection Should Be Based on Place-Use Fit and Microclimate

Place-Use Fit: the strongest future fit is in places that value a combination of modest waste reduction, visible greening, seating and place activation, rather than simply high-volume organics processing. Promising settings include community shared spaces, apartment courtyards, local councils delivering public seating and waste-reduction initiatives, sustainability-minded cafés, hospitality venues and offices, and community organisations seeking more greening or shared gardening opportunities. Also, access to water is essential if garden beds are included.

Microclimate: simulation of the same system at Susuro, St Ali and Yarra's Edge suggest lower heat stress in more open-air conditions. Data analysis indicates that sufficient space around the unit and inside the unit for airflow, surrounding surface materials, and the presence of cooling influences such as nearby green space and water all affect heat build-up and release. Future rollout should therefore prioritise sites with better airflow and a site-responsive design.

8.3. The Operating Model Matters

Because this is a living composting system, the bench depends on a clear and realistic operating model, not design alone. This includes how responsibilities are shared between the host, support network and program lead. The pilot suggests that the following are valuable ingredients of a successful operating model:

- A primary host is needed to keep the system running. This would typically be a nearby business, organisation or community volunteer responsible for regular feeding, basic monitoring, and maintaining cleanliness and presentation. A steady source of food scraps is valuable, as more consistent feeding helps aerate the system and maintain worm health.
- A secondary supporter would significantly improve resilience. This could be a nearby neighbour, second champion or support organisation able to provide backup during absence for more than 2 weeks or extreme weather.
- The system also benefits from an oversight role, whether held by council, program lead, or a delivery partner. This role would be responsible for onboarding, training, maintenance guidance, performance monitoring and issue escalation.
- A technology support that looks after sensor upkeep, connectivity, dashboard function and periodic system checks.
- Simple how-to and trouble-shooting guides and a clear pathway for support when needed.
- A take-back or transfer pathway may also help with onboarding new hosts, especially during an early adoption phase, by giving them more confidence that there is an exit option if site conditions or operations change.
- Early involvement of the primary host in design brainstorming workshop, site selection, installation and visual appearance, community- or business-led care, and consistent motivation to keep the unit on site, whether for social, environmental or economic reasons.

8.4. Technology Supports Action and Design Learning

The pilot showed that technology is most useful when it reduces maintenance uncertainty, reveals patterns in feeding and biological behaviour, and prompts timely action. The pilot suggests that compost temperature, odour and moisture sensors were the most essential for flagging operational issues, while ambient temperature, CO₂ and lid-opening sensors were more useful for understanding design performance, feeding behaviour and waste volume. Future sensor selection should therefore depend on the purpose of the system and how it is intended to be used in rollout.

The dashboard was most valuable when it helped users understand what was happening in the compost, what maintenance was needed, and what the right response was.

The pilot also suggests that reporting linked to feeding and observation remains important for interpreting patterns between feeding events, compost response and design testing. It worked best when it was simple and easy to use, and a text- or voice-based input method appears more practical than requiring users to fill in formal forms.

8.5. Height Variation Improves Accessibility and Maintenance Use

Testing in real conditions showed that the table-height unit was more comfortable for standing tasks such as feeding, checking and everyday observation, particularly for people with back problems, although bending was still required for harvesting or swapping trays. The bench-height unit was suitable for users who were comfortable bending and may also be more approachable for children and some wheelchair users who prefer a lower profile.

9. Future Pathways

The next phase should focus on refinement, targeted testing and pathway building.

9.1. What should be improved first

Priority design improvements for the next iteration are:

- Develop site-responsive design with improved summer thermal performance
The next version should prioritise stronger passive airflow, faster heat release to increase composting capacity in constrained urban sites. Insulation should be refined together with ventilation and enclosure geometry.
- Simplify the technology package
Future versions should use only the data streams most useful for maintenance and design decisions based on the learnings from this pilot.
- Adjust appearance, materials and detailing to suit different host settings
Council applications may call for raw material and increased perforation for easier maintenance and anti-graffiti purpose, while business and certain community settings may benefit from coloured and a more welcoming identity.

9.2. Where and what should be tested next

Further testing is needed across a wider range of conditions to understand where the system performs best and how it should be adapted in the settings above. Priority testing areas are:

- Different microclimates with updated design
Test sites with different airflow, solar exposure, surrounding materials, green space and water proximity.
- Different host types
Compare performance across council-supported local activation sites, small cafés and hospitality venues, apartment communal areas, shared workplace or campus.
- Different composting system typologies
Compare different compost system arrangements to understand trade-offs between airflow, clean harvesting, maintenance comfort and compost health.
- Different maintenance schedules
Test how the system performs under different feeding and checking rhythms.
- Different food-waste input ranges and volumes
Test how different quantities and feeding patterns affect stability, odour control and composting speed.
- Different technology packages
Compare simpler and more advanced monitoring setups to identify the minimum useful technology package for future rollout.

9.3. What pathway should be built next

One of the key targets for the next phase is to find the best suitable integration, collaboration pathway moving forward.

Key areas to explore include:

- Integration with existing greening and public-realm programs
This includes street garden programs, verge or vegetable garden initiatives, local activation projects, and city cooling or urban greening frameworks.
- Build relationships with future host types
Future testing should be developed with communities, businesses, councils, developers and organisations that can support real operating conditions.
- Develop shared maintenance partnerships
Future rollout should test how responsibilities are shared between host, delivery partner, council and technical support in a way that is practical and sustainable over time.

9.4. Research opportunities

The pilot also opened longer-term research opportunities that would strengthen future decision-making. Priority research areas include:

- Long-Term Delivery and Economic Models
- Urban heat stress and compost-enabled cooling mitigation
- Feeding and Maintenance Models for Different Host Types, Settings and compost systems
- Public trust and perception of living infrastructure in dense urban environments
- Community Stewardship Models for Shared Living Infrastructure
- Cross-disciplinary collaboration between design, composting, technology and public-realm practice
- Decentralised Composting Compared with Centralised Organics Systems in Different Urban Settings
- Compost quality and soil-health outcomes
- Biodiversity Benefits of Compost-Supported Planting

Appendix

Potential appendix content to be included:

Appendix 1. Activities Delivery Checklist

Phase	Key activity	Delivered Status
Phase 1: Discover / Identification /	Project kick off and initial planning; Stakeholder workshops; Internal meetings; Scope of works and Collaboration Agreement drafting and review	Delivered
Phase 2: Initiation / Planning / Design	Risk workshop	Delivered
	Stakeholder Mapping – Potential groups identified: 1. businesses near immediate site 2. residents 3. people free weekends only	Delivered
	Technology and Worm Farm Research and expert consultations for – Baseline waste data; Technology design for worm farm; What good/can be better/poor compost data look like; Efficient worm farm design on public land	Delivered
	Site Scoping – Documenting site options with clear site criteria; Site data (i.e. sensors); Liaising with City Design, City Strategy and City Infra to get input on proposed site/s	Delivered

	Community and Business Engagement – Worm farm, technology and dashboard co-design workshop with community and business respectively; Workshop at 18 pence lane café for community to bring their food waste and discuss current food waste situation, data, worm farm composting barriers and concerns	Delivered
	Community maintainer recruitment	Delivered
	Self-Sustaining Model Planning – Preliminary financial model for self-sustaining model, including logistics, maintenance associated costs, and revenue streams	Delivered in the final report
	Testing sensor signalling – Purchase 1–2 sensors; Utilize the existing Coolseat model to evaluate potential issues with distance to gateway and data transmission within the metal garden bed structure	Delivered. Considered signalling requirements during design phase. Testing delivered by Dev Patel
	Technology requirements and Design	Delivered. Requirements delivered by Zoe W., technology development and deployment delivered by Dev Patel
	Sensor/Tech options – Market research; LoraWAN Sensor, display and power solution design, searching and selection (screen and power TBD); Screen: Dot-matrix or other; Power: voltage converter, solar, battery	Delivered. Explored options for sensors and screen by Zoe W. early on and handed over to Dev Patel with technology requirements.

	Dashboard & Monitoring System Design and Build – Preliminary concept; Testing with community	Delivered. Workshops with Dev for the Dashboard design. Supported moisture sensor calibration and provided feedback
	Sensor/ tech procurement – Testing sensors in the office to ensure functionality; Testing display, power, and sensors function together as one, and all sensors are sending data	Delivered by Dev
	Worm Farm Design and Council Design Approvals – Workshops to understand stakeholder requirements, compost efficiency and technology integration requirements; workshops to review worm farm design concept; construction drawing and review	Delivered
	User Feedback Workshop – Testing system as a whole with stakeholder group; Ideal to have two community engagement/feedback checkpoints throughout this process, in the middle and very end	Delivered during launch event and operational phase by interpersonal meetings with Susuro
	Detailed Project Plan – Updates based on user feedback, design outcomes	Delivered. Modified project budget.
Phase 3: Doing / Deliver	Signage / artwork design	Managed by SCI team
	Signage / artwork printing and production	Managed by SCI team
	Obtain permits and approvals to install	Delivered by Susuro with body corporate

	Signage / artwork installation	Managed by SCI team
	Seat manufacturing – 2–3 smart worm farm manufacturing	Delivered
	Seat delivery and installation – Installation will take 1 day for each compost bench	Delivered
	QR channel set up	Delivered for the bench at Susuro, managed by Zoe W.
	Maintainer notification set up	Delivered. Notifications sent manually through communication platform by Zoe to Nikki
	Dashboard development and testing	Delivered by Dev
	Sensor installation	Delivered. Coordinated and Supported Dev and polynova for sensor installation
	Sensor configuration and calibration – End-to-end testing; Data storage and connectivity; Data collection	Delivered by Dev. Supported moisture sensor calibration
	Community maintainer workshops – For maintaining compost; For simple sensor maintenance	Conducted training with Nikki for the bench at Susuro and delivered How to Use Guide. Clean up sensors bio-monthly by Zoe W. when visiting the bench

	Pilot launch event	Delivered
	Councils and Industry Event and story telling	Delivered through FB Ideas showcase, within Hassell Studio and post installation walking tour
	User Feedback Workshop/Survey – Collecting feedback on the system as a whole via workshop or survey	Delivered by SCI
	Maintenance of: Sensors; Connectivity; power supply; dashboard; hardware; environmental protection integration with compost system	Delivered by Dev
Phase 4: Document and Done / Closure	Detailed Report on performance, viability, community participation	Delivered in final report
	Document Findings and overall pilot evaluation	Delivered in final report
	Stakeholder feedback workshop	Delivered through post installation walking tour and managed by SCI team
	Final Reporting	Delivering
	contract closure completed	Delivering

Additional Delivery	Development of public-friendly How to Use and troubleshooting Guide (partially funded by the pilot)	Delivered
	Installation of a fan system to test airflow during midnight (not funded by the pilot)	Delivered
	Re-planting post continuous heatwaves (not funded by the pilot)	Delivered
	Lock fobs programming and duplication (not funded by the pilot)	Delivered

Appendix 2. Initial Technology Design & Involvement Checklist

Item #	Activities	SCI team Involvement (Yes + involvement details, No)
<i>New (added by SCI)</i>	<i>Requirements and Design</i>	<i>SCI to participate in requirements definition and design process, to help define data needed to be captured and the technical and installation requirements for the sensors in the bench.</i>
1	Compost sensors research and consultation	<p>Yes.</p> <ul style="list-style-type: none"> · Expectation is to do this in collaboration with Zoe and Michael. · SCI to concurrently undertake market research to provide advice on sensors most fit-for-purpose · SCI can link to existing technology/vendors used for prior projects. · SCI should ultimately approve the chosen sensors (as SCI will own the asset at completion of pilot).
2	<p>LoraWan Sensor, display and power solution searching and selection</p> <p>Screen: Dot-matrix or else</p> <p>Power: volage converter, solar, battery</p>	<p>As per above.</p> <ul style="list-style-type: none"> · Screen display TBD – pending costs, potential consumption etc · Initial advice provided indicated questionable project viability for a screen display during the pilot.

3	Community & business engagement (requirements for sensors and dashboard)	<p>Yes – SCI would love to be involved in this.</p> <ul style="list-style-type: none"> · Include SCI in design of workshops, insights from dashboard, attending the workshops.
4	Power solution including location planning (not required if only using battery)	<p>Yes – SCI can provide advice on different opportunities based on sensor requirements.</p> <ul style="list-style-type: none"> · Potentially can assist with power requirements but depends on technical need. · If internal approval required from Council for power/location SCI can assist. Zoe and Michael may need to liaise with external power providers, if required (e.g. private business, utility company). · Current advice is not to use continuous power in the tech solution.
5	Create Power Bi dashboard(s) for community and maintenance members	<p>Yes – SCI will collaborate with Zoe and Michael, and community, to develop this.</p> <p>SCI has the internal skillset required to achieve this.</p>
6	Testing sensors in the office to ensure functionality	Yes – SCI can assist with this task.
7	Testing sensor signal in existing Coolseat at 18 pence Lane (due to the usage of metal material)	Yes – SCI can assist with this task.
8	Testing display, power, and sensors function together as one, and all sensors are sending data (location TBC)	Yes – SCI can assist with this task.
9	Data storage and connectivity	Yes – SCI can assist with this task.

10	Custom IoT device connection and computing for weight and its activation sensors (and potentially display screen and Monty sensor)	As per item 1, SCI will assist with market research to identify available sensors, to avoid the need for custom sensors and associated R&D costs.
11	Integrate sensor/systems into each smart worm bench	<p>TBD – depends on sensor installation requirements.</p> <ul style="list-style-type: none"> · SCI will assist where they can but may require sensor vendor or another service provider to install. · Vendor might be able to recommend positioning for the sensors. · Design process should inform where sensors need to be placed.
12	Risk assessment	SCI happy to be involved in a risk assessment workshop with Zoe and Michael.
	Technical Specification Document	<p>SCI to lead this activity, as SCI will be the technical lead on the project.</p> <ul style="list-style-type: none"> · Each sensor may come with its own technical specification. · We may need to consider an overall tech spec for the bench and how its various sensors are integrated as well.
	Workshop with community for maintenance of sensors health, power etc. and handover of simple maintenance tasks	<p>Zoe and Michael to lead this.</p> <p>SCI to be a participant of this workshop.</p>

	Collect environmental data from microclimate stations, and compost data from datahub for analysis	<p>SCI to lead this activity – could be achieved via the dashboard developed.</p> <ul style="list-style-type: none"> · May require support from SMEs re definition and interpretation of the specific data. · Any quantitative data analysis will sit with SCI.
	Data analysis for food waste recycling impact, community participation, and validating sensor data against on-site survey reports to enhance compost health and maintenance	<p>SCI to be involved in collaboration with Zoe and Michael.</p> <ul style="list-style-type: none"> · Need to understand the broader data analysis requirements beyond sensor data (e.g. community survey data, engagement data, other qualitative data) as this may not be solely dependent on SCI.
	Channel for collecting maintainer reports and business registering types of food they put in (only during the first month)	More clarity required from Zoe on what this is.
	Channel for guiding maintainers through notifications, emails or messages (ensure important intervention within the day)	Requirements to be defined, but SCI may be able to assist with creating a daily report for the sensor data.
	Maintenance of sensors, connectivity, power supply, dashboard, hardware, environmental protection, integration with compost system	<p>SCI can assist with maintenance of tech components during the duration of the pilot.</p> <p>Depending on chosen sensor solution, this may also be provided by the vendor.</p> <ul style="list-style-type: none"> · This is dependent on the maintenance process being defined and operating models chosen. · It is not expected that SCI would be responsible or involved in maintenance of the seating structure itself.

Table drafted by Zoe Wang and responded by Smart City Incubator, City of Melbourne

Appendix 3. Ethnographic research carried out by the Monash University FUTURES Hub

This summary describes the insights from ethnographic research carried out by the Monash University FUTURES Hub alongside the Worms at Work Pilot between August 2025 and March 2026. This comprised ethnographic interviews with 11 participants (3 male, 8 female) including 5 members of the Worms at Work project team, 2 community champions, and 4 people involved in food and waste oriented green infrastructure initiatives in the City of Melbourne. This was complemented with intensive ethnographic fieldwork with the Worms at Work project team, including the two project leads Zoe Wang and Michael Mobbs.

Worms at Work is concerned with how to embed a complex ecological process - worms and worm farming - in an urban and industrial environment such that they were not only of benefit to the environment, but that people might take an active interest in and participate in those systems. By building three prototype worm benches in Fisherman's Bend - where the environment is currently hostile to worm farming - the project offers three key insights into how to create socially and ecologically sustainable green infrastructure in Australian cities:

1. Paying attention to location - participants drew on their extensive experience with community-based composting and gardening to anticipate the sensory and material impacts that composting might have in each of the three locations where benches were installed. This allowed the initial designs to account for factors including: smell, mess, and pathogenic risk; the needs of the worms; and the methods required for composting to thrive in an environment where both weather and paved surfaces made conventional composting difficult.
2. Prioritising the sensory expectations of potential users - participants adjusted the bench design to safeguard potential users from adverse sensory experiences and to accommodate fine tuning after installation. Prioritising users' sensory expectations in this way made the benches easier and more comfortable to use.
3. Using sensor data to understand ongoing needs - sensor data enabled the team to remotely monitor sensory dimensions including smell, temperature, and soil moisture which allowed them to imagine how the worms felt. In combination with frequent in-person visits to the benches, sensor data allowed the team to intervene when required to ensure the compost and the worms remained healthy.

Appendix 4. Other Events

Launch Event

The launch event was held on 16th Oct 2025; it is a major milestone and one of the strongest moments of public enthusiasm during the pilot. Community members were able to see the unit up close, touch the worms, feed the worms and try the furniture in person. This hands-on experience helped make the system feel less abstract and more approachable. Positive responses on the night suggested strong interest in the Council-community collaboration model behind the actual furniture.

Walking Tour

The walking tour was held in Feb 2026. It is useful for sharing updates and learnings during operation, showing the unit in context, and discussing its broader potential. They helped council and community see both the strengths and limitations of the pilot over a short operating period and opened up conversation about where this type of system might work next.

