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Remix Raingardens – repurposing local waste for bio-infiltration garden construction

Remix Raingardens - la réadaptation des déchets locaux pour la construction de jardins par bio-infiltration

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RÉSUMÉ

Remix Raingardens est un projet de création de connaissances qui consiste à remplacer les matériaux conventionnels des jardins pluviaux fraîchement extraits par des options durables provenant de la construction locale et des déchets organiques. Grâce à plusieurs cycles de prototypage, de tests et d'analyse de données, ce projet vise à évaluer la faisabilité technique de cette innovation de l'économie circulaire. Plus précisément, l'équipe d'étudiants en ingénierie environnementale évalue si les mêmes critères de filtration, d'infiltration et de croissance des plantes pour un jardin pluvial conventionnel peuvent être atteints dans un système de biorétention à 100 % de matériaux recyclés. Les déchets alimentaires, le verre, le biochar, les balayures de rue, les granulats de béton sont tous des flux de déchets incorporés dans la conception. Les résultats préliminaires sur la qualité de l'eau des études de jardin à petite échelle sont prometteurs, avec des parcelles expérimentales à plus grande échelle qui seront installées dans le Fishermans Bend, sujet aux inondations, à Melbourne au début de 2023. Cela servira d'essai pour une mise en œuvre ultérieure dans tout le quartier, tout en augmentant l'engagement de la communauté dans les principes de gestion des eaux pluviales. La vision à long terme est de repenser les spécifications des jardins pluviaux pour qu'elles soient plus locales, durables et circulaires, tout en augmentant simultanément la prévalence et la compréhension du public des pratiques de gestion des eaux pluviales urbaines.

ABSTRACT

Remix Raingardens is a knowledge creation project that involves replacing conventional, freshly quarried raingarden materials with sustainable options sourced from local construction and organic waste. Through several rounds of prototyping, testing and data analysis, this project aims to assess the technical feasibility of this circular economy innovation. Specifically, the student environmental engineering team are evaluating whether the same filtration, infiltration and plant growth benchmarks for a conventional raingarden can be achieved in a 100% recycled material bioretention system. Food waste, glass, biochar, street-sweepings, concrete aggregate are all waste streams incorporated into the design. Preliminary water quality results from small scale garden studies are promising, with larger scale experimental plots to be installed in Melbourne's flood-prone Fishermans Bend in early 2023. This will be used as a trial for further implementation throughout the precinct, while also increasing community engagement in stormwater management principles. The long-term vision is to redesign raingarden specifications to be more local, sustainable and circular, while simultaneously increasing the prevalence and public understanding of urban stormwater management practices.

KEYWORDS

Bioinfiltration, Circular economy, community engagement, recycled materials, water sensitive urban design

1 PROJECT BACKGROUND

The Remix Raingarden project stemmed from a multi-disciplinary Engineering subject at the University of Melbourne in 2020 where a team of students were tasked with the challenge of creating a circular economy waste system for Australia's largest urban renewal project, Fishermans Bend. Since then, the concept of a recycled material raingarden has been further researched and prototyped by a team of three Environmental Engineering Master students. This student-led project is a hybrid between an academic research project, and a fast-paced prototyping program where the objectives are to design, build and test within a short timeframe. Hence the project 'approach' has been largely focused on 'BMP', building and then evaluating. The student team has been supported by academics from various faculties, including landscape architecture, ecosystems and forest sciences, and engineering.

The project is being partially funded by the University of Melbourne and Development Victoria (government body), who see the value in using materials that would otherwise go to landfill to assist in managing stormwater in urban environments. Since winning the Fishermans Bend Innovation Challenge in July 2022, the project has gained the support of the City of Melbourne, partnering to create the first pilot Remix Raingarden in Fishermans Bend in early 2023.

Profiling of this project would be a valuable contribution to the Novatech Conference due to its alignment with several conference themes (discussed below), including *Stormwater and technical solutions*, and *Stormwater and society*, with a large component of this project being a focus on community engagement and stormwater education.

2 METHODOLOGY

Remix Raingardens is a knowledge creation project seeking to validate the technical feasibility of creating a viable raingarden made with local, repurposed construction materials. In order to test this, the project has been divided into several key phases:

- 1) Literature review and interviews (commenced July 2022)
- 2) Proof of concept testing
- 3) Pilot build and sensor installation
- 4) Data analysis and conclusions (June 2023)

The key deliverable (by June 2023) is to use data obtained from various stages to develop design specifications for a recycled material raingarden that is viable anywhere at Fishermans Bend. The long-term vision includes not only the implementation of recycled material raingardens in Fishermans Bend, but also the ongoing generation of a body of knowledge around the use of recycled materials in bioretention systems. This will allow designers to build effective recycled material bioretention systems in cities around the world, accounting for differences in local climate and available recycled materials.

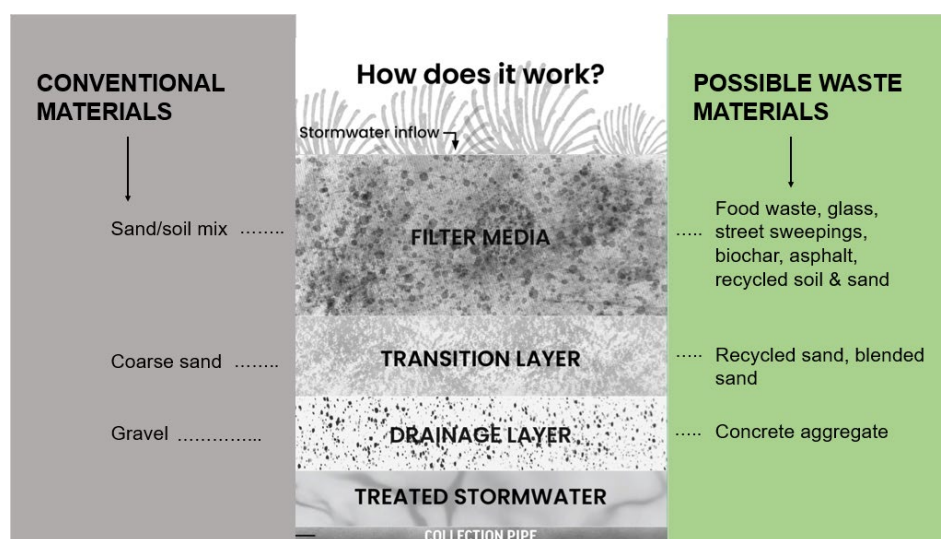


Figure 1 - Diagram showing conventional raingarden materials on left, and possible waste material alternatives under consideration (right).

3 'PROOF OF CONCEPT' TESTING

Phase 2 involves conducting tests to better understand the performance of recycled materials in raingardens, compared with conventional materials. Specifically, the performance of the filter media layer is tested using different recycled materials and a control. After consulting with experts and investigating the range of materials available, five mixtures were created that were all composed with a 3:1 ratio of sand-type material and soil-type material. The materials were sourced from either the University of Melbourne or a local material processing and recycling company, Repurpose It.

Appendix A below outlines the materials being tested in each filter media mixture.

The prototypes were created with 150mm diameter PVC pipes. The pipes were all constructed with three layers including the filter media, a transition layer and a drainage layer. In half of the prototypes, *Carex Appressa* was planted, so that the impact of plants on raingarden performance and the growth of plants in recycled materials could be investigated. This species was selected for its demonstrated ability to filter nitrogen and its status as an Australian native (Bratieres et al., 2008). The prototype vessels are arranged in a semi-random formation as seen in Figure 1.

The raingardens are being watered consistently with a simulated stormwater comprised of sediment sourced from a stormwater detention basin, rainwater and additional chemical solutions to mimic typical Melbourne stormwater concentration (Blecken et al., 2009).

The vessels are being monitored for at least eight months, having begun in September 2022.

The performance criteria being monitored are:

- Infiltration rate
- Filtration/ Water quality
- Plant growth/health

Currently, results indicate a reduction of Total Suspended Solids (TSS) across all filter media. Additionally, effective filtration of Total Phosphorus (TP) and Total Nitrogen (TN) has been observed for media with blended sand and in the control. In the next six months, data will be captured to assist with making more conclusive findings.



Figure 2 - Prototype 'proof of concept' testing site at the University of Melbourne (Parkville campus).

4 KEY LEARNINGS TO DATE

4.1 Water quality

- Preliminary results from the prototyping tests are varied yet promising.
- Figure 2 shows the removal of TSS, N and P in the varying filter media prototypes. Evidently, there is a substantial discrepancy in performance between the prototypes, where those with blended sand have reduced contaminants and those with glass have increased the phosphorus and nitrogen levels in outflow.
- It should be noted that greater data analysis will take place once further rounds of water quality testing are completed.

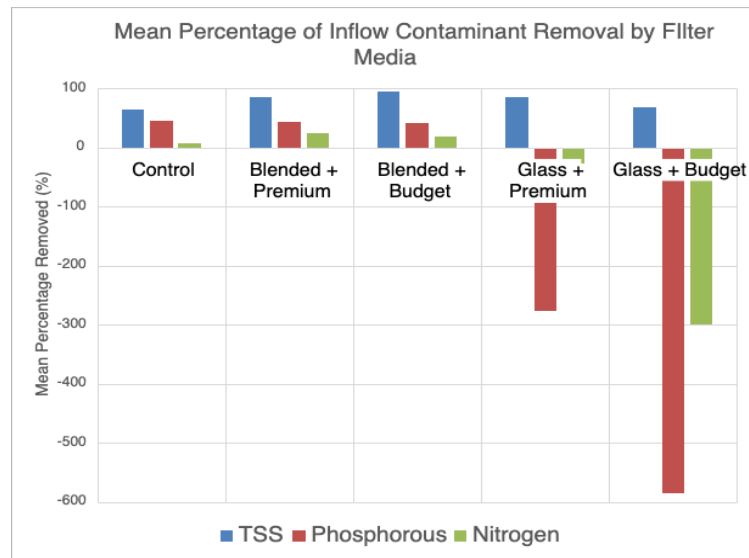


Figure 2 – Graph showing the mean percentage removed of TSS, phosphorus and nitrogen in outflow water captured from each prototype vessel. Those values above zero indicate percentage removed, compared with stormwater added. The lines below zero indicate a case where the contaminant has been added, not removed.

4.2 Plant growth

The plants are growing successfully in all raingardens. Despite the concerning colour of outflow water from raingarden vessels containing crushed glass, the *Carex Appressa* is growing remarkably well.

4.3 Community engagement

This project has garnered significant attention from community members, students and academics from various disciplines. The use of both a website and social media page has enabled stakeholders to follow along with the project’s journey in a transparent and accessible way (Participate Melbourne).

While early testing is promising and suggest positive results, more comprehensive data on the efficacy of larger scale systems will be available by June 2023.

5 NOVATECH THEMES

5.1 Theme 1: Stormwater and technical solutions

It is anticipated that the valuable, unique insights generated in this project can be used by cities, Melbourne and beyond, to mitigate the ever-growing risk of urban flooding and improve the quality of runoff entering urban waterways. Remix Raingardens, like regular raingardens, intends to reduce peak flows, filter stormwater, enhance biodiversity and augment public awareness of water sensitive urban designs.

However, it is hoped that Remix Raingardens can go beyond the traditional approach and become an innovative, educational, and practical way to manage stormwater in urban environments, while also offering simultaneous societal benefits. It will also support broader goals such as a circular economy, innovation and the concept of a ‘living laboratory’.

5.2 Theme 2: Stormwater and society

A key part of this project is using technology to deliver social value, including educational opportunities, public engagement, and innovation. Alongside prototyping recycled materials within the raingarden, the team has also worked on specifying sensors and software that can be used in the

raingarden to track its performance and translate that information for residents and scientists. The data obtained will drive improvements in the designs of the raingardens over time.

Additionally, sensors will provide data that can be used to create educational experiences for community members and students. Citizens will gain access to the insights generated from technology, in the form of a clear and accessible website. This will increase civic engagement and increase the value they derive from spending time in public open spaces served by raingardens. Moreover, it will increase their environmental sensitivity, and will make them more aware of possibilities for circular economy thinking.

6 CONCLUSIONS AND NEXT STEPS

The knowledge created from this project has significant, far-reaching implications as cities move towards a climate resilient future and look for new ways to manage stormwater and the growing problem of waste. Remix Raingardens provides a model of sustainability, circular economy, repurposing of waste, while also enhancing urban spaces and liveability. At present, the student team is working towards building nine large-scale, above ground, 100% recycled material raingardens at Fishermans Bend for further testing and analysis (Phase 3). By July 2023, we will have data and results on the performance of various recycled materials in bioretention systems. This information is novel and has far-reaching implications for cities all around the world.



Figure 3: The project team. From left to right – Professor Alexander Felson, Ema Hagihara, Andreas Baruhas & Amira Moshinsky.

LIST OF REFERENCES

- Blecken, G.T., Zinger, Y., Deletic, A., Fletcher, T.D., Viklander, M. (2009). Influence of intermittent wetting and drying conditions on heavy metal removal by stormwater biofilters. *Water Research*. 43 (18), doi: 10.1016/j.watres.2009.07.008
- Bratieres K., Fletcher T. D., Deletic A., Zinger Y. (2008). Nutrient and sediment removal by stormwater biofilters: a large-scale design optimisation study. *Water Research*. 42(14) doi: 10.1016/j.watres.2008.06.009.
- Participate Melbourne (webpage) <https://participate.melbourne.vic.gov.au/emerging-tech-testbed/remix-raingardens>

APPENDIX A – PROOF OF CONCEPT TESTING MATERIALS & COMBINATIONS

Three sand-type materials were used:

- Conventional, white-washed sand – sourced from excess stock at The University of Melbourne
- 'Blended sand' made with crushed brick, aggregate, and sand – sourced from Repurpose It
- 'Glass sand' using 100% crushed glass - sourced from excess stock at The University of Melbourne

Three soil-type materials were used:

- Conventional soil - sourced from excess stock at the University of Melbourne
- 'Premium' soil made with 30% food waste and street sweepings – sourced from Repurpose It
- 'Budget' soil made with 20% food waste and street sweepings – sourced from Repurpose It

	Filter media 1	Filter media 2	Filter media 3	Filter media 4	Filter media 5
Sand (75%)	Conventional sand	Blended sand	Glass sand	Glass sand	Blended sand
Soil (25%)	Conventional garden soil	Premium soil	Budget soil	Premium soil	Budget soil